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Artículos Científicos

La creatividad en la formación del arquitecto, el proceso creativo y las neurociencias

***Creativity in the Training of the Architect, the Creative Process and
Neurosciences***

Criatividade no treinamento de arquitetos, processo criativo e neurociência

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Resumen

El presente artículo expone resultados primarios sobre el papel que juega la creatividad en la arquitectura y la formación de los arquitectos, la cual es fundamental en el proceso del diseño arquitectónico, desde todo el proceso formativo en la universidad hasta la etapa profesional-laboral como egresados. Esta investigación se apoya en algunas nociones de las neurociencias, que ayudaron a entender el proceso del pensamiento creativo, crítico y analítico. Estos conocimientos ratificaron la importancia de ejercitar la creatividad, de dominarla, manipularla y controlarla para solucionar problemas arquitectónicos. Mediante la observación, el estudio de casos, las encuestas, las entrevistas y el estudio del nuevo diseño curricular de la Escuela de Arquitectura de la Universidad de Sonora (2018), se obtuvieron las variables necesarias para poder ofrecer una alternativa de solución al problema de introducir la creatividad dentro del proceso de formación del arquitecto en dicho recinto académico. Los resultados muestran que el proceso de formación de los estudiantes de arquitectura es reproductivo y no se le da la importancia que merece a la creatividad en los procesos productivos de innovación en el plan de estudios. Además, si bien la planta académica ve a la creatividad como un factor importante, no la promueve y no la incorpora

en sus actividades docentes de forma específica. Para solucionar esta situación, se propone la aplicación de una metodología epistemológica que ayude tanto en el macro como en el microdiseño curricular, que contemple incluir la creatividad como necesaria en el perfil de ingreso de los aspirantes y que le dé mayor énfasis durante el proceso de aprendizaje formativo, lo cual es imprescindible para desarrollar esta competencia, así como modificar el perfil de egreso de los futuros arquitectos.

Palabras claves: creatividad, diseño curricular, espacio arquitectónico, estudiante de arquitectura, neurociencias.

Abstract

This research was supported with some knowledge of neurosciences, which helped to understand the process of creative, critical and analytical thinking. This knowledge confirmed the importance of exercising creativity, of mastering, manipulating and controlling it to solve architectural problems. Through observation, case studies, surveys, interviews and the study of the new curricular design of the Escuela de Arquitectura at the Universidad de Sonora (2018), the necessary research variables were obtained in order to offer an alternative solution to the problem of introducing creativity into the architect's training process in the aforementioned academic precinct. The results of the research show that the process of training of architecture students is reproductive and it is not given the importance of creativity in the productive processes of innovation in the curriculum. In addition, although the academic staff sees creativity as an important factor, does not promote and does not incorporate it in their teaching activities specifically. To solve this situation, the application of an epistemological methodology was proposed that helps both the macro and the micro curricular design, that includes creativity as necessary in the profile of entry of the applicants and that is emphasized during the process of formative learning, which is essential to develop this competence, as well as modify the graduation profile of future architects.

Keywords: creativity, curriculum design, architectural space, architecture student, neuroscience.

Resumo

Este artigo apresenta resultados primários sobre o papel que a criatividade desempenha na arquitetura e no treinamento de arquitetos, fundamental no processo de projeto arquitetônico, desde todo o processo de treinamento na universidade até a etapa do trabalho profissional como graduados. . Esta pesquisa é apoiada por algumas noções de neurociência, que ajudaram a entender o processo de pensamento criativo, crítico e analítico. Esse conhecimento confirmou a importância de exercitar a criatividade, dominá-la, manipulá-la e controlá-la para resolver problemas arquitetônicos. Através da observação, estudos de caso, pesquisas, entrevistas e o estudo do novo desenho curricular da Escola de Arquitetura da Universidade de Sonora (2018), foram obtidas as variáveis necessárias para poder oferecer uma solução alternativa ao problema de introduzir criatividade no processo de treinamento do arquiteto no referido recinto acadêmico. Os resultados mostram que o processo de formação dos estudantes de arquitetura é reprodutivo e a criatividade não recebe a importância que merece nos processos produtivos de inovação no currículo. Além disso, embora a equipe acadêmica veja a criatividade como um fator importante, ela não a promove e não a incorpora especificamente em suas atividades de ensino. Para resolver essa situação, propõe-se a aplicação de uma metodologia epistemológica que ajude tanto na macro quanto na microdesign do currículo, que contemple a inclusão da criatividade necessária no perfil de entrada dos candidatos e que dê maior ênfase durante o processo de aprendizagem formativa, essencial para desenvolver essa competência, bem como modificar o perfil de graduação dos futuros arquitetos.

Palavras-chave: criatividade, desenho curricular, espaço arquitetônico, estudante de arquitetura, neurociência.

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Introduction

The creative process in architectural design is the cornerstone of architects' work. That is why we must master and teach it properly: make it a competition for our students. For the development of creativity, the architect's brain must have the ability to identify patterns and show curiosity about the novel and the unknown. Without a doubt, architecture and creativity are two words that go hand in hand, it is not possible to conceive one without the other; erecting walls and putting ceilings is not doing architecture.

There are many and varied definitions of architecture: from the most technical to the most poetic. Here we can define it as the discipline (considered art by some) that conceives spaces destined for a certain use and that is not only capable of satisfying the needs of users, but also of providing sensations. To achieve this requires theoretical, practical knowledge and a lot of creativity.

As if the above were not enough, Ibo Bonilla (s. F.) Made a collection of thoughts on what architecture is. Here are some of these ideas.

First, Luis Barragán (quoted in Bonilla, s. F.) Mentioned the following:

The ideal space must contain elements of magic, serenity, charm and mystery. I think these can inspire men's minds. Architecture is art when consciously or unconsciously an atmosphere of aesthetic emotion is created and when the environment creates a feeling of well-being (p. 9).

Tadao Ando (quoted in Bonilla, s. f.), on the other hand, indicates the following:

Architecture must be the result of an encounter between logical reasoning and creation that results from the use of the senses. It is not enough just with knowledge and the logical response to the program, but also with mere sensitivity it is not possible to satisfy the demands made by reality. (p. 7).

Lastly, Ibo Bonilla (2004) himself created his definition: "Architecture is sculpting space to satisfy physical, emotional and spiritual needs, protecting the result with a skin that is in harmony with the aesthetics, techniques and site of the moment it is carried out. . (...) It is to model social meta skin with art "(p. 1). As can be seen, some of these definitions consider architecture as an art, because it has been established for a long time. Undoubtedly there will be some theorists who differ, however, this discussion is not relevant to the present work, which is intended to clarify that without creativity there would be no art and architecture (Ando, Heneghan and Pare, 1996).

Creativity does not figure as one of the competences to be developed in the curriculum of the School of Architecture of the University of Sonora, which suggests two scenarios: either it is perceived as an inherent characteristic of the program, or it is considered unnecessary.

Due to the importance of creativity in the architect's work, it must be considered as a competence to obtain and develop, and to achieve this it is necessary to include it both in the study plan and in the graduation profile of the students. In many cases, however, there is no awareness of this, which could cause the loss or atrophy of creativity during the training process. The worst is when teachers do not even give it importance and try to make it appear spontaneously, at best, or the need to have it is disdained, pretending that based on data and exercises the student will creatively solve spatial problems. This is not possible.

In some cases, it is intended to use architectural graphing software to carry out the process of designing architectural spaces, which, without a doubt, is incorrect, because these softwares are for drawing, for graphing, not for designing, because the machine does not think, but follow established guidelines, which, while helpful, are not a substitute for creative thinking. In architecture, creative thinking requires sensitivity, to involve feelings, in order to create spaces that help the user feel comfortable, safe, relaxed, comfortable, in short, that help the spaces created serve what they were designed for. : make us feel, and this is precisely what fosters innovation, breaking spatial and temporal paradigms (Corral y Díaz, 2009; López de Asiain, 2005; Mendoza, Zacarías y Moreno, 2015; Rueda, 2014)

The architect, to carry out his profession, must be an excellent researcher, because he needs to have the necessary data to solve any spatial problem entrusted to him. But this is not enough, creativity is what makes the difference: it is the one that contributes the special elements that differentiate one design from another, one architect from another, a reproduction of an innovation.

It is in the creative process that dreams come true, where, in addition to the functionality highlighted in the Bauhaus modernism created by Walter Gropius in 1919, the inhabiting machine, as Le Corbusier said, or the aesthetics of different times, we must make a difference by uniting functionality, aesthetics, sustainability and creativity to make architecture, as well as taking into consideration, on the one hand, the user and considering, on the other, the importance of studying the terrain, flora, fauna, the area, accessibility, necessary infrastructure, required public services, weather, costs, laws, rules and regulations. Obviously, the protection of ecology, sustainability and sustainability must be taken into

special account, these last three are generally treated as something separate, and it should not be so, as if an ecological, sustainable and sustainable architecture could be made and another no, good architecture and bad architecture. Here, on the contrary, it is stated that there is only one. And for it to be considered as such, it must gather and integrate all these studies, requirements and care; otherwise, although it would be satisfying the user or client, it would be threatening society, our planet and humanity: this could not be called architecture.

Sensations are an important part of human development and architecture must add to achieve it. Creativity is responsible for making architecture feel.

The creativity

In the Encyclopedia of Psychopedagogy Ocean (1998, cited in Esquivias, 2004) creativity is defined as the "disposition to create that exists in a potential state in every individual and at all ages" (p. 3). On the other hand, in the Santillana Dictionary of Education Sciences (1995, cited in Esquivias, 2004) it is pointed out that the term creativity means "valuable innovation and is of recent creation" (p. 3).

Esquivias (2004), likewise, points out the following:

The creative process is one of the highest and most complex potentialities of human beings, it involves thinking skills that allow the integration of less complicated cognitive processes, even those known as superiors, to achieve a new idea or thought. (p. 3).

For the purposes of this work, we will define creativity as the capacity of the human being to contribute new ideas, technologies, or artistic expressions, to innovate.

Architectural design

Young applicants to study architecture should become aware of the importance of architectural design in their professional development. In fact, such is its importance that without it there would be no architectural works. The architectural design is to capture first with sketches, then with plans in one dimension, in two dimensions with perspectives, renderings or any other architectural graphic expression, the project in its different stages, and the models that show us in three dimensions a project that was born of a spatial need, of an architectural problem and it was solved in a professional way. It all starts with a problem to solve. From there a first idea is born and, at that moment, the brain sends an order to the

hand to graph it, express it, draw it. That is why graphing, architectural drawing, is the architect's language and we must master it to be able to visibly and adequately express our ideas, our architectural proposals. To achieve this requires practice, a lot of practice, and following an appropriate methodology.

The creative process

What function does the brain have within the creative process? The right part of the brain is creative, while the left part is logical. The right hemisphere is specialized in sensations, feelings and special visual and sound abilities, such as music or art, but not verbal (the perception of space, rhythm, color, dimension, imagination and daydreams, among others) . The left hemisphere deals with the verbal and numerical parts (arithmetic, sequential, logic and analytical).

"The fundamental thing is to have the necessary skill to use both hemispheres, since this way you are in complete balance and you achieve more effective creativity" (Alcaraz, 2006, p. 11).

Cerda (2000), for his part, says that the ability of our brain to identify patterns and show curiosity about the novel facilitates learning, which is based, in part, on creative capacity. And it is this creative thinking, which complements critical or analytical thinking that uses a rigorous and linear scientific methodology, that allows us to solve a wide variety of problems in a way that is sometimes unpredictable. Said result is the one that many times helps us to achieve a suitable architectural work and, on more than one occasion, a unique work for its creativity and representativeness, breaking paradigms and implanting some innovative trend in its time and place. (Cerda, 2000).

Neuroscience

Neuroscience is the set of scientific disciplines that study the nervous system in order to approach the understanding of the mechanisms that regulate the control of nervous reactions and the behavior of the brain. Disciplines such as neuroanatomy, neurophysiology, neuropharmacology, neurochemistry, etc. That is why neuroscience must be studied in an integrated and complementary way in order to understand the complexity of the brain (De la Barrera and Donolo, 2009)

The new paradigm that arises in the 21st century in relation to architecture arises with the discoveries of neurosciences and studies of environmental psychology: these scientific advances have shown that certain spaces help adulthood to produce new nerve cells, and that the design of architectural spaces influences the emotional states and behavior of individuals (Elizondo and Rivera, 2017; Franch and Camacho, 2016). Neurosciences and environmental psychology are making it possible to answer questions such as:

- How does the degree of privacy that the workplace gives us affect our behavior?
- How does our brain interpret the space in which we live?
- Why do the sick recover more quickly in hospitals with natural spaces and large windows to the outside?
- How does natural light influence our performance
- Which environments generate more discontent and aggression?
- What environments favor our collaboration at work?
- Why do certain spaces inspire a feeling of well-being?
- How do spaces affect our thoughts or our degree of stress?

All these aspects and many more are those contemplated by the new paradigm of neuroarchitecture, a science that has just been born and that in the future will be compulsory subject in architectural studies. The first institutions focused on the investigation of this new science are relatively recent. Thus, in 2003, the Academy of Neurosciences for Architecture was created in San Diego (California). The mission of this center is to investigate what space design should look like in the 21st century to improve our well-being, increase performance and reduce fatigue and stress in cities.

Neuroarchitecture

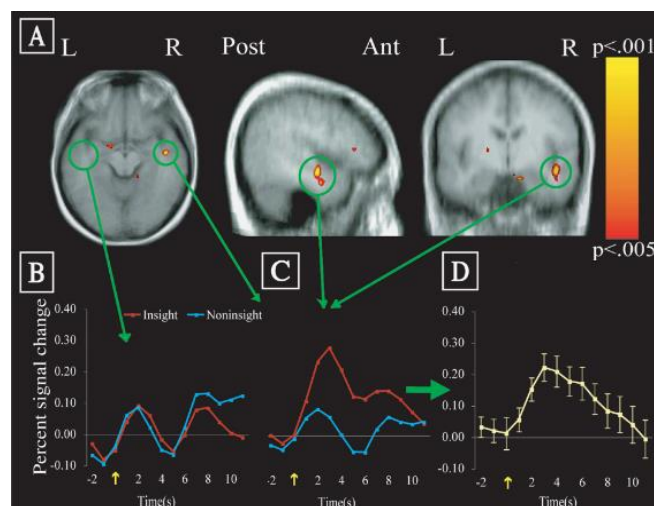
Regarding this discipline, Punset (s. F.) Refers to the following:

It begins to shed interesting clues to help us understand how the habitat in which we live affects our physical and mental health. It's not just about intuiting that color or space has an impact on our mood. It's about going one step further and inquiring about what specific effect spaces have on stress, hormones and the type of thoughts we generate (párr. 2).

The relationship between wide spaces and creative thinking is currently being investigated; on the mysterious power of nature to stimulate both concentration and healing of people after illness; or on the impact of buildings and furniture with sharp angles on the amygdala involved in the defense and aggression processes of the brain (Gutiérrez, 2017). Neuroarchitecture must be taken by the curricula for future architects as fundamental for achieving the creation of adequate spaces for human beings due to the importance of their contribution to our professional development (Elizondo and Rivera, 2017) .

As we can see, neurosciences deserve a separate study due to their great importance in human development. Among them, for the subject that interests here, neuroarchitecture, which helps us to understand the architectural creative process and how we can resort to it consciously and effectively (Portellano, 2000). There are two general strategies that allow us to solve problems differently: an analytical one, which involves a systematic evaluation of the different stages in which the problem can be broken down, and a more creative one, which involves a process known as insight, which allows us to solve the problem suddenly without being aware of the process and that causes us great satisfaction (Tirapu and Luna, 2008). Understanding the neural mechanisms that insight entails has important educational implications due to the direct relationship that this cognitive phenomenon has with learning, creativity and strategies in problem solving. (Kolb y Whishaw, 2006).

Figura 1. Localización en el cerebro del momento creativo



Fuente: Jung *et al.* (2004)

Creative, critical and analytical thinking

Huerta (February 16, 2016) mentions that "critical thinking consists of not accepting the apparent truth without a demonstration" (para. 2). He does not allow himself to be seduced by his interlocutor. Requires testing. Not all of us have this type of thinking, generally children do not. This type of thinking is very useful when making decisions (Huerta, February 16, 2016).

Analytical thinking, for its part, and following Huerta himself (February 16, 2016), "consists of having the ability to break down a complex problem into simpler parts (...). People with analytical thinking apply differential diagnosis in solving problems naturally and unconsciously "(paras. 6 and 7). It does not stay turning the problem without finding solutions, it analyzes and solves (Huerta, February 16, 2016).

There is also creative thinking, which is what allows us to find solutions to challenges. Huerta (February 16, 2016) states: "Creative thinking is very similar to that of an artist. Something is being created out of nothing. So you have to be born with that talent as an artist if you want to be able to create something really good. That is why I consider that creative thinking is in the genes and that it cannot be taught "(para. 11). However, I do not agree on this last statement, because creativity is a competence that we can acquire and perfect to create, a term used in the artistic process; we are not really creating but using the knowledge and skills necessary for this purpose. I agree, yes, in giving a predominant role to creativity and emphasizing its importance, and the need to develop creative, critical and analytical thinking, which is fundamental for the architect and should be used as a valuable tool in the process of architectural design, It will serve as an action guide, using both the methodological and the epistemological position for solving problems. In addition, there must be an adequate methodology and a holistic vision of the conflict and thus, through the methodology, gradually solve the architectural problem (Huerta, 16 de febrero de 2016; McLaren, Huerta y Rodríguez, 2010)

This work presents results on creativity in the architect's training process at the University of Sonora and its influence on his professional work performance.

Method

For this investigation we use the empirical method of observation, document review, surveys and interviews. For the processing of the data obtained and to analyze and interpret the information obtained and validate the results of the investigation, we rely on the mathematical and statistical levels. According to the statistics of Human Resources and Student Services, the Department of Architecture and Design of the University of Sonora has a population of 61 professors and 884 students (August 2019), and is made up of a division director, a department head and a coordinator. The study plan is 10 semesters and has as its backbone the Architecture Workshop, which takes place in all semesters.

Review and observation

The review of the new study plan of the School of Architecture of the University of Sonora (2018), based on competencies, was carried out with the aim of knowing the role of creativity in the architect's training process, both in macrodesign and in curricular microdesign. The entry profile, the professional performance model containing the exit profile, the objectives and the competencies were reviewed. The content of the different learning units, the evaluation system and the methodological indications were also reviewed.

The way in which students work to solve an architectural project was observed, with or without a methodology, with or without correct guidance from their teachers; also if the student applies the knowledge and skills obtained in the other disciplines and what attitude they have in the process; in short, if you have been acquiring the required and necessary skills to correctly carry out your creative work. In addition to the above, a general observation was made of the infrastructure that the School of Architecture has for the training of students, teaching spaces and recreational areas, research areas, workshops and specialized classrooms. Also, the website and the Communication and Informatics Techniques (ICT) laboratory, including specialized software.

Study of cases

By studying the works of the students of the ten semesters, architectural proposals were reviewed and analyzed, the application of a methodology and, above all, the use of creativity in their proposals was verified.

Polls

Students, teachers and graduates were surveyed in order to know how aware they are of the important role that creativity has in their architectural work.

Surveys were conducted with 200 students from the University of Sonora, from the 1st to the 10th semester, with the purpose of knowing their point of view about the importance of creativity in their professional preparation. Also 20 teachers and 20 architects graduated from the School of Architecture of the University of Sonora.

Questions to students

- 1) Is architecture an art?
- 2) Do you consider fundamental creativity for the architect?
- 3) Do you consider yourself creative?
- 4) Do you follow a methodology in your design process?
- 5) Do you have any specific kind of creativity?
- 6) Have you had any specific creativity test?
- 7) Has the school expressly motivated you to develop your creativity with any extracurricular activity?
- 8) Have teachers expressly motivated you to develop your creativity?
- 9) Is creativity innate?
- 10) Do you consider creative to design, draw and graph by hand?
- 11) Do you design by hand?
- 12) Do you design directly on the computer?
- 13) Is designing on the computer creative?
- 14) Do you design by hand and draw on the computer?
- 15) Do you think that renders sell architecture?
- 16) Do constructive technologies require creativity?
- 17) Do digital technologies require creativity?
- 18) Does building require creativity?
- 19) Does management require creativity?
- 20) Is creativity required to choose design strategies?

Figura 2. Encuesta a los estudiantes

%	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
100																				
95																				
90																				
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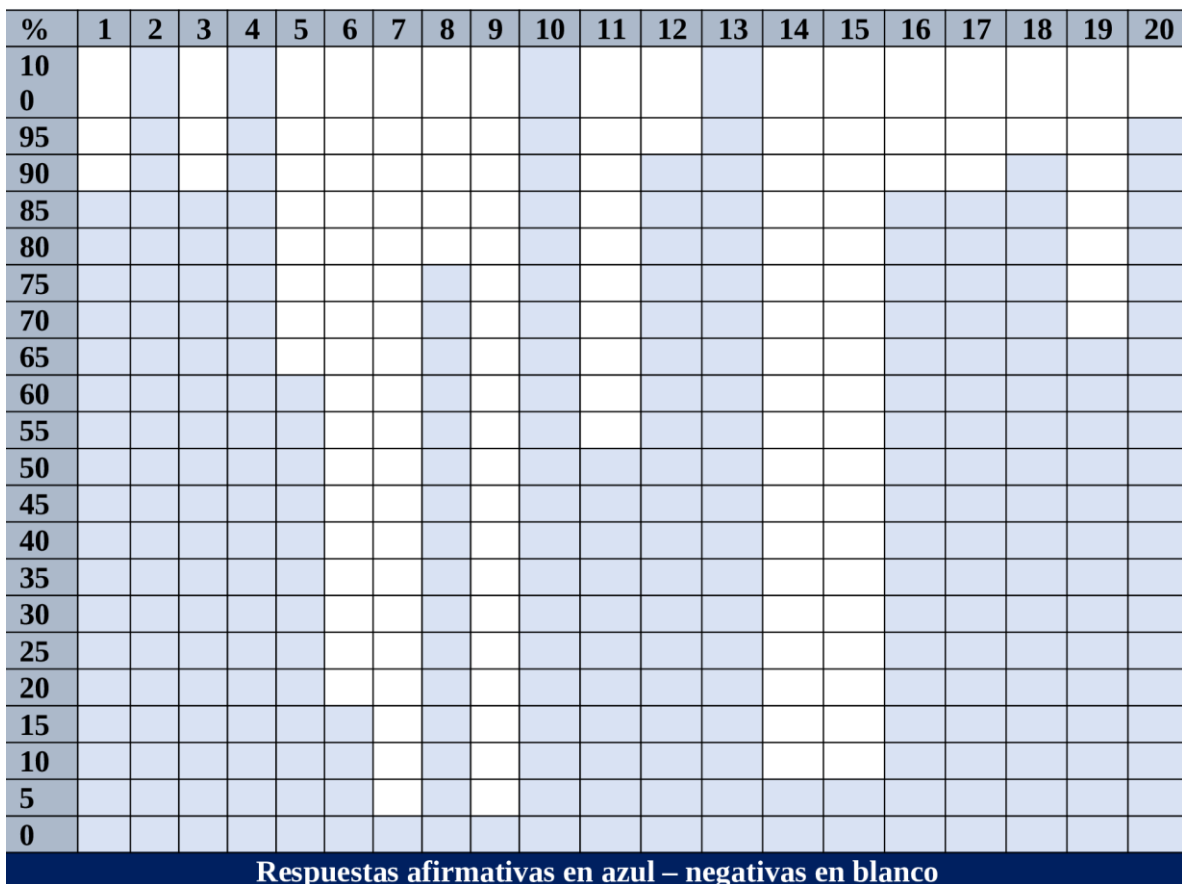
Fuente: Elaboración propia

Questions to teachers

- 1) Is architecture an art?
- 2) Do you consider fundamental creativity for the architect?
- 3) Do you consider yourself creative?
- 4) Do you teach your students a design method?
- 5) Is there a specific kind of creativity?
- 6) Do you carry out any specific creativity test on your students?
- 7) Does the school expressly motivate students to develop creativity with any extracurricular activity?
- 8) Do you expressly motivate creativity?
- 9) Is creativity innate?
- 10) Do you consider creative to draw and project by hand?
- 11) Do you teach to design by hand?
- 12) Do you allow designing directly on the computer?
- 13) Is designing on the computer creative?

- 14) Do you teach to design by hand and draw on the computer?
- 15) Do you think that renders sell architecture?
- 16) Do constructive technologies require creativity?
- 17) Do digital technologies require creativity?
- 18) Does building require creativity?
- 19) Does management require creativity?
- 20) Is creativity required to choose design strategies?

Figura 3. Encuesta a los profesores

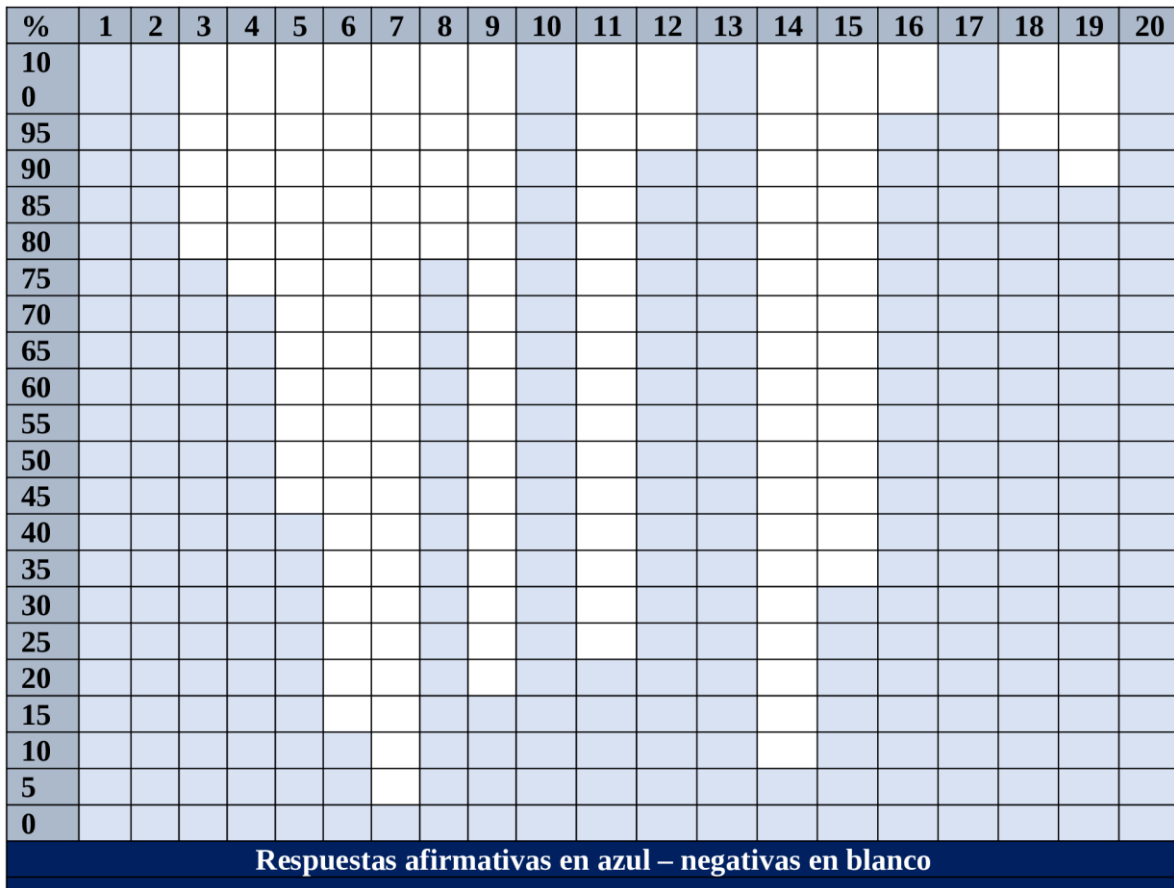


Fuente: Elaboración propia

Questions to graduates

- 1) Is architecture an art?
- 2) Do you consider fundamental creativity for the architect?
- 3) Do you consider yourself creative?
- 4) Were you taught as a student a design method?
- 5) Did you receive any specific kind of creativity?
- 6) Did you have any specific creativity test?
- 7) Did the school expressly motivate you to develop creativity in the students with some extracurricular activity?
- 8) Do you expressly motivate creativity?
- 9) Is creativity innate?
- 10) Do you consider creative to draw and project by hand?
- 11) Were you taught to design by hand?
- 12) Were you allowed to design directly on the computer?
- 13) Is designing on the computer creative?
- 14) Were you taught to design by hand and draw on the computer?
- 15) Do you think that renders sell architecture?
- 16) Do constructive technologies require creativity?
- 17) Do digital technologies require creativity?
- 18) Does building require creativity?
- 19) Does management require creativity?
- 20) Is creativity required to choose design strategies?

Figura 4. Encuesta a los egresados



Fuente: Elaboración propia

Interviews

The interviews carried out were semi-structured so that the interviewees could continue developing some idea resulting from one of the topics.

The interviews were conducted based on the following questions:

- 1) Should the architect be creative?
- 2) Does sustainable architecture require creativity?
- 3) Does the design of the different installations in a work require creativity?
- 4) Should creativity be essential in the income profile?
- 5) Should creativity be essential in the graduation profile?
- 6) Are you aware that the University of San Diego included the study of neuroarchitecture in its study plan?
- 7) Should neuroarchitecture courses be promoted at the university?
- 8) What would be the main characteristic of the architect in your opinion?

- 9) Is the existing infrastructure and equipment sufficient to develop the creativity of the students?
- 10) Is creativity a specific competence in the curriculum?
- 11) The new study plan for the Architecture degree program what graduation profile do you want from your students?
- 12) What should be the main characteristic of a graduate of the Architecture career?
- 13) Why?
- 14) Does the School of Architecture have the infrastructure and furniture appropriate to the needs of teaching architecture, to achieve this end?
- 15) Is the University of Sonora willing to support the Department of Architecture and Design to ensure that it has such facilities?
- 16) Would having a better infrastructure and equipment help develop the creativity of the students?
- 17) Are teachers expressly given the facilities and tools necessary for their continuous improvement in teaching?
- 18) Are the teachers willing to excel?
- 19) If the answer is negative, why?
- 20) Do teachers encourage creativity in their classes?
- 21) Is creativity important to architecture students?
- 22) Is creativity a specific competence in the curriculum?

Results

The interviews yielded diverse and worrying data. Everyone thinks that creativity is necessary for the architecture student, however, they do not consider it necessary that it be expressly indicated in the curriculum as a competence to acquire and develop, and unfortunately a minimum but important percentage considers that with furniture and equipment It is sufficient for the correct teaching of architecture, which unfortunately is not the case. They see creativity as something that students should have, and if they don't, they can supply it with work. These views do not distinguish between specific creativity directed at an art such as architecture and creativity accumulated by empirical experience.

Regarding the physical spaces for the study, the necessary equipment and the adequate furniture, almost all agree that it is essential to have them. This leads us to think that we need modern structures that help students develop architectural creative thinking.

Now, Ing. Heriberto Encinas, secretary of the Division of Humanities and Fine Arts, opined that a change should be made in the way of teaching architecture, updated to have the creative competence to make an innovative architecture, create something different but that solve the problems of the present with a view to the future. The doctor in Architecture Oscar Palafox, coordinator of the School of Architecture, commented on the importance of creativity in students, but he does not consider it necessary to put creativity as a specific competence. In addition, he said that what is currently available in infrastructure, services and furniture is sufficient, but that if it is considered necessary to acquire other infrastructure elements, a substantiated proposal should be submitted to the Department and it will manage before the Rectoría to obtain the resources and implementation of these. These comments consider creativity as very important in architects, however, it is still thought that it is a problem of the students and not of the teaching, and does not consider how environmentally in an architecture school you can contribute with teaching and learning the fundamental aspects of creativity. The teacher in Architecture Luis Franco, a full-time teacher and founder of the School of Architecture and Design, proposes a theoretical foundation for creativity in order to have sufficient elements on which to sustain it and thereby achieve better results in architectural work.

For the architect Raúl Gutiérrez, professor at the School of Architecture, creativity is essential for the student to be able to perform professionally as an architect. According to him, it should be present in the curriculum in a formal way and, of course, prepare the teaching staff in neuroscience and neuro-architecture to be in a position to foster and enhance creative competence. These comments are very important, because creativity cannot be introduced in the Architecture curriculum if teachers are not prepared and are not clear about what creativity is and its link with neuroscience. The architect Fernando Padilla, an independent professional who works in Guadalajara, Jalisco, commented that in professional practice creativity in all aspects of architectural work is essential, that without creativity at all levels of work architecture would be reduced to nothing, we would be only designers and builders of spaces without personalized meaning, without making any contribution to each

of our clients, which is what they really need: their own and personal spaces. These views fully coincide with our hypothesis about creativity in the training of architects.

Discussions

In the surveys, questions were asked about the importance of creativity and we obtained the following results. Regarding questions one, two and three, the vast majority consider architecture to be an art, creativity is essential and they do consider themselves creative. Regarding question four, students and graduates consider that they did teach them a method of designing; the teachers all expressed having taught it. In question five, only the majority of teachers considered that there is a specific kind of creativity. In question six, about whether they had had any specific creativity test, the vast majority answered negative. To question seven, where they were asked about whether the school specifically encourages creativity, 100% answered negatively. While regarding question eight, which inquired about whether teachers motivate creativity, only these considered that they did; students and graduates responded negatively. In question nine, they asked if they considered creativity to be innate, all answered no. In question 10, if you considered drawing and designing by hand to be creative: all answered yes. In question 11, on whether to teach to design by hand, the teachers were divided and 65% of the students and graduates said no. In question 12, the highest percentage of responses was that it is allowed to design directly on the computer. Everyone agreed that designing on the computer is creative (question 13). In question 14, the majority agreed that they are not taught to design by hand and draw on the computer. Regarding question number 15, on whether the renders sell architecture, only the majority of students answered yes. In questions 16, 17, 18, 19 and 20, the answer to all of them was that creativity is necessary in all aspects of architectural work, including management, structural, choice of design strategies, building and use of construction technologies.

According to the results of this research, there are worrying data that require particular treatment in order to solve the problem and its causes. The results obtained from both the observation and the revision of the 2018 study plan and the surveys and interviews clarify the panorama on the lack of specific inclusion of creativity in the holistic spectrum as a necessary competence for the correct performance of creation. architectural. Although it is true that in general terms creativity is considered inherent in the methodological process of architectural work and within the curriculum there are subjects that help to reinforce and

practice it, it is inferred as something necessary but inherent in both students and professionals. architecture and it is not considered important to mention it or give it too much importance. Due to this situation, creativity has been left out of the entry and exit requirements, with which the transcendental role it has in the development of the architectural project and the professional work of the architect has been minimized.

When reviewing the new study plan, it was observed that only in the curricular microdesign is creativity included as a required skill, but neither in the professional performance model nor in the entry and exit profiles of the students, nor in the in professional and disciplinary competencies, it appears explicitly and is not contemplated in the general objective. We can see how only in the first specific objective of the career description is mentioned the promotion of logical, critical and creative thinking (Universidad de Sonora, 2020).

From the review of the curricular microdesign of the study plan, we observed that there is no subject exclusively aimed at the development of creative thinking. There are also no methodological indications about the contribution of the other subjects to the formation of creativity. In the evaluation process, there are no methodological indications to evaluate the development of creativity.

When observing the spatial infrastructure, the rooms dedicated to teaching the workshops, to check if they had the spatial requirements, furniture and equipment they need to be able to carry out the teaching-learning activities, it was detected that none of the classrooms where the classes are taught. The different workshops meet the optimal conditions necessary for learning, much less there is a classroom with virtual simulations and adequate equipment for the development of creative thinking. Unfortunately, the infrastructure, furniture, services, and technologies are outdated and inadequate for architecture education, and spaces do not contribute to achieving the required concentration and creative work. The classrooms do not have the necessary furniture, and the one that exists is not in good condition so that the students can carry out their learning correctly.

Through observing how students work, we have been able to detect errors in the design process, generally without a method, by trying to design using the computer as a first instance. This was observed in both students and young graduates. There is in the new generations the unfortunate idea that this should be the case, but doing it in this way skips something extremely important, the methodology of architectural design, because it helps us

to order the stages that we must carry out for this purpose. When you use the computer directly to design you are forgetting that, although it is an excellent drawing tool, it does not think, it does not design, only graphics. Only with a lot of experience could, if desired, resort to this strategy, but it generally requires much more time to achieve the desired result.

It is common to hear that the renders, which are the perspectives made by the computer, are those that "sell" the architecture. Thinking like this implies that the project is secondary, secondary spatial creativity, and nothing more wrong, because the objective of architecture is spatial creativity. Renders are an excellent tool to show our project, but they should be done after completing the design stage, in order to be able to professionally show our ideas, our proposal: let's not confuse being an excellent renderer with being an excellent architect. The process of architectural design begins in the human mind, continues by hand and ends with the support of technology, which helps us a lot in this last stage of graphing.

We observed by visiting the classrooms that some teachers confuse creativity with an arrangement of spaces that apparently works, and when this happens the result is a proposal where, in the best case, the entire list of needs is included, but without a suitable spatial conception, which offers, in addition to utility, the sensations that make it more pleasant to carry out the activity for which it was designed.

In the teaching process, great importance is given to operation, form and aesthetics, three extremely important factors that are part of architecture, but it forgets creativity to achieve the appropriate sensations and the fundamental role it has in the design process, both in structural design, facilities, and design strategies, in choosing the right materials, technologies and construction processes, all this requires creativity, little directly required in the classroom; It seems that it is supposed to be implicit, and it is not, so we must make a special emphasis on this point, because it is the basis of the design.

Based on the above reflections, teachers must know how to guide students on the marvelous path of architectural creation, on the eureka of creation, when what we imagine becomes reality through the graphing of said creation, guiding the student, providing the methodology necessary for this purpose, throughout the methodological process of architectural design, realizing that the machine will shape our architectural proposal; When we can visualize what we imagine through the different architectural plans, which will help us carry out the actual construction of the designed spaces.

Students generally use a basic methodology with some shortcomings, which will have to be improved. When analyzing their architectural proposals, the vast majority rely on an attractive formal proposal, which is not a bad thing; the problem is that they neglect the creative spatial-sensory aspect, and in some cases the formal aspect does not correspond to the planes presented. I have also observed in the competitions in which I have participated as a jury of architectural work, both for students who represented the University of Sonora and for young architects who present their first film, which is the same thing, the indiscriminate use of software, perhaps inadvertently, to supplement creativity with just an attractive presentation.

General proposal

The result of this study yielded worrying data and to solve this situation, the application of an epistemological methodology is proposed that helps to solve the existing problem both in the macro and in the microdesign of the curriculum, and that contemplates including creativity as a necessary competence, not just state it, but include it in the entry profile of the applicants, and that emphasizes that during the learning process it is necessary to develop the creative competence, essential in the graduation profile of future architects.

Specific proposals

- 1) Incorporate creativity as part of the main objective in the curricular macrodesign.
- 2) Include creativity as the guiding axis of all subjects, including theoretical ones, in the curricular microdesign.
- 3) Add a course in neuroarchitecture to the curricular microdesign.
- 4) Add creativity in the entry profile and creative competence as essential in graduate students.
- 5) The realization of creativity tests in all the subjects and all the semesters of the degree in order to evaluate the progress made every six months.
- 6) Train the teaching staff in creativity in order to detect, evaluate and promote it.
- 7) Add periodic neuroscience and neuroarchitecture courses for teacher training.
- 8) Hire experts in these subjects or train some teachers to teach courses, seminars and diplomas.

- 9) The inclusion of new technologies in the application of creativity to acquire creative competence within a very special historical moment, supported by the past, solving current problems with a vision for the future.
- 10) The creation of a digital training center, where both students and teachers are trained in the use of digital technologies, which is not part of the curricular program, but is instead a training and constant improvement center.

The inclusion of technologies will be of great importance because for the students of the 21st century it is essential that they use the new digital tools to show their creativity. But they require constant training, since the appearance of new software is common, hence the importance of a technological training center

It is extremely important, in the same way, to carry out creativity tests on the students, because with the results we will be able to assess the personal development of this competition. One of the tests of creative thinking that constitutes a reference method to measure creativity is that of Torrance (1977), a verbal test in which participants are asked to give unusual objects to common objects; There is also a figurative test where it is asked to incorporate simple or abstract forms in a complex drawing (Thorne, 2008). The evaluation criteria of the answers will serve as a reference to stimulate creative processes. According to Thorne (2008), said criteria are the following:

- Fluency: if you have many ideas.
- Flexibility: if different ways of proceeding are considered.
- Originality: if you think of unique aspects.
- Elaboration: if you think of complements to the idea you have had.
- Execution: if creativity can be implemented in practice.

There are several tests that can help us to evaluate the creativity of students, for example, the aforementioned Torrance test (1977), the Guilford test (1949) and the Wallach and Kogan (1965).

Conclusions

After a thorough review of the results of this research, it is concluded that we have a problem in the way we have been educating our students, and in order to solve it, we must contribute a new vision that complements what we currently have and that allows us to offer them a better education to equip them with adequate preparation to help them face their professional practice. We must recognize creativity as an intrinsic part of architectural design, encourage it, practice it, improve it, and to achieve this requires that the curriculum emphasize its importance, reinforce the subjects that promote it and require it so that both authorities and teachers and students recognize it, exercise it and use it consciously in architectural projects. It is also concluded that it is necessary to provide the School of Architecture with the necessary and current spaces, infrastructure, technology and services; reinforce the creative competence, the study, updating and mastery of technologies for both teachers and students and for a correct follow-up and improvement of the study plan, as well as the important work that academies must do in monitoring, review and contribution to improve the educational process.

It must be emphasized that creativity is not exclusive to the formal-aesthetic aspect, to the methodological process of designing architecture, creativity must also be applied in technological and constructive aspects, in the use of suitable materials and in the application of design strategies. appropriate to help achieve an adequate, functional and unique projective-spatial-sensory proposal.

It must be recognized where the state of the methodological deficiency originates and how it is affecting students and future architects in the creativity of their professional work. It is very important to train the academic staff and promote a change of mentality, if necessary. See the past to adapt what is important and necessary to the new era, at a different time with different needs and great opportunities and above all the inclusion of new technologies and ways of thinking prevailing today to be able to prepare competent professionals not only in the present but also in the future.

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