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The Impact of Software Pedagogy on Architectural Creativity: Finding the Appropriate Method and Time for Teaching Software to Architecture Students

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ABSTRACT

Background and Objectives: The rapid advancement of computer technology has revolutionized various aspects of work and life, emphasizing the need for training and proper utilization of digital tools. Architectural software has become integral to the design process, enabling architects to explore new methods. However, concerns have arisen regarding the impact of software on creativity and innovation. This study aims to determine the appropriate timing and method for teaching software to architecture students while mitigating the negative effects on creativity. The findings will contribute to the development of more effective software training approaches in architecture schools and design firms. While technology offers benefits such as increased design speed and visualization, a balance between digital tools and traditional methods should be maintained in architectural education.

Materials and Methods: The study adopts a qualitative approach, involving activities such as observation, interviews, and extensive participation in research activities to obtain firsthand information about the research subject. Qualitative research encompasses various data collection methods such as field research, observation or participation, and in-depth interviews. In the initial phase, the documentary method and library study were employed to establish the theoretical foundations of the research topic. In-depth interviews were conducted to gather information from experts in the field of architectural education. Data analysis involved content analysis, where the components of the collected text were categorized and counted. The independent variables of the research are the correct method and timing of teaching architectural software to students, while the dependent variable is the improvement of students' efficiency and benefit from learning the software. The findings were derived from the analysis of the interview responses and logical reasoning.

Findings: The findings of the research indicate that students entering the field of architecture should first develop a solid foundation in hand drawing and design principles before delving into architectural software. Early exposure to software without a proper understanding of architecture can hinder creativity and result in the production of complex forms devoid of purpose and spatial understanding. It is recommended that students establish a strong connection between their hand, eye, and mind through freehand drawing and creative thinking before transitioning to digital software. The concept stage of design is best approached through manual sketches and modeling, while software can be utilized in later stages. Simultaneous teaching of software alongside other architectural subjects may lead to information overload and reduced focus. A progressive and integrated approach to teaching software within the curriculum is suggested to enhance students' practical application of software tools. This research provides insights for developing an effective educational method that prepares students for the job market while fostering their creativity and architectural understanding.

Conclusions: The research findings suggest that students should learn architectural software after developing a foundation in hand drawing and design principles. Starting software training too early can hinder creativity and result in superficial designs. Teaching software alongside other architectural subjects in a progressive and integrated manner is recommended. Practical, project-based training helps students understand software features and promotes lasting learning. Unnecessary software components should be avoided to prevent confusion. Universities should modify their programs to meet students' needs in the job market and provide comprehensive software education.

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66

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مقاله پژوهشی

تاثیر آموزش نرم‌افزار بر خلاقیت معماری: یافتن روش و زمان مناسب برای آموزش نرم‌افزار به دانشجویان معماری

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چکیده

پیشینه و اهداف: پیشرفت سریع فناوری کامپیوتر، جنبه‌های مختلف کار و زندگی را متحول کرده و بر لزوم آموزش و استفاده صحیح از ابزارهای دیجیتال تاکید دارد. نرم‌افزارهای معماری به فرآیند طراحی تبدیل شده‌اند و معماران را قادر می‌سازند تا روش‌های جدید را کشف کنند. با این حال، نگرانی‌هایی در مورد تأثیر نرم‌افزار بر خلاقیت و نوآوری ایجاد شده است. این مطالعه با هدف تعیین زمان و روش مناسب برای آموزش نرم‌افزار به دانشجویان معماری ضمن کاهش اثرات منفی بر خلاقیت انجام شده است. این یافته‌ها به توسعه رویکردهای آموزش نرم‌افزار موثرتر در دانشکده‌های معماری و شرکت‌های طراحی کمک خواهد کرد. در حالی که فناوری مزایایی مانند افزایش سرعت طراحی و تجسم را ارائه می‌دهد، تعادل بین ابزارهای دیجیتال و روش‌های سنتی باید در آموزش معماری حفظ شود.

روش‌ها: این مطالعه رویکردی کیفی را اتخاذ می‌کند که شامل فعالیت‌هایی مانند مشاهده، مصاحبه و مشارکت گسترده در فعالیت‌های پژوهشی برای به دست آوردن اطلاعات دست اول در مورد موضوع تحقیق است. تحقیق کیفی شامل روش‌های مختلف گردآوری داده‌ها مانند تحقیق میدانی، مشاهده یا مشارکت و مصاحبه‌های عمیق است. در مرحله اول از روش اسنادی و مطالعه کتابخانه‌ای برای ایجاد مبانی نظری موضوع تحقیق استفاده شد. مصاحبه‌های عمیق برای جمع‌آوری اطلاعات از کارشناسان در زمینه آموزش معماری انجام شد. تجزیه و تحلیل داده‌ها شامل تحلیل محتوا بود که در آن اجزای متن جمع‌آوری شده دسته بندی و شمارش شدند. متغیر مستقل تحقیق روش و زمان بندی صحیح آموزش نرم‌افزارهای معماری به دانشجویان و متغیر وابسته ارتقای کارایی و بهره مندی دانشجویان از یادگیری نرم‌افزار می‌باشد. یافته‌ها از تجزیه و تحلیل پاسخ‌های مصاحبه و استدلال منطقی به دست آمده است.

یافته‌ها: یافته‌های پژوهش حاکی از آن است که دانشجویانی که وارد رشته معماری می‌شوند، قبل از پرداختن به نرم‌افزارهای معماری، ابتدا باید پایه‌ای محکم در اصول طراحی دستی و طراحی ایجاد کنند. استفاده زودهنگام از نرم‌افزار بدون درک صحیح از معماری می‌تواند مانع خلاقیت شود و منجر به تولید فرم‌های پیچیده عاری از هدف و درک فضایی شود. توصیه می‌شود که دانشجویان قبل از شروع به استفاده نرم‌افزار دیجیتال، از طریق طراحی دست آزاد و تفکر خلاق، ارتباط قوی بین دست، چشم و ذهن خود برقرار کنند. مرحله مفهومی طراحی به بهترین وجه از طریق طرح‌های دستی و مدل سازی انجام می‌شود؛ نرم‌افزار را می‌توان در مراحل بعدی مورد استفاده قرار داد. آموزش همزمان نرم‌افزار در کنار سایر موضوعات معماری ممکن است منجر به اضافه بار اطلاعات و کاهش تمرکز شود. یک رویکرد مترقی و یکپارچه برای آموزش نرم‌افزار در برنامه درسی برای افزایش کاربرد عملی ابزارهای نرم‌افزاری توسط دانش آموزان پیشنهاد شده است. این تحقیق بینش‌هایی را برای توسعه یک روش آموزشی مؤثر ارائه می‌دهد که دانشجویان را برای بازار کار آماده می‌کند و در عین حال خلاقیت و درک معماری آنها را تقویت می‌کند.

نتیجه‌گیری: یافته‌های تحقیق نشان می‌دهد که دانشجویان باید نرم‌افزار معماری را پس از ایجاد پایه‌ای در طراحی دستی و اصول طراحی بیاموزند. شروع زودهنگام آموزش نرم‌افزار می‌تواند مانع خلاقیت شود و منجر به طراحی‌های سطحی شود. آموزش نرم افزار در کنار سایر دروس معماری به صورت پیش رونده و یکپارچه توصیه می‌شود. آموزش عملی و مبتنی بر پروژه به دانش‌آموزان کمک می‌کند ویژگی‌های نرم‌افزار را درک کنند و یادگیری پایدار را ترویج می‌کند. برای جلوگیری از سردرگمی باید از اجزای نرم افزاری غیر ضروری اجتناب شود. دانشگاه‌ها باید برنامه‌های خود را برای رفع نیازهای دانشجویان در بازار کار اصلاح کنند و آموزش نرم‌افزاری جامع ارائه دهند.

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Introduction

The rapid advancement of computer technology has revolutionized various aspects of work and life, making training and proper use of these technologies essential [1]. Digital technologies are recognized as essential tools for achieving quality, universal, and equitable education [2-4]. Today, social and technological innovations are intertwined, and the use of digital tools in the design process has become essential. Architectural software, such as computer-aided design, parametric design, 3D printing, augmented reality, and artificial intelligence, has transformed the architectural design process, enabling architects to invent new design methods. As a result, the use of these technologies has been accelerated in architecture schools and design companies [5- 7].

Moreover, the complexity of building construction projects and the need for more efficient and cost-effective manufacturing methods have made it critical to develop architectural engineering education using multimedia systems such as immersive virtual reality, videos, and simulation technologies [8,9]. Such advancements can also be particularly useful in disaster-prone areas for building shelters quickly and efficiently [10].

However, while learning architectural software is crucial for architecture students to increase the speed of work, prepare them to enter the labor market, and create designs with formal complexities, concerns have been raised regarding the impact of software on students' creativity and innovation. This study aims to determine the appropriate method and time for teaching software to architecture students to mitigate the negative impacts of using software on their creativity and innovation.

This research seeks to answer two main questions: when is the best time to start teaching architectural software to students, and what is the most effective method of teaching these software tools? The study will employ qualitative and survey methods, using content analysis to evaluate the gathered data from interviews.

The classification of digital design methods shows that the computer is not a neutral tool but actively shapes the designer's thinking and problem-solving approach [11]. Therefore, it is essential to determine the appropriate way and time to teach software to architecture students to ensure that their creativity and innovation are not limited to software. This study aims to provide insights into the best practices for teaching software to architecture students, taking into account their creativity and innovation. This research aims to find answers to the following questions: When is the best time for architecture students to start learning architectural software? And what is the best way to learn these software programs? The findings of this research will inform the development of more effective software pedagogy in architecture schools and design companies.

Review of the Related Literature

While information and communication technologies have been successful in teaching and learning, they face challenges in creative fields like architecture [12]. The range of professional skills required in architecture, including freehand design and model making, are traditionally passed down from teacher to student [13]. However, the new digital generation of students has led to a shift towards computer-aided design, which can significantly improve the quality of teaching and learning [14,15].

The use of software in the design process has received significant attention from

researchers, as it may limit creativity, which is a crucial tool for designers [16]. Architectural software, despite their high efficiency and accuracy, can be complex and confusing for students [17]. Therefore, choosing the right software and using it effectively at all levels of design is essential for maintaining creativity [18]. Juhani Palasma believes that computers are incapable of thinking and imagination, and such mental abilities cannot be digitized or simulated by computers. The involvement of computers in design diminishes the role of humans in the design process and naturally diminishes their imaginative role [19].

The use of technology has many benefits, including increased design speed and the ability to visualize architectural plans from all angles before implementation [15, 20]. Virtual Reality (VR) technology is an essential tool for transitioning from teacher-centered to student-centered learning. VR technology offers an efficient and engaging way for students to learn, and it can be easily used in many courses offered in the architecture curriculum [21-24]. Architectural professors and students have a strong preference for using architectural design software due to its high precision, aesthetic appeal, ease of modification, and time-saving benefits [15].

Moreover, the development of computational design tools, such as generative design and machine learning, has also helped architecture students achieve better results in designing complex and challenging spaces [25]. However, to maintain a balance between digital tools and traditional methods, education based on manual skills and one-to-one construction should still be a fundamental part of architectural education programs [13,26]. the current structures of architecture education curricula cannot match the innovative challenges and social demands of architecture in the digital age [27].

As observed, most research has focused on the numerous benefits of architectural software in improving architectural quality, while some have addressed the drawbacks and deficiencies in education. However, none of the studies have delved into the impact of software on creativity, which is one of the primary tools of architects. Fostering creativity among architecture students is one of the main objectives of architectural education. Despite the considerable advantages of architectural software, it is essential to evaluate the side effects on students to determine the best approach for their education.

Optimized Learning Process

The optimized learning process refers to the use of methods that help students achieve the best results in the process of architectural design, taking into account the needs of the students and the characteristics of the software [21]. To achieve this goal, attention must be paid to the needs of the students in the learning process and methods should be chosen that facilitate learning and increase the students' concentration. In addition, modern and digital tools should be used for education, so that students can become familiar with new and better methods and achieve the best results in the process of architectural design [28-31].

Design Process

The architectural design process involves stages that range from initial design to project implementation [32, 33]. In this process, the design process is optimized based on the needs of the clients [34, 35]. The design stages include problem analysis, preliminary design, detailed design, and implementation [36]. In each of these stages, the characteristics and needs of the clients are considered to reach a final design that is compatible with the clients' goals [37-40].

Concept

Concept formation is a crucial aspect of architectural design. The concept is the result of problem analysis and is created in different stages of design with different scales and hierarchical nature [41]. Concept in architecture refers to the fundamental idea or central concept behind the design and creation of a building or architectural space [42]. This conceptual framework is used by architects to generate plans, forms, structures, and architectural details [11, 31]. Concepts are expressed with a simple diagram and a few words and may include the whole project or be part of the related plan [43]. Concepts are solutions to design problems that are formed in the mind, and their ability to be implemented is higher than ideas [39, 44, 45]. The concept is defined as the answer to the question because it is a vital question in the advancement of architectural design [46]. The architectural concept serves as a guide and foundation for design and implementation decisions throughout the architectural process. The architectural concept is intertwined with concepts of spatial qualities, interaction with the environment, user experience, materials and structures, connection with social and cultural context, and technology and innovation [47].

Digital architecture

Digital architecture is a field that utilizes computer modeling, programming, simulation, and visualization to create virtual forms and physical structures [48]. This movement in architecture provides a platform for increased creation and innovation by bridging architecture and digital science [11, 49]. Digital architecture encompasses all aspects of architecture, not only in the design and planning phase but also throughout the execution or construction phase. Furthermore, it can offer aesthetics through computer devices and systems with patterns different from contemporary architecture [50]. Digital architecture refers not only to architectural designs created using digital tools but also to designs proposed by computers as design collaborators [51,52]. Digital technologies make projects more efficient. Digital architecture is not merely the adoption of a set of technologies; it represents a fundamental shift in the architectural culture worldwide [53-55]. The use of digital design tools, aided by high-speed computer processing, increases the speed of design [56]. Architectural software in Iran can be divided into two categories: software used for drawing and presenting works and software that influences the conceptualization and architectural design process [57].

Digital architecture is already functioning worldwide, particularly with the use of Building Information Modeling (BIM), and its influence and culture cannot be disregarded. Despite being a relatively young subject, it necessitates scientific research [58]. Artificial intelligence has emerged as the latest digital tool that assists architects in various aspects, ranging from designing traditional structures to creating decorative elements [59].

Research innovation

This research focuses on the innovative aspect of investigating the impact of software pedagogy on architectural creativity. While previous studies have primarily highlighted the benefits of architectural software in enhancing architectural quality and discussed the drawbacks and deficiencies in education, none have specifically addressed the influence of software on creativity, which is a fundamental tool for architects. This study aims to fill this gap in the literature by exploring the appropriate method and time for teaching software to

architecture students, taking into account the potential negative effects on their creativity and innovation.

The research seeks to provide answers to two key questions: when is the optimal time to introduce architectural software to students, and what is the most effective teaching method for these software tools? By employing qualitative and survey methods, including content analysis of interview data, the study aims to shed light on these questions.

Method

This research is practical in terms of its purpose, and the results of this research can be used to improve the time and method of teaching architectural software to students in this field. In terms of method, the present research is qualitative. Qualitative research is a set of activities such as observation, interview, and extensive participation in research activities, which help the researcher obtain first-hand information about the research subject [60-62]. The term qualitative research refers to several methods of data collection, such as field research, observation or participation, and in-depth interviews. There are considerable differences between these strategies, but all of them emphasize approaching the data [63, 64].

Participants

According to the topic, the statistical population of this research is the experts in the field of architectural education, professors working in the public universities of Tehran (University of Tehran, Shahid Beheshti University, University of Science and Technology, University of Arts, Shahid Rajaei University, Tarbiat Modares University, etc.) Ph.D. who are rich in information in the target area of research and have more than 10 years of teaching experience in architectural design courses. The purposeful sampling method was selected based on the mentioned criteria. The number of statistical population was determined by experts, and 15 of these professors were interviewed.

Instruments

In the first part, the documentary method and library study were used to verify the theoretical foundations of the research topic. To collect information, an in-depth interview method was used to clarify different angles of the problem and gather the required information. For this purpose, a researcher-made questionnaire was designed, the reliability of which was confirmed by experts.

Design

The research design is qualitative, incorporating various methods such as observation, interviews, and extensive participation in research activities. The data collection methods include field research, and in-depth interviews. Although these strategies have differences, they all emphasize approaching the data.

Procedure

Data analysis in qualitative research begins immediately after the beginning of data collection. In fact, data collection and analysis are usually done simultaneously. As the research continues, less data is collected, but more analysis is done. In practice, there is considerable overlap between these two stages. Qualitative data analysis requires information organization and data reduction [63]. To evaluate the data in this research, the method of content analysis has been used. The content analysis consists of placing the components of a text, such as words, sentences, and paragraphs in predetermined categories. The method requires the classification and counting of elements and components of content [65].

The independent variables of this research are the correct method and proper timing to teach architectural software to students. The dependent variable is increasing the efficiency and benefit of students from learning architectural software so that they are fully prepared to enter the job market. The independent variables as the cause of the relationship will affect the dependent variable as the effect.

After conducting interviews with architecture experts (university professors), their responses were classified and coded using MaxQDA 2020 software. The amount of information obtained from the interviews was reduced using coding techniques, and the points they expressed in response to the questions were analyzed in the form of logical reasoning to determine the effect of these points on the main topic of the research. These analyses are presented in the findings section. By performing these analyses and logical conclusions from the answers of the interviewees, the answers to the research questions were also determined.

The purpose of this type of research is to reach theoretical saturation or not to add a new concept to the collected concepts. In the interview method, new points that were hidden from the researcher emerged. Therefore, the researcher, as an interpretive and determining element, repeatedly refers to the identified and required sources of the research problem to reach theoretical saturation [66].

Results and Findings

In this section, the responses of the interviewees were analyzed and the findings were categorized to determine the answers to the main research questions with logical arguments.

Preparations for starting the software

When students enter the field of architecture, they do not have a correct understanding of this field and profession, they are not familiar with the concepts and basics of architecture, and they do not know design and drawings. In the first step, it is better for students to familiarize themselves with drawings, design, and the basic principles that an architect must know so that they can objectify what they have in mind and visualize it using the visual literacy and understanding they have gained from design.

The ability to design and draw by hand is one of the skills that every architect should know and use to express his meaning. Freehand design, along with the principles and basics of architecture, makes intellectual and mental creativity flourish and the power of imagination develops. After the flourishing of creativity and imagination, it is the time when the student can properly think about the subject of architecture and start developing ideas, then visualize them and draw them on paper with the ability to draw by hand. When the correct connection between the hand, eye, and brain is established and it can understand the proportions with the eye and draw the perspective; his talents flourish.

> *Architecture is a field in which the discussion of the perception of action and creativity is particularly important. In the first semester, the student gets to know the principles and basics of architecture, how to think, how to design, and how the design process takes place. It is easier and better to transfer the thoughts of the mind from hand to paper*. (Interviewee No. 2).

Disadvantages of starting the software early

When the student is not yet fully familiar with drawings and does not have a correct

understanding of architecture, if he enters the fascinating and vast world of software, he can get better results than hand drawings with little training. This issue can cause the student's heart to strengthen his hand. In the future, when he faces complex designs, he will not be able to imagine the design and will not even be able to model it. It is usually the case that people learn the software to a limited extent and leave aside the learning of the rest of the parts that have limited use in architecture. and slow down his mental capacity. Early learning causes the student to think about what he knows about the software instead of thinking freely, and his creativity decreases. In Table 1, the disadvantages of early software training are briefly stated.

The use of architectural software is an undeniable necessity, but when a student enters the world of software without understanding architecture, he can easily produce forms that are complex in terms of appearance, but because he has no understanding of the space he has created, he cannot put himself inside. imagine that space and understand the characteristics of that space and its proportions, therefore architecture is not formed and only a produced form that is not purposeful and has no idea behind it, and is not valuable in terms of architecture.

> "*Many times, after an hour of working with the software, the student produces a strange and complex form, then works on the connecting points of volumes and heights; And it changes the form and makes it more complicated. This complexity of the form increases so much that it resembles one of the works of famous architects. But basically, it is also nothing because it does not know what spatial characteristics the space it creates has. He doesn't even know what order the plan and heights are, and what issues and possibilities he produces. It only shows the capability of the software and the student's ability to work with it*." (Interviewee No. 7). (Fig. 1)

The best time to start the software

When the creative and capable mind of a student is full of innovative ideas that can provide a suitable answer to any design problem and cannot be limited by software. The best time to enter the world of software is to learn and work with it. Fig. 2 shows how effective factors for understanding the concept of architecture prepare students to enter the world of software.

When the relationship between the hand as a draftsman, the eye as an indicator to correctly understand the scale, and the mind as an idea generator is properly formed, a person can express his creativity well. Ideation with hand sketches can prevent the production of a worthless form because the person understands well what he shapes in the software and can communicate with it and solve his problems.

As shown in Fig. 2, to enter the world of digital architecture software, the student must first establish a connection between hand, eye, and mind, be able to design freely, develop his creativity, and gain the power of imagination and visualization. To achieve these abilities, it is necessary to gain the power of imagination by increasing the ability of freehand drawing and learning freehand drawing; with the help of visual literacy and the understanding he gained from architecture, he established a relationship between hand, eye, and mind and his creative power and imagination blossomed (Fig. 3 and Table 2).

Table 1: Coding the results of the early start of using software for architecture students

Code	concepts	Subcategories	Categories
Using a computer has a better graphical display than a free hand - not doing things with the hand and the power of the mind	Discouragement of freehand drawing	Decreased imagination	Inability to design
Lack of complete training - confusion in a large number of software - rely on little knowledge	Lack of learning of all parts of the software	Limiting creativity	
Creating a complex plan with limited training - not knowing the volumes in a tangible and objective way - being limited to software	Decreased power to enliven the imagination		
Lack of understanding of proportions - Lack of understanding of scale with the eyes - Lack of perspective - Inability to visualize space in three dimensions	Lack of understanding of space	Lack of understanding of architecture	

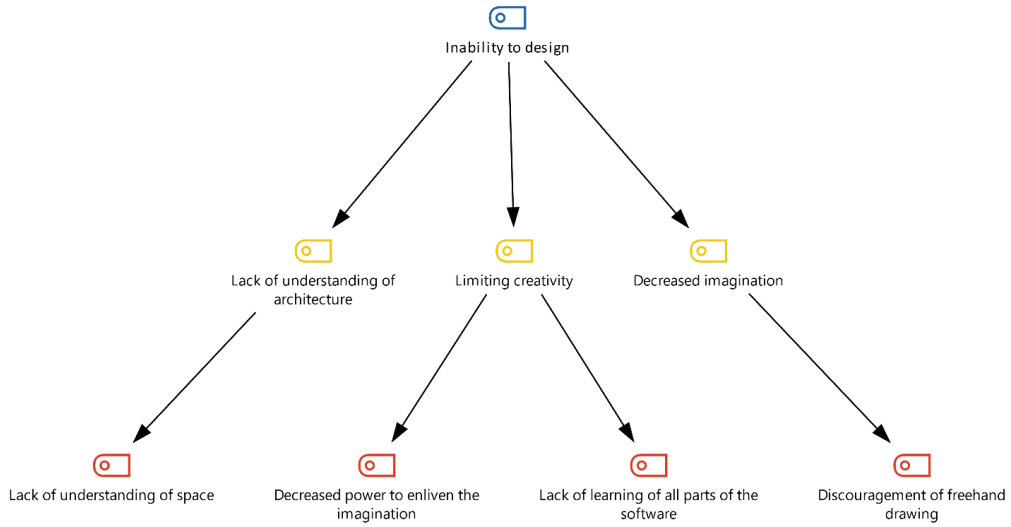

Fig. 1: Early Introduction of Software for Architecture Students Chart

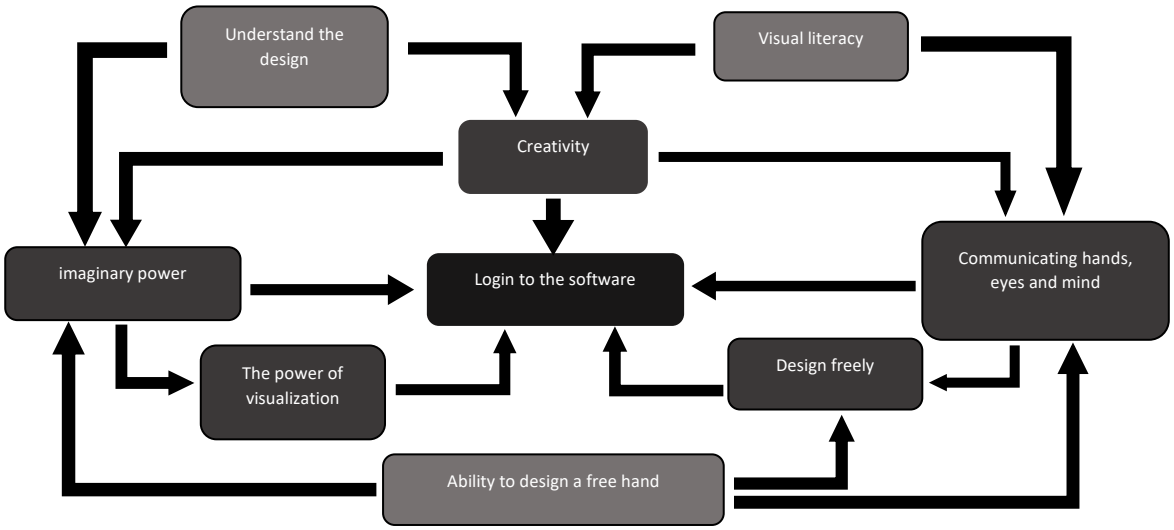

Fig. 2: Prerequisites for Software Entry for Architecture Students Chart (authors)

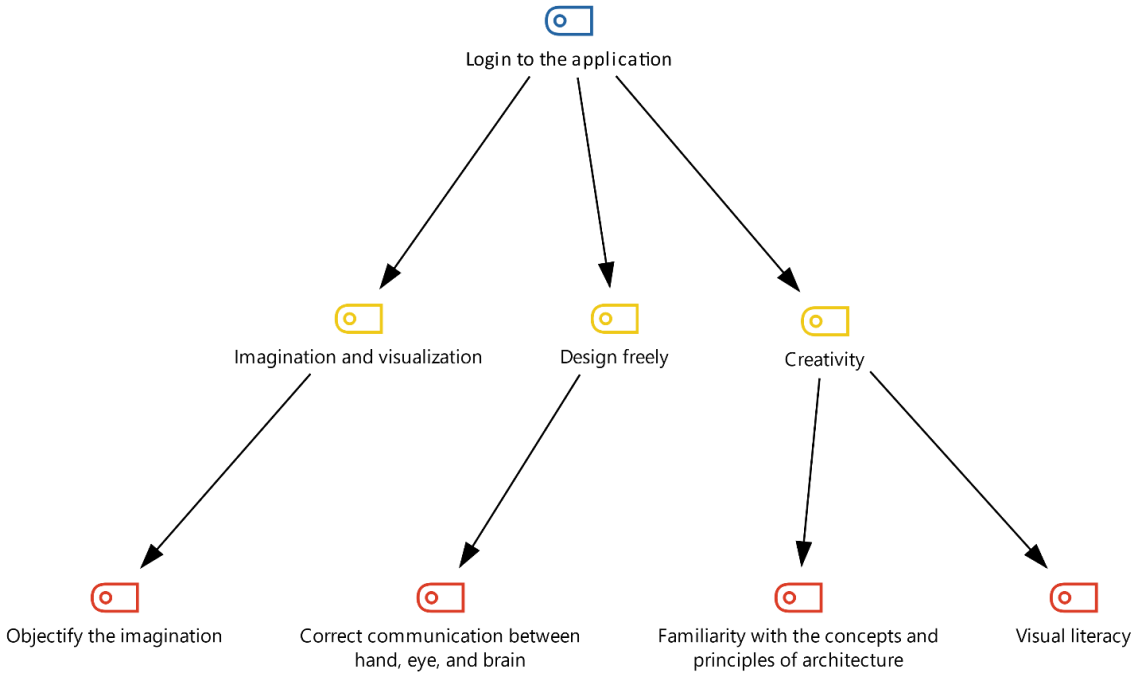

Fig. 3: Software Entry for Architecture Students Chart

Table 2: Software entry coding for architecture students

Code	concepts	Subcategories	Categories
Knowledge of architecture - Knowledge of art - Familiarity with works of art	Visual literacy	Creativity	Login to the application
Understanding Design - Understanding Proportions and Perspectives	Familiarity with the concepts and principles of architecture		
Freehand drawing - Cognition of design - Perception of perspective - Perception of proportions - Perception of dimensions	Correct communication between hand, eye, and brain	Design freely	
Ability to draw a free hand - Understand the concept of space - Strong three-dimensional thinking - Model making	Objectify the imagination	Imagination and visualization	

Computer design, a new style of design

Modeling and manual sketches are easier and more efficient at the beginning of work and in the ideation and concept stage and play an important role in the emergence of creativity. For this purpose, it is suggested to do it in the traditional way (working by hand) in the concept stage. When the concept enters the software, changes are made to it, but the main idea is preserved. And in the rest of the design stages, software can replace manual work.

> *"At the beginning of the work, I suggest students do the work manually so that their hand strength is preserved; And after the idea is formed, software should be used for presentation.* (Interviewee No. 3).

Designing with software is a new way of designing and concepts such as building information models (BIM) and virtual reality technology (VR) are based on software and computer power.

Another way to teach software

In the interviews, the professors talked about teaching the software simultaneously or separately to the students. They listed the advantages and disadvantages of these methods, which are summarized in Table 5. The professors described these points according to their experiences in teaching.

In the experience of simultaneous teaching, due to the high volume of materials and exercises and the pressure on the student, it reduces the student's learning; And it diverts their focus from the main lesson. (Interviewee No. 2).

If we can introduce and teach software related to it in every lesson, or at least encourage the student to learn them, it will help for lessons such as analysis of environmental conditions and statics, which the student will learn in a practical way and use them in his projects. use. Teaching at the same time leads to the teaching of more application software to students. (Interviewee No. 7). (Tables 3-4 & Figs. 4-5)

Table 3: Coding of simultaneous teaching of software and courses to architecture students

Code	concepts	Subcategories	Categories
Familiarity with the software related to the course - attractiveness and enhancing learning	Creating questions and motivating the student	Complete learning of software in a practical way	Software training related to each course at the same time
Apply training	Comprehensive software review		
Unnecessary learning is prevented	Training optimization	Learn more software	
Increase classroom activity	Compactness and heaviness of exercises	Damage to the course of lessons	
Need to increase teaching hours	lack of time		

Table 4: Encoding of Separate Teaching of Software and Course Units for Architecture Students

Code	concepts	Subcategories	Categories
Emphasis on software training individually	Increased focus	Complete and specialized training	Teaching software to students in a separate unit
There is enough time to teach	Complete software training		
Lack of familiarity of professors of other units with software training - training only through specialized personnel	Specialization of Education		

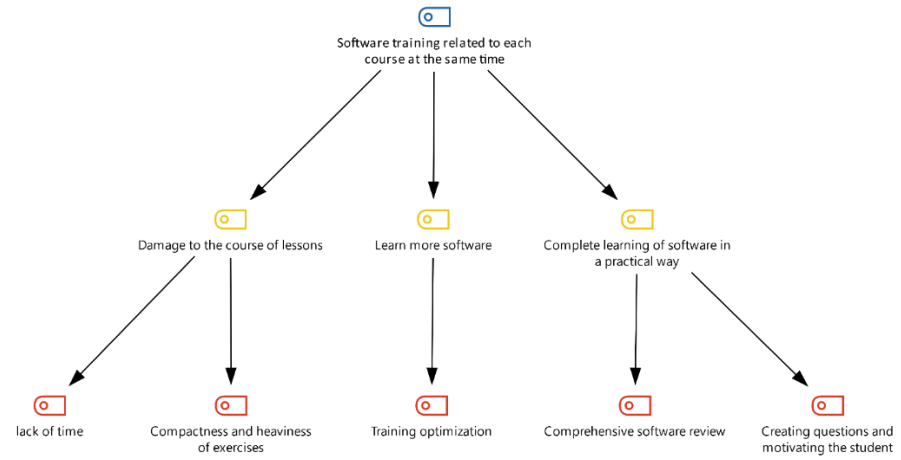

Fig. 4: Simultaneous Teaching of Software and Course Units for Architecture Students Chart

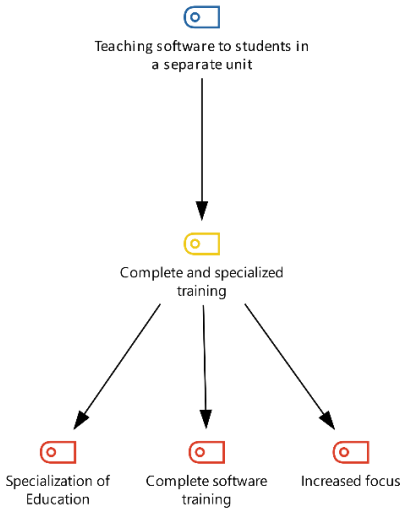

Fig. 5: Separate Teaching of Software and Course Units for Architecture Students Chart

Table 5: Pros and Cons of Separate and Simultaneous Teaching of Software and Course Units for Architecture Students

Title	Advantages	Disadvantages
Teaching related software at the same time as teaching courses	Familiarity with the correct use of software tools. Creating questions and motivating the student. Apply the tutorials. They get acquainted with the software while working. Charm and enhance learning. Unnecessary learning is prevented. Targeted training of more software.	Spend more time on lessons Damage to the course of lessons Compactness and heaviness of exercises
Teaching software as a separate course	Students focus on the topic of the lesson. Focusing on software training prevents the allocation of other training time to the software.	Failure to provide exercises appropriate to the lessons Lack of familiarity with other professors of software courses Teaching by people who do not have an architecture degree Teaching may be unrelated

To use a new method for teaching architectural software in an academic way, an educational process must first be defined and then implemented. Possible defects can be solved and compared with other methods. After understanding the advantages and disadvantages of different methods, the best possible method for education can be found. In this research, the experiences of professors about different methods of education to find a better method that makes education attractive and can prepare students for the job market and eliminate the need for classes outside the university led to the proposal of this method for education.

Discussion

According to the opinion of Juhani Palasma, computer-aided design causes the designer's imagination to diminish [19]. Our findings confirm this issue regarding students who are learning the basic principles of design. During this period, if a student relies heavily on software, their imagination declines. In researching the application of technology in the process of architectural design, Mozaffar and Khakzand stated that computers have increased the skill of architects in the process of drawing diagrams and sketches and increased the speed in all parts of drawing; and it is not recommended to teach architectural software from the beginning of the students' entry, but it is a requirement that they should be familiar with the software from one stage onwards [16]. Our findings confirm and confirm their opinions; but in another part of this research, they state that the most important tool of the designer is his creativity, which the software solidifies from the designer; but our findings show that if the student (designer) learns to show his creativity completely without the software, the software can no longer be an obstacle to creativity. Also, in the research of analyzing the effect of using digital software on the promotion of creativity in architectural design education, Asefi and Imani state that software should play a role in all levels of architecture in order to bring out creativity [18]; which agrees with the findings of this research.

The findings of the research show that, in general, it is better to use manual sketches in the idea generation stage and to refer to software only to present the work; In researching the effect of architectural design software on design speed, Shahbazi and Arbaban Esfahani showed that software increases design speed, but designers prefer manual work and sketches in the early stages of design [20]. According to Kara, manual skills such as freehand drawing and model making should be part of the architectural education program [26]. Our findings confirm this issue. Manual skills foster students' imagination.

Conclusions

The research findings provide valuable insights into the optimal timing and effective methods for teaching architectural software to students in the field. One of the key contributions of this study is the exploration of the impact of software pedagogy on architectural creativity. In the current landscape, students often face confusion in selecting the right software and appropriate educational approaches due to the abundance of available software options and new design methods. By analyzing qualitative data from interviews and conducting in-depth studies, the research sheds light on the appropriate method and time for teaching software to architecture students, with a specific focus on its influence on students' creativity.

The answer to the first question (when to start teaching software to students?) is as

follows: software training should start only when the student has learned the alphabet of architecture, his creativity has blossomed, and he knows how to design and draw by hand. With his visual literacy and understanding of architecture, he can easily objectify what he has in mind and in a word, he knows architecture; if this issue is not followed properly, it will create restrictions for the student and destroy his creativity. Therefore, the teaching of architectural software should commence in the fifth term, concurrently with Architectural Design 2, at the undergraduate level. Initially, students should be taught 2D design software, gradually progressing to advanced and 3D design stages. It is also important to note that software should not be used during the ideation phase of design to allow students' creativity to fully flourish. Afterward, the software can be utilized during the completion and editing stages of the drawings.

Nowadays, designing with software has become the main way of designing in architectural offices, and it is almost impossible to design without the help of computers. But if the student enters this field directly into the software, he cannot develop his mental skills as an architect (the one who creates the space). Someone who has learned to design with the software but does not have the skills to understand three-dimensional space is more like a sculptor who designs a good volume but cannot understand its dimensions, know the sense of space and the impact of this volume on the surrounding environment. to understand. The result of this architecture is a break from the design context. An architect must see all aspects of work in design before construction, and if he cannot cultivate this power in himself and only relies on software, he will face problems in the future.

Also, in response to the second question of the research (how to effectively teach architectural software to students?), it can be concluded that; The advantages of teaching related software at the same time as teaching lessons are more than its disadvantages; And it can better attract students to education and help them achieve their goals. In order to learn a software, we must first know the goal of the software producer and know their outputs, and move the learning path towards the best outputs. It is better to start the training with simpler software and enter specialized plugins in the later stages. Also, practical training for students should be in such a way that they can work with the software in a principled and scientific way and solve their needs. This project-based education, considering the attraction it creates for students, can play a significant role in discovering the features of the software and better and more lasting learning. Teaching parts of the software that are not necessary for the students of this field should be avoided because it only confuses them.

If the environment of the university and the educational program of the university can meet the needs of students to enter the labor market, then the education has been correct. For various reasons, software education, which is called the new way of designing today, is scarce in universities. In order to enter the labor market, a student needs to know and work with software. Unfortunately, after entering the labor market, the student faces a lot of software and different educational methods, which has nothing but confusion for him. The university can effectively prepare people for the job market and give them correct and complete education by modifying its educational program and changing the course of the semester.

In the next step, the teaching methods should be investigated by conducting quantitative studies in order to determine their effectiveness and determine the best way to teach software to the students of this field.

Authors' Contribution

Seyed Mohammad Ali Ahmadi Tabatabaie was involved in the sections of study design, literature review, data collection, analysis and interpretation of results, writing the original version, and editing the article in this research. Seyed Mohsen Moosavi was engaged in the sections of study design, literature review, article editing, manuscript correction, and article review in this research.

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Conflict of Interest

The authors have no conflicts of interest.

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