THE CHALLENGES OF TEACHING ARCHITECTURAL PROJECT IN THE 21ST CENTURY

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Abstract. In recent years we have witnessed a series of changes that make it both necessary and urgent to redefine the limits of the architectural discipline, and in particular those of its teaching. The traditional profile of the architect as a builder has been radically transformed and has evolved towards other scenarios. The traditional teaching tools and procedures do not offer a response to the professional reality that the architect must assume in the face of the new approaches, services and considerations that contemporary society demands for this century. The aim of this article is to offer a reflection, from an educational perspective, on the challenges that the teaching of architectural project must face in order to provide future architects with the tools that will allow them to both approach new professional scenarios and respond to untested problems and unforeseen situations in a complex world. Training professionals to think for themselves with a critical and innovative spirit, encouraging the practice of creative and flexible thinking that enables them to define proposals and make imaginative decisions, developing work skills in co-production and co-creation environments or incorporating digital technology in the training of professionals are some of the challenges that this research addresses.

Key words: creativity, critical thinking, design process, collaborative practices, digital technologies.

1. Introduction

In recent years we have witnessed a considerable increase in the number of architecture schools in Europe. According to The Architectural Profession in Europe Sector Study conducted by the Architects' Council of Europe (ACE) in its 2022 edition, the total number of architects in Europe is estimated to be around 620,000. This value has increased rapidly by more than 100,000 in the last ten years, with Italy and Germany being home to the highest number of architects, 151,000 and 119,000 respectively. Other countries with considerable numbers are Turkey (72,500), Spain (50,000), the UK (42,000) and France (30,000). On average, there is one architect per 1000 inhabitants, though this figure varies from country to country, rising to 2.5 architects per 1000 inhabitants in Italy and Cyprus, 2.0 in Portugal and 1.5 in Denmark, Greece and

Malta (Architects' Council of Europe, 2022).

This unstoppable increase in the number of architects coincides with a period of very low demand for architectural projects and works. In 2020, the number of unemployed architects rose from an estimated 2% in 2018 to 7%. This growth is partly justified by the crisis generated by the Covid-19 pandemic, but the underlying unemployment rate was already rising before the pandemic struck (Architects' Council of Europe, 2020). In the current precarious economic context we can see how older economies are struggling to cope with obsolete, heavily burdened economic models while emerging powers are growing at a disproportionate pace.

It is very likely that this situation does not merely apply to the economy, meaning our profession is going to change radically in the near future. As a consequence, we will find that an increasing number of young architects will emigrate while those who remain will have to consider a professional activity in accordance with their desires and abilities but in an ambit other than that of designing and constructing buildings. According to The Architectural Profession in Europe Sector Studies in 2020 and 2022, in recent years there has been a substantial proportion of architects, between 7% and 9%, who have chosen to seek employment in another country, the most popular destinations in 2022 being the UK, France, Switzerland and Italy. It is also worth noting the high percentage of architects, between 19% and 29%, who have seriously considered the option of working in another country, even if they did not, in the end, choose this option. Of these, two thirds showed a preference for a European destination and one third for a country outside Europe (Architects' Council of Europe, 2020, 2022).

The profession today has been radically transformed and has evolved towards scenarios that lack the clear definition of the traditional builder model. As a result, the programming of digital environments, the management of cultural initiatives, publishing projects, teaching, dissemination, company creation and administration, design, fashion, innovation and research, and so forth, are some of the new activities that have emerged.

As far as universities are concerned, we could ask ourselves which of all these professionals we are training and with what criteria? What competences correspond to our professional profile when we are witnessing a complete stagnation of building activity? What is an architect and what does society demand from an architect? From a university perspective it is essential to lend credibility to these other forms of practicing the discipline of architecture, as today's economic and professional models, those that have prevailed in recent years, those which establish as the maximum and almost the only aspiration that of the autonomous architect who, individually or as part of a team, carries out his or her building projects, have been totally exhausted (Harriss and Widder, 2014; Nicol and Pilling, 2000).

In the words of Carmen Espegel, "the architect will no longer be the one who studies architecture, but the one who is able to act effectively and become involved in architecture" (2019: 23). The university, in this sense, should contemplate training systems that are both versatile and adaptable to the social

demand to which future architects will have to respond. Its role will be key when it comes to encouraging the practice of creative and critical thinking in terms of training professionals who are capable of accepting these challenges and developing the effective practice of the profession in the face of emerging systems (Zernike, 2009). The training of future architects must enable them to face new roles that transcend the traditional skills of designing and constructing buildings.

It is time, therefore, to review the current teaching models in schools of architecture (Nicol and Pilling, 2000; Salama, 2009, 2016; Alba 2016a). While it is true that no standardised curriculum exists, it is possible to observe how classical architectural teaching, which continues to set the design guidelines for most of the current curricula, is rooted in practices that are both resistant to change and barely capable of addressing the issues that the profession currently requires, given the changes that have taken place in both society and the construction industry in recent years (Nicol and Pilling, 2000; Marinic, 2010). The traditional architectural academy continues to project a profound ambivalence towards new methodologies and alternative approaches to teaching practice; virtually its sole aspiration being the training of the master builder architect. Today, however, not all architecture students graduate with a degree and enter conventional architectural practice, an increasing number choosing to involve themselves in projects that bear little relation to the field of construction (Nicol and Pilling, 2000).

In this sense, the teaching of architecture must position itself in the face of the new approaches, services and considerations that society demands in this second decade of the new millennium by defining strategies and mechanisms for continuous reflection that will lead it to adapt to the new changing situations, and do so, moreover, from a standpoint of quality and excellence.

"Architectural education must adapt by providing vital, flexible, and open learning environments that address the emerging needs of our changing built environment. Classic architectural education has typically been rooted in practices that are both reluctant to change and slow to address transformative forces in an honest and open manner. (...). If architecture is a living organism of historical reference, trans-disciplinary theory, social consequence, aesthetic preference, and changing technology then architectural education should flexibly interface with, adjust to, or address reigning paradigms" (Marinic, 2010: 62).

Today's world requires us to be attentive to the changes taking place around us, changes that are taking place much faster than our ability to understand and control them, a fact that is creating a gap between today's real world and the future academic world (Salama, 2017). In light of this situation, a reductionist pedagogical stance that attempts, through the definition of a series of rules, to dominate reality makes no sense today, nor does it make sense to transmit knowledge in a unidirectional manner. Traditional teaching tools and procedures do not seem to provide an answer to the professional situation that the future architect will be obliged to face.

What is important now is to provide future architects with the technical and

intellectual tools that will allow them to design and create within their own context, to develop in a contemporary society that is both unstable and imprecise, to understand the role they will have to play in this society without renouncing innovation, creativity and constant experimentation, and to respond to untested problems and unforeseen situations in order to be able to address new professional scenarios. In this sense, the aim of this article is to reflect, from an educational perspective, on this wealth of challenges that the teaching of architectural project must face when training future architects.

2. Methodology

As a working methodology, the proposal is to review the teaching model in today's schools of architecture, paying special attention not only to what is taught, but, above all, to how it is taught, in order to determine whether this teaching is in line with the expectations of undergraduate and graduate students in our country and whether it responds to the needs and considerations that society demands for this century. To this end, special attention will be paid not only to the study and consideration of the development of and results obtained by current teaching practices, but also to the new demands that the architectural profession requires as a consequence of the recent changes that have been taking place in society, in the profession, in the construction industry, in the technological field, and so forth.

On the basis of this review, it would appear that we need to devise new strategies and mechanisms of reflection that allow the teaching currently offered in architecture schools to be adapted to the professional situations that the future architect will have to face. This makes it necessary to define a teaching methodology that prioritizes training over information, that demonstrates an approach to teaching that fosters the creation of more flexible learning situations and itineraries that facilitate and support subsequent, ongoing education and allow for more critical, profound intellectual development that enables the student to not only generate knowledge but also to acquire autonomy of thought, fostering the capacity for self-learning and adaptation in the student body (Alba, 2018a) (Fig. 1 and Fig. 2).

Fig. 1 and Fig. 2. Development of a class session with students of the first year Architectural Projects subject at the University of Malaga, Spain (Source: Photograph by the author).

Based on these reflections we will now proceed to identify the challenges that the 21st-century university must face in terms of training students to develop the practice of the profession in the face of emergent systems.

The definition of these challenges raises the need to reconsider the concept of the

university. This does not mean wiping the slate clean and looking only towards the future. While everything we already know helps us to better understand the point at which we find ourselves, we must also learn to face future situations and questions, and to do this it is necessary to define teaching methodologies that both contemplate and help navigate the journey towards the uncertain and the unknown.

Experimental teaching methods have been developed in the field of architecture since the mid-20th century. In their study *Radical Pedagogies*, Colomina, Choi, González and Meister (2012) analyze the teaching methods that emerged as a response to a specific political context, to the existence of an authoritarian institutional structure, to the emergence of new technological and material possibilities, etc., and that came to reflect on the limits of the architectural discipline and especially of its teaching through the search for alternatives to the traditional forms of education. While these teaching methods left an indelible mark on the history of modern architecture, this attitude of experimentation, permanent search and openness to the unknown that characterized them and that, together with the involvement of students in this type of movement, determined their success, has taken a back seat in recent years, yielding to a more inflexible, bureaucratized educational model that in no way favors the emergence of innovative teaching experiences such as these. So, while students wait passively to receive specific instructions from an educational system that is increasingly rigid, corseted and, for some years now, oblivious to the changes that are occurring globally in the economic, political, social, technological, spheres, among others, the professional profile of the architect has been radically transformed, evolving towards scenarios that do not correspond to the clear definition of the traditional model of the architect as a builder (Nicol and Pilling, 2000; Harriss and Widder, 2014).

As it stands today, a thorough review of teaching in the university field in general is urgently needed. In the field of architecture in particular, we should ask ourselves what the competencies of the architect are and whether the current curricula are capable of responding to them or whether impatience has led us to merely adapt what we already had in order to be able to continue (Salama *et al.*, 2002; Salama, 2009, 2016).

This question is more pertinent today than ever, given that the profession is in a moment of absolute instability. The crisis has brought about a shift towards the strategic which, fortunately, has reinforced the idea of the architectural project as a system of thought and positioning in the face of reality. The traditional image of the architect as a genius, a solitary creator of dogmatic proposals has disappeared. The profession has evolved towards other scenarios the likes of design, the programming of digital environments, editorial projects, the management of cultural initiatives or new forms of digital fabrication, etc., in response to a multi-specialized, collaborative and complex professional reality that is distancing itself from the traditional, individual models.

There is an urgent need to redefine the limits of our discipline, and in particular those of its teaching. A review is required of the capacities and skills that an architect must acquire in order to respond as a collective to what society

demands of him or her. To this end, it is necessary to ask ourselves what kind of professional we are preparing and how it is possible to train and guide him or her in the context of a society of exhausted economic and professional models.

3. Results and discussion

In a complex, uncertain, unpredictable, plural and fragmented world, the architect must know how to read and anticipate the problems of an ever-changing society and propose alternative, creative and innovative solutions. This is why the ultimate goal of our teaching must be to train people to think for themselves so that they may understand the role they will have to develop in the society of their time (Koch *et al.*, 2002; Salama and Wilkinson, 2007). It would not be advisable to prepare our students for one particular future, since by the time it arrives their intellectual baggage will have become obsolete. It would be more pertinent to educate them to be able to think for themselves, in such a way that the future will be in their hands and they will possess the means to build it (Espegel, 2019).

Schools of architecture must become spaces for research, discussion, critical positioning, production, and so forth, and should teach both how to "think architecture" as well as how to "make architecture" in an effort to blur the separation between theory and praxis, between the academic and professional worlds, since both find points of coincidence in their approach to reality and the acceptance of its complexity (García, 2011; Harriss and Widder, 2014; Salama, 2017).

The definition of new teaching models that are more in line with the professional reality must contemplate the development of creative, critical and complex thinking while introducing research, focusing on processes rather than results, and encouraging the development of collaborative practices and the use of new technologies (Sgambi *et al.*, 2019; Salama, 2017). All these are aspects the presence of which constitute the common denominator shared by the various scenarios towards which the profession has evolved in recent years and define the challenges that the teaching of architectural project must face.

3.1. Development of creative thinking

The university has a key role to play in encouraging the practice of creative thinking that produces professionals who are capable of facing up to the challenges posed by contemporary society. While nobody today knows what the world will be like in the coming years, the speed at which it is changing makes it necessary to anticipate these changes. In this sense, training must involve more plasticity of thought than rigidity of concept. It is no longer enough just to acquire knowledge, but rather to acquire the ability to integrate oneself into an ever-changing world.

Teaching from a perspective of creativity is synonymous with training flexible, adaptable, versatile professionals who are capable of defining proposals and making imaginative decisions in an ever-changing, complex and uncertain world. If we are to speak of creative learning, we must do so by adding subtlety to its meaning, as José Antonio Marina (2013) does when he refers not so much to artistic activities, but to a way of dealing with life itself, and its opportunities and problems. This creative attitude has nothing to do with passivity or inertia, but rather with the ability to face the new and the unexpected.

It is precisely this capacity for learning and adaptation that should be taught at universities. Contrary to traditional belief, creativity is not a gift that is only enjoyed by a few, but rather an innate capacity that we all possess and, as such, one that can be taught.

Today we can see how many young architects who have developed a capacity for creative thinking and adaptability during their learning stage are more successful in their profession, they perform better in their jobs and are able to reinvent the profession by developing activities that may often seem alien to the discipline. The ability to imagine and structure at the same time involves establishing a creative thinking process that can be equally applied to the design of a building, the development of cultural management initiatives, the realization of publishing projects or an entrepreneurial task.

The development of creativity is currently one of the priorities for the educational system. It appears in the *European Parliament and Council Recommendation* of the 18th of December, 2006, as one of the key competencies for lifelong learning. Likewise, it is considered by the *Partnership for 21st Century Skills* as one of the most relevant education-related skills that distinguishes people for employment and development in 21st century society.

Creativity is a quality that should be implicit in any training program, to the extent that, as psychology professor Antonio Rodríguez (1996: 127) states, "it favors the development of conditions and formative contexts that can stimulate creative potential". In a discipline such as architecture, especially in the first years of training, the development of innovative teaching proposals that nurture and promote creativity is essential (Fernando, 2006; Salama, 2017; Park and Kim, 2021) (Fig. 3).

The importance acquired by this creative component in the training of students entails an entirely new approach to teaching (Baker and Rudd, 2001; Combs *et al.*, 2009; Dorst, 2010, 2011; Teal, 2010; Choi and Kim, 2017). At present we observe how, in the syllabi of architecture studies, which contain many subjects, as in many other branches of knowledge, the development of students' creativity appears as an objective. The truth is that creativity has been part of the ideology in schools of architecture for decades, but more as a requirement for students than as an action strategy on the part of teachers, so few professors go so far as to point out how to develop it. There is a tendency to believe that our training as architects, which enables us to design spaces, has also trained us to develop creative thinking, but this is not always the case.

Current pedagogical systems based on behaviorist methodologies and focused on the immediate achievement of results have ended up excessively regulating the learning process, thereby subduing creativity (Wang, 2010; Ustaomeroglu *et al.*, 2015). On many occasions in our discipline, training continues to apply the approach of routine and inertial activities inherited from the academic tradition as a response, contrary to what constitutes the embryo of creative thinking. In the area of knowledge of architectural project, training continues to be marked by teaching through the use of models, an approach clearly influenced by the learning methods of the French Beaux Arts School and based on case studies and mimetic reproduction of these for the acquisition of ideas and their reuse for critical thinking processes.

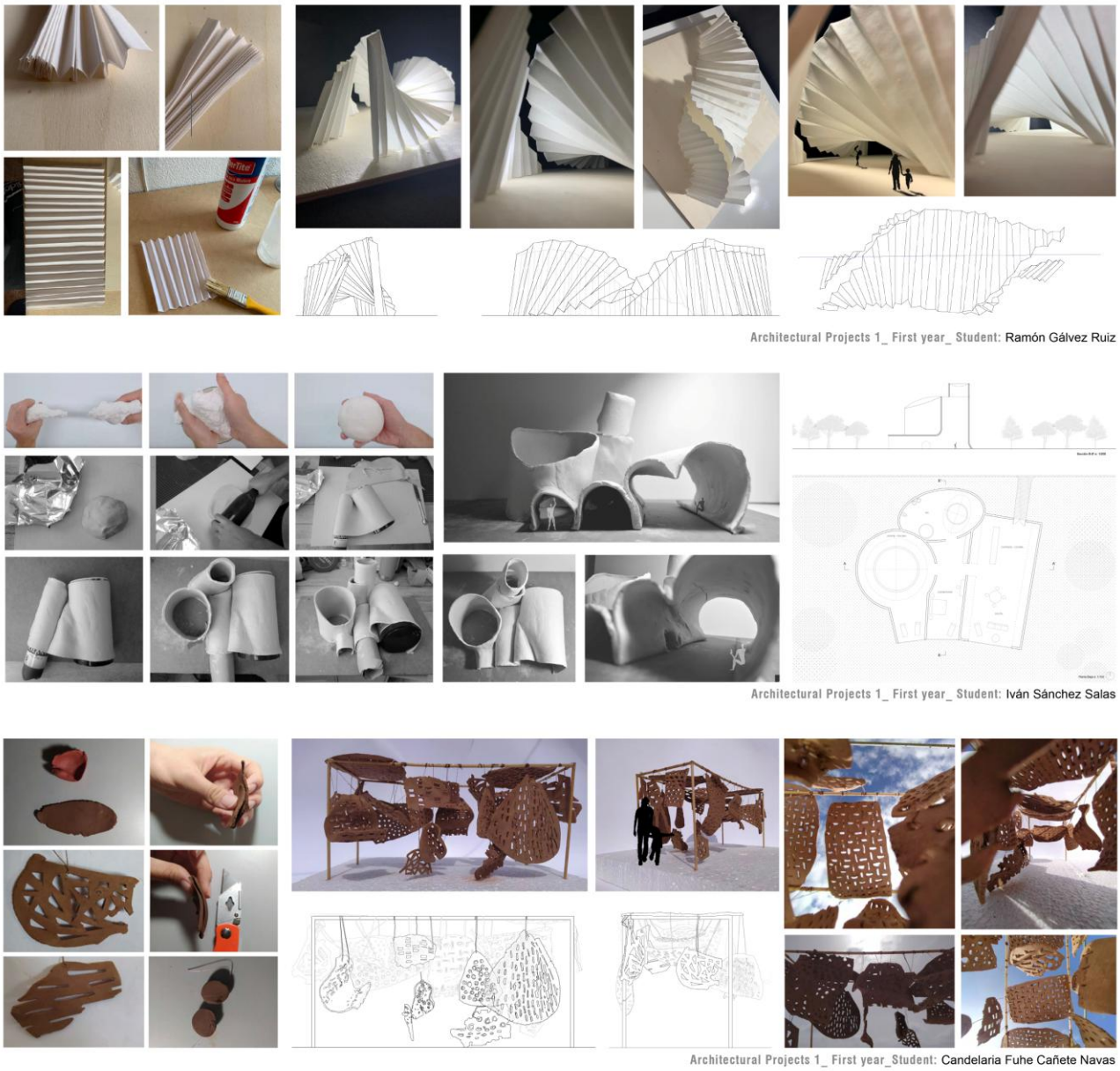

Fig. 3. Examples of exercises carried out by students of the first year Architectural Projects subject at the University of Malaga, Spain, whose objective is to promote the development of creative thinking (Source: Author).

Training in creativity and in the development of creative thinking requires the introduction of innovative ways of learning that embrace uncertainty, indeterminacy, change, and the unexpected. Requiring teaching to revolve around a competence such as creativity, which depends on aspects that are difficult to measure, requires a change in the teaching strategy on the part of the teacher and a predisposition on the part of the students to accept the indeterminate and leave their comfort zone, abandoning the safety net of determinism and control.

The teaching of the architectural project must maximize the development of creative thinking by introducing forms of learning that focus more on encouraging the search for processes and the opening of new avenues of

experimentation that distance themselves from those that tend towards systematization and/or the attaining of a specific, predetermined result (Potur and Barkul, 2006; Allen, 2010; Choi *et al.*, 2013; Cho, 2017; Park and Lee, 2022). It must reveal, awaken, exercise, strengthen and reinforce the students' design and creative capacities from the point of view of diversity and in order to foster their identities. Activating the creative subjectivity of students involves, as Robinson and Aronica (2016: 14) says, "creating the circumstances in which each person can bring out his or her natural talent".

3.2. Development of critical thinking

Never have we had so much information at our fingertips, and yet never has it been so difficult to achieve true knowledge. The world we live in today is very complex, and knowledge has to be continuously reconsidered and revised through thought.

In contemporary society we have overcome elitism and exclusivity with regard to the possession of information sources. Knowledge is no longer centralized, but rather can be accessed through multiple channels and media. This situation has led us to a knowledge scenario in which the most interesting thing is not the possession of knowledge, but the ability to know how to order, select, relate and post-produce it. "Intelligence needs to be educated, which means something loftier than instructing in methods or imparting knowledge" (Meseguer, 2016: 43).

Learning becomes a process of personal enrichment in which each student must produce his or her own knowledge by reconstructing his or her own internal learning experience (Wick, 2000). The teaching of intelligence using critical reasoning leads to optimal learning. Awakening a critical, innovative spirit that leads to the construction of individual thinking in students is fundamental (Kiliçaslan, 2018), and for this it is necessary to impart skills such as critical capacity and research, which are essential if the student is to be able to expand his or her own talents.

By means of research the student is able not only to obtain new knowledge that he or she can later apply when responding to intellectual questions that arise in the development of the architectural project, but also to establish strategies for connecting with reality, leaving aside formal questions and defining a field of innovation of his or her own. We must not forget that every architectural project is conceived as a research process linked to a creative, reflective and speculative activity.

Faced with the bombardment of information that the student receives during their time at the school of architecture, they need to learn to navigate this information from a critical, reflective perspective. Their general training as an architect must contemplate their own personal training; training that will lead them to approach the development of the architectural project not as an accumulation of information or as the result of an exercise carried out with the dexterity of an acquired technique, but rather as a speculative, reflective process that includes the construction of their own thinking (Alba, 2013, 2016a, 2016b; Al Khalifa, 2017). "For this reason, it becomes a necessity to cultivate creative individuals who are curious, inquiring and multi-faceted thinkers" (Kiliçaslan, 2018: 633).

The complexity of the technical, artistic, social, legal, economic, and other variables that affect the definition of a project and interact in its development means that neither knowledge nor information alone are sufficient if the project is not guided by thought. Developing the capacity for critical thinking becomes one of the imperatives in the teaching of architectural project (Bose *et al.*, 2006; Salama, 2017; Asefi and Imani, 2018).

Teaching to think in architectural terms is perhaps one of the most fruitful and functional actions at the time of teaching design. The project as a reflective exercise makes it necessary, during its development, to transcend the limits of the issue that is the basis for the project proposal. To achieve this it is necessary to guide the student towards a methodical doubt, towards insecurity with respect to what is already known, towards uncertainty with respect to what appears certain, in order that they may begin to generate critical thinking that helps them respond to and satisfy the questions that every project must bring to light.

The methodology used for teaching architectural project must transcend the mere production of results and focus on the creation of an investigative space in which to detect issues, propose innovative solutions and inculcate the ability to communicate these. As teachers, we must implement critical, proactive thinking, introduce diversity in the classroom, strengthen the unique capabilities and identity of each student and integrate divergence of ideas (Bose *et al.*, 2006; Salama, 2017; Asefi and Imani, 2018).

3.3. Focus on processes rather than results

The educational system as we know it is overly focused on the assessment of results, and projects are only evaluated once they reach their final stage. This does not mean that the student's learning process is not considered throughout the course, in fact, this is a factor that is taken into account in the students' final grade. However, exercises are formulated with certain objectives and a certain time frame in mind, and it is on the basis of these objectives, which are attained once the exercise is concluded, that the exercises are assessed. So that, "one of the weaknesses of the traditional studio is that students, in paying so much attention to the end product of their labour fail to reflect sufficiently on their process" (Lawson 2006: 7). Very rarely does the process leading to these final stages have any impact, despite the fact that this very process is precisely the key enabling element in terms of dealing with professional situations that are not exclusively limited to construction (Fernando, 2006; McAllister, 2010).

Why is a focus on processes so important? The architectural project is a speculative process of thought construction. It is a complex process that is difficult to dissect or reduce to simpler processes; a process in which many disparate variables interact and where thought moves forwards and backwards, from the whole to the parts and vice versa, exploring different scales in an effort to find one particular solution among many (Alba, 2016b). The architect becomes a builder of strategies. He or she must be able to propose architectural organizations or systems, which means considering processes other than the formal definition of an architectural object.

"The process itself is rarely celebrated. However, with students in the early stages of their education, it is vital to help them come to grips with the "messy" business of design. An understanding of the design process is essential. (...) Later on in their careers, with greater experience, they will be able to cope more quickly with the many challenges inherent in design" (McAllister, 2010: 88).

The professional reality towards which we are heading is a complex, uncertain one that increasingly demands more and more generalist professionals who both connect and harmonize with a multiplicity of specialized knowledge. To emphasize the investigative nature of the design process is to lend more importance to the path taken by the student than to the results obtained by them; it is to place the academic objective on both diligent day-to-day progress and the learning that has been insisted on during their training in how to approach the development of an architectural project (García, 2017; Salama, 2017) (Fig. 4).

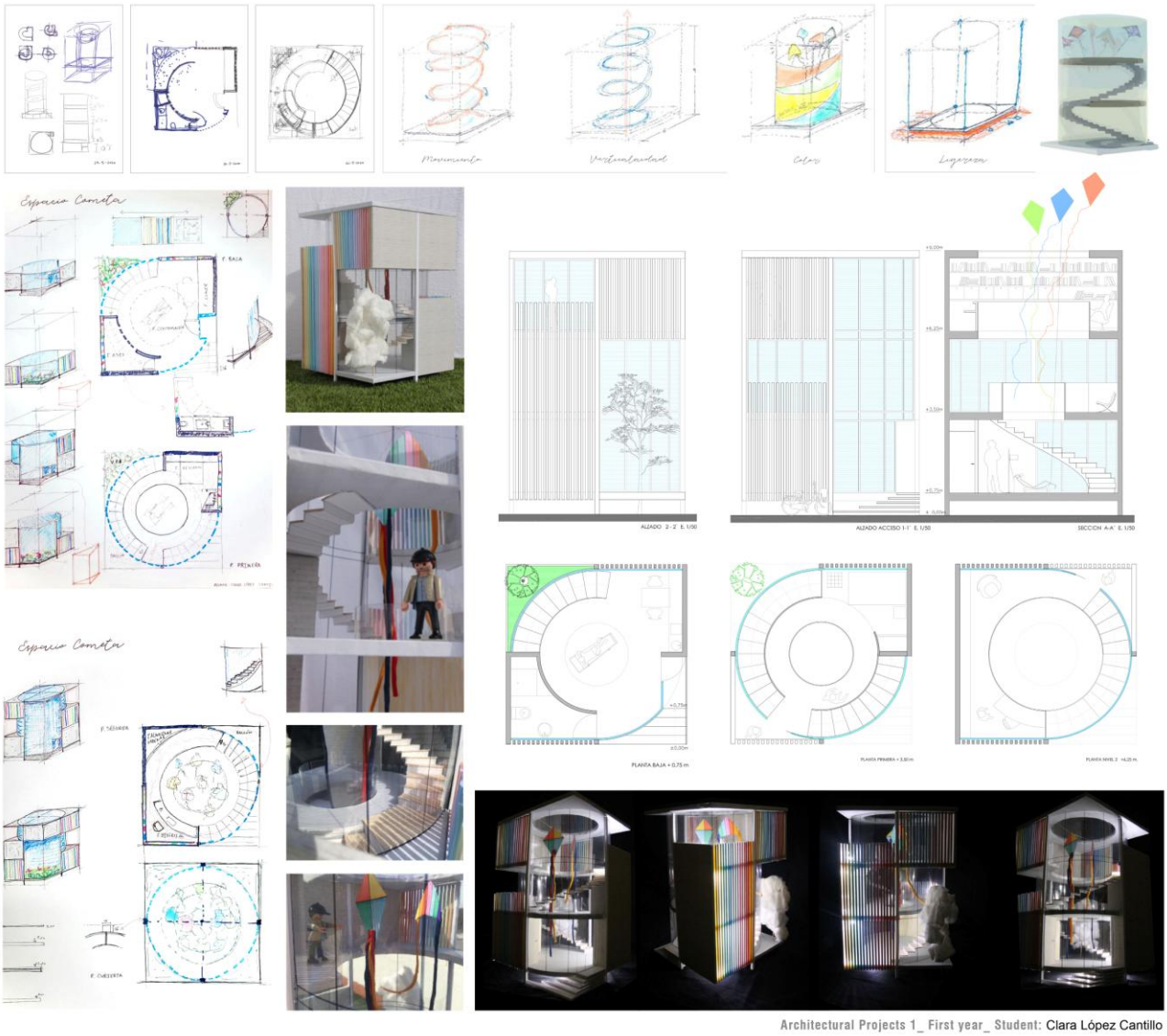

Fig. 4. Architectural project developed by a student of the first year Architectural Projects subject at the University of Malaga, Spain, which emphasizes the project process developed from the beginning to the final result -ideograms, previous sketches, planimetry and final model- (Source: Author).

3.4. Development of collaborative practices

Collective working is a phenomenon that has invaded our profession; a profession that is increasingly distancing itself from traditional individualistic models (Crosbie, 1995; Smith and McCann, 2001). Long gone is the image of the individualistic architect, the creative genius, as portrayed by Gary Cooper in *The Fountainhead* (1949). Architectural practice today responds to a multi-specialized, collaborative and complex professional reality where an increasing number of actors participate, and is gradually becoming a multi-professional practice. In this scenario the architect achieves protagonism as an interlocutor between the various specialists involved in the realization of a project. This involves the development of increasingly collaborative practices and entails a growing complexity of professional processes (Rodriguez *et al.*, 2018).

In this context, collaborative work is an essential element in terms of offering competent services (Muir & Rance, 1995). "This type of collaborative learning incorporated in the vertical design studio pedagogy helps the students with better learning and by positively developing their potentials and skills that are needed for confronting the present and future challenges of the design profesión" (Ismail and Soliman, 2010: 210). It requires people who are able to interact adeptly in co-production and co-creation environments, to initiate communication channels between individual and social interests, and to lead, coordinate and plan teamwork. This is something that must be reflected in our classrooms. We need to explore new teaching models that are more in line with the professional reality towards which we are moving.

In the traditional architectural project teaching methods developed during the twentieth century, individualism predominated over collectivism, and the student's learning process was developed mainly in isolation in an effort to promote his or her uniqueness as a person. Today, more than ever, social learning theories make sense, these being environments in which the student learns from others via procedures that encourage interaction, collaboration and even negotiation (Austerlitz and Sachs, 2006; Emam *et al.*, 2019). Education in the 21st century "must be not only a process of individualization, but also of integration, that is, of reconciliation of individual uniqueness with social unity" (Espegel, 2019: 24).

This gives rise to a form of connected learning in which knowledge hierarchies disappear (Boyer and Mitgang, 1996; Sancar and Eyikan, 1998). The teacher is no longer the sole bearer of knowledge, but rather all the participants in this learning process, including students themselves, become producers of knowledge (Smith and McCann, 2001). This group learning constitutes an exponential learning method that should be given suitable consideration in an environment such as the university and in an era such as the present one, marked by technology and communication.

This group-based, collaborative learning facilitates, in addition to the acquisition of knowledge, the development of communication and transmission skills, and gives rise to network learning in which students learn from other students (Ribot *et al.,* 2017; Rodriguez *et al.,* 2018). Students see themselves reflected in the design processes of their classmates, thereby finding answers to their issues in the work of others, to the extent that students learn to build and share personal learning environments, exchange and enhance their work and that of their classmates, and create an environment of

teamwork rather than a series of unconnected individualities, so everyone emerges a winner (Umbach and Wawrzynski, 2005; Emam *et al.*, 2019). Education is a collective event, and the advancement in knowledge and skills of group members is always greater than the sum of the progress made by each of them individually. "Collaborative learning clearly establishes its superiority over individualistic and competitive modes of learning. Isolated students do not learn as much or as well as students who are embedded in a network of informal social relations" (Rau and Heyl, 1990: 150).

This networking and collaborative work allows for peer-to-peer, student-to-student exchange, and encourages horizontal learning. Teamwork assists in both the resolution of the complexity of the architectural project and the administration of work processes that approximate contemporary reality, so the whole class operates in a manner that approaches that of an innovative professional studio.

In order to achieve this, it is necessary to design creative dynamics for collaborative work in the classroom that take into account the skills and knowledge of each team member and that are potentially useful for the group as a whole (Fig. 5). It is also necessary to develop divergent and convergent dynamics that favor networked, integrative, transversal and cooperative learning (Bardi *et al.*, 2019). In this learning process an open, proactive attitude is of particular interest as it both fosters student participation in the teaching-learning process and allows the motivation and quality level of the students' work to be raised to the level of the most outstanding students.

In this type of group learning, however, it is essential that each student also learns to enhance his or her interests and individuality in the group context. It's a question of the student, without losing sight of the objectives of the social component, having an impact on his or her own development as an individual. In the teaching of architectural project, this issue will lead students to become aware of the diversity of approaches and solutions that may be applied to a given situation (as many, in fact, as the number of students who approach the situation). The ability to offer different approaches and answers to the same question and deal with complex situations with multiple variables enables students to develop versatile, flexible and, at the same time, critical thinking when it comes to selecting an option or, if necessary, reaching a consensus on the best option. All this enables him or her to work in a team.

In this sense the teaching of the architectural project should be directed towards a horizon of innovation that "promotes the consolidation of true learning and research communities. And since the outcome will be their conversion to a civically committed individual, this training process must be developed while maintaining close ties with the socio-cultural environment" (Campos, 2017: 15).

3.5. Use of the new technologies

Students studying architecture today have been born and raised in the omnipresence of new technologies and the use of social networks. This technological revolution has affected teaching to the point that today no one questions the use of the tools provided by new technologies in teaching, as happened in the 90s. Their presence is a necessary part of the training of the future architect and we can neither remain on the sidelines nor reject them (Salama and Wilkinson, 2007; Marinic, 2010; Semenyuk *et al.*, 2019; Zakharova, 2022). In

architecture, "due to architects' work that involves constantly evolving digital tools, perfecting one's skills in this type of work is of critical importance" (Gyurkovich, 2020: 165).

The incorporation of digital technologies has brought about important changes, speeding up and expanding graphic and design processes, favoring the development of critical and creative processes and significantly multiplying the imaginary capacity.

"The digital environment of new technologies proposes open, non-linear and dynamic teaching strategies based on collaborative learning, social construction of knowledge and self-learning. Analog-digital tools suggest an integrative and complementary vision for the creation of forms and spaces. They allow a better understanding and development of complex systems related to the act of creative thinking" (Mántaras, 2011: 216).

The complex nature of architectural practice and the increasing amount of data and factors involved in the design process of the architectural project has accelerated the use of computational technologies designed for architectural purposes, making architecture an important area of experimentation for the development of artificial intelligence applications (As and Basu, 2021; Ceylan, 2021; Wang *et al.*, 2022; Nabizadeh and Nabizadeh, 2023).

Fig. 5. Collaborative practice developed by the group of students of the first year Architectural Projects subject at the University of Malaga, Spain (Source: Author).

Artificial intelligence has enormous potential for improving the knowledge and skills of architects and expanding design capabilities (Nabizadeh and Nabizadeh, 2023). It offers not only a wealth of data, but also a data-processing capability that provides analytical information that has a significant impact on any design phase. It also offers significant support in the processing of data that, in the initial phases of architectural project design, is usually extensive and relates to a variety of issues (analysis of the physical environment, programming, regulatory, functional, user needs, etc.), allowing this data to be processed, a task that, without the contribution of computational technologies, could be excessively complex, thereby reducing the time needed to analyse and classify said information.

Artificial intelligence and computational technologies also offer efficient, fast and alternative visualisation and prototyping methods that can reach very advanced levels. Computer-aided design applications such as CAD (Computer-aided design) or CATIA (Computer-aided three dimensional interactive application), still used by architects to design and disseminate their work, as well as other algorithmic design tools, allow complex shapes to be generated (Steenson, 2018). Since the early 2000s, CAD software has gradually evolved into what is known as Building Information Modelling (BIM) software, which is currently one of the most popular tools in contemporary architecture and one that is capable of working with not only geometric, but also material, programming, budgetary and other data, in an effort to provide support in the management of the different stages of design and construction of the architectural project as a holistic process. Likewise, the use of software such as Grasshopper and Dinamo, as complementary tools to other more advanced programmes such as BIM or Revit, allow for the formulation and generation of parametric designs.

The impact of artificial intelligence on the design of the architectural project has led to significant results that influence both the present and future of innovative architectural practice (Ceylan, 2021). In terms of complementarity the use of these technological instruments and tools, and even combinations of the same, along with more traditional ones, leads to both an enrichment of the creative process and a greater diversity of results. Hence the need to use, perfect and capitalize on these new technologies in the development of the creative process of the architectural project. For this to occur, however, the teaching of architectural design must keep up to date with the technological advances taking place in the field of architecture.

Artificial intelligence, therefore, must constitute an element of architectural education (Ceylan, 2021). Its integration into the teaching of architectural design requires both a systematic approach and the definition of effective actions designed to equip future architects with the tools required to meet the emerging demands of society (Ceylan, 2020). So, for example, the teaching of architectural representation methods based on the use of digital technologies should be based on the use of artificial intelligence, and not only as a drawing tool, but also as a design tool.

Artificial intelligence can provide support in all stages of the design process of the architectural project: In the initial analysis phase, by processing data to obtain information relevant to the development of the same, in the preliminary design phase, through the use of algorithmic or parametric design tools in an effort to

offer decision-making support, and in the more advanced phases, where it is necessary to analyse the behaviour of the proposal in terms of structure, energy efficiency, etc. or to represent it either graphically or using more precise 3D physical models.

The use of artificial intelligence in the teaching of architectural design must be carried out with the understanding that it is a tool that is to be used in the manner in which it is most favourable, but without forgetting that it is always the architect who ultimately designs (Ceylan, 2021). Artificial intelligence processes data solely according to defined algorithms, but the final decision-maker is always the architect, who is also the element providing the creative capacity (Nabizadeh and Nabizadeh, 2023). It is important, therefore, that the student learns to use these tools as an aid for focussing on those aspects of the architectural design process that are most important, rather than considering them as the principle actors in this process.

Likewise, we are currently witnessing an expansion of Information and Communication Technologies (ICT), and their incorporation into the educational process is an unavoidable necessity that is in tune with the educational requirements of today's society. In fact, these technological tools occupy a privileged place, since they are themselves presented as content, objectives and teaching objects (Cervantes, 2017).

The results of various studies reflect the successful impact of ICTs on learning (Wang, 2009; Hurtado and Meneses, 2015; Cervantes, 2017). Due to their multidimensional nature, ICTs offer numerous ways of improving the development of creativity, generate a high motivational potential due to their strong appeal, encourage students to work individually, stimulate educational interaction among students, promote general and motivational attitudes such as the desire to learn and openness to new ideas, encourage free expression and imagination, galvanize mental activity by avoiding mechanical learning (Franco *et al.,* 2018; Alba, 2018b; Alba *et al.*, 2019), and constitute a propitious opportunity for stimulating meaningful learning (Hurtado and Meneses, 2015).

The new technologies constitute a new paradigm that imposes changes in the way of conceiving the teaching-learning process, using technology in favor of teaching, incorporating it into teaching methodologies, defining the role played by each member involved in the training process, etc. with the aim of improving university teaching (Becker, 2000). That is why its use should transcend a mere reproduction of the traditional way of teaching using new media. The use of these technological tools should stimulate and enhance creative thinking in students and their lifelong learning, guiding their use towards a more educational, formative framework.

Currently, however, we can see an urgent need not only to explore the potential that these digital tools and technologies offer in terms of teaching, but also to provide relevant teacher training that instils educators with vital training in the field of technologies and digital competence in order to enable them to correctly guide students during the creative process of the architectural project and achieve the expected results (Higgins and Moseley, 2001).

Today's students are digital natives, possess technological capabilities, and live in virtually connected societies. With regard to their training as future

architects, however, it is not enough to be aware of these tools, they must learn to master them and use them properly in order to be able to explore their capacity and creative potential in favor of the development of the architectural project. They need to become technologically competent, critical users.

4. Conclusion

The myriad of changes we have been witnessing in recent years are forcing us to redefine the limits of the architectural discipline and especially those of its teaching. The university must carefully contemplate these paradigm shifts that are already beginning to appear on the horizon, place itself in the contemporary reality and accept the challenge of training professionals who are able to foresee unknown scenarios and anticipate their competencies.

In the field of architectural project, teaching must contemplate the complexity of the architectural fact and transcend the mere transmission of knowledge. It is necessary to explore new teaching models that contemplate the multiplicity of scenarios towards which the profession has been evolving and that do not correspond to the clear definition of the traditional model of the architect as a builder. Defining a teaching model in accordance with this complex, diverse professional reality is not an easy task, but if we had to define those issues that should be addressed in terms of the teaching of the architectural project and that constitute the common denominator shared by the different professional scenarios towards which we are moving, these would be: provide training in creativity and in the development of creative thinking through innovative learning systems that encourage the search for processes and the opening of new avenues of experimentation; provide training skills such as critical capacity and research in order to awaken in students a critical and innovative spirit that leads to the construction of their own thinking; focus teaching more on the design process than on results; encourage the development of group and collaborative learning systems and incorporate digital technologies in the teaching-learning processes in order not only to be able to master and use these tools properly, but also to explore their capacity and potential to stimulate and enhance the development of creative thinking in the student body.

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