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Analyzing and Examining the Role of Computers in Improving the Quality of Undergraduate Architecture Projects

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ABTRACT: The complexity of the field of architecture, its ever-increasing application, and the rapid growth of technologies and software used in this field necessitate the need to investigate the effects of computer software on the quality of students' learning and a solution to improve the role of software in learning. Therefore, research has been carried out to investigate the role of computers in improving the quality of undergraduate architecture projects. This research is applied research, and its nature is descriptive-analytical and inferential research. The data for this research was obtained through questionnaires distributed among 86 undergraduate students in the 3rd course. The final reliability of the questionnaire was 0.889 using Cronbach's alpha test. The research findings were analyzed using T-test, ANOVA, and Tukey's. The t-test showed that the role of computers in architecture students' learning rates differs from each other. Also, the ANOVA test results showed that students' learning amount based on the type of software has a significant difference equal to Sig=0.000. According to the results obtained from the findings of the research, it can be said that despite the effectiveness of computer systems in improving the learning of architecture students, the priority is on the individual and collective characteristics of students, and the use of computers should be appropriate to the nature of the course, students' ability and interest.

Keywords: *Architectural Design, Computer Systems, Gender, Software, Project Topic.*

INTRODUCTION

The research literature on the present topic, in terms of time, about how the architectural work is formed, goes back to the second half of the last century, which at the same time led to the emergence of a special field of knowledge in architecture, which is called the design process. (Asefi & Imani, 2016). In recent decades, this field has expanded and appeared more comprehensively, which is referred to as research design and includes various parts such as the design process, creativity, and artificial intelligence. (Priya et al., 2020) the research design is a word that includes all the studies carried out on how to perform design (Newton, 2019). A person's familiarity with the design process made what was considered a secret among architects in the past to be changed into a problem, and design is considered a way to solve the problem. The process of creative design in architecture includes stages of problem-solving and creativity. (Torabi, 2013, 54)

In recent years, application software in architecture has brought about considerable transformations in architectural design if people using these technologies can easily create different formal structures in other areas of aesthetics. Various new things arrive which could not even be traced in the designer's or employer's mind. Technologies can transform the human experience (Rosenberger & Verbeek, 2015, 10). It should be noted that technology gains meaning based on the type of use it is made (Aagaard, 2015). The relationship between humans and technology is different and ambiguous in different situations (Langsdorf, 2016).

In the current research, the qualitative improvement of architectural design is identified as a dependent variable, which includes the interface between the designer and the design, an element called creativity. In the following, creativity is considered the main variable to improve the quality of the design. Creativity is a mental process composed of the power of initiative and flexibility (Sternberg, 1988). The design process

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is based on a person's creative development, formed using architectural design tools. The conditions that affect the main variables of using architectural software and its relationship to cultivating creativity in a person are the subject of this research. The authors are looking for effective factors in improving the design quality, i.e., increasing the individual's creativity in the face of architectural software and related digital technologies in designing an architectural work, whether this architectural work is a professional project. It is considered an academic design exercise. Of course, here and in the current research, the meaning of architectural design is a design that can be got in Iran's university system and architecture studios by people (students) at a certain time.

In 1970, John Chris Jones divided the evolution of design methods into four eras of development of art and craft, design with the help of drawing, systematic and systematic design, and design in the present era. Artisans used limited tools to create their pieces during art and craft development and had a direct relationship between their thoughts and their hands. In the design period, with the help of drawing (Renaissance to 1950), the designer's method was not obvious to anyone, and sometimes the designer did not know how the problem was solved. Systematic design began in the 20th century and was according to the military needs of World War II. At this stage, design is a tool to solve a micro-problem and part of a more extensive system. The present age is the age of rapid technological changes or tech-oriented social innovations. One of the modern methods of evaluating the problem and discovering the plan in the contemporary period is the principle of changing the strategy and allowing the penetration of involuntary thinking into planned thinking and vice versa (Rezaei, 2014, 26).

According to the proposed problem, it can be said that the current research sought to find scientific answers to these questions.

What is the role of computer software in the learning rate of architecture students? What are the advantages and disadvantages of students learning two ways of designing with software and freehand design?

Horst Rittel divides the models presented for the design process into two generations. While the first generation (the 1960s) is defined based on scientific, rational, and systematic methods, the second generation (from the early 1970s) is for increasing the collaborative process of design and making the environment designer a partner of the problem owners, the employer, customers, users and introduces social groups (De Vries et al., 1993, 17).

After referring to Rittel's theory about two generations of rational and argumentative models, John Lang pointed to the emergence of a new generation of design under the title of hypothesis building and testing, which is influenced by Popper's ideas and relies on the mental structure of the designer himself. Ashraf Salame introduced three models for the design process: the intuitive model (black box approach), the rationalist model or problem-solving, whose approach is by the glass box, and two systematic design approaches and pattern language. The third model, the collaborative model, follows the research approach or design and refers to society (Salman et al., 2014). Voort and Van Vegan stated that the design was emphasized as a problem-solving activity in the first generation at the beginning of the 1960s. In the second generation (the second half of the 1960s to the mid-1970s), with growing criticism of the resulting failures, attention shifted to social solutions. The design methods movement ended in the third generation (the mid-1970s to 1980s). Thus, Alexander strongly opposed labeling any idea with the title of the method. In the fourth period (1990s to today), attention to information processing systems and decision support systems in design has increased significantly. The design process can include hypothesis and hypothesis testing, but it cannot be expressed as a cause-and-effect relationship; A bit; this process works relatively with a connection between change and disturbance.

Besides the design process, various researchers have provided several patterns for it. Alexander's model (Alexander, 1964, 94). Dubberly has classified these patterns as academy, advisory, cyclical, and hierarchical (Dubberly, 2004), while Cross has introduced design processes as two descriptive and prescriptive patterns (Cross, 2000, 30-34).

Along with the research of thinkers in the framework of expressing creativity, which has often been based on exploitation in the production of industrial products, experts of design techniques and psychology, idea generation, and idea generation have proposed a general form and typically in architecture in a certain way. That is often based on the behavioral and psychological sciences data and can be considered the result of generalizing research results and commenting on these basic sciences (Abel, 2013). Researchers in this field aim to understand the structure of the design process, design issues, solutions, and design thinking to help architecture design education and the development of computer-aided design techniques and software. Several architects, interior designers, industrial designers, engineers, urban designers, and urban planners can be considered among these researchers (Wyatt et al., 2012).

Before any other architectural phenomenon, architectural design will benefit from understanding the place of media in the world of architecture; because, in the contemporary period, the last medium between man and reality, the computer, recreates a critical role in the most tangible manifestation of design activity, namely the design process (Eilouti, 2018). The architectural design process without a computer disadvantages architectural design activity (Benzenberg, 2011). Today, architectural design, production processes, tools, ideas, theories, methods, and forms have widely influenced computers and communication technology (Cudzik & Radziszewski, 2018). The increasing use of computers in architectural and engineering design is

one of humanity's most important recent achievements in the design process and increases productivity in various stages of construction (Navarro et al., 2016; Vuletic et al., 2018).

Studies and research around the design process occupy a huge amount of research. Such texts remain from Archer and Christopher Alexander in the 1960s to the recent research of Cross, Ullman, Rosenberg, and Lawson and studies about design patterns, including Christian works (Gislason, 2010). Design methodological studies about design theories and paradigms have dealt with design's essence, the leaders of which are Simon and Shun (Menges & Ahlquist, 2011). Wiggin, Seva, and Torski have conducted extensive studies to investigate the information that architects think about and what they infer from their freehand sketches (Caetano et al., 2020), and Rioca based on existing models of design, Axman has proposed new models of digital designs that explain the difference between the developing paperless design style and the traditional paper-based process (Furniss, 2020).

Among the most significant research conducted in the role field of computers in improving the quality of architectural designs, Öztoprak & Çağlar (2020), in an article on examining the different dimensions of design methods in architectural design studios, investigated the innovative aspects of the subject and concluded that the use of simultaneous methods of idea generation by free hand and digital methods could lead to brilliant results in this field, providing comprehensive guidance of students in terms of creativity and visualization. Newton (2018), in an article about the optimization of design methods, pointed out that interactive solutions can improve students' creativity in this field because of the rapid growth of technology in architecture and urban development projects.

Mahdavinejad (2013), in the paper entitled "Creativity and the Process of Creative Education in Architectural Design," concluded that using computers can create a suitable platform and environment for the emergence of creativity. The research results showed that computer systems can simultaneously and interactively promote the role of the computer in the design of architectural projects by cultivating spatial intelligence and creativity. Jamiri et al. (2013), in a study entitled "Investigation of Adaptation of the Architectural Engineering Curriculum to the Needs of the Labor Market in Iran," concluded that the topics of the bachelor's degree in architectural engineering did not match the needs of the labor market, and computer expertise and specialized software lesson added to their class. Naserkhaki (2008), in a research paper entitled "The Role of Computer in Architectural Design Process: The Comparative Comparison of Two Generations of Contemporary Architects in Iran," concluded that two models, "the situational interaction model of the designer and the computer" and "the model of acquiring the skills of designers," are the needs of contemporary architects that should be considered in designing using computers. Asefi & Imani (2016) analyzed the effect of using digital software on promoting creativity in architectural design education. The research showed that developing computer systems could improve imagination in teaching applicable architectural design by creating dynamics and purpose.

MATERIALS AND METHODS

This research is based on the purpose of applied research, and in terms of nature and method, it is descriptive-analytical. According to the research hypotheses, the statistical population of this research includes undergraduate students studying in the architectural engineering field at Islamic Azad University and Tabriz University. According to the statistics from the education office, 86 students took design lesson 3 in three semesters. Because of the low number of students (the statistical population of the research), sampling was not done in this research, and the selection of the statistical population was based on the total number. The validity of the questionnaire was confirmed with the opinions of university professors, and the reliability of the questionnaire was confirmed using Cronbach's alpha, separately for each dimension. The results are in Table 1.

A review and study of all kinds of internal and external written sources, including books, articles, treatises, reports, and other written research, has been conducted. The general results from the studies show the existence of variables with various dimensions, including the type of software, age, gender, educational level, previous design experience, and freehand skills. In the quality improvement of the design. The variables Identified for the first hypothesis includes 25 variables in the

Table 1: Validity and Reliability Results of the Research Questionnaire

Dimension	Validity	Reliability
Anthropological	The item was approved in good condition	0.875
Environment design	The item was approved in good condition	0.902
Final	The item was approved in good condition	0.889

two dimensions of anthropological characteristics and design environment (Table 2).

Pearson correlation, t-tests, and ANOVA tests are used to analyze data. The t-test is used to check the average of independent groups. This test is used when the researcher's goal is to investigate the significance of the average difference of a trait in two.

Random samples from two independent societies. The assumptions of the t-test with two independent samples must meet the following conditions:

a) The variable whose average is compared in two independent groups must be quantitative (i.e., its scale must be interval or ratio).

b) The scale of the variables should be qualitative and at the nominal level (bi-dimensional).

c) The variables must be independent and distinct from the two populations.

d) Variable data distribution should be normal (Equation 1).

$$H_0 : \mu_1 = \mu_2$$

$$H_1 : \mu_1 \neq \mu_2$$

Equation 1: T-Test calculation method

Where μ_1 is the average of the first sample and μ_2 is the average of the second sample.

Analysis of Variance (ANOVA) test

Variance analysis tests are a set of statistical models that examine the average of groups and functions related to them

Table 2: The dimensions and indicators of each of the variables based on the studies conducted

Dimension	Index	References
Anthropological	Age	(Vowles et al., 2012; Asefi & Imani, 2016)
	Gender	(Glatt et al., 2007; Vowles et al., 2012)
	Interested in architecture	(Gorji Mahlbani & Sadeghi, 2018)
	Approach and motivation to use the software	(Bahmanesh nia & Sheikhiyeh Gol-Zardi, 2015)
	Previous design experience	(Mousavi & Pejohanfar, 2018)
	Practice and repetition times	(Mousavi & Pejohanfar, 2018; Asefi & Imani, 2016)
	The power of student visualization with project design	(Kalisperis et al., 2002; Navarro et al., 2016;
	Practice and individual software work during the design	(Navarro et al., 2016)
	Using self-learning resources in design (educational software, internet, mobile.)	(Benzenberg, 2011)
	Practice and software teamwork during the design	(Navarro et al., 2016)
	Software type	(Newton, 2019; Kruchten et al., 2009)
	The teacher's power of expression	(Al-Matarneh & Fethi, 2017)
	Time design	(Dalziel, 2003)
	Ambient light compatibility	(Gislason, 2010)
	Compatibility of tables and chairs with architectural work	(Gorji Mahlbani & Sadeghi, 2018)
	Atile's temperature compatibility	(Gislason, 2010)
environment Design	The elasticity of the labor market and the possibility of employment in the field of software	(Kruchten et al., 2009)
	Interacting with others while designing	(Sanchez & Mahoney, 1996)
	Type of computer system	(Mitchell, 2017; Salman et al., 2014)
	The number of corrections	(Henri, 2003)
	The degree of difficulty of the project	(Eilouti, 2018)
	The duration of experience working with the software	(Kruchten et al., 2009)
	The time limit for submitting the plan	(Green & Bonollo, 2004; Benzenberg, 2011)
	The degree of freedom of action of the student in the ideation of the plan	(Priya et al., 2020)
	Educational electronic peripherals (video projector)	(Mitchell, 2017; Salman et al., 2014)

(such as variance within a group or between multiple groups). In the analysis of variance, research hypotheses can take two forms: 1) the existence of a significant difference between variable groups: Do the means of the dependent variable differ in the groups created by the factor variable differ, or are they equal?

2) The existence of a cause-and-effect relationship between the variables: If the averages of the dependent variable in the groups created by the factor variable are not equal, it means that the independent variable affects the values of the dependent variable in the groups of the factor variable. If so, these two variables (independent and dependent) can have a cause-and-effect relationship. It can be said that variance analysis and variance analysis methods are a category of statistical models that can investigate the difference between groups or categories. Conditions to consider when using analysis of variance include:

• The values of each group or community must have a normal distribution.

• Variance must be constant in each group. This shows that the data should not contain "outliers."

• The variance of the groups should be equal to each other.

• The average must be different among the groups. This is the same expression we seek as a counterhypothesis in variance analysis. As mentioned in the method, to survey the quality of the projects presented by the students, similar criteria were needed to evaluate and prioritize the student's projects. Using these criteria, the data in the ultimate results of evaluating the goat quality of students' designs were presented in Table 3. The results of the findings in this field show that the measure of implementation ability and the progress from research to design had the lowest values, with values of 2.14 and 2.11, respectively. Regarding the criterion of executive ability, it can be said that this is caused by the major weakness of education in Iranian universities, which ignores the needs and demands of the labor market. Also, regarding the criterion of the transition from research to design, it can be said that one of the biggest challenges of education in architecture is the lack of attention to theoretical foundations and theoretical studies that lead to the presentation of surface designs because of the lack of study before the design process begins. The results connected with the criteria of creativity, attention to the texture of the designed site, aesthetics, proposed materials, change of climatic conditions, and the ability to express the design taken from the software verbally were also higher than the average (5-2.5-1). Using software in the design of architectural projects leads to improved beauty of the architecture design, enhanced ability of the student to explain their project, greater freedom of action in choosing materials, improved visual aesthetic dimension of the architecture design, and better analysis of the project site because of the ease of use of the site maps (Table 3).

Besides deepening the criteria of project evaluation by separate gender criteria, project subject, and the type of software used for design, the difference between the average of design evaluation scores has been separated by separating the above three criteria. The most important findings of this section of the study show that, in terms of executive criteria, male students with an average of 2.74 were over 2.60 female students. Also, in both groups of male and female students, the project's implementation criteria on residential issues have been more than other issues. Regarding the measure of creativity, the average got for male students is 2.91, and for female students, it is 9.71. Also, most of the calculated averages were for recreational projects in both groups of male and female students. The results of the research findings regarding the criterion of progress from research to design also showed that female students with an average of 2.64 were more compared to male students with a value of 2.42. The got results for the criterion of paying attention to the texture of the site in the design showed that there was almost an equal number of male and female students. In terms of aesthetic criteria and the overall fit of the project, female students had an average score of 2.67, which was higher than the average male 2.49 for students. According to this criterion, the highest scores were related to residential, recreational, and commercial projects. (Table 4)

Table 3: The Obtained Average from Students' Projects According to Eight Criteria

Criteria Evaluation	Quality Average
To The Existing Execute	2.14
create	2.62
From research to design	2.11
Attention to the existing texture of the site in the design	2.65
General aesthetics	2.51
Suggested materials	2.64
setting environmental conditions (climate)	2.66
The ability to verbally express the plan taken from the software	3.01

RESULTS AND DISCUSSION

The research results using the t-test show that the role of computer use in improving the quality of architecture projects of undergraduate students has a significant difference between the two groups of male and female students. The role of the computer among these two groups of students in terms of the variables of executive ability, creativity, progress from research to design, attention to the existing texture of the site in the design, general aesthetics, the suitability of the proposed

Table 4. Character and score of each criterion

Score	Character		criteria evaluation	Score	Character		criteria evaluation
49 .2	Male	Gender	General aesthetics	2.74	Male	Gender	Executable capability
2.67	female			2.60	female		
2.54	Residential	Project Subject		2.74	Residential	Project Subject	
2.50	Commercial			2.56	Commercial		
2.46	Educational			2.55	Educational		
2.51	Recreational			2.63	Recreational		
2.36	Treatment			2.61	Treatment		
2.88	3-D	Software		2.84	3-D	Software	
2.71	V-Ray			2.75	V-Ray		
2.70	SketchUp			2.64	SketchUp		
2.64	Autocad			3.05	Autocad		
2.70	Revit			2.62	Revit		
2.41	Male	Gender	The proportion of the proposed materials with the subject of the project	2.91	Male	Gender	Creativity
2.44	female			2.71	female		
2.56	Residential	Project Subject		2.78	Residential	Project Subject	
2.54	Commercial			2.54	Commercial		
2.50	Educational			3.05	Educational		
2.52	Recreational			3.14	Recreational		
2.52	Treatment			2.64	Treatment		
2.45	3-D	Software		3	3-D	Software	
2.54	V-Ray			2.89	V-Ray		
2.53	SketchUp			2.71	SketchUp		
2.78	Autocad			2.68	Autocad		
2.61	Revit			2.72	Revit		
2.88	Male	Gender	(setting environmental conditions (climate	2.42	Male	Gender	From research to design
2.83	female			2.64	female		
2.71	Residential	Project Subject		2.53	Residential	Project Subject	
2.54	Commercial			2.54	Commercial		
3.01	Educational			2.60	Educational		
2.64	Recreational			2.55	Recreational		
2.66	Treatment			2.50	Treatment		
2.41	3-D	Software		2.31	3-D	Softwere	
2.47	V-Ray			2.30	V-Ray		
2.45	SketchUp			2.35	SketchUp		
2.65	Autocad			2.40	Autocad		
2.50	Revit			2.41	Revit		

Continiue of Table 4. Character and score of each criterion

Score	Character		criteria evaluation	Score	Character		criteria evaluation
2.42	Male	Gender	The ability to verbally express the plan taken from the software	2.74	Male	Gender	Attention to the existing texture of the site in the design
3.24	female			2.75	female		
2.87	Residential	Project Subject		2.81	Residential	Project Subject	
2.85	Commercial			2.84	Commercial		
2.76	Educational			2.64	Educational		
2.80	Recreational			3.12	Recreational		
2.77	Treatment			2.79	Treatment		
2.80	3-D	Software		2.64	3-D	Software	
2.89	V-Ray			2.78	V-Ray		
2.83	SketchUp			2.96	SketchUp		
2.90	Autocad			2.97	Autocad		
2.89	Revit			2.88	Revit		

materials with the project topic, setting the environmental conditions (climate) and the ability to express verbally, and the plan taken from the software has an average difference. In the meantime, all the variables, except the two variables of the suitability of the proposed materials with the subject of the project, regulation of environmental conditions (climate), correlate by 0.000 (Table 5).

Also, the one-way variance analysis results showed that the difference between the five groups of variables related to the software in the presentation of architectural designs was significant at the level of 0.001, and the error coefficient was 0.05%. Meanwhile, the average difference between AutoCAD and 3-D software with the value of F=15.368 has the maximum average difference with the rest of the group in the quality of the designs presented, and then, the 3-D variables, respectively, V-Ray, SketchUp, and REVIT. The exact results of the ANOVA

Table 5: t-test results regarding the role of computer systems in improving the quality of student projects in terms of gender

Variables	Use of computer in design		Not using computers in design		t	Sig
	Average	SD	Average	SD		
Executable capability	4.625	1.365	3.365	2.352	2.511	0.000
Creativity	4.447	2.254	2.254	1.365	2.421	0.000
From research to design	4.651	3.351	3.541	2.255	2.885	0.000
Attention to the existing texture of the site in the design	4.365	3.545	3.545	1.625	12.121	0.000
General aesthetics	4.300	3.855	3.855	2.325	2.585	0.000
The proportion of the proposed materials with the subject of the project	4.630	3.365	3.365	1.368	2.006	0.004
setting environmental conditions (climate)	4.984	3.541	3.541	1.985	2.052	0.003
The ability to verbally express the plan taken from the software	4.320	3.880	3.880	1.902	2.157	0.000

test regarding computers' role in improving the architecture scheme's quality using different software. (Table 6).

Finally, Tukey's test has been used to analyze the gap between the qualities of architectural designs using five types of software statistically. The results of Tukey's test showed that both the internal difference between the five groups of used software is significant, and the external difference between the groups is significant in terms of the impact of the software on the quality of architectural designs. (Table 7).

The results of the one-way variance analysis regarding the role of computer systems in improving the quality of architectural designs in terms of the project topic showed that the difference of five groups of variables related to the project topic in the presentation of architectural designs was significant at the level of 0.000 and the error coefficient of 0.05%. The recreational subject had the most significant average difference with the F=15.368 value, compared to the remaining subjects regarding the quality of the plans presented, followed by educational, residential, commercial, and other treatments. The more detailed results of the ANOVA test regarding the computer's role in improving the architectural design quality using different software are in Table 8.

Table 6: The results of the ANOVA test regarding the difference between student designs in terms of the software used

P	F	average of squares	df	sum of squares	Index
0.000*	13.474	81.325	86	187.254	3-D
0.000*	11.331	69.471	86	145.632	V-Ray
0.000*	9.789	65.520	86	88.024	SketchUp
0.000*	15.368	83.221	86	189.460	Autocad
0.000	8.635	59.069	86	71.765	Revit

Table 7: The results of Tukey's test about the gap between the quality dimensions of architectural designs using architectural software

Confidence Interval		Sig	Est. error	mean difference (1,2,3,4,5)	Five variables	Architectural Software	
upper bounds	Lower bounds						
0.9865	-6.6574	0.000	1.74589	-2.6000	X1		
-1.6574	-8.9865	0.000	1.74589	*-5.2000	X2		
6.5095	-0.9865	0.000	1.74589	2.6000	X1		
1.3095	-6.1065	0.000	1.47589	-2.4000	X3	Five architectural software	
8.9865	1.4950	0.000	1.74589	5.2000*	X1		
6.6574	-1.3095	0.000	1.74589	2.4000	X4		
6.452	2.365	0.000	1.74589	-2.4000	X1		
7.365	3.698	0.000	1.74589	-5.2000	X5	X1 3- =D	
10.9865	-7.5065	0.000	1.74589	-2.6000	X2	X2 =V-Ray	
8.3028	-9.9865	0.000	1.74589	5.2000	X3	X3 =SketchUp	
12.9095	-1.9095	0.000	1.74589	-2.6000	X2	X4 =Autocad	
9.1095	-7.3625	0.000	1.74589	2.4000-*	X4	X5 =Revit	Tukey- HSD
9.258	2.674	0.000	1.74589	-2.6000	X2		
9.742	-3.852	0.000	1.74589	-2.4000	X5		
14.3028	2.9865	0.000	1.74589	5.2000	X3		
11.1095	-2.3028	0.000	1.74589	2.4000	X4		
13.587	-3.657	0.000	1.74589	2.4000	X4		
15.854	-5.451	0.000	1.74589	5.6000	X5		

Finally, Tukey's test was used to analyze the gap between the qualities of architectural designs in terms of five groups of different subjects. The results of Tukey's POSt-HOC test showed that both the internal difference of the five groups of the considered subjects was significant and the external difference of the groups in the effect field of computer systems on the quality of architectural designs in terms of different subjects was also significant (Table 9).

According to the investigations conducted on the primary scope of the subject, there is still much qualitative research to be done on improving architectural designs. According to the identified problem, research was conducted to investigate the role of computers in the qualitative improvement of architectural designs. To better understand the role of various types of architectural software in the quality improvement of designs, as well as the role of computers in the quality improvement of designs, males and students were asked to female examine and analyze the presented designs according to different topics so that the sides hidden from the role of computer systems in improving the quality of architectural designs could be better understood.

Table 8: The results of the ANOVA test on the role of the computer in improving the quality of architectural designs in terms of the project topic

Index	sum of squares	df	average of squares	F	P
Residential	159.362	86	82.652	15.474	0.000
Commercial	155.874	86	78.028	12.331	0.000*
Educational	165.369	86	89.754	19.789	0.000*
Recreational	190.785	86	97.368	21.368	0.000*
Treatment	87.324	86	68.810	9.635	0.000

Table 9: The results of Tukey's test about the gap between the quality dimensions of architectural designs in terms of the project topic

Confidence Interval		Sig	Est. error	mean difference (1,2,3,4,5)	Five variables	Subjects of architectural projects	
Lower bounds	Lower bounds						
1.6574	-6.6760	0.000	1.74589	-2.6000	X_1		
-1.3240	-9.3625		1.74589	*-5.2000	X_2		
6.6760	-1.0760	0.000	1.74589	2.6000	X_1		
1.4760	-6.2760		1.74589	-2.4000	X_3		
9.3625	1.3028	0.000	1.74589	*5.2000	X_1		
6.3028	-1.4760		1.74589	2.4000	X_4		
11.9865	-8.9865	0.000	1.74589	-2.6000	X_1	Residential = X_1	
8.1095	-10.9095		1.74589	5.2000	X_5	Commercial =X_2	
13.3028	-2.9095	0.000	1.74589	-2.6000	X_2	Educational =X_3	
10.3028	-8.3028	0.000	1.74589	*-2.4000	X_3	Recreational =X_4	**Tukey- HSD**
15.9095	3.9865	0.000	1.74589	5.2000	X_2	Treatment =X_5	
13.1095	-3.3095		1.74589	2.4000	X_4		
6.2258	2.6704	0.000	1.74589	-2.6000	X_2		
9.7942	-3.3510	0.000	1.74589	-2.6000	X_5		
10.9865	-7.5874	0.000	1.74589	-2.6000	X_3		
8.3028	-9.3098		1.74589	5.2000	X_4		
13.587	-7.7452	0.000	1.74589	2.4000	X_4		
15.845	-5.3658	0.000	1.74589	5.6000	X_5		

CONCLUSION

The general results of the research showed that the role and function of computer systems had a significant difference according to the gender of the students, the subject of the project, and the type of software used.

In response to the first question of the research, it can be said that using the t-test, it is determined that the role of computer use in improving the quality of architectural designs of undergraduate students has a significant difference between the two groups of male and female students.

The most significant difference between the two groups of male and female students was the variables of interest in the field of architecture, interest in the subject of the project, and previous experience using the software.

In response to the second question that what is the advantage of freehand skill, it is based on the research output that it is clear that the most important negative aspect of using computer systems is the lack of attention to human emotions in the designs, which ultimately leads to the architectures without considering the space for human use. Also, according to the research findings regarding the advantages and disadvantages of software and freehand design, it can be said that using computers in design has advantages such as increasing the speed of design, providing complex designs, and providing real models. Before construction, it is to adapt to the market's needs and increase students' creativity. On the other hand, it has disadvantages, such as not paying attention to individual and collective students' feelings and psychological characteristics. In contrast, in freehand design, students can easily bring their emotions and feelings into the design, which leads to more lively and dynamic designs. According to the mentioned problem, nowadays, many types of research have been presented to humanize the architectural designs presented in the computer software environment.

According to the research results, the greatest impact of computer systems was in the environment of AutoCAD software and related to recreational subjects. The main reason is that the use of AutoCAD software in architecture, especially for architecture students, is more prevalent than other software. Also, entertainment subjects are designed mostly to be enjoyable; therefore, students feel more freedom of action in their subconscious minds when working on this subject, which is the effect of computer systems in entertainment subjects. Because of the high repetition of residential subjects among different subjects, students have gained more and better knowledge of this matter, and because of gaining more knowledge, they seek to present more creative designs using computer systems. The results are like the results of the study by Gharibpour (2013) regarding the role of computers in improving the quality of architectural designs and Mozaffar & Ekhlasi (2017) regarding the act of computers and software. Architecture is in harmony with the new design horizons and the findings of Asefi & Imani (2016) regarding the act of architectural software in creating creativity in architectural designs. According to the research findings, it can be suggested that paying attention to the human-centered dimensions in architectural education at the undergraduate level, which is considered a basic level, should be given serious attention. Choosing the right software can lead to the improvement of students' architectural designs. Finally, it can be said that one of the most important aspects of the impact of computer systems in the quantitative and qualitative improvement of architectural maps is related to the subject of projects. Therefore, improving the quality of architectural designs is effective by providing specialized training on computer systems for each subject. Finally, it can be said that improving the quality of architectural maps is a complex process that is influenced by various types of human conditions, software, and hardware. Therefore, to accurately understand this issue, it is suggested to conduct studies on the role of educational systems, the act of native culture, and the mental characteristics of students.

AUTHOR CONTRIBUTIONS

B.Fadavi Akhavan performed the literature review and experimental design, analyzed and interpreted the data, and prepared the manuscript text and edition. Sh. Akbari Namdar performed the experiments and literature review, compiled the data, and manuscript preparation. M. Mousavi helped in the translation and manuscript preparation.

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CONFLICT OF INTERESt

The authors declare no potential conflict of interest regarding the publication of this work. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication or falsification, double publication or submission, and redundancy, have been completely witnessed by the authors.

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