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THE COMPUTATIONAL THINKING SKILLS IN ARCHITECTURE SKILL DEVELOPMENT AS A CASE STUDY

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Abstract:

The research aims to identify the effectiveness of computational thinking in developing the thinking skills of the architectural designer to create creativity .The research revealed the extent to which the results were achieved for the goal sought by the research in upgrading the process of architectural education to develop skills and the difficulties facing the learning process and skill development. The researcher followed the descriptive analytical survey method through the use of the personal interview and the questionnaire as a tool for collecting information from the study sample. The results were treated statistically using the (SPSS) program. It has the ability to improve the educational process and achieve its objectives with a high degree of proficiency, Therefore, the research problem was (creating a method for developing the skills of the architectural designer based on algorithms to develop the designer's mental abilities as an intellectual tool before it is computational).In order to solve this problem, the researcher put a vision within the general research hypothesis (computer thinking is a successful educational method at the level of education and advanced cognitive design).It is achieved through the special hypothesis (computer thinking works to develop the skills of the architectural designer and develop his capabilities).The descriptive analytical method was adopted for a set of questionnaires, which gave the reliability of the hypothesis stability. That computational thinking skills, including algorithms, be an essential part on which the curricula are built.

Keyword: Algorithm, computational thinking, architecture, designer, skills

1. Introduction

The design process associated with nature and man has been present in the world of architecture for a long time as an approved scientific method for the traditional architectural designer, Today, after the technological development in the world of architecture and the architectural programs auxiliary to the architectural designer, this approach has been replaced by a modern algorithmic method based on understanding the natural principles of work and simulating them technologically in all stages of design. In this study, "the research focused on the most important differences between the development of the capabilities and skills of the designer by means of the product of traditional design and the product of algorithmic design As one of the mathematical rules that the research adopts, by identifying the external factors of the algorithm's thought as a model based on multiple factors. This study aimed to explore the true role of architectural programs based on algorithmic intelligence in developing architectural thinking skills and scientific and cognitive excellence through a

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comprehensive analysis of studies and research, To achieve the objectives of the study, the research used the descriptive method as a practical study from all the published researches. In order to start the process of improving the quality of software used in the early stages of thinking about architecture, where the principle of the process of checking, testing and evaluating an architectural data set from a database was adopted. The results indicated that the method used by modern methods achieved a remarkable improvement in the process of skill development, performance and quality for all design methods used in the research and selection of features on the basis of improvement and mobilization to predict the defects of traditional thinking.

2. Research goals

1- The effectiveness of computational thinking in upgrading the architectural curriculum and teaching methods

2- The effectiveness of algorithmic thinking in developing the capabilities of the designer

3- Addressing the difficulties encountered in understanding the method of using computational thinking in the learning and teaching process.

3. Research Methodology

The research uses the descriptive analytical survey method as an appropriate method for this type of study because it is concerned with studying existing facts related to the nature of the educational phenomenon and developing the skills of the student and designer through survey and investigation to reach conclusions that contribute to understanding and developing the architectural reality.

Time limits of research - students and professors of the Department of Architecture - University of Duhok from the year (2017-2022)

Spatial Research Limits - University of Duhok - Department of Architecture.

Search procedures

The study is applied in the province of Dohuk and the selection of computer thinking based on the algorithm as a scientific method in developing the skills of architectural education and the architectural designer. The research sample was chosen and the questionnaire was designed for the study.

4. The history of computational thinking

The advanced technology has brought about a wide change in the way we live, and the human being has a need for new jobs, and on the other hand, the need for other jobs has decreased, and the educational institutions have the largest part in preparing the future generation for coexistence and interaction with the new era with its various variables.This change in lifestyle requires special attention by architects in educational initiatives and scientific curricula, by increasing interest in the jobs of future architecture and preparing the generation for them.At the beginning of the new century, what is known as learning skills appeared in the twenty-first century, and the need for the new generation to arm themselves with these skills to take their role in

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the new contemporary architecture, which is characterized by rapid developments and changes, And to be more effective and present in future architecture jobs that rely heavily on technology and machines, and require higher thinking skills.

The research will focus on the role of Creative Thinking skills in creating a new generation of architects who are able to produce the architecture of creativity and innovation. Scholars have increasingly recommended that computer thinking skills, including algorithms, be an essential part of building curricula. The best global education systems were directed to adopt teaching such skills in the curricula and in the early stages of the primary stage before architectural education.[1]

5. Traditional and modern design methods

Architects who use computers to teach design face many intellectual problems in applying this new tool to well-known design methods and theories. And there are two main reasons for this problem, the first is the apparent weakness of the design systems using the computer that are currently available in the qualitative and functional expression of the different aspects of design, and the second is the lack of appropriate teaching or design methods different from those we are dealing with to deal with the computer.[2].

Osborn touched on the process of thinking and developing a design methodology to solve problems during his work in the commercial sector in New York City. In his studies, Osborn reached the conclusion that thinking is a process consisting of three main stages, and that each stage includes two sub-stages. .[3].

First stage: Facts Finding:

This stage includes the following:

1- Defining the problem after verifying its existence and defining it clearly.

2- Preparing and analyzing all relevant data.

The second stage: the stage of generating ideas:

This stage includes the following:

A- Generate ideas or alternatives that can help solve the problem.

B - Developing ideas by testing some of them and adding, modifying, merging and reviewing new ideas.

The third stage: Finding the solution:

This stage includes the following:

(1)- Evaluation means verifying the initial solutions by examination and tests.

(2)- Choosing the final solution and making the decision to implement it. .[3] .

6. Generating ideas the traditional way

A - The black box method

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In this way, the designer conducts a quick analysis of the requirements and available resources, and then gives a preliminary perception of the architectural configuration that seems appropriate until this moment. The remaining time is to develop this configuration by addressing its problems in a sequential manner. In most cases, the process of creating the initial idea depends on restructuring the problem. as a whole and transform it from a complex problem to a problem with a simplified structure, It is affected by testing the most important element that the designer focuses on and selects intuitively, after which the stage of developing the idea begins. [4] This method is characterized by ambiguity, the process of extracting the idea is not revealed, and the non-participation of others in creating ideas. It is characterized by moving from the general to the particular and from the whole to the part, meaning there is an inevitability in the result and does not allow the possibility of decision-making and the involvement of others..[4]

B - The transparent box method

The designer performs a broad analysis of the requirements and available resources, and then gives alternative solutions, after which these alternatives are divided and the optimal model is selected, and this model is developed to choose the design idea, so this method depends on

Analysis phase + installation + evaluation + development

Here, the problem is divided into many problems, so that an analysis process is carried out for each of the problems.

One of the advantages of this method is that the design thought is open and public, allowing participation in the design process and creating ideas, and that the smallest decision is taken at the beginning and the most important decision is postponed to the next stages after the information accumulates in a manner consistent with its importance. That is, each is integrated from the beginning and then fragments them. Fragmenting the problem into small components and solving them and then collecting solutions brings the thinking closer to the work of the computer, where the designer finds himself in the direction of very many parts of the problem, as well as more solutions, which makes the process of evaluating all of them and collecting them in one solution becomes greater than possible The human mind, but rather the competence of the computer, and this means the relationship with the designer to deal with the parts of the problem, that is, the problem is variable throughout the solution period and is not fixed, and here the designer’s subjectivity is eliminated.[4].

Make plan → goal analysis → Beneficiary's activities → Site analysis Functional Analysis → symbolic analysis

We see that the steps of creating computer design ideas are a process similar to the transparent box method, where the problem is fragmented into a group of parts, and each part is dealt with separately in the manner of moving from the specific to the general and from the part to the whole, and the whole is greater than the sum of the parts, i.e. the process is sequential, by calculating a set A large number of solutions. Each process of changing any value gives a new solution in light of the required

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determinants of the design. Comparison and comparison between these solutions are made through evaluation processes and testing to achieve the goal. This is what distinguishes algorithmic methods from traditional methods, and adds the architect through his dialogue with the algorithm written by his experience His sense and intuition, and we find that the integration between the architect and the computer is a harmonious digital approach that contributes to avoiding the weaknesses of both approaches.[4].

The rational model is mainly based on the information in all the steps, the information is collected in the analysis stage and classified so that creative ideas are produced from its analysis in accordance with the basic principles of solving the problem, and through the transformations that take place by changing the form of information from the reality of the state of the image on which the program is to initial ideas and an image for production Alternative solutions associated with partial problems. It produces alternatives solutions that are evaluated to find out the efficiency of the intellectual performance and the extent to which the objectives of the project are achieved, as the evaluation of architectural projects is one of the most important activities that the architectural design proposal goes through since the beginnings

For the first to the design process and even to reach its final output, the designer's greatest effort is focused on trying to reach the best judgments of judgment for his design proposal.[5].

7. Literature review

Many architects have discussed the role of computation thinking in the design process, including: (**Jirapong & Krawczyk,**) ,he referred to the re-installation of natural forms in an algorithmic digital form with changes in the mathematical relationship between the basic determinants of the constituent elements, as it is possible to achieve a new architectural form that simulates nature by applying those key determinants to an algorithmic process that translates the architectural form as well as using mathematical operations as a tool in Research and investigation in both architectural and natural forms in the exploration of multiple forms in an easy way that allows in the application of new determinants in the computational framework. Three-dimensional graphics. The output of these shapes developed by this process can be applied in specific architectural functions. [6].

Shuchi notes that over the past two decades there has been a concerted paradigm shift in our beliefs that it is not only important that we learn in science, engineering, and mathematics subjects, but also in the humanities. This shift has privileged the teaching of higher-order critical thinking abilities in every area such as meta-learning and procedural skills, in what has been described as "deep learning" as an attempt to differentiate computational thinking or thinking such as the computer world over other aspects of computing (such as learning binary arithmetic). and what is “computational thinking” . [7].

(**Shea**) He pointed out that computer technologies continue to influence the world of design where we can design, what we can create and build, and as a result of what is imagined. Programs intended for engineering and architectural design provide drafting

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systems to effective tools that integrate drafting and a wide range of analytical capabilities, as they help facilitate the creation and modification of accurate digital models of ideas.

Computational analysis is essential in designing modern structures from modern materials and as a tool for retrospective study, and can be used to understand past design[8].

(Terzidis, 2006) It is inevitable to enter the black box of programming in order to use the computer creatively. In this perspective where the study focuses to explore what mastery of scripting techniques are and how they can bring to architecture.

The main benefit of algorithmic architecture may lie in its relationship with architecture. It defines between a detailed examination of possibilities provided by a computer that is more general and of an interrogative, philosophical nature about the treatment of architectural design.[9]

Previous studies indicate the importance of using the philosophical aspect of algorithmic thinking in the design process and making the algorithm interrogate architectural thought to produce models, as the computer is not just a machine for producing models, but rather a way of thinking along with the philosophy of architectural design.

8. Development thinking skills

Basic thinking skills are certain mental processes practiced by the conscious mind of a person, by processing inputs of information and data to reach educational goals and different results. These results are represented in outputs that vary in nature between remembering, describing, observing, and even deducing, evaluating, researching, and solving problems.[7]

A-Mathematical thinking

Where the individual depends on preparation and thinking to reach the appropriate decision by resorting to various rules and evidence.[7].

B-Scientific thinking

This style depends on the organized scientific method for making decisions and solving problems facing the individual. It is carried out according to sequential steps, starting with defining the problem, evaluating the solution and finding possible alternatives.[7]

9. Desirable thinking skills

1. Analytical skills.
2. A fertile and creative imagination.
3. Flexibility and achievement.
4. Exceptional insight into situations of uncertainty and unpredictability.
5. The courage to take calculated risks.

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6. Intuitively aware of what is going on in secret.
7. Lack of vanity and welcome criticism.
8. Be decisive when a decision is required. [2].

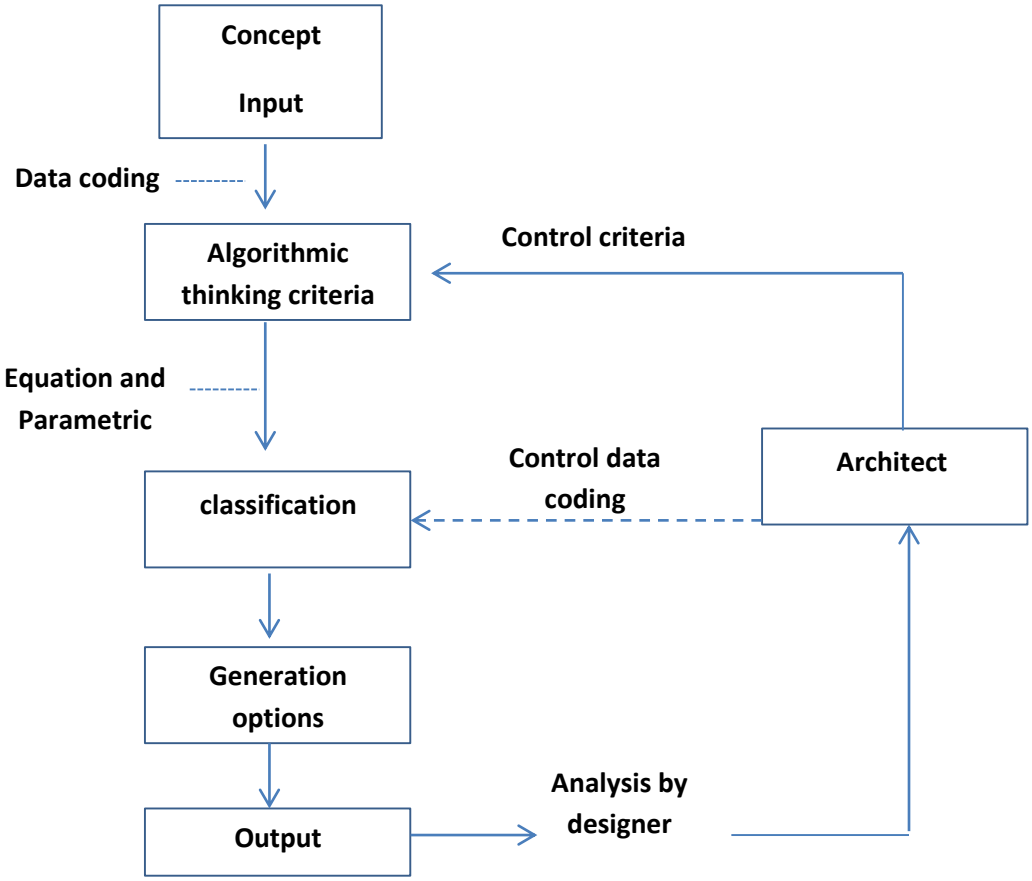

Diagram (1): Architecture Algorithmic thinking(researcher)

10. Algorithmic thinking or algorithmic steps

There are skills on which these basic skills depend, which the student and designer must train on, such as: methods of data collection, analysis, classification and representation, and these skills are basic that must be included in the initial architectural education; Because it is necessary to collect data about the problem in order to be able to partition, model and abstract, and thus we come up with the solution in the form of algorithmic steps that anyone can apply and reach the solution. [2]

Some of the education systems around the world have introduced the computer in the primary for one goal only, which is to develop computer thinking skills, in addition to integrating other digital skills with curricula for other subjects, which prompts us to

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think carefully about such decisions for global education systems that have given the utmost importance to the development of such skills. And benefiting from the experiences of countries, such as: Britain, Finland, Australia, and Singapore, which went to name the national capabilities of computer thinking skills. [10].

computer aided	traditional way	Comparison
Unrestricted by expression levels at different stages of design	Constrained by gradual levels of expression and increasing precision as the design evolves	Design Expression Levels
Multiple methods based on capabilities	Traditional graphics and models	ways of expressing design
Continuous decisions at any time	Specific decisions in specific drawings	Making Design Decisions
computer rules	Rules of practicing the profession and drawing	Rules to be followed
Exploiting computer capabilities to solve design problems	Solving design problems using traditional methods	Design Problems
It has no direction. It can start from bottom to top or from top to bottom	Heading from top to bottom, starting with generalities and ending with details	Design process

Table (1) A comparison between the architectural design in the traditional way and with the aid of computer [2]

11. The effect of computer use on architectural design

Many universities and architectural schools have adopted the computational thinking approach and have incorporated it into the educational process, including:

- **Harvard School of Design**

The Harvard School of Design was one of the schools that initially backed away from the use of computers, but has now become a leader in computer technologies. The school administration realized that the time had come for the computer to change the profession and began to see how the computer and dealing with digital image information changed the possibilities of exploration and recognition. And all this is still in the beginning.

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- **Cornell University**

Donald Greenberg, a professor of architecture at Cornell University, believes that students who can make 3D models on computers produce better work. He agrees that architects are needed to lead the field of computer graphics.

- **Ohio University**

Ohio University describes its advanced work as primarily research. And Chris Lysius, director of the graduate program in computer-aided architectural design, says that 60-70% of students are computer scientists. His works concern the use of computers to generate ideas and as a tool for brainstorming. The goal is not solutions, but the production of ideas in the form of graphics.

And the attitude towards artificial intelligence is to take care of it as industrial innovation, that is, how the power of the machine can help our power of creativity. And focus on defining the composition lanterns used to produce architectural formations in two and three dimensions. The result is not given a great meaning from a functional point of view, but it has a meaning from an aesthetic point of view. And by defining the shapes, we can produce designs for buildings that have a function. Ohio University is interested in research on the use of video in design.

- **University of Michigan**

Most of the new students in the architecture program have computer skills, and the result is that students see the computer as a natural part of their work and not as a specialty, and half of the faculty members have their own devices. Robert Buckley, Dean of the College of Architecture and Urban Planning, says that the computer has not made a fundamental change in the way architecture is taught, but he expects the computer to change the way architecture is understood and described. And the university is still trying to determine the best areas of computer application, and it is expected that this will be in large spatial problems and not in small details.[2]

12. Computational Thinking Elements

After reviewing previous studies and putting forward concepts and trends that indicated a different role for computer development and technology and their relationship to architecture, idea generation and education methodology through the concepts and practices of computer thinking.

Concepts of computational thinking include:

- logical thinking
- Algorithms and computational thinking
- patterns and pattern recognition
- Abstraction and generalization
- rating
- automation
- Problem and analysis

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- Create an arithmetic formula
- Testing and debugging
- iterative refinement (incremental development)
- Collaboration and Creativity .[7].

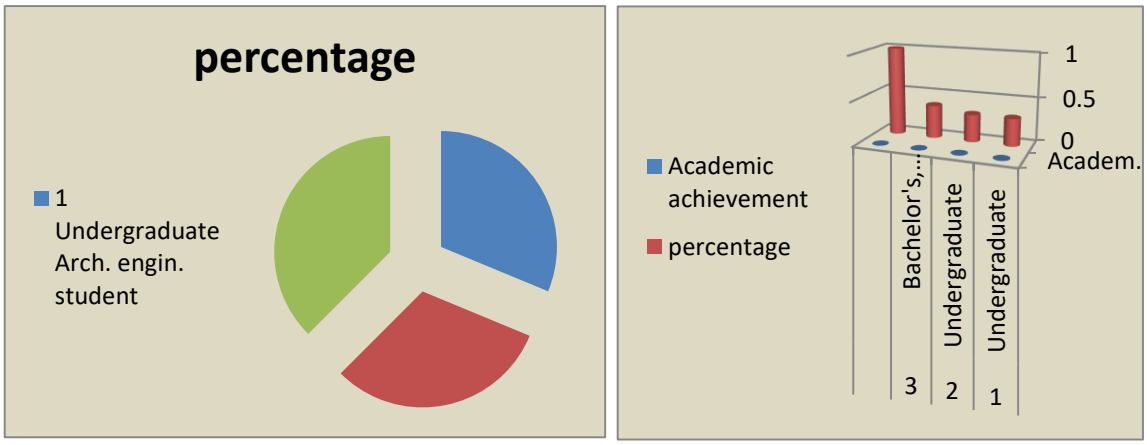
These concepts will be addressed as indicators of the role of computational thinking in developing the skills and capabilities of the architectural designer.

13. Search procedures

Adopting the descriptive analytical survey approach, collecting real information, and the correct organization of a series of different ideas. The phenomenon has been described well in quantity and quality by collecting the data necessary for the research procedures and has been analyzed and study of modern and contemporary trends related to the subject of the research to direct a questionnaire designed on the role of computational algorithmic thinking To develop design skills for students and architectural designers and to know the problems that hinder the use of that role.

percentage	Academic achievement	no.	level	no
31.25%	Undergraduate student	50	Architectural engineering student	1
31.25%	Undergraduate student	50	Female architecture student	2
37. 5%	Bachelor's, Master's, and Ph.D	60	Architectural engineering graduate	3
100%		160	The grand total of samples	

Table (2) the selected sample (researcher)



(diagram (2) the selected sample (researcher)

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14. Search tools

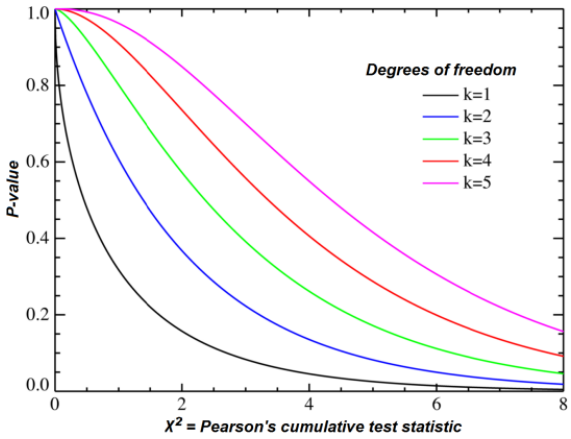
In order to achieve the objective of the study represented by (the role of computational thinking in developing the skills of the architectural designer), the researcher used the following tools:

15. Questionnaire

It is an interview form or a measuring tool developed by the researcher with several stages and questions designed to collect the data necessary to solve the research problem and be filled by the elected sample. The credibility of the data and the availability of stability and consistency between the answers were tested.

Chi-square test, also called chi-square test, is a statistical hypothesis test in which the sample distribution of the test statistics is a chi-square distribution.

, when the null hypothesis is true, or any convergent element is true, meaning that the sample distribution (if the null hypothesis is true) can be made according to the nearest chi-square distribution, near the optimum to make the sample size large enough and indicates that the hypothesis is valid if it is significant or not. [11].



Diagram(3)(Chi-square test)https://www.google.com/search?q=Chi-square

If the potential chi-square value is less than the permissible level of error which is (0.05), then the statistical interpretation and the test result are significant, that is, there is a significant difference between the answers of the respondents.

But if the potential chi-square value is greater than the permissible level of error (0.05), then the statistical interpretation and the test result are not significant, that is, there is no significant difference between the answers of the respondents.

The pentatonic scale was used and values were given for each value, which is strongly agree with its value (5), agree with its value (4), neutral with its value (3), Disagree with its value (2), and strongly disagree with its value (1), so the arithmetic mean of these values is (3)

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If the value is greater than 3, go to strongly agree and agree, and if it is less than 3, go to strongly disagree or agree.

After conducting the questionnaire and entering the answers into the statistical programs used in the research, the researcher obtained the following results:

No.	the question	Chi-square probability value	Interpretation of the result	Arithmetic mean value	the scale
1	A commitment to unity, order, and coherence in organizational rules is found in computational thinking	0.06	An insignificant difference between the answers	1.7	Strong disagreement
2	Computational thinking leads to freedom from specific formal elements and the striking of historical patterns	0.053	An insignificant difference between the answers	2.9	disagreement
3	The use of algorithms can replicate and even amplify human and systemic bias when they are based on insufficiently diverse architectural data. It may mean a lack of diversity in architecture information	0.07	An insignificant difference between the answers	1.2	Strong disagreement
4	Architectural computer programs affect the efficiency of architectural work during the design process stages	0.01	Significant difference between the answers	4	Strong agreement

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agreement	3.8	Significant difference between the answers	0.012	Modern means of communication affect the speed of obtaining information in the design process	5
Strong agreement	4	Significant difference between the answers	0.01	Architectural websites and digital libraries serve to enrich information about a project to be designed	6
Strong agreement	5	Significant difference between the answers	0.00	Experimenting with the use of computers develops your design capabilities	7
neutral	3.1	Significant difference between the answers	0.02	There is trouble and difficulty when using computer programs in the design process	8
Strong agreement	5	Significant difference between the answers	0.00	Students or designers prefer computational thinking to conventional thinking	9
Strong agreement	5	Significant difference between the answers	0.00	Universities that rely on computational thinking are more desirable for students and designers	10

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Strong agreement	5	Significant difference between the answers	0.00	The functional and formal aspect in the architectural style resulting from computational thinking made a change in the formulation of ideas in the design process	11
Strong agreement	4	Significant difference between the answers	0.01	The computer thinking technique helps in developing the mental imagination skills of the designer during the design process	12
agreement	3.7	Significant difference between the answers	0.014	Digital technology and computational thinking, such as data aggregation and artificial intelligence, are used to track and diagnose problems in architecture, design process, and skill .development	13

Table (3) Statistical results for the most important indicators of computer (thinking and the development of architectural designer skills (researcher)

16. Results Analysis

After collecting the forms and analyzing their results using statistical programs and extracting the values of the chi-square for each question and its arithmetic mean, and then the arithmetic mean and standard deviation for each question, the researcher found that the statistical results of the first question (commitment to unity, order, and cohesion in organizational rules are present in computational thinking) relative to the probability value of chai-square It was (0.06), which is a value greater than the permissible level of error (0.05), so the statistical interpretation and the test result are not significant, that is, there is no significant difference between the answers of the

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respondents. Its arithmetic mean is (1.7) and it is moving away from (3) and therefore it go to (strongly disagreement).

As for the statistical results of the second question (Does computational thinking lead to liberation from specific formal elements and multiplying historical patterns) with respect to the chai-square probability value (0.053), which is a value greater than the permissible level of error (0.05), so the statistical interpretation and the test result are not Significant, that is, there is no significant difference between the answers of the respondents. Its arithmetic mean is (2.9) and it moves away from (3) by a little and therefore it tends to (disagreement).

As for the statistical results of the third question (the use of algorithms would lead to the repetition of human and systemic bias and even amplify it when it is based in its work on insufficiently diverse architectural data. It may mean a lack of diversity in architecture information) with respect to the chai-square probability value (0.07) which is a value greater than the permissible level of error which is (0.05), so the statistical interpretation and the test result are not significant, that is, there is no significant difference between the answers of the respondents. Its mean is (1.2) and it is away from (3) and therefore go to (strongly disagreement).

As for the statistical results of the fourth question (architectural computer programs affect the efficiency of architectural work during the stages of the design process) with respect to the probability value of the chai-square (0.01), which is a value less than the permissible level of error (0.05), so the statistical interpretation and the test result are significant. That is, there is a significant difference between the answers of the respondents. Its arithmetic mean is (4) which is higher than (3) and therefore it go to (strongly agreement).

As for the statistical results of the fifth question (modern means of communication affect the speed of obtaining information in the design process) with respect to the probability value of the chai-square (0.012), which is a value less than the permissible error level which is (0.05), so the statistical interpretation and the test result are significant, i.e. There is a significant difference between the answers of the respondents. Its arithmetic mean is (3.8) which is higher than (3) and therefore it go to (agreement).

As for the statistical results of the sixth question (architectural sites and digital libraries serve to enrich information about a project to be designed with respect to the chai-square probability value (0.01), which is a value less than the permissible error level, which is (0.05), the statistical interpretation and the test result are significant, meaning there is a difference Significant among respondents' answers, and its mean is (4), which is higher than (3), and therefore it go to (strongly agreement).

As for the statistical results of the seventh question (experimenting with the use of the computer develops your design capabilities) with respect to the probability value of the chai-square (0.00), which is a value less than the permissible level of error (0.05), then the statistical interpretation and the test result are significant, that is, there is a significant difference between the answers respondents. Its arithmetic mean is (5) which is higher than (3) and therefore it go to (strongly agreement).

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As for the statistical results of the eighth question (there is trouble and hardship when using computer programs in the design process) with respect to the probability value of the chai-square (0.02), which is a value less than the permissible error level, which is (0.05), so the statistical interpretation and the test result are significant, that is, there is a difference Significance between the respondents' answers. Its arithmetic mean is (5) which is higher than (3) and therefore it go to (strongly agreement).

As for the statistical results of the ninth question (students or designers prefer computational thinking over traditional thinking) with respect to the chai-square probability value (0.00), which is a value less than the permissible error level (0.05), so the statistical interpretation and the test result are significant, meaning there is a significant difference Among the respondents' answers. Its arithmetic mean is (5) which is higher than (3) and therefore it go to (strongly agreement).

As for the statistical results of the tenth question (universities that depend on computer thinking are more desirable for students and designers) with respect to the chai-square probability value (0.00), which is a value less than the permissible level of error (0.05), so the statistical interpretation and the test result are significant, meaning there is a difference Significance between the respondents' answers. Its arithmetic mean is (5) which is higher than (3) and therefore it go to (strongly agreement).

As for the statistical results of the eleventh question (the functional and formal aspect in the architectural pattern resulting from computer thinking caused a change in the formulation of ideas in the design process) with respect to the probability value of the chai- square (0.00), a value less than the permissible error level, which is (0.05). So, the statistical interpretation and the test result are significant, that is, there is a significant difference between the answers of the respondents. Its arithmetic mean is (5) which is higher than (3) and therefore it go to (strongly agreement).

As for the statistical results of the twelfth question (the computer thinking technique helps in developing the mental imagination skills of the designer during the design process) with respect to the chai-square probability value (0.01), which is a value less than the permissible level of error (0.05), which is the statistical interpretation and the test result. Significant, that is, there is a significant difference between the answers of the respondents. Its arithmetic mean is (4) which is higher than (3) and therefore it go to (strongly agreement).

As for the statistical results of the thirteenth question (digital technologies and computer thinking, such as data collection and artificial intelligence, are used to track and diagnose problems in the fields of architecture, design process and skill development) with respect to the chai-square probability value (0.014), which is less than the permissible error level. It is (0.05), so the statistical interpretation and the test result are significant, that is, there is a significant difference between the answers of the respondents. Its arithmetic mean is (3.7) which is higher than (3) and therefore it go to (agreement).

The total percentages of the arithmetic mean of all the questions in the questionnaire form indicate that l is strongly agreement for most of the questions about 50% and 15% agreement and 10% are neutral, the total is 75% towards the approval of those

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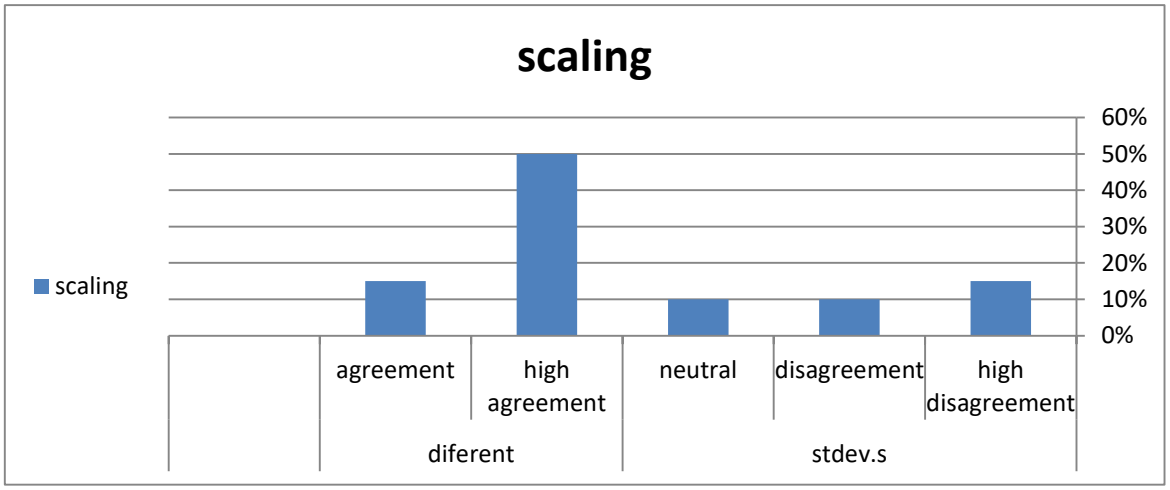
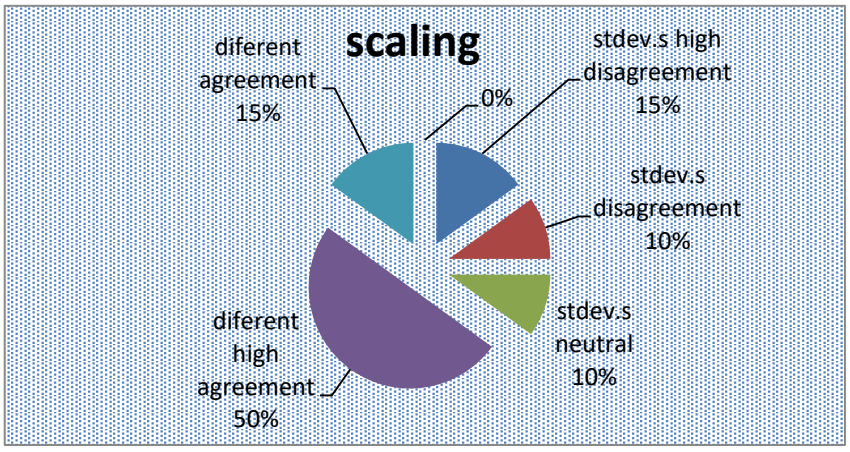
questions that relate to a positive role of computer thinking in the development of designer skills As shown in the following table:

Data analysis						
	stdev.s			diferent		
	high disagreement	disagreement	neutral	high agreement	agreement	
scaling	15%	10%	10%	50%	15%	

Table (4) Percentages of achieving research indicators (researcher)





(**diagram (4) Percentages of achieving research indicators (researcher)**

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17. Conclusions

1- The design process, educational goals, student development, mastery of technology, and development of teaching aids
2- The results indicated that the commitment to unity, order and cohesion in the organizational rules is present in computational thinking in a more flexible, free and broader imagination, where computational thinking leads to liberation from specific Euclidean formal elements and develops historical patterns and imitates them with more creative imagination.
3- Experimenting with the use of the computer develops design capabilities and reduces the trouble and difficulty when using computer programs in the design process, such as architectural sites and digital libraries, to enrich information about a project to be designed.
4- The computer thinking technique helps in developing the mental imagination skills of the designer during the design process, and that the functional and formal aspect in the architectural pattern resulting from computer thinking makes a positive change in the formulation of ideas in the design process.
5- Self-reliance in developing an understanding of the design process and technical accuracy.
6- The storage of knowledge is very important to reproduce the knowledge in a renewed way, and this is easily applied in the algorithmic method.
7- Computational thinking in the architectural approach is the way to break the familiar geometric relationships that determine the interconnection of divergences so that the revolutionary leaps are invested in thinking and access to the product, and thus the time stages will be folded and reduced to heal in the context of the new product and in the light of the idea or the significance of the influential event.
8- Developing the skills of architecture students, through computational thinking, through which he records his observations, measures and classifies data, infers and predicts solutions, sets hypotheses necessary to solve problems, sets designs and implements them, and thus the designer’s thinking grows and plays the role of discoverer.
9- The role of the computer in architecture is no longer limited to the artistic presentation of architectural works, but the study proves the possibility of investing it as an effective means to reach the development of thinking skills for the product of creative architectural design.
10- The algorithmic computer approach leads to achieving aspects of the creative design process represented by fluency, flexibility, sensitivity to problems and originality in a manner that respects the designer's subjectivity and opens the appropriate space for thoughts of intuition and chance, especially in architecture, which clearly indicates the importance of the subjective and objective aspect.
11- Creating an algorithmic thought in architecture requires a fundamental change in the system of thought, ideas, or current adopted by the designer, and this fundamental change imposes a breach of previous patterns of thinking and a

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breach of the formulas of design solutions to the problems imposed by the architectural project program.

12- Computational thinking in contemporary architecture opens horizons for developing skills from references and fields from outside the field of architecture and investing in technological, biological and other theories, in order to formulate an event that the designer can translate architecturally, because the means of expression in the field of architecture are the forms and their expressive systems that produce the language of communication with the recipient from Through the free space created by the algorithm and the computer field.

13- Computational thinking helps in developing the knowledge and skills that the architect must acquire and affect the preparation of the architectural personality to keep pace with progress and qualify the architect for responsibility and participation in local and international issues concerned with architecture and urbanism in the era of globalization.

14- To see computational thinking as information technology in architecture at the level of changing form, function and modeling tools only, to be an extension of the architect's mind in architectural design.

15- The resulting model of algorithmic thinking implemented in the program, which makes modifications to this model, is directly related to the architectural problems facing the designer.

And based on the conclusions obtained by the research from the achieved results, which confirm the validity of the research hypothesis (computer thinking based on the architecture algorithm, an educational approach for the development of designer skills).Which in turn solves the research problem.

18. Recommendations

There are a number of directions to consider for computer-aided architecture education:

1- Qualifying students with the ideas and skills necessary to use computer-assisted architectural design systems after their graduation.
2- Qualifying the student to control the development of architectural design systems with the help of computer and to develop and create these systems on their own.
3- Providing laboratories and laboratories to test their designs through a new design environment.
4- Introducing computational thinking in the curricula of architectural schools and revising the computer science curriculum in universities to meet the needs of specialists and the labor market.
5- Modifying and developing the digital architectural education curricula to be formulated in ways that allow to bring out and activate the mental abilities of architecture students, through the development of programs and study plans for architectural education.
6- A computer programmer or an architectural designer should design the most common algorithm drivers in an easy and applicable way.

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