TECHNOLOGY AND TOOLS INTEGRATION IN ARCHITECTURE EDUCATION: REFLECTION ON STRATEGIES AND TECHNIQUES

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ABSTRACT

This study aims to investigate the multifaceted considerations requisite for the seamless integration of digital technology into architectural cognition that can help formulate a robust framework for digital pedagogy. The research endeavors to scrutinize extant methodologies and techniques employed in Digital Design Studios globally, drawing comparisons with the prevalent practices in Pakistan. By analyzing design methodologies and tool integration in studios across three distinct countries, this study seeks to illuminate variances and commonalities, thereby contributing to a comprehensive understanding of the prevailing frameworks. The examination of case studies from diverse geographical contexts will catalyze interrogating and, subsequently, can help in refining existing pedagogical practices. Within the Pakistani context, a reliance on pedagogical approaches dating back several decades is discerned, underscoring a compelling imperative for the evolution of architectural education and its harmonization with contemporary digital media. This investigation, therefore, represents a pivotal step towards the understanding of a novel architectural pedagogy that intertwines with technological advancements.

KEYWORDS

Digital integration, Design pedagogy, Digital tools, Studio-Framework, Digital Transition, Computer-aided Architectural Design

INTRODUCTION

Recent technological developments have revealed that an architect's vision and practice are currently influenced by the use of digital tools utilized in this industry, which is changing architecture in the modern world (Soliman et al., 2019). Image architecture, digital simulation, and virtual scenes among other applications have gradually become progressive architectural design phases in practice nowadays and have become a requirement in the field. With the advent of this influence, some people are accepting or depreciating this change of process. Everyone acknowledges the

change in the process of designing brought by these tools and understands the flow of how and where these tools are helpful in the field of architecture.

A challenging problem that arises in this domain is what the future directions are of digital tools in this field. Different advancements in digital technology that were formerly thought to be difficult to undertake are now within reach, notwithstanding their complexity with time. These tools are changing the course but is this change overcoming the symbolic value of what architecture represents? The industry that has opened doors to using these tools in creative designing and executing has for some reason been not upfront in making this a part of the criteria for becoming an architect. Information or digital technologies are diligently being used in architectural design like all other science fields, but architectural schools don't seem to have much focus on the proper and orderly integration of computer applications in the curriculum, and with these rapid developments, our knowledge of how to teach digital technology as a necessary design aptitude has not kept up (Papamanolis & Liapi, n.d.). It is studied that most architectural teaching technologies comprise specific topics like structural design, environmental systems, etc. In this widespread domain, coming to one computer-aided technology framework is quite a difficult task as it mainly involves breaking away from the traditional approach and introducing the potential to replace an ongoing thing with a newer one to provide a futile track for the faculty. Many institutions are still juggling it. Computer-aided education provides a healthy environment to think and decide what the need for an hour is and how to work on it. This leads to designing the curriculum, through which the impression may be shifted towards understanding the medium as design decision-making, as the initial step in addressing the requirements of educational systems like the addition of computer-aided design content (Piatkowska, 2016).

Providing quality professional education, with the belief that the word quality is dynamic concerning place, is taken as an essential priority. This priority is limited because of the design process and education. The work experience of educators is limited to technologies with physical construction rather than intellectual design processes. The mission has not changed but the context. The debate arises of whether it is worth practicing or not. Unfortunately, both the institute and the candidate hesitate to take challenges to take on new issues, revise course contents, learn new skills, abandon hard-earned skills, speak a new language, and work in an alien environment. In some places, it will surely be very challenging as well as aggressive to introduce. Either the debate continues noisily, or quietly by creating forums. Neither is the solution. The real challenge is to find ways to deal with changing design factors. The student may be willing to learn this approach, but it is hard for the instructor as it is not his major or area of interest. Also, some strict teachers may feel disturbed by changing their ways of teaching over the years which won't be easy either. The

situation may go opposite with the student not taking interest in this challenging method which may be proven more conventional for design. The result of the debate points to positive evidence of providing quality and appropriate education as with future changes of need and the advancement of technologies in every field design processes also deserve advancement.

Without judging the future as better or worse than the past or present, the first step is to initiate the curricular system, which eases the ways to tackle the hardships that are very well expected in adopting this change. Once the debate is accepted by society, the next is to educate the instructors to make their grip, while providing the mechanism for a longer-term transition to an information-based educational format. Two major approaches, or a combination thereof, have generally been applied to the curriculum. The first is to add computer courses as many of us are not computer-friendly. The second approach is to integrate the existing computer courses. (Mackey 1992) The courses will not be all about design but they should make a friendly working environment for an old age user who saw the birth of the computer which is now going to play a major role. Once the courses are introduced every age and learning experience should give time to learn about the new world. Even though the students may overcome their fear of accepting this change of shifting towards computer aid way faster than the instructors. as this is a dynamic discourse, there will always be room to accept more future changes and advancements in design approaches.

LITERATURE REVIEW

The amalgamation of the Modern movement and the technological invasions during the 1960s inserted and invaded computer technology in architecture (SaraSoliman, DinaTaha, ZeyadEl Sayad. 2019). It initiated with the insertion of programming languages to develop layouts and plans in 1958 (Schieck, Ava Fatah gen. 2008), Architectural layouts were drawn for the first time by 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). Within a few years after this, prompt propagation of technology and the use of new software, Computer-Aided Architectural Design (CAAD) penetrated all educational systems all around the world, not leaving the required time for the proper development of an inclusive and articulate transformation of CAAD (Antonios, Vasiliki. 2018). Form generation has always been crucial for architectural productions, be it in academics or in the field practice, and which is why the process adopted or the design approach that ties the various aspects of the design together i.e. user requirements, form, function, aesthetics, structure, context, construction cost, etc. has always been into debates for 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.

The works of Frei Otto and Fredrick Kiesler are examples of similar techniques in the early twentieth century. But does this mean 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 should it rely on mere personal inspiration. There has always been support for both in addition to which there is another type of thinking which supports the emerging design technique through computational and fabrication tools. So, for a better understanding, one needs to further dig out a bit about the historical design philosophies that paved the way for architectural productions of their time (Agakthidis, Asterios. 2015). Emerged as an answer to a similar question of its time, 'the design process driven by nature' got prominence in the late nineteenth century. 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 Nature 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 the many others in Art Nouveau, Art Deco movements. The emergence of more projects inspired by nature continued from the 1920s to 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 incorporated 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 encouraged the usage 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 makes students lose in the skill development phase, Computer-aided design has become entangled in terminology, leading to limited spatial design quality. With the widespread use of digital media, the integration of digital tools with architecture education and discourse for design education is a common theme. Open-source

parametric and algorithmic design tools are developing the architectural design process. However, some studies demonstrate student learning outcomes through digital design and architecture courses that focus on the junior years of architecture design education are more effective. Initial experimentation with digital tools in the early stages of architecture training can be used 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 integrate calculations for the design of studios. This research (Guzden, Suheyla, and Sema) Identifies the four levels of digital media interaction for design courses: General Computer Usage, Applications Involvement in digital media, design computation, and advanced exploration of design theory and ways. In Duarte, Celani, and Pupo's essay (G.Celani, R. Pupo and J. Duarte. 2009), a comparison of two universities' strategies is discussed when changing the architectural curve along with alternative approaches to integrate digital tools in design education performance. Citing two examples from Duarte, he proposes the isolated studio model with an updated computer curriculum against the traditional curriculum bottom-up approach. However, that is not clear how to make the basic structures of the design curriculum transformation effectively incorporate cutting-edge technology. Finally, when the basics of the traditional curriculum are completely covered; The argument is ongoing that students are traditionally adequately equipped to design the methodologies to start implementing advanced digital devices. However, more and more, as these technological advances continue to make progress, we found that students had difficulty understanding the language around them (Celani G 2012).

This discussion leads us to conclude that we need to maneuver 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 utilize concepts drawn from the field of natural sciences (such as mathematics, physics, or biology) as the basis for the development of an architectural methodology. Although the question of whether these tools are capable of grounding a new architecture in and of themselves remains open (Kara, Dr. Levent. 2015), it is important to note that they introduce new concepts to architectural thinking, such as mass customization 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. Every area of our existence is being transformed by it. Collaboration and creativity are enabled by a digitally transforming culture. 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 discusses the importance of architectural education for the development of our built environment and how it changes with the changing times and for that study of architectural design also needs to be advanced and developed with time. In a digital environment, digitalization is about reinventing how you integrate humans, information, and systems to generate value for your consumers and preserve competitiveness. As we are well aware of the fact that architecture is concerned with the creation of a planned environment, it is one of the oldest professions. 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 have a significant influence on a variety of facets of our lives, including home, leisure, and work.

Digital Studio Framework in Architectural Schools across the World

Digital Design in Architecture is one of the topics that has been pushing the limits of architecture for almost more than a decade now. Architecture schools, for example, AA, Bartlett, SCI-arc, Columbia University, or Pratt Institute are driving the contemporary talk. Their exploration is shifting the subject innovatively and hypothetically, and it is getting the consideration of the structural network and architectural community. Consequently, the universities of many other countries are following the trend. One of the significant ramifications of digital design is the way that this type of mediated structure, isn't just developing the one-of-a-kind conventional substance yet alongside it produces plenty of selective building ideas (Oxman, Rivka. 2008). This structure of the design, their connection to hypotheses, models, innovations, and methods at present utilized in computerized configuration investigation and digital praxis, is proposed as a model of design education. Any new system for structure teaching methods must be receptive to conditions in which digital concepts are incorporated as a novel assemblage of information comprising the connection between digital architectural knowledge and digital design ability. Any exhaustive hypothesis of digital architecture must start to recognize the connections between theory and utilization of tools. 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 is the benchmark for the development of these abovementioned talents for the trainee architect, and so the growth of confidence and pedagogical expertise is dependent on how effectively the students are introduced to the development of technology. Preparing architecture students for the difficulties of the 21st century is particularly difficult, given that professional associations, skeptics, 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) It is also alleged that architecture schools produce graduates who lack a sense of the reality of architectural practice and are difficult to teach. There is also demand for existing architecture degree curricula to be changed (or at least reassessed) to better represent the reality of our changing culture and how there is a very apparent and obvious gap in the education of architecture that bounds knowledge and performance.

Design education could be enhanced by offering particular ways of developing a sense of how to use pedagogical digital resources and not just technical skills in how to use programs or run equipment, but also how to design digitally. The base of students for deep learning should include know-how of fundamental policies, structures, and ideologies, and this should be made in institutions for a better future in practical routine (Muhammad,2017). Computer-aided architecture design (CAAD) has been a part of architectural education for quite a while now and it’s been so long that students are using it but it’s still not made an official tool. The education of architecture in universities of Pakistan has several issues, making it difficult to compete well with colleges and schools throughout the world. Educational technologies are digital innovations that are used to store and retrieve information (Schieck, Ava Fatah gen. 2008) the ability to create a constructive interplay between modernization and human values. The limitations like the financial conditions of the students, unpredictable electricity supply, failure of mechanics, and device storage collapse are also the reasons why CAAD is still not being used as an official digital resource in architectural institutions of Pakistan. 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 the USA

This is a two-year professional graduate program in one of the most renowned universities in the USA, converging with a two-year core program that concedes students with different majors too. This is an accredited program in the United States. Advanced technology and tools initiate usually from the first term. Thus, there are just two design studios that utilize digital production, and joining into the thesis relies upon the specific understudy. Digital tools are instructed as elective courses, and there are

no necessary courses. In their advanced studios, they underlined the merger of Ruskin's origination of magnificence and digital design tools. They consider 8 distinct parts of beauty that are examined through patterns of natural as well as artificial means. The reason for existing is to make the students work with a unique approach that consolidates theory on beauty with digital tools to rethink design research as an open-ended practice. The studio is separated into two principal areas of about two months long each. In the first half-section, a group of two students each explores various subjects of the beauty of their inclinations through gathering imaging and outlining.

Right off the bat, the research is accomplished as a collaboration of two students each, however; later, the real structure is done independently in the second section of about two months. In the research segment, the assignment of the students is to look at the aspects of beauty by collecting images to study them in detail. They discovered different instances of natural patterns and artificial techniques to separate data about their subject so that they come to know how beauty works in a part-to-whole process; at that point, they revise these pictures with various examples dependent on the parameters of digital design. In this stage, students break down the structures of these examples profoundly to discover variable figures and their characteristics. Because of this, they are prepared to comprehend various items under various conditions that can be made in the area of their theme. In the wake of separating existing examples of the pictures, the following stage is to make new examples by changing inputs and control. From the start, their modules are flat matrices and they are manipulated into a set of three-dimensional patterns. These are additionally formed into computerized demonstrating methodologies to make different surface topologies. At this stage, the students utilize the digital software Rhino to create models that assist with producing three-dimensional patterns. In the subsequent half area, these outlines of excellence are applied to an urban city square.

Digital integration in Turkey

They practiced a digital design studio during one of the years of the undergraduate program. The digital design studio is divided into two sections, theory-based, and lab-based. The aim of this is to make the students understand how theory and computational resources can work together to produce a better design. Students are encouraged to involve these procedures in the imminent phases of their architectural projects. Students are engaged with framework-based design principles by getting a handle on these frameworks as geometric elements. For this purpose, different software including Rhino is being explored in the first semester along with the lectures and discussion sessions about digital design. Later on, they practiced the digital theory in architecture in their studios. The complete design project in studios is processed in such a way that the theoretical and practical knowledge about the topic related to digital theory is comprehensively used. The learning factor depends on both eye-hand

coordination and the use of this technique in computerized approaches. Advanced 3D modeling techniques are also practiced and digital fabrication is the fundamental part of this course. Workshops equipped with 3D printers and CNC machines are used for fabrication. The use of technical software enables the students to resolve tasks and coordinate the aesthetic, technical, structural design, financial, environmental, and social requirements of the construction.

Technology integration in Pakistan

In the fourth year of their five-year program, students were introduced to digital design theory, marking their initiation into this domain. The focus of this introduction was the exploration of "Biomimicry," a concept centered around emulating natural processes and phenomena in design. The studio commenced with a research phase, during which students were tasked with identifying intriguing phenomena or processes in the natural world. Upon selecting their areas of interest, a systematic approach, characterized by the utilization of "mind mapping," was introduced. This technique aimed to refine the students' research and guide them toward 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, emphasizing a hands-on learning approach. In addition to grappling with these new and unfamiliar tools, students were confronted with 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 modeling into the curriculum marked a pivotal juncture, emphasizing the synthesis of theoretical knowledge with practical application. The utilization 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.

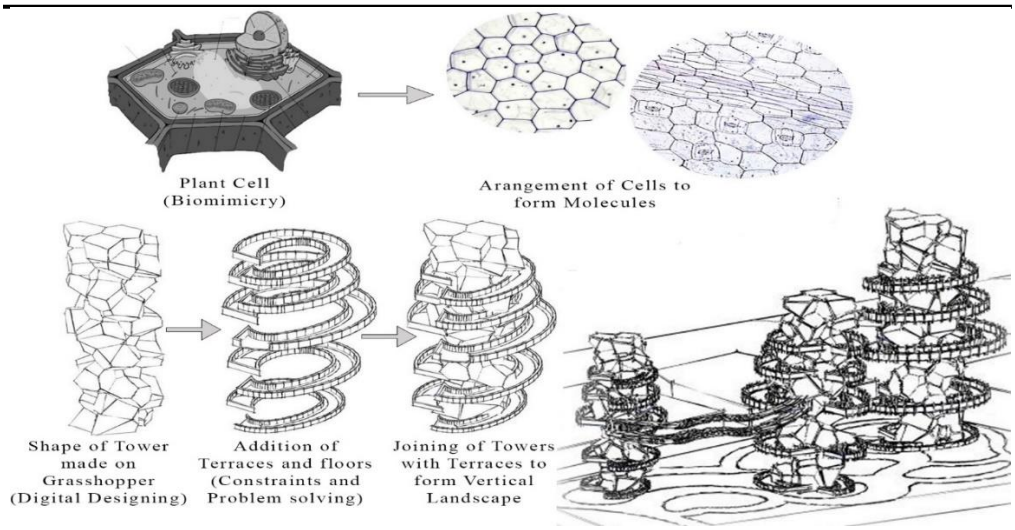

Fig 1: ***Example of Vertical Landscape Project using Biomimicry and Digital Designing Software taught in Architectural Design Studios in Pakistan (student work)***

Advancement in technology in Architectural Education in Pakistan

Technology infusion in architectural schools across the country is moving ahead at a very slow pace. As of now, there is no basic framework or structure for the use of information technology in the teaching of architecture. Some schools of architecture have tried to adopt these contemporary changes in teaching; however, the majority of studio educators are still finding it inconvenient to infuse novel tools as a medium to the design process. The conventional system of education is popular in the studios and transformation is slow-paced. This research inspects the pedagogical techniques and strategies in Pakistan by discussing a research-based educational approach that has been applied in teaching fourth-year students. This fourth-year design studio is discussed as experimentation undertaken and the outcomes are used to compare with studios around the world. It has been four consecutive years since the author has been teaching this method in the design studio. The digital design studio was introduced at the Department of Architecture in 2013; technically the first department to initiate it all over the country, however, its true abilities have not been acknowledged, as it is just restricted to a fourth-year plan studio for a year. First, second, and third-year studios are arranged as a mix of both the customary strategies for drafting with the utilization of Auto Cad, and new advanced structure devices like Rhino, Maya, and Revit are presented during the fourth year as it were. Majorly 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 aims to explain the concept of Biomimicry, which we have encountered in the field of architecture in recent years, and take into account

the design and nature of the relationship in Architectural Design Education The main purpose of this study is to teach students one of the design techniques by applying and showing biomimicry and the contribution of living animals to architectural design. Unfortunately, the transition from traditional methods to computer-aided design methods is not clearly defined, along these lines, some students are left off guard and tasked to use technical software to design. Then again, students are introduced to both methods of architectural design education and can implement either or both methods when needed.

RESEARCH OBJECTIVES

1. To study and analyze the current teaching methods used in Architectural studios internationally that integrate technology and tools to design.
2. To reflect upon the studio teaching methods that can help evolve the Integration of tools and technology in architecture education in Pakistan.
3. To recommend the way forward in this domain It will provide suggestions and recommendations for the new methodology for the studio framework to be implemented in Pakistan.

RESEARCH METHODOLOGY

This study analyzes the inclusion of tools and technology in architecture education by instigating studio teaching methodologies globally and then reflecting on the studio design methods these institutes are using. Teaching methodologies from three architectural studios located in the United States of America, Turkey, and Pakistan are studied the detailed literature review and the studio instigation helped to propose solutions for the tools and technology integration, especially for countries like Pakistan where changes due to technology and tools integration are not being welcomed. These outcomes are then compared with each other to chalk down an implementation approach for refurbishing the architectural education framework where technology is involved. This study will help provide some important insight into the educational institutes implementing logical and methodological ways of teaching digital design. The take-home from this research has been derived 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 designed pedagogical methods suitable for the local context.

REFLECTION AND DISCUSSION

It can be witnessed that for the theoretical or research part almost all three studios are relying on phenomena adopted from natural sciences which inevitably integrates 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. The other important observation is that teaching digital tools as supportive electives and courses doesn't make many transformations in the overall integration of digital 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 tool only. The tasks in the different support courses will in the general spotlight on the basics of drawing or modeling with software, these tools don't locate 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 to 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). Digital tools are being used more and more in design studios all around the globe. At the same time deciding when, where, and how these tools are integrated into the curricular framework makes a decipherable difference also. While the process and production in the profession move toward digital environments - even the physical models are now mostly produced with CAM techniques—these tools still require an internalized knowledge of seeing, thinking, and making space that cannot be cultivated through the digital environment alone (Simkovic, Vladimar. 2015). Nearly all three studio frameworks are using the tools to solve a particular problem. It can be observed that the process remains the same and the main importance is given to the process, not the tools. Therefore, the pedagogic framework should be maneuvered with the dynamic design process. Conversely, technology and tools should not determine the design product but instead, should be used as a medium to produce innovative and sustainable architecture. The major methodology should include a design course well-articulated into smaller important phases like research, creative development, implementation, and presentation, which helps to provide a system for the framework and sets the direction for the pedagogical process. Therefore, the contemporary studio framework is faced with a sequence of challenges, 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. In the sense that they influence how students employ technical abilities, digital soft skills 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. Most

of those instances in the soft skills section may be classed as personality or character qualities. Soft skills are typically thought to be character qualities rather than teachable attributes since successful students may already exercise them. Soft skills should be reinforced in the studio and lab, even if they are not being formally taught, in order to appropriately establish habits. Instructors should be aware of and consistent in their own habits, modeling the behaviors they teach in their own activities. Soft skills and learning objects help students achieve the aim of not only functioning well with technologies but also working collaboratively with others in technologically aided ways. Students may use digital soft skills to assist them to understand computer-aided design and, subsequently, use technological expertise effectively and with refinement, as well as adapt to a quickly changing digital context. Understanding, talents, perspectives, and practices influence not just the design process but also the goals and outcomes. Design is influenced by soft skills and learning objectives, which go beyond academic considerations. Knowing and learning digital modes of design is a need for designers of the 21st century and how architectural education must now start focusing on incorporating digital technology courses in their academics so that the students can learn and practice all the soft skills that are being practiced in the field of architecture for producing digital complex and contemporary architecture. This research also highlights how developing a framework for enhancing the learning aims of the students and teaching facilities is needed in today's architectural education.

It also helps to highlight the influence of tools and technology on design studio learning. The problem starts from the fact that being architects we are working in a time where there is a conjunction of traditional and modern methods in architectural design studios where these new technologies in design education have been accompanied by a problematic relationship between the techniques and the desired results that causes obscurity concerning the design concept. Digital Architectural design is a complicated process that involves the creation of a cohesive structure or system made up of numerous united pieces that have been defined by different theorists where according to Archer (Kara, Dr. Levent. 2015) it is a goal-directed problem-solving activity.

In the design process and the final product, architecture has been affected by the increasing use of digital technology to satisfy particular practical, cultural, and aesthetic requirements. As a need in terms of aesthetics, the environment, and socioeconomics digital technology became 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. As a result, software like "Revit" and BIM" was added to their curriculum as electives. In general, Pakistani architectural schools blend the 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. The necessity of establishing manual graphic communication skills, drawing, and the practice of constructing physical models is emphasized in design training for first- and second-year studios. Most schools' present architectural design curriculum, on the other hand, lacks synchronization and integration between computer courses and design projects.

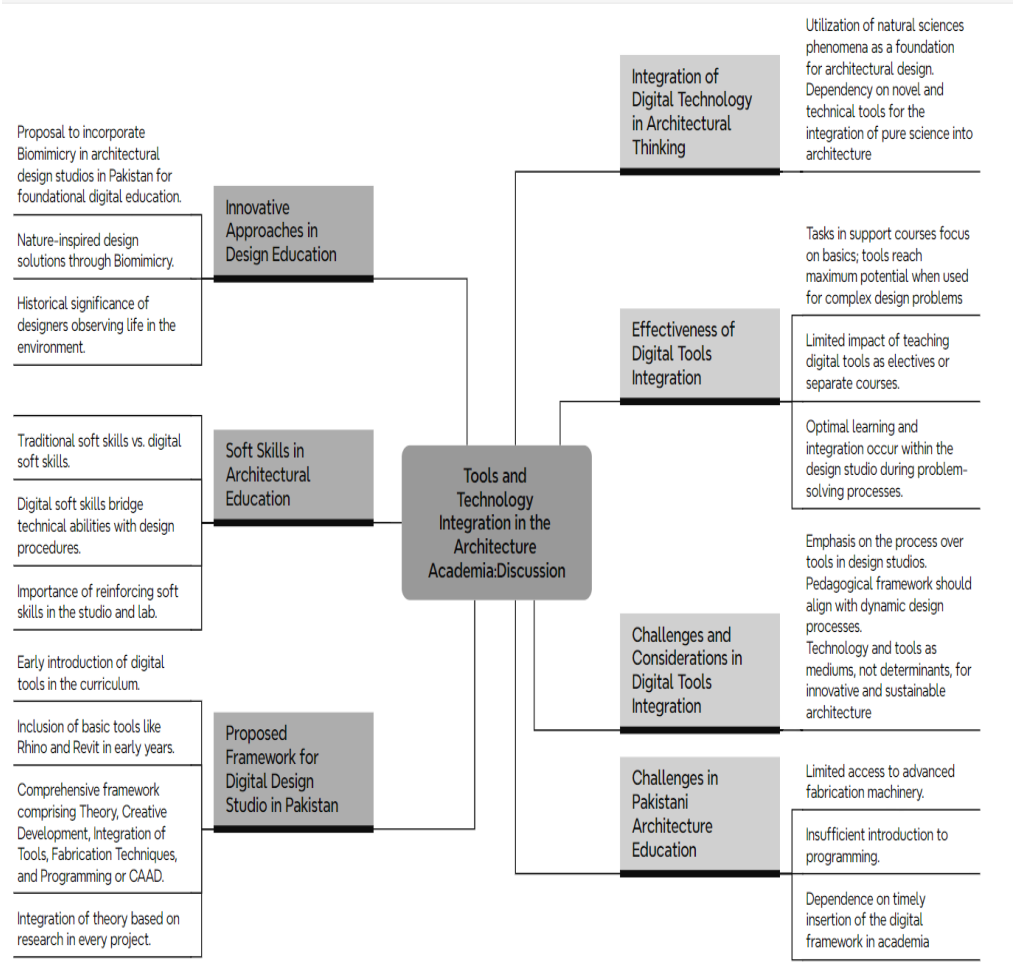

Fig2: ***Discussion and way forward***

The above discussion leads to the fact that the use of digital technology has brought about a paradigm shift in architectural design. Internationally most schools are using different design methodologies and are experimenting with algorithmic design,

performative design, parametric design, and fabrication in their capacity. The commonality among these studios' approaches is that the theory is usually drawn out from natural sciences and phenomena.

Research based on natural phenomena and processes makes the use of tools in design theoretically strong. Nature is a cradle to some very complex phenomena and learning from those with the help of technology can be a very creative process. What is important here is the use of these tools should be as a medium to design and not just accept what these have produced for the architects. A framework for the digital design studio in Pakistan has been proposed here partially based on the discussion above. A major component of this framework is based on these factors: i) The Introduction of digital tools at a very initial stage like the first year or pre-foundation (time after getting selected for architecture) should be made compulsory. Students should be sent a list of software to be learned before joining the program. ii) Introduction to basic tools like Rhino and Revit should become part of their first, second, and third-year studios as well as every project and assignment should involve theory based on detailed research) Fourth-year should initiate with the proposed framework shown below in Fig 7. After evaluating the above studio methodologies, it is concluded that the framework for Design studios in Pakistan should be composed of five major components: Theory based on research, creative development, Integration of tools, Fabrication techniques, and at an advanced level programming or CAAD.

Modern development, as well as innovative approaches and different training methodologies in design education, allow to broaden the student perspective in design education and allow them to analyze things around them differently than usual.

RECOMMENDATIONS

It is recommended that technology integration should be initiated at a very early stage for architecture students. There should be more technology like materials and methods which will help in increased experimentation which is always good for the evolution of ideas in architectural projects. The multidisciplinary joint effort combined with stakeholder support is recommended to guarantee advanced practice is generally welcomed in the built environment. The inclusion of digital design theories in higher education syllabi and the help of specialized training workshops and occasions are highly suggested. Development of digital labs, use of innovative materials, and manufacturing procedures should initiate in academia which will lead to important environment-friendly results owing to their sustainable potential. Architecture schools or departments working on the digital design framework ought to be set up in Pakistan.

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