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The Reduction Mechanism for the Impacts of Digital Software Tools on Students' outputs in Architectural Design courses: Case Study Architecture Department, Tripoli University, Libya

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آلية الحد من تأثيرات الأدوات البرمجية الرقمية على مخرجات الطلاب في مواد التصميم المعماري حالة دراسية: قسم الهندسة المعمارية، جامعة طرابلس-ليبيا

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Abstract:
Architectural design is considered the fundamental pillar of architectural education, through which it is possible to keep pace with the development of the curriculum and modern digital software tools. Therefore, this research paper highlights both the negative and positive effects of using modern digital software tools on students' architectural design outputs. In past years, before the emergence of modern advanced computer technologies, students in architecture departments at universities around the world, generally, and in Libyan universities, relied on traditional methods for design, such as two - and three-dimensional hand-drawn sketches. Digital software tools, such as ArchiCAD, Revit, virtual reality programs, and, more recently, artificial intelligence, have been developed to meet the diversity of needs (users, design, construction, and creativity), which has had, and continues to have, a transformative impact on architectural design tools. These tools were introduced into Libyan universities, specifically the Department of Architecture in Tripoli, in the late twentieth century. They have brought a radical change in architectural design courses in Libyan universities. Therefore, this research paper aims to understand the impact of using digital software tools on student outputs in architectural design. The descriptive-analytical method was applied to answer the paper's questions from different aspects of the theoretical and empirical parts. One of these questions is the main question that addresses the effects of digital software tools on student output in architectural design courses, and how their negative effects can be reduced? Questionnaires were distributed to 105 students and 19 professors to determine the extent to which digital software tools impact student outcomes in architectural design. To come up with at a mechanism for reducing the negative effects of using digital applications on architectural design outcomes and students' intellectual and creative capabilities in various typologies of architectural design subjects.

Keywords: digital software tools; architectural design; skills; student outcomes.

الملخص :
يُعد التصميم المعماري ركيزةً أساسيةً في التعليم المعماري، حيث يتم من خلاله مواكبة التطور في مناهج التصميم المعماري وأدوات البرمجيات الرقمية الحديثة، هذه الورقة البحثية تُسلّط الضوء على الآثار السلبية والإيجابية لاستخدام أدوات البرمجيات الرقمية الحديثة على مخرجات الطلاب في التصميم المعماري، ففي السنوات الماضية، وقبل ظهور تقنيات الحاسوب الحديثة والمتطورة، اعتمد طلاب أقسام العمارة في جامعات العالم، عمومًا، وفي الجامعات الليبية خاصة، على الأساليب التقليدية في التصميم، كالرسومات اليدوية ثنائية وثلاثية الأبعاد، لقد تم تطوير الأدوات البرمجية الرقمية الحديثة، مثل ArchiCA و Revit وبرامج الواقع الافتراضي، ومؤخرًا الذكاء الاصطناعي، لتلبي الاحتياجات المختلفة على جميع الأصعدة (الإنسانية، التصميمية، الانشائية، والإبداعية) التي كان لها ولا يزال الأثر التحول الرقمي في أدوات التصميم المعماري، وقد دخلت هذه الأدوات الرقمية إلى الجامعات الليبية، وتحديدًا قسم الهندسة المعمارية في جامعة طرابلس، في أواخر القرن العشرين، وأحدثت تغييرًا جذريًا في مقررات التصميم المعماري في الجامعات الليبية، وتهدف هذه الورقة البحثية إلى فهم تأثير استخدام تطبيقات البرمجيات الرقمية الحديثة على مخرجات الطلاب في مقررات التصميم المعماري، وقد استخدم الباحث المنهج الوصفي التحليلي للإجابة على أسئلة البحث من جوانب مختلفة (النظرية والعملية). إحدى هذه الأسئلة السؤال الرئيسي الذي يتطرق الي تأثيرات الأدوات البرمجية الرقمية على مخرجات الطلاب في مواد التصميم المعماري، وكيف يمكن الحد من تأثيراتها السلبية؟ وقد تم توزيع الاستبيانات على 105 طالبًا و19 أستاذًا، لتحديد مدى تأثير أدوات البرمجيات الرقمية على مخرجات الطلاب في التصميم المعماري. للخروج بآلية لتقليل من الآثار السلبية على مخرجات التصميم المعماري، والقدرات الفكرية والإبداعية للطلاب في مختلف مواد التصميم المعماري.

الكلمات المفتاحية: الأدوات البرمجية الرقمية، التصميم المعماري، المهارات، مخرجات الطلاب.

Introduction

Since its emergence, digital technology has provided students and architects with advanced capabilities, replacing traditional thinking and design tools. This has made intelligence, creativity, and imagination physically attainable through the use of various computer technologies in many fields of architecture, from planning to urbanism and design. The widespread use of digital technologies and their applications in the early 21st century has had a significant impact on reshaping the structure of the architectural education curriculum. The largest part of the use of digital software tools in architectural design, with its various functional classifications, has evolved beyond being an effective tool for drawing to influence modelling, analysis, programming, and other uses of digital applications. This has forced architecture departments to adopt them within the educational curriculum as core academic subjects taught to students, such as CAD, RIFT, and other programs, all the way to artificial intelligence (AI) [1]. Digital drawing technological advancements have had a significant impact on the development of architecture education, changing our perspective as architects on how to approach form and link it to spatial, structural, and aesthetic functions. The widespread use of digital programs has had a clear impact on their adoption as a contemporary design tool in architectural design subjects by students, which has given them great freedom in dealing with site data, its environmental and topographical constraints, and their effects on the formation of complex architectural forms [2].

According to the experimental study by Angelil (2003), who emphasized the importance of incorporating modern digital software tools into at least the last three years of the academic curriculum for architecture students. (Angelil, M. Uziyel, L. 2003). In addition, digital software tools contribute to the production of attractive architectural forms and ideas with relatively little effort from students [3]. On the other hand, Achten (2003) highlighted the negative effects of digital transformation in architecture, especially architectural design, to replace the traditional design method, which plays a major role in developing and enhancing the physical relationship between the tool of drawing and creativity (the hand) and the tool of thinking (the brain). Many researchers concentrated on the problems resulting from the excessive use of digital tools and their applications by students in the initial stages of the study, without introducing the concept of thinking and creativity to the architectural ideas proposed for projects [4]. But in return, the viewpoints of other thinkers, including Breen (2004), encouraged the connection between digital and traditional tools and their integration into educational programs to develop students' skills at all intellectual and practical levels. It also provides students, through the link to the two tools, with several different ideas and directions for their development in a way that is compatible with various characteristics of (users, functions, and locations) [5]. One of the most important capabilities that distinguish these programs is the speed in preparing, completing, and producing architectural forms and plans [6]. These programs develop students' decision-making abilities and reduce problems and risks by offering the best solutions, enabling students to develop their projects and gain a more accurate and realistic vision [7]. Additionally, these digital software tools enable students to make modifications and changes to designs in a seamless manner that is easy to use and clear to present [8].

The use of digital software tools in architectural projects in design courses at the Department of Architecture at the University of Tripoli has had a significant impact on the outcomes of architectural work and also on the capabilities and skills of architectural students. This is where the problem emerged and was identified by the author.

Research Problem

The impact of technological progress is significant and evident in all practical and scientific fields, which in turn casts its shadow on the educational process in Libyan universities, especially in applied specializations, including architecture design. Digital progress has had a positive and possibly negative impact on various aspects of the educational, social, and economic life of architecture students. Therefore, this research paper sheds light on the extent of the effects of using digital software tools on the architectural design outcomes of architecture students at the University of Tripoli across different academic levels. In addition, it identifies the positive and negative effects on the potential of architecture students and their cognitive, sensory, creative, and intellectual abilities, as well as their future career prospects in this field.

Therefore, this research paper introduces several objectives that serve as a guide to help the researcher identify the impact of using digital software tools on the academic outputs and capabilities of architecture students.

Research Paper Objectives

- To identify the impact of using modern digital software tools on students' outputs in architectural design.

- To highlight the impact of these technologies on students' efficiency and their design and creative abilities.

- Propose a mechanism that may have a significant impact on reducing the negative impacts of using these digital tools on students' intellectual and creative abilities in the design process in architectural design subjects.

Research Paper Questions

Main Question

1. How do digital software tools impact students' output in architectural design studios, focusing on creative, intellectual, and collaborative skills and communication, and how can their negative effects be reduced?

Sub questions

2. What digital software tools do students and faculty members prefer to use?
3. What are the advantages and disadvantages of using digital software tools in architectural design?
4. What are the dilemmas and challenges facing architectural education in using such digital software tools in the Department of Architecture at the University of Tripoli?

Research Methodology

This research paper employs a descriptive and analytical approach to review the literature related to the topic, which serves as the foundation for the field study. One of the most important tools used in this research was a questionnaire, which included numerous questions related to the topic. The program used to analyze the results was Microsoft Excel.

The integration of digital software methodology, its applications, and tools in architectural science, as well as the rapid comprehensive shift to digitization, has led to changes in the features of the traditional curriculum and the way students and professors interact with it and view the built architectural environment. Therefore, the researcher sheds light on the review of the theoretical literature focusing on thinkers' opinions to obtain more information about the research problem.

Theoretical Framework

Architectural Education and the Transition from Traditional to Digital Tools.

Architectural education, in its early years, relied and continues to rely on traditional manual tools and techniques (pens, paper, and various types of rulers) in the design process and presentation of plans. Despite the interactive relationship between the student and the project, and the resulting understanding and awareness of all creative, intellectual, and spatial sensory data, it is prone to errors and limited ideas requiring a long time to implement [9]. Architecture is not only limited to meeting the user's needs within the specific sit of a particular building type, but it extends far beyond that to serve as a cultural and social identity for any country, reflecting architectural development and progress, which tell great stories and philosophical values for the development of any country (Fadjri, M., Ekawardhani, Y. 2020).

The emergence of digital globalization in recent years has witnessed significant progress, acceleration, and a scientific revolution unprecedented in previous eras. As a result of keeping pace with and paying attention to this type of development, it has had a great impact on the development of students' capabilities in terms of thought, design, and technology. It has also influenced the ideas and visions of students through the creativity of the architectural ideas and virtual simulations in advanced stages of architectural education, specifically design subjects. The integration of modern digital technologies into the field of architecture has had a significant impact on the way architecture students approach their various projects. Furthermore, they have opened up vast horizons for the development of design capabilities and raised awareness of precision and efficiency among those interested in this development, producing unconventional architectural geometric forms that reflect the technological advancements in this field, particularly in innovative structural systems. The development of building modelling processes, digital parametric design programs, virtual reality simulation, and other digital software has played an effective role in improving the outcomes of architectural design [10]. These applications have motivated many architects interested in innovation and complexity in architectural projects to work on developing their methodologies and tools to enable architecture students to use these technologies to support their educational projects in architectural design studios and work to develop them and raise their efficiency. According to Dizoni,et al (2024) who stated that “Such tools could intuitively aid in the generation of design concepts inspired by various stimuli, while concurrently documenting these thought processes and ideas within interactive design databases” [11] (p. 492).

Doyle and Senske (2017) discussed the duality of effective scientific interaction between design in architectural education and digital technology in modern globalization and its impact on the digital transformation in architectural education. As a result of this interaction, some of the challenges faced by architectural education have surfaced, most notably how to integrate digital technology into the curriculum, adopt it, and overcome the problems arising from its implementation. Therefore, the researchers proposed developing students' capabilities and skills in digital software and its application in architectural design to bridge the gaps that may arise from teaching architectural design and digital technology separately in architectural education [12]. Ceylan (2024) explained that the mechanism of dealing with and using such digital software tools requires considerable effort to learn, especially for new students [13]. On the other hand, the frequent use of digital tools and complete reliance on them has negatively affected the cognitive, analytical, critical, and various manual drawing skills of students [14].

Ceylan, S., et al. (2024) highlighted some of the weaknesses they identified in their research, including that some students have no financial ability to acquire computers compatible with the requirements of digital software. However, they identified several opportunities, including digital software tools used in architectural design studios, which create a social foundation for collaboration and participation and develop teamwork, discussion, and the exchange of technical skills. Furthermore, it encourages file transfer among students (Ayeke, E. et al. 2024). Shinde, P. et al. (2024) [15] emphasized that digital software tools play an active role in developing students' capabilities in several areas, including easy and smooth interaction and communication between students and their professors. Digital software tools provide an educational environment that helps them exchange opinions, criticism, and feedback, and fosters their ability to develop. Students' reliance on ready-made models in various digital software tools and programs has many advantages, including reducing thinking and production time, reducing errors, and allowing for modification according to project requirements. But, excessive reliance on this model weakens students' ability to think and innovate, acting as a creative impediment, limiting architectural ideas, and preventing brainstorming, which can help solve many design problems (Gerlich, M. 2025).

According to Narimane, H. et al. (2024) [16], digital software tools serve as basic rules that have contributed to solving many complex problems at all levels of thought, design, and construction. These advanced technologies have expanded the horizons of creativity and innovative visions beyond traditional education methods in architectural science. The main credit for all this digital development began with pen and paper, which paved the way for the development of digital software tools supported by several advanced tools, starting with CAD and extending to artificial intelligence. These digital software tools have changed the traditional concept of architectural science and made great deal of progress in architectural design.

Digital Software Programs and Tools

Since the era of digital transformation requires significant capabilities and skills to keep pace with this rapid technological development, available traditional design methodologies and tools are ineffective within this dynamic environment, which requires keeping up, being flexible, and adapting to it [17]. In response to this development, numerous digital software tools have emerged, such as CAD, SketchUp, Revit, Photoshop, and V-Ray, all of which rely on computers for downloading. Most of the digital software tools are used in architectural design processes, each according to its function. For example, CAD was one of the first digital programs to appear in the early 1980s. Its use in two-dimensional design has become widespread, contributing to increased design efficiency, quality, accuracy, and speed of completion. The output of this application resembles hand-drawn designs, making it easier for users to understand its working mechanism due to its proximity to traditional architectural design methods.

SketchUp has been introduced in 2000 to visualize projects in 3D. It is easy to use and provides near-realistic images. It also allows for the exchange of 3D files with other digital programs.

Building information technology (BIM). It is a program characterized by its diverse specializations in all engineering fields, from electrical, mechanical, and construction sciences to architecture and other disciplines. BIM has different types of tools such as Revit and Lumion. Revit characterized by its speed of preparing two-dimensional plans in one second. In addition to that, it works to raise the efficiency of two-dimensional architectural drawings and works to modify all plans simultaneously [18]. As well as Lumion, which works specifically to present the projects in 3D.

Many digital software tools have recently emerged with advanced technical methods and various uses, such as VR, AR, and AI, which have a significant impact on the design process of architectural projects during the design and implementation phases (Fadjri, M., Ekawardhani, Y. 2020).

Modern digital software tools have become a reality, and their use and integration into the educational framework of architectural education are inevitable, given their significant impact on the way many architectural projects are conceptualized and produced. Therefore, the researcher deemed it necessary to conduct a field study to gain insight into the opinions of samples, including professors and students, thereby linking them to the literature reviews. To arrive at more precise answers to the research questions.

Fieldwork

Data Collection

The Department of Architecture and Urban Planning at the University of Tripoli is one of the oldest departments in architectural education in Libya. The department was established in 1969 within the Faculty of Engineering at the University of Tripoli. “The department seeks to keep pace with technological development in all its educational, scientific, and research stages to catch up with scientific progress, similar to global architectural departments] ”[19] (p. 4).

To keep pace with this development and highlight the impact of digital tools on student outcomes in architectural design, and to answer the questions of this research paper, were selected random samples from architecture department students at different academic levels and several faculty members in the department who use various digital programs to assist in the design diverse types of buildings. The survey's participants numbered 124 from

several categories of students and professors. The percentage of students who completed their responses was 70%, or approximately 105 students out of 150 who participated in the field study. In addition, 19 faculty members out of 30 professors were included in survey in the Department of Architecture and Urban Planning at the University of Tripoli.

The researcher prepared two versions of the questionnaire for each of the target groups: students and faculty members. Each version highlighted significant topics that address the research problem. The subjects that introduced to the samples were Section 1, general information about the samples; Section 2, the digital programs used; Section 3, an evaluation of the impact of using digital software; Section 4, the advantages and disadvantages of using these applications; and Section 5, the obstacles and challenges facing architectural education in using such applications.

The questionnaire was organized using the Customer Effort Score (CES) method, based on a five-point Likert scale. This tool is for assessing the opinions of participants based on their different classifications on the specific topic (strongly agree, agree, neutral, strongly disagree, disagree). The questionnaire contained various sections, as previously explained. The journey of searching and investigating unprepared information is not a simple one but rather a series of interconnected stages. The research begins with a data collection phase, followed by quantitative statistical analysis of responses using Excel, a tool for analyzing data collected from survey participants. After this stage, the discussion of the results, based on previous literature relevant to the topic, answers the research questions and comes up with recommendations for relevant stakeholders.

Results and Discussions

The responses of the survey participants from the various samples (students and faculty members) categorized into sections relevant to the research questions. This data then entered into Excel to obtain percentages for comparison with other responses from the same group.

The most important parts of the survey are as follows:

- **Section One:** Information about the survey participants by gender.
- **Section Two:** The digital software tools used in the various design studios.
- **Section Three:**
  A. Evaluating the impact of using digital software tools on the quality of architectural design outputs and design creativity among students and faculty members.
  B. The impact of digital software tools on student collaboration in group projects.
- **Section Four:** The advantages and disadvantages of using digital software in architectural design courses.
- **Section Five:** The obstacles and challenges facing architectural education in the use of such digital applications in the Department of Architecture at the University of Tripoli.

Section One: Demographic Classification

The demographic breakdown of the participating samples included 24 male students, accounting for 25%, and 81 female students, representing 80% of the total. Note the higher proportion of females compared to males in the Department of Architecture at the University of Tripoli, indicating a rising number of females enrolling in the department. According to statistics from the National Center for Education, Science, and Community Engagement (NCES), more than half (57%) of students enrolled in higher education across the United States are female [20]. This increase is due to several reasons, according to Steffens, such as architecture being a flexible major that takes into account the possibility of working from home and meeting the needs of children and families. It offers a work-life balance and achieves a greater degree of inclusiveness and diversity. These are among the reasons that motivate female students to enter this major [21].

Section Two: Digital Software Tools Used in Various Design Studios

Table (1) shows the most significant digital programs used by both students and faculty members for architectural drawings. The most important of these is AutoCAD, with 100% of both faculty and students using it. SketchUp also accounts for 100% of faculty and 83% of students. Photoshop also accounts for 84% of faculty members, while students use the same program at 76%. We cannot forget some of the other programs, such as Revit and Lumion, with varying percentages ranging from 42% to 58%.

Table (1): Programs Used

Programs	Percentage of Students (105)	Percentage of Professors (19)
AutoCAD	100 %	100%
SketchUp	83%	100%
Revit	52%	42%
Photoshop	76%	84%
Lumion	42%	58%

Both professors and students emphasized the importance of these programs, based on the high and varying percentages of their use. They all agreed on the widespread use of digital software tools such as AutoCAD, SketchUp, Photoshop, and Revit, as shown in Figure (1). Most of the digital software tools used in the design and visualization of various projects in two- and three-dimensional formats. According to Fadjri, M. and Ekawardhani, Y. (2020), these programs contribute to improving the efficiency, quality, accuracy, and speed of design, providing images that are almost realistic and deal with building information technology (BIM), which has different types of tools such as Revit and Lumion. They characterized by their speed of preparing 2,3 D plans in one second. In addition to that, Revit works to raise the efficiency of two-dimensional architectural drawings and works to modify all plans (Qiang, L. Badarch, T. (2022).

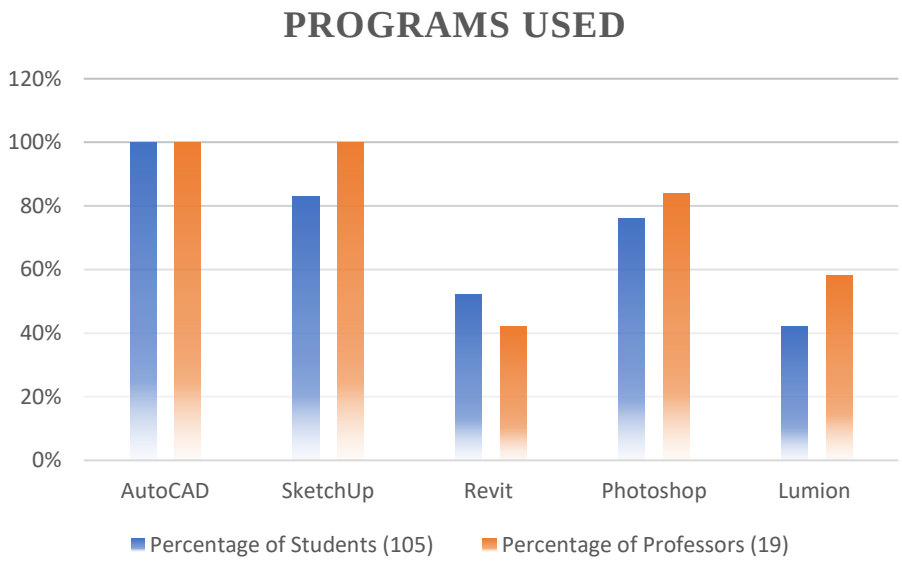

Fig 1: Programs Used

Section Three:

A- Evaluating the impact of using digital software tools on the quality of architectural design outputs and design creativity among students.

Some different opinions raised regarding the impact of using digital software tools on the quality of students' design output in their architectural projects, as shown in Table 2. The answers varied, as shown in Figures 2 and 3.

Both professors and students were strongly agreed, with varying percentages ranging, 79%, 58%, 55%, and 36%, that digital software tools contribute to the better development and production of diverse design ideas while investing time and effort. Achten, H. (2003), spotted the light on digital tools that contribute to producing and presenting attractive architectural forms and ideas easily, without requiring any effort or trouble from students.

Both professors and students were strongly agreed, with 63% and 58%, respectively, that digital software tools enhance design quality and deliver more accurate and professional outputs. Ayeke, E. et al. (2024) noted in their research paper that the entry of modern digital software tools into architecture has had a significant impact on the way architecture students approach their various projects and has raised awareness of accuracy, efficiency, and professionalism.

Both professors and students strongly agreed that digital tools help express architectural ideas and provide virtual simulations for projects before implementation, with percentages ranging from 58%, 39%, respectively. This is consistent with Ayeke, E. et al.'s (2024) view that digital programs influence students' ideas and visions through creativity in the design concepts. Additionally, they assist professors in the evaluation process and clarify design and construction problems through digital parametric design programs and virtual simulations of projects at advanced stages of architectural education, particularly in design, thereby playing an effective role in improving architectural design outcomes.

Both professors and students were neutral in their opinions about the hypothesis that total reliance on software tools reduced the quality of architectural projects in various design studios by close percentages (47%, 51%), respectively. This neutrality on this hypothesis, from my perspective as a researcher and professor of advanced architectural design, and through my educational experience in this field, is due to students' weak abilities to deal with various digital software tools, which negatively affected their ability to communicate architectural and design ideas at different stages. Guney, D. (2014) and Achten (2003) explained that the use of digital software tools and

their applications in the initial stages of study has many passive effects, such as a weakness of ability to think and creativity, and a lack of awareness of basic architectural concepts. However, we cannot ignore the clear impact of these digital software tools on enhancing the quality of various architectural projects. In addition, this is reflected in the development of students' capabilities and skills, replacing traditional thinking and design tools, and making intelligence, creativity, and imagination materially attainable, as emphasized by Soliman et al. (2019). Yanga (2015) highlighted that adopting various digital software applications as a modern design tool in architectural design subjects grants students greater freedom to deeply study with all site data, its environmental and topographical determinants, and their impact on the formation of complex architectural shapes, in line with diverse climatic conditions. These opinions were expressed by both participants, with similar percentages (53% and 50%), who disagreed with the statement that these programs have no noticeable impact on architectural projects.

Table 2: Evaluating the impact of using digital software tools on the quality of architectural design outputs.

Topics	Strongly agree		Agree		natural		Disagree	
	Professors	Students	Professors	Students	Professors	Students	Professors	Students
Contributed to the development of design and technical ideas and produce of better architectural forms and ideas.	58%			36%				
Investment in time and effort	79%	55%						
Improve design quality and deliver more accurate and professional output.	63%	58%						
Digital programs helped express ideas and simulate the project virtually before implementation.	58%	39%						
The total reliance on technology has reduced the quality of the project.					47%	51%		
No noticeable effect							53%	50%
Linking digital and traditional tools and integrating them into educational programs to develop students' skills at all intellectual and practical levels.	53%	40%						
It contributes to opening new horizons for design and increases creativity.	58%			39%				
Distract from the main ideas					42%	42%		
Relying on ready-made designs without thought, which moderates students' architectural creativity							32%	42%

Both professors and students (53% and 40% respectively) strongly agreed on the need to link digital and traditional tools and integrate them into educational programs to develop students' skills at all intellectual and practical levels. This mechanism encourages students to devise and create different ideas, then improve them to suit the various characteristics of the function, the user, and the site (Breen, 2004).

58% of faculty members strongly agreed, and 39% of students agreed that these digital software tools contribute to opening new horizons for design and increasing students' creativity level. These advanced technologies have expanded the horizons of creativity and innovative expression beyond the traditional architectural role by producing unfamiliar architectural geometric forms that reflect the technological and digital development in this field, which were previously unattainable and changed the tradition concept of architecture, and ushered in a new era of development in architectural design (Narimane, H. et al, and Ayeke, E. et al. 2024).

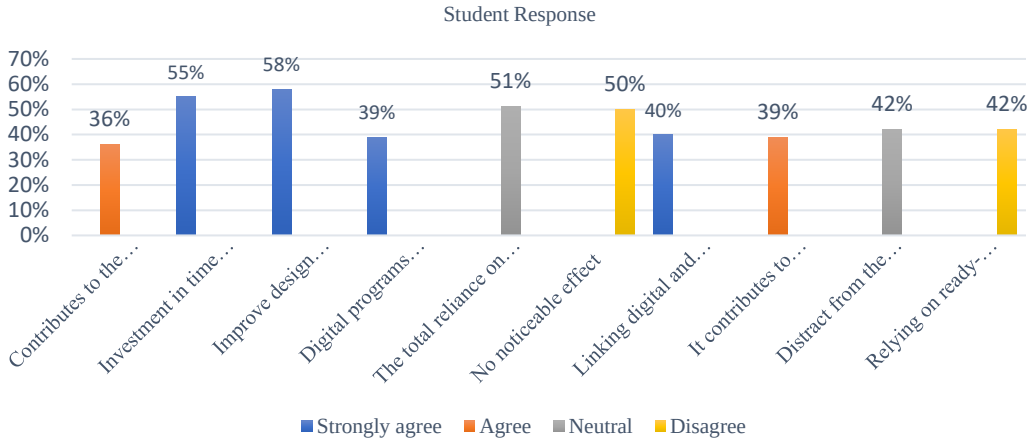

Fig 2: Students' Responses

Both professors and students were equally neutral (42%) regarding the assumption that digital software tools distract from the main ideas. The overuse of digital tools in architectural design and their reliance on them may distract from the basic and essential ideas in the design process. Students pay great attention and focus on the technical characteristics of digital software tools and learning them, neglecting many design aspects, such as design standards and linking them to function, focusing on movement of all kinds, losing the sense of human scale within buildings, and other functional and technical characteristics, that must take into consideration, that focused on, and not neglected. Furthermore, it negatively impacts students' cognitive abilities, critical analytical thinking, and various manual drawing skills, as emphasized by Gerlich (2025).

Both professors and students, with varying percentages (32% and 42%), disagreed with relying on ready-made designs without thought, which moderates students' architectural creativity. Students' reliance on ready-made models in various digital tools and programs has several advantages, including reducing thinking and production time, minimizing errors, and being adaptable to project requirements. But Gerlich, M. (2025) explained that excessive reliance on this model weakens students' ability to think critically and innovate, acting as a creative impediment and limitation of architectural ideas, and preventing brainstorming, which can help solve many design problems.

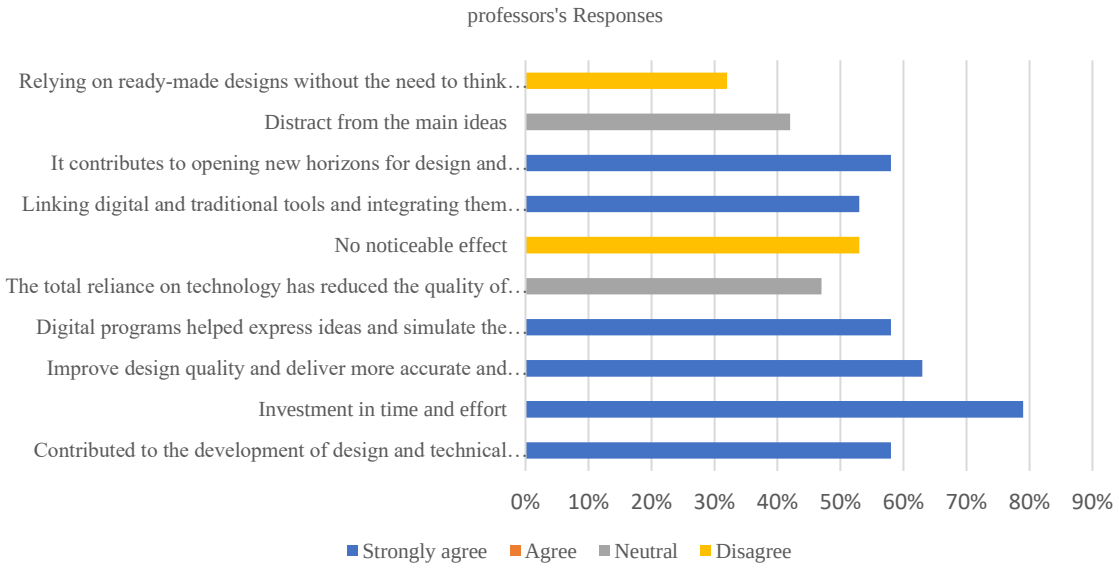

Fig 3: Professors' Responses

B- The impact of digital software tools on student collaboration in group projects?

Table 3: The impact of digital programs on student collaboration in group projects

Topic	Strongly agree		Agree		Disagree	
	Professors	Students	Professors	Students	Professors	Students
Reduces interaction between students and hinders communication between them.					68%	41%
Facilitates file sharing and encourages collaborative work.		44%	58%			
Use digital programs in teamwork effectively			58%	49%		

As shown in Table 3 and Figure 3, both professors and students disagree with varying degrees on the statement that digital software tools reduce interaction among students and hinder communication at varying rates, 68% and 41% respectively. But they agree that rates 58%, 44%, and 49% of users of digital software tools facilitate and effectively impact group work. These percentages support the discussions of Shinde (2024), Ceylan (2024), and Ayeke (2024), who discussed that digital tools play a significant role in developing students' capabilities through various means, including easy and smooth interaction between students and their professors. Furthermore, these software tools create a social base and educational environment that fosters collaboration, participation, discussion, the exchange of opinions, the development of technical skills, criticism, and feedback. They also develop the ability to work collaboratively and communicate in academic projects that require group participation, as digital software tools provide opportunities for file transfer and collective learning.

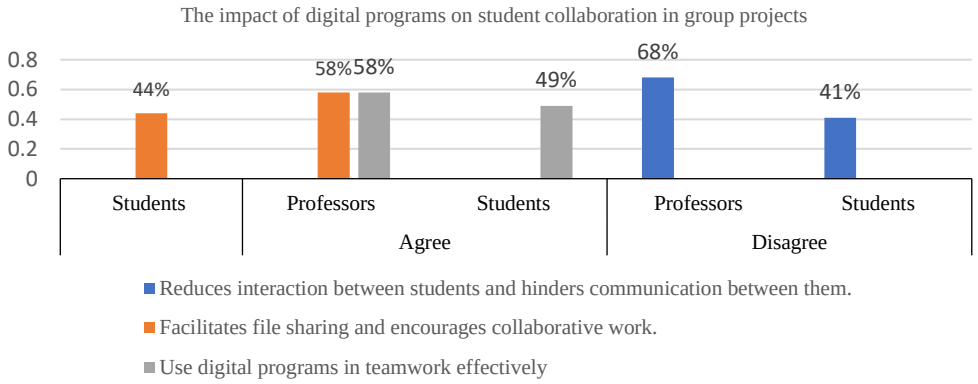

Fig 3: Professors and Students' responses

Section Four:

A: Advantages of using digital software tools in architectural design.

Some of the advantages of using digital software tools in architectural design have been presented to professors and students to obtain their opinions, which are in Table 4. All opinions were somewhat similar in some topics and divergent in other points, as shown clearly in Figure 4.

Table 4: The advantages of using digital software in architectural design.

Topic	Strongly agree		Agree		Natural	
	Professors	Students	Professors	Students	Professors	students
Ease of modifying and changing designs	63%	64%				
Speed of output of charts and drawings	63%	53%				
Accuracy and speed	68%	46%				
Adaptation and integration			53%	37%		
Improve decision-making and mitigate risks	37%					39%

Both professors and students strongly agreed, with very close percentages (63% and 64%, respectively), that digital software tools facilitate the process of modifying and changing the design without requiring significant effort from students. The researchers (Fadjri, M., & Ekawardhani, Y., 2020) indicated that these programs reduce the problems resulting from modifying and changing the designs smoothly, characterized by ease of use and clarity of presentation.

The percentages varied (63%, 68%, 53%, 46%), expressing strong agreement for both samples regarding the accuracy and speed of producing plans and drawings. Mosalanejad, N (2025) discussed these points, stating that these tools have high efficiency and accuracy in terms of speed of preparation, speed of completion, and production of architectural plans in record time and at the lowest cost. On the other hand, traditional tools can take time to design, modify, and produce the project in its final form.

Both professors and students, at varying rates (53% and 37% respectively), agreed on a significant feature of digital software tools: the ability to integrate and modify many of the basic components of architectural designs, such as plans, sections, facades, and other elements, to create a diverse architectural, spatial, and illustrative vision for the project. These are confirmed by Kwak, E. (2023) [22], who stated that digital tools contribute to integrating architectural elements to create a realistic interactive environment, with the possibility of diversifying the presentation of ideas, which is compatible with the surroundings and location, and completing all requirements quickly.

Professors strongly agreed (37%), while students were almost neutral (39%), regarding the idea that this digital software contributes to enhancing decision-making ability and reducing risks. Irwan, D., & Nurmala, N. (2023) emphasized that these programs develop decision-making abilities and reduce problems and risks by offering the best solutions, which allows students to develop their projects and obtain an accurate vision of them that is closer to reality.

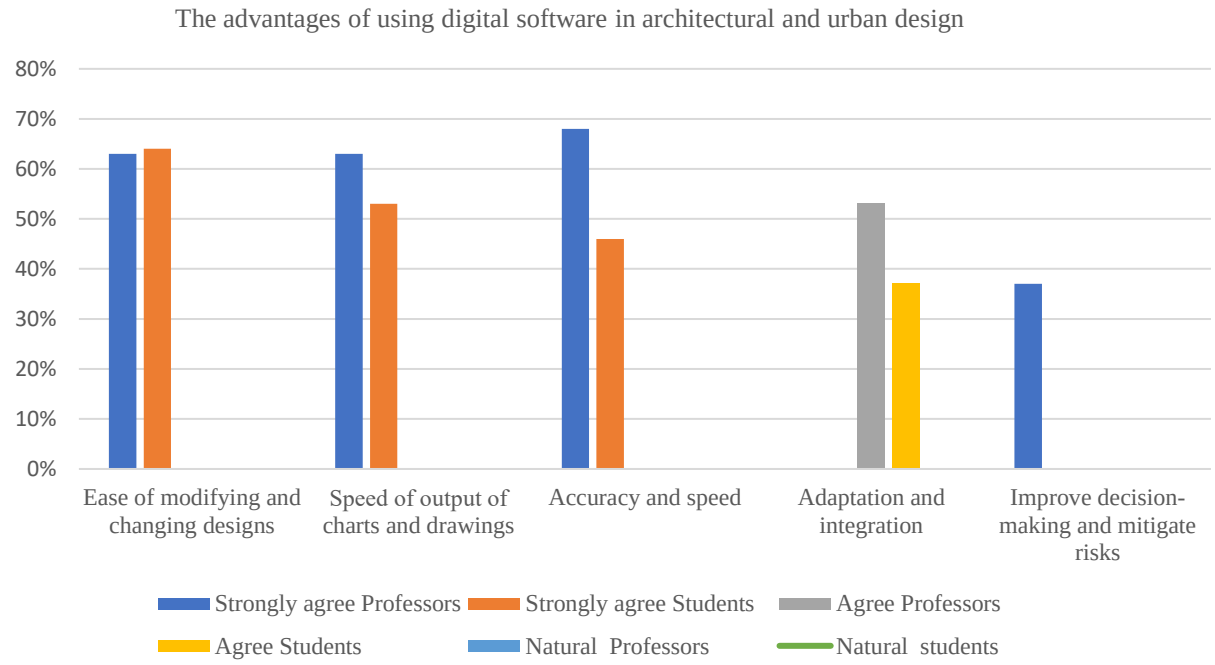

Fig 4: Professors and Students' responses

B: Disadvantages of using digital software tools

The researcher discussed some shortcomings and problems that students and professors face. The responses were similar in opinion but divergent in percentages, as shown in Table 5 and Figure 5.

Professors and students agreed that the difficulty of learning several digital software programs for students at varying rates was 63% and 49%, respectively. Many digital tools may require high skills, significant effort, and a considerable amount of time to learn, especially for new students. These statements align with what Ceylan (2024) indicates, that the mechanism of dealing with and using such digital software tools requires considerable effort to learn.

Both professors and students strongly agreed with percentages (47%, 40%) that excessive reliance on digital tools weakens the hand-drawing of students. In addition, they create a gap in all levels (intellectual, creative, and cognitive) between them and their architectural work. This agrees with Gerlich's (2025) view, who explained that the frequent use of digital software tools and their complete reliance on them negatively impact the creative abilities of students, including various hand-drawing skills.

(47%, 54%) were the percentages of both professors and students who strongly agreed with the statement that digital programs require powerful, high-spec computers. Such devices are expensive and require a large amount

of money to purchase. It is one of the weaknesses that Ceylan (2024) has pointed out in their research. They clarified that some students' financial inability to acquire computers is compatible with the requirements of digital software. Both professors and students agreed, to varying degrees (32%, 46%), that digital programs and tools weaken or reduce the critical and analytical thinking abilities of students in general. It is compatible with the findings of Kamel, M., & Khalil, M. (2023) [23], who concluded that students lose their passion for creativity in the early stages of the design process and, during the idea generation stage, as a result of excessive use of digital software tools as design aids. It is clearly evident in limited thinking, negatively impacting their creative potential.

Table 5: The most important disadvantages of using digital software tools.

Topic	Strongly agree		Agree		Natural		Disagree	
	Professors	Students	Professors	Students	Professors	students	Professors	Students
Difficulty learning some programs for students			63%	49%				
Over-reliance on digital software weakens hand-drawing skills.	47%	40%						
The need for powerful and expensive computers	47%	54%						
Reducing critical and analytical thinking			32%	46%				
Technical problems and data loss		41%	42%					
Confusion due to the large number of tools and programs			42%	29%				
Complexity in implementation					42%	44%		
Reduces the creativity of the architect.							26%	17%

Both professors and students agreed with very close percentages (41%, 42%) that computers and digital software tools are prone to technical problems, which sometimes result in data loss and corruption. Kamel, M., & Khalil, M (2023) confirmed that issues arising from technology and digital software malfunctions, and sometimes security breaches of these programs, require a long time to resolve, which in turn leads to distraction and a lack of thinking and creativity in solving design problems, especially during the idea generation stage.

Both professors and students agreed, with varying rates (42%, 29%), on the confusion and disarray that occur among students due to the use of a large number of digital software tools in the design process. It leads to a lack of interaction between students' skills in drawing and design thinking, a lack of focus on several important design details, a lack of balance, clarity, and precision in the architectural project stages [24].

The opinions of both professors and students were natural, with very similar percentages (42%, 44%) on the complexity of design and implementation resulting from the complex architectural forms that emerged with the advent of digital software tools. This requires providing a digital infrastructure that serves as a foundation to allow students to learn professionally and proficiently, that rises to the level of complexity in the formation, employment, construction, and implementation of such complex designs.

Both professors and students, with percentages of (26%, 17%), disagreed with the view that digital tools reduce the creativity of students. On the contrary, they opened horizons for them to think outside the box without any intellectual, creative, or artistic limitations. Ayeke, E. et al. (2024) discussed the positive impact of digital software tools on students' ideas and visions through creativity in architectural concepts and virtual simulation in different design stages. These programs contributed effectively to enhancing their architectural capabilities and skills.

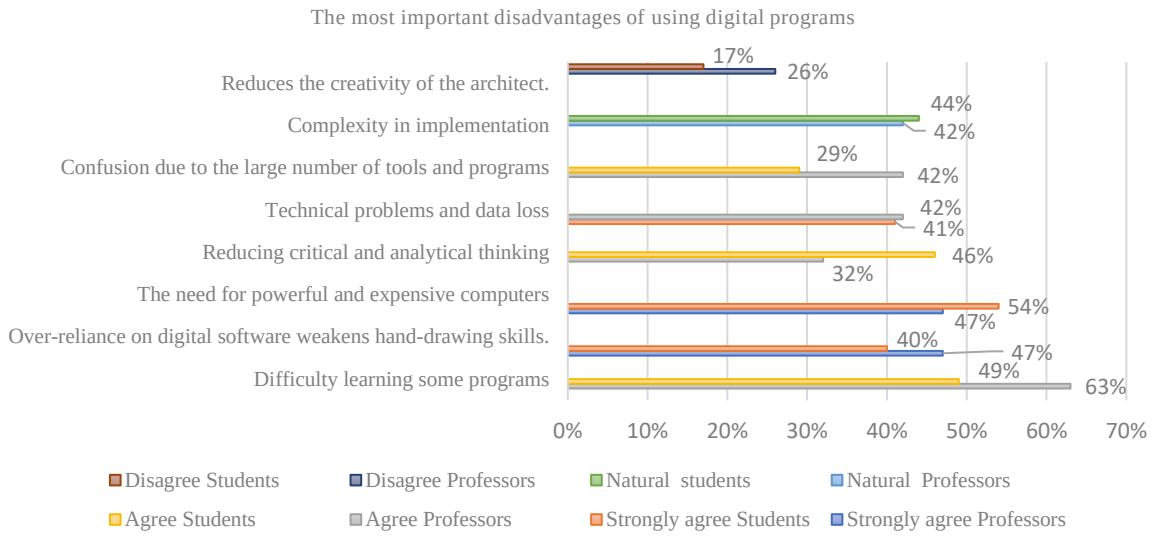

Fig 5: Professors and Students' responses

Section Five: Dilemmas and challenges facing architectural education in the use of such digital tools in the Department of Architecture at the University of Tripoli

Some of the challenges and obstacles that resulted from the use of digital software tools in architectural design surfaced. The researcher identified a number of them and discussed them with the samples, as shown in Table 6.

As shown in Figure 6, 42% of professors agreed that the quality of drawings using digital tools is low. It is clearly evident in the drawings of students in the early stages of their study who are using digital software tools such as CAD for the first time, as well as advanced-stage students in their education who are using AI for the first time. Some students (33%) disagreed with this opinion, who believed that digital tools do not affect the quality of the drawings presented. But this is contrary to the view of Qaradaghi, A., Jamal, H. (2015) [25], who explained that the frequent use of digital software tools harms the drawing skills of students and architects in general. In addition, it weakens the skills of discovering and creating ideas, slows down creative and imaginative thinking, and makes them dependent on initial ideas when using digital software tools, and does not develop their sketches.

Both professors and students agreed on varying stages of difficulty in learning some complex digital software tools (79%, 51%). Learning various types of digital software tools requires learners, whether students or engineers, to put in a great deal of effort, focus, understanding, and the ability to apply what they have learned in practice. Furthermore, these tools require users to acquire advanced computers that are compatible with multiple programs, and to spend a significant amount of money on training courses to learn how to use these advanced tools [26].

Professors strongly agreed (47%), while students (43%) agreed, regarding the lack of practical training for students, on all different types of digital software tools during their studies. This is attributed to several reasons, including the lack of trained, qualified academic staff with technical knowledge of the various types of these tools. At this statement, both samples strongly agreed with similar percentages (63% and 59%). The high financial cost of training in these programs, combined with the continuous and rapid progress and development of these programs, makes keeping up with them extremely difficult. This is consistent with what Praise, K & Grace, I. (2023) [27] discussed that regular, prepaid training for lecturers, organized by their affiliated entities, on all digital software tools and programs, enables them to develop their technical and digital capabilities and stay updated on modern developments. It allows professors to solve all issues raised by students related to the use of digital software tools in architectural design.

Professors with a percentage (95%, 74%) and students with a percentage (60%, 50%) both strongly agreed with the statements regarding the lack of full support for digital software tools from the college and the high cost of electronic devices supporting this software. Both original software and computers are expensive and strain the budgets of students and professors. Ceylan, S, & et al (2024) discussed that some students are unable to afford computers that meet the requirements of digital programs. Digital software tools are essential and supportive in developing students' various skills to keep pace with quick technological developments. Furthermore, without computers, these programs cannot work. Therefore, universities are responsible for providing these digital software tools in their original versions for free and computers at a reasonable and affordable price in all their colleges, making them available to all students and professors, contributing to improvement and raising the level of educational strategies. In addition, Mexhuani, B. (2024 emphasized the importance of advanced strategic planning to develop, support, and integrate digital software tools into the educational plan to create an academic environment that keeps pace with digital progress.

Table 6: The obstacles and challenges facing architectural education in using such digital technologies in the Department of Architecture at the University of Tripoli

Topics	Strongly agree		Agree		natural		Disagree	
	Professors	Students	Professors	Students	Professors	Students	Professors	Students
Decreased quality of graphics			42%					33%
Difficulty learning some complex programs			79%	51%				
Lack of practical training in digital applications during the study	47%			43%				
Lack of full support from the college	95%	60%						
High cost of equipment required for operation	74%	50%						
Failure to update curricula to keep pace with technological developments	68%	52%						
Lack of qualified academic staff to teach the programs	63%	59%						
Some professors' resistance to digital change			53%			30%		
Poor basic digital skills			47%			33%		
pressure of the academic curricula and many projects		44%	53%					
Power and internet outage	37%	34%						

Both professors and students strongly agreed with percentages of (68% and 52%, respectively) that curricula had not been updated to keep pace with technological developments in assistive computer programs. Soliman, S & et al (2019) explained that the widespread and rapid improvement of digital technologies and their applications has had a significant impact on reshaping the educational structure of architectural education curricula. The largest share of digital technology use was in architectural design, with its various functional classifications, which has evolved beyond being an effective tool for drawing to include effect modelling, analysis, programming, and other digital uses. This forces architecture departments to develop a strategy that integrates these technologies into the curriculum as basic academic subjects, adapts to these developments, and is taught to students within a practical framework interconnected with traditional architectural education methods.

Fifty-three per cent of professors agreed, while 30% of students remained neutral, regarding resistance to the implementation of digital software tools. Some professors opposed incorporating these tools early in the design curriculum for various reasons, including concerns about their effect on students' creative and analytical abilities and drawing skills in design subjects. This finding is consistent with the view of Heidari, P., and Polatoğlu, C. (2018) [28], which indicated that professors prefer students to initially use their hands for drawing or combine traditional methods with different programmes rather than relying solely on digital tools in the advanced stages. Additionally, Deacon, B. et al. (2025) [29] noted that some professors' reluctance to adopt these programmes may stem from a lack of a clear scientific framework for integrating computer software tools into the architecture curriculum.

Forty-seven per cent of professors agreed, while 33% of students were neutral, about the weak capabilities and skills of new or novice students in working with digital software tools. Students enter architecture departments without the slightest idea about these digital assistant tools. As soon as they enter the architecture department, they begin to learn the basics of this technology, which does not qualify them to be creative with it. Therefore, through my experience in dealing with students in the courses I undertake, I noticed that students' weak capabilities in using drawing assistance tools are due to their limited experience with them, and their failure to use some of the advanced programs required for the semester, which require practice and familiarity. It has led to a decline in the quality of students' drawings and, consequently, weak design outputs for their projects in all aspects [30].

Fifty-three per cent of professors agreed, and 44% of students strongly agreed, that academic pressure and the large number of projects significantly impact students' design and creativity skills, weakening their ability to use digital computer tools and programs, thus affecting their educational outcomes in architectural design. Figueroa, R. et al. (2025) explained that managing academic pressure has a significant impact on students' physical, mental, and creative well-being. Factors that cause stress include time constraints, level of performance, and academic workload, all of which have significant impacts on students' academic performance and the quality of education.
Both professors and students strongly agreed, with similar percentages (37% and 34%), that power and internet outages are among the obstacles and challenges that face students and professors, impacting their educational outcomes. Shibub, M. (2025) highlighted that power outages cause internet cuts, which prevent students from downloading essential programs and applications that aid in digitally drawing their projects. In addition, Oluwapelumi, T; et al. (2024, P. 51 stated that "students reported that power outages during critical study periods or while working on assignments led to reduced study time, missed deadlines, and lower-quality work submissions".

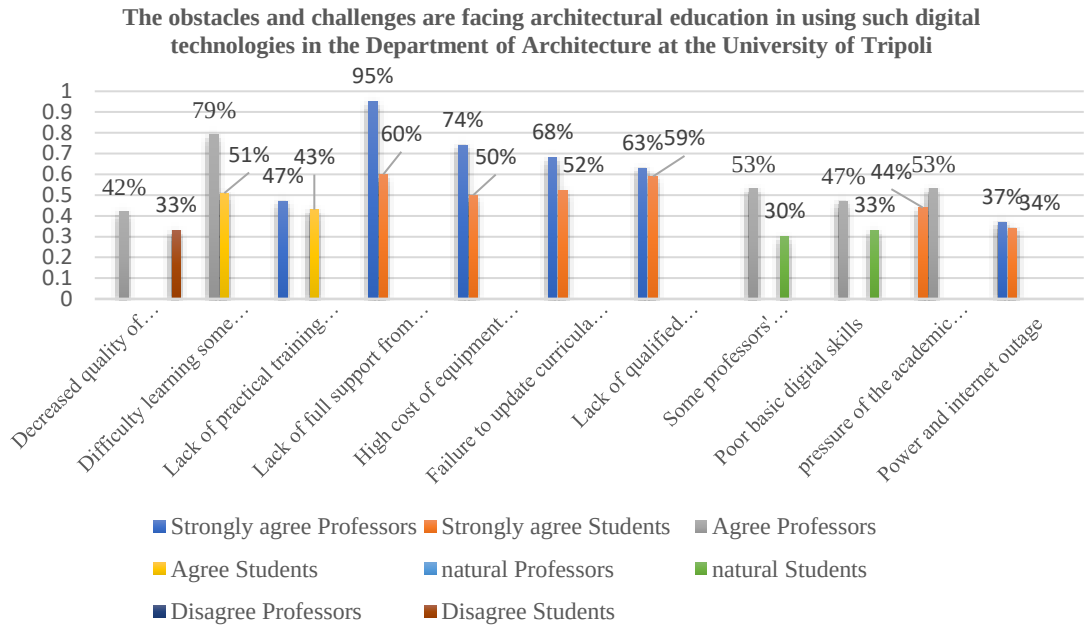

Fig 6: Professors and Students responses

Conclusion

The widespread use of digital software tools and their applications has had a significant impact on reshaping the educational structure of architectural curricula. The largest share of digital software technology used in architectural design, regardless of its functional classification, has evolved beyond being an effective tool for drawing to become influential in modelling, analysis, programming, and other digital uses. Architectural design is the fundamental pillar and backbone of architectural education, through which it is possible to keep pace with the development of curriculum and educational tools and reflect the outcomes of adopting modern digital software tools. From this perspective, the researcher has sought to shed light on the positive and negative effects of using modern digital software tools on students' outputs in architectural design. In previous years, before the advent of advanced computer technologies, students in architecture departments at world universities, in general, and in Libyan universities in particular, relied on traditional design methods, including two- and three-dimensional sketches drawn by hand. But, with the emergence of modern digital software tools in the early twentieth century, such as CAD, ArchiCAD, Revit, and virtual reality tools, along with artificial intelligence and other advanced digital software that witnessed unprecedented rapid development to meet diverse needs at all levels—humanitarian, design, construction, and creativity—this had a transformative impact on architectural design drawing tools. These tools entered Libya in the late twentieth century, bringing about a radical change in architectural education in the architecture departments of Libyan universities.
By reviewing various literature reviews and analyzing the opinions of professors and students, the following research questions can be addressed:

Main Question

1. **How do digital software tools impact student outputs in architectural design studios, focusing on creative, intellectual, and collaborative skills and communication?**

The introduction of digital software techniques and tools into architecture has had a significant impact on the way architecture students approach their various projects. These include:

- Raising awareness of precision, efficiency, and professionalism.
- Contributing to products' attractive architectural forms and ideas easily, without the need for any effort or trouble.
- Enhancing students' capabilities and skills, opening new horizons for design, replacing traditional thinking and design tools, making intelligence, creativity, and imagination within reach.
- Reducing thinking, production, and error time, and allowing for modification based on project requirements.
- Providing students with greater freedom to engage in depth with all site data, its environmental and topographical limitations, and their impact on the formation of architectural forms, while adapting to diverse climatic conditions.
- Expands the horizons of vision and innovative expression by producing unconventional and complex architectural geometric forms that reflect the influence of digital software tools, ushering in a new era of development in architectural design.
- Assists professors in the evaluation process and clarifies design and construction problems through digital parametric design tools and virtual simulation, effectively enhancing architectural design outcomes.
- Enhances easy and seamless interaction between students and their professors, fostering a social environment and educational atmosphere that promotes collaboration, participation, discussion, opinion exchange, technical skill development, constructive criticism, and feedback.

The use of digital software tools and their applications in the early stages of study has many cons, including:

- It reduces the quality of architectural projects in various design studios due to students' weak skills in handling multiple digital tools.
- It negatively impacts students' ability to communicate architectural design ideas at various stages.
- It leads to loss of critical thinking and creativity; furthermore, a lack of understanding of the basic concepts of architecture.
- It distracts from the essential ideas of the design process, given that students' focus is on learning the technical characteristics of digital software tools.
- It neglects a large number of fundamental design aspects, such as design, functional, and structural standards.
- It leads to a loss of a sense of human scale.
- It negatively impacts students' cognitive abilities, critical analytical thinking, and various manual drawing skills.

Reliance on ready-made models in software tools weakens students' ability to think, limiting their architectural creativity and preventing them from applying the brainstorming method to solve many design problems.

Sub Questions

2. **What digital software tools do students and faculty members prefer to use?**

The most important software that professors and students emphasized in their widespread use are AutoCAD, SketchUp, Photoshop, and Revit. Many digital software tools have recently emerged with advanced technical methods and various applications, such as VR, AR, and AI, which have a significant impact on the design process of architectural projects during the design and implementation phases. Most digital software tools are used in the design and visualization of various projects in 2D and 3D formats, contributing to the production of images that are almost realistic for architectural projects.

3. **What are the advantages and disadvantages of using digital software tools in architectural design?**

The most important advantages include:

- Facilitating the process of modification and change, reducing the resulting design problems, without significant effort on the part of students, through applying a seamless approach characterized by ease of use and clarity of presentation.
- Highly efficient and accurate in terms of speed of preparation, rapid completion, and the production of architectural plans in record time and at the lowest cost.
- Integrating architectural solutions to create a realistic, interactive environment, with the possibility of diversifying the presentation of ideas compatible with the surroundings, location, and completing all requirements quickly.

- Developing decision-making capabilities and reducing risks by offering the best solutions, enabling students to develop their projects and gain an accurate and realistic vision.

The disadvantages of using digital software tools are:

- Many digital software tools require advanced skills, a significant effort, and a long time to learn, especially for new students.
- Over-reliance on digital software weakens hand-drawing skills, negatively impacts students' creative abilities, and creates a gap at all levels (intellectual, creativity, and cognitive) between them and architectural work.
- The poor quality of drawings that have been created by using digital tools is evident in the drawings of students in the early stages of study, such as CAD for the first time to use, as well as advanced students in their use of AI and some other tools, due to their limited knowledge of these digital software. In addition, Students begin to think and create initial sketches of the idea and plans directly through using these software tools, without using external hand sketches.
- Students rely entirely on initial ideas and do not develop them further.
- Students' critical and analytical thinking abilities are weakened or diminished, and they lose their passion for creativity in the early stages of the design process, such as the idea generation stage.

4. **What are the dilemmas facing architectural education in the use of such digital software tools in the Department of Architecture at the University of Tripoli?**

Architectural design projects output dilemma.

- The weakness of students' capabilities to work with assistive digital software tools.
- The lack of trained personnel with technical knowledge of the various types of these tools.
- Practical training is lacking for students on all digital software types during their studies.
- The high financial cost of training for these programs.
- The continuous and rapid advancement and development of these programs make keeping up with them extremely difficult.

Financial dilemma.

- Digital software requires high-quality computers that are compatible with these programs. Furthermore, learning how to use these advanced tools requires enrolling in training courses. However, these types of equipment and courses are expensive, requiring significant financial resources that burden the budgets of students and professors.

Supportive dilemma.

- The lack of full support for purchasing original digital software tools for students by the relevant university's authorities.

Curriculum modernization dilemma.

- The failure to update curricula to keep pace with technological developments in many programs, as well as the lack of mechanisms for integrating these digital tools with traditional methods in selected courses within the architecture curriculum. These issues stem from a lack of scientific vision in addressing these challenges.

Academic pressure dilemma

- The various types and large number of projects that students undertake during the course have a significant impact on students' design and creative skills, and weaken their ability to use digital software tools and programs.

Power and internet outages dilemma

- The poor electricity and frequent internet outages are leading to damage to digital copies and sometimes loss of them. All the previous issues have caused the accumulation of tasks and the short timeframe allotted for project completion. As a result of all problems, the lower-quality architectural project drawings negatively impact students' educational outputs.

The answer to the second part of the main question in this research paper, which is how to reduce the negative impacts of digital software tools, involves a mechanism to lessen the adverse effects of digital software on students' outputs in architectural design.

Recommendations

The Reduction Mechanism for the Impacts of Digital Software Tools on Students' outputs in Architectural Design courses.

1. Control the use of digital software tools.

- Preventing students in the early stages of architectural design studies within architecture departments from using digital software tools, as they weaken their hand-drawing skills. It negatively impacts their creative abilities and creates a gap at all levels (intellectual, inventive, and cognitive) between them and the architectural project.
- Develop students' architectural and freehand drawing skills at the beginning and enhance their ability to generate ideas, innovate, cultivate imagination, and express themselves through their architectural design.
- Raise students' awareness of precision, efficiency, professionalism, and a sense of space and human scale in architectural projects.
- Enrich students' thinking through an in-depth introduction to the basic concepts of architecture.
- Focus on the basic stages of the design process in core subjects for architectural education.
- The quotation of selected ready-made architectural models or projects has negatively affected students' thinking and limited their architectural ideas. Using brainstorming can help solve several design problems.
- Regulating the use of some advanced digital tools, such as artificial intelligence, in the advanced stages of architectural design in architecture departments, such as the Graduation Projects Studio.

2. Developing the Digital Infrastructure

- Developing the capacity of students and faculty to learn such digital programs and tools by providing several free training courses that keep pace with these modern technologies.
- Providing full or partial support from university authorities for the purchase of original digital software tools and modern computers, making them available to all students and professors, and contributing to improving and raising the level of educational strategies.
- Proactive strategic planning for the development of digital tools and supporting them to build an educational environment that keeps pace with digital developments.
- Providing a clear scientific vision regarding the structure of integrating computer software tools into the architecture curriculum.
- Updating curricula to keep pace with technological developments in assistive computer programs.
- Maintaining and developing electricity and internet services, increasing their speed, and making them available free of charge to students, professors, and campus workers, to enhance the level of technical services.

3. Encouraging the Integration of Digital and Traditional Tools at the Intermediate and Advanced Levels of Architectural Education.

- Integrating digital and traditional tools into educational programs opens new horizons for design, enabling intelligence, creativity, and imagination to be reached at all intellectual and practical levels.
- Managing academic pressure, which has a significant impact on students' physical, mental, and creative health, and consequently on the quality of education and its outcomes.
- Motivating students to devise and create a variety of ideas and solutions in architectural design and develop them according to the various characteristics of the function, the user, and the site.
- Working to produce attractive architectural forms and ideas in a sophisticated style keeps pace with digital development.
- Reducing thinking and production time, errors, and the possibility of modification according to project requirements by using digital software tools.
- High efficiency and speed in preparation are the most notable features that drive the completion of architectural plans in record time.
- Contributing to the integration of architectural solutions to create a realistic interactive environment, with the possibility of diverse presentation of ideas compatible with the surroundings, and completing all requirements quickly.
- Develops decision-making skills that help reduce risks and problems and gain a more accurate, realistic view of them.
- Expands the scope of vision and creative expression by dealing with unconventional and complex geometric shapes in architectural design

.

4. Establishing a Social Foundation for Architectural Work

- It fosters positive interactions between students and their professors, creating a social foundation and learning environment for collaboration, participation, discussion, exchange of opinions and technical skills, criticism, and feedback.
- It supports collaborative group work among students and enables the transfer of digital files.
- It promotes unified, collaborative, and integrated group work, aligning vision and efforts to exchange knowledge and achieve desired goals.

5. The Evaluation Process and Digital Performance in the Architectural Design Process

- Assists professors in the evaluation process and clarifies design and construction problems through the use of digital parametric design programs and virtual, thus playing an effective role in improving architectural design outputs.
- Assesses knowledge skills, reflected in the compilation of relevant information using the techniques of research, compilation, study, and analysis, and extracting what is appropriate for the design problem.
- Assesses innovative ideas and precision in production.
- Assesses the ability to link function, form, and structural system through digital software tools.
- Assesses the ability to sense human scale.
- Assesses decision-making skills at all levels (thinking, analysis, creativity, productivity) affecting the design process.

Ethics Statement

This research was conducted in accordance with the ethical standards of Tripoli University and comparable ethical standards. Informed consent was obtained from all individual participants included in the research. All data were anonymized to protect participant confidentiality.

No animals were used in this research. The author declares that she has no conflicts of interest related to this research.

Authorship Contribution Statement

Dr. Mariam MT Shibub writes all the parts of the research paper, including (Research paper structure and design, review and writing of the scientific article, methodology, data collection and analysis, discussion and conclusion, strategy, and recommendations).

Declaration of Competing Interest

The author declares that she has no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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