Open House International
DOI 10.1108/OHI-07-2021-0144

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| Journal: | *Open House International* |
| Manuscript ID | OHI-07-2021-0144.R2 |
| Manuscript Type: | Research Paper |
| Content Classification: | Built Environment Tectonics and Technologies |
| Keywords: | Architectural design education, communication, Architectural Design Communication (ADC), online education, COVID-19 pandemic, design studio |
| | |

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# Architectural Design Communication (ADC) in Online Education During COVID-19 Pandemic: A Comparison of Turkish and Spanish Universities

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**Abstract**

**Purpose** – The paper aims to examine the concept of Architectural Design Communication (ADC) for updating design studio dynamics in architectural education during the COVID-19 pandemic. Within this perspective, the changing and transforming contents of architectural education, the thinking, representation and production medium are examined through the determined components of ADC. There are five components in the study, which are; (a) Effective Language Use, (b) Effective use of Handcrafts, (c) Effective Technical Drawing Knowledge, (d) Effective Architectural Software Knowledge, (e) Outputs.

**Design/methodology/approach** – The research method is based on qualitative and quantitative methods; a survey study is applied and the comparative results are evaluated with the path analysis method. The students in the Department of Architecture of two universities have been selected as the target audience. Case study 1 survey is applied to Altınbaş University (AU) and Case study 2 survey is applied to Universitat Politecnica de Valencia (UPV) students during the COVID-19 pandemic;' 19-'20 spring term, online education.

**Findings** – As a result, two-path analysis diagrams are produced for two universities, and a comparative analysis is presented to reveal the relationships of the selected ADC components.

**Originality/value** – This paper fulfills an identified need to study how architectural design communication can be developed in online education platforms.

**Keywords** Architectural design education, communication, Architectural Design Communication (ADC), online education, COVID-19 pandemic, path analysis, design studio,

**Paper Type** Research Paper

## 1. Introduction

Acknowledging, grasping, and internalizing the contemporary architecture agenda is possible with the assimilation of the concepts that make up the difference of the architectural fields in terms of the information and communication languages. The establishment of this information infrastructure and communication environment in architectural design education has been continuously transforming due to technological developments. While adapting, monitoring, and comprehending the novel communication mediums that emerged through the technological developments in architectural design education, it is essential to update and reconsider the Architectural Design Communication (ADC) and its components.

Communication has been an up-to-date problem in architectural design education. The fact that the communication dialogue between instructor-student and student-student cannot be developed sufficiently during the education process decreases the quality of the education provided. The architectural design process becomes an interactive learning medium through this dialogue constructed by the ever-changing ADC language. The environment of this interaction is a design studio where learning occurs through the accumulation of experiences during the architectural design process. Along with technological developments, this design studio environment has started to be both virtual and physical. Online communication mediums have mostly begun to be examined in terms of interaction, collaboration, and efficiency (Rodriguez, et al., 2018) (Jones, et al., 2020) (Simoff & Maher, 2000) (Gabriel & Maher, 2002) (Chiu, 2002). However, these examinations could not have a global impact on architectural design education until 2020. Almost every design studio became online in the 2019-2020 Academic Year Spring term because of the COVID-19 pandemic when Emergency Remote Teaching (ERT) protocols were initiated worldwide. The universities with an infrastructure for distance learning started ERT immediately, while those without an infrastructure have rapidly initiated an emergency plan within short notice.

Along with a methodological shift in architectural design education, the essence is that communication dialogue has been rapidly transforming in online education during the COVID-19 pandemic. Especially structuring the shared meanings and contents of the concepts and terminology subject to communication and placing them on the agenda of architectural design education, gain importance in terms of the currency of the online education environment.

In this context, this research examines the concept of Architectural Design Communication (ADC) for exploring the internal dynamics in means of online medium in architectural design education. The study compares the ADC components' relationships in architectural design education in two universities of Turkey and Spain by using qualitative and quantitative methods. According to the paper's hypotheses, a survey is conducted in both universities. The results of the survey are compared with path analysis subsequently. The research tries to determine the correlation between technology-oriented skills and handcraft skills in ADC through these comparisons.

## 2. Theoretical Background

### *2.1. Design Communication*

> …[B]efore they can hope to communicate fully, one group or the other must experience the conversation that we have been calling a paradigm shift (Kuhn, 1970)…

Communication plays a vital role in our social life interaction. Claudia Eckert et al. describes communication in design as exchanging data and information, as well as

creating knowledge (Eckert, et al., 2005) However, initiating communication has been disrupted due to some unequal circumstances. Jurgen Habermas criticized such situations as "ideal speech situation" and defended the democratic communication of social actors under identical conditions (Habermas, 1984). Today, this ideal situation has been realized with the advent of the Internet (Heng & De Moor, 2003). Habermas's communicative action theorem is an action type that is not limited to verbal actions but coordinated with them. Although Habermas avoids drawing the communicative boundaries of language with social necessity, he limits the field of social theory to the grammatical rules of linguistic communication. He considers a possible and legal communication environment as undistorted communication. It is about searching for an agreement in the interpersonal relationship of at least two subjects with communicative action, language and action skills by coordinating their action plans and interactions in an appropriate way to reach consensus.

The relationship between communication and language has been studied among many researchers. David Blair's language and representation studies (Blair, 1990), George H. Mead's symbolic interactivity (Mead, 1982), Ludwig, J.J. Wittgenstein's' language games' (Wittgenstein, 2008), Hans, G. Gadamer's Commentary information (Gadamer, 1980) provides guidance. Semiotic (De Sassure, 2006) and semantic studies (Chomsky, 1972) are also essential resources for determining the methods of evaluating designer communication in terms of components, structure and meaning relationship. In the framework of this literature, the desired conclusion to be reached with this proposed study is to shed light on how to improve communication, which is also impaired in architectural design education, and to emphasize communicative action.

The above-mentioned communicative action is called design communication, habits in a universe of representation where the language is structured in architectural design education. According to Gabriela Goldschmidt, "to design is to represent," so there can be no design without representation. Representation functions as the dialogue between the student and the instructor (Goldschmidt, 2004). A multi-layered communication channel emerges through representations such as sketches, plans, sections, diagrams, models and animation, etc. A student/instructor communicates through internal and external representations where the language multiples within the design studio. As the technology developed, this channel started to grasp new design and representation tools. The adaptation of these new digital tools to the design process took a long time. Malcolm McCullough underlines this as the invention and innovation cannot often occur contemporaneously (McCullough, 1996). This adaptation plays a crucial role where the one who does not know the language or cannot adapt to it cannot communicate efficiently.

### *2.2. The Role of Design Communication in Architectural Education*

Communication is the basis of architectural design. In design, what is important is not "watching" what is being discussed but "seeing / understanding" (Gabriel & Maher, 2002). This interpretation takes place through verbal, visual and sensory communication. The structure of architectural education curriculums based upon the foundation of design communication primarily concentrates on visual matters in the first year. The learning outcomes of these courses are designed according to the objectives gathered around constructing a skill set based upon sketching, drawing and technical representation. Students need to gain the knowledge and ability to express their design ideas through sketching, orthographic projection set and perspective drawings, etc., starting from the first semester. Structuring these

abilities initially bases upon developing 2D and 3D perception with or within the visualization of design and toolset integration like pen/pencil and ruler,etc. As technology developed, the visualization and representation tools have changed. Accordingly, the use of the mouse, keyboard, and perception of the visualized matter through the screen has also started to be an ingredient of design communication. Besides the visual expression abilities, gaining the ability to present the design work verbally is a fundamental issue in first-year architectural design education.

After gaining the essential abilities in the first year, students develop their skills and gain more knowledge on design communication through various mandatory courses such as architectural design, building science and technology, digital drawing/design, etc. The curriculum structure in terms of design communication regarding four folds is (1) the content of the communication, (2) tools of communication, (3) medium of communication and (4) effectiveness of communication. This structure comes from the nature of the discipline. The creation, perception and experience of the content in architecture, whether the representation of a design or the built environment itself, constructs a meaning at the end.

Besides the architectural design curriculum, the architectural project has its forms of representation used as means of production and communication. The seminal essay by Robin Evans (*Translations from Drawing to Building*, 1997) is frequently used to highlight some arguments regarding drawing in architecture, the architect's relationship with his graphic production, and its interference in the design process. Evans affirms that the act of drawing and the represented object is not as dissociative as it seems. He states that "architects do not make buildings, they make drawings for buildings." According to Evan, those drawings can be descriptive when generated to convey a particular set of formal conditions. However, they can also be prescriptive when they act as tools to interrogate adjacencies and spatial relations (Evans, 1997). Thus, a well-elaborated drawing (or other representation) becomes a feedback loop for the architect, allowing architects to question their design, respond to the drawing and promote their proposal.

Traditional graphic media coexist with other visual modes such as photography, cinema, or augmented reality at the present architecture studio. In addition, the production of these representations can be analog or digital. All this broadens the panorama of the exploration and notation of the architectural object and the means to communicate and maintain a record of work with others. The representation must then be understood as a necessary means of mastery in architectural education, not only regarding its production techniques but also the potential of its conceptual limits (abstraction, definition, expressive capacity, material dimension ...).

During their formative years, the architecture students try to put their communication skills into practice while improving them. This is a continuous feedback process that goes on extending beyond the formative stage. The architecture studio is still a simulation of professional practice, and communication in this learning environment reproduces characteristics similar to those between the architect and the client. Effective communication addresses a specific functionality (what is to be transmitted), a process (the development of work, the causality of decisions), and an interface (how it is communicated) (Norouzi, et al., 2015 ). However, the interlocutor of an architecture student is the tutor, and therefore, some of these variables acquire their characteristics. Since the sender and receiver, in this case, share the same language, and the critiques of a study are made iteratively from time to time with a student, communication can focus on more specific and technical aspects, ignoring the general explanations that are given when

communicating a design in general terms. In addition, the tools are also more specialized and the language can almost become context-specific jargon.

Furthermore, although the central communication is between student and tutor, in a learning environment such as the architecture studio, it is essential that the whole group can participate in this transmission of information (the rest of the group of students are also transmitters and receivers). Consequently, it is of vital importance that the aforementioned variables are leveled in the group.

### *2.3. Communication in Online Distance Education*

Online teaching is an educational medium that dates back to the mid-1980s. The method was used in some universities on specific subjects for years. However, in practice fields, such as architectural education, its use was limited since architecture education required hands-on production and social interaction. Distance education has not been a prevalent topic until then. With the COVID-19 Pandemic starting in the 2019- 2020 Spring Term, Emergency Remote Teaching (ERT), a type of online education, was introduced worldwide. ERT is a temporary shift from the regular mode of education, an alternative to face-to-face education due to crisis circumstances (Anon., 2020) (Hodges, et al., 2020). The main aim of ERT is to create an urgent setup for quick access to the educational ecosystem rather than recreating it (Hodges, et al., 2020). Where online education requires technological infrastructure, pedagogical content knowledge (PDK) is also required to achieve adequate quality.

Throughout the history of online education, the milestones are as follows: Correspondence, broadcast radio and television, open universities, teleconferencing, and finally, internet/web applications (Garrison & Anderson, 2011). Looking at the conceptual model of distance education (DE), technology is the crucial aspect supporting learning, teaching and program/course design (Zawacki-Richter & Anderson, 2014). Substantial research on the generations of DE describes the fifth generation as *The Intelligent Flexible Learning Model* (Heydenrych & Prinsloo, 2010), (Taylor, 2001) content starting to move away from the university where asynchronous and synchronous interaction occurs.

Many researchers deal with online education problems, and many of those papers have been dealing with the top three issues, i.e., interaction and communication in learning communities, since the late 90s (Garrison, et al., 2000). In DE this process is facilitated through asynchronous and synchronous communication media and technologies. From this perspective, communication is one of the most critical issues in online education. There are some negative and positive aspects of communication, so it is crucial to identify them. Likewise, Harasim addresses the paradigm shift by presenting an overview of the history of online education while underlining the importance of communication (Harasim, 2000). In the near past, one of the important researches focuses on online education during the COVID-19 pandemic and finds out that course management, communication and interaction are the key factors affecting user experience (Chen, et al., 2020).

Another vital aspect of online education is interaction. The online education model reinforces this social nature of learning and assumes that learning occurs through the interaction of three core elements: social, cognitive, and teaching presence (Garrison, et al., 2000). They also argue that online learning is in its capacity to facilitate communication and thinking and thereby construct meaning and knowledge" (Garrison & Anderson, 2011). Since architecture is a discipline where social interaction and knowledge transfer are dense, interaction methods should be reconsidered and redefined. In communication literature, the research

presents five degrees of communication in education: oral gestural, writing, audio, audiovisual, and digital, which highlighted the changes introduced by the online scenario in the educational process, and the relationship between the instructor and the student (Perceval-Verde & Tejedor-Calvo, 2008).

In order to evaluate communication, it is also crucial to understand the behavioral pattern of the new generation. Another essential book on Online Distance Learning (ODL) introduces the new way of approaching the educational system where users are defined as digital natives and net generations. The milestone research on the terminology of digital immigrants (Prensky, 2011), net generation (Tapscott, 2009), and next-generation of learners and their learning methods (Palfrey & Gasser, 2008) have been discussed. These authors argue that this so-called net generation has been immersed in a networked world of digital technology; they behave differently with various social characteristics, different ways of learning, and different expectations about life and learning via using and making sense of information (Zawacki-Richter & Anderson, 2014).

Consequently, one of the most powerful aspects of online education is using technology and software tools more often, which strengths communication. This research will focus on students' communication capabilities through the technological use of design and representational tools.

### *2.4. The Mediums of Communication in Design Studio Environment*

Studio courses have been at the core of architectural design education since their inclusion in the 19th century (Ozer & Ayci, 2017). Communication has been chiefly monologues in these studios, due to the master-pupil relationship where the knowledge exchange was one way. This situation has begun to be criticized starting from the 20th century, and the design studio environment has transformed into a mutual learning environment. The first theories about the specificity of the design studio as a mutual learning environment go back to the 1970s when Donald Schön emphasized the similarity of learning architectural design with professional practice. In 'Educating the reflective Practitioner' the author already highlighted the reflective nature of teaching design in a discursive setting (Schön, 1987). Subsequent studies have depth on how the design studio is a 'highly social environment' where 'students learn to communicate, criticize, and respond to criticism and collaborate' (Gross & Do, 1997). This social environment has been a quest of research in the design education field regarding knowledge and skills transition especially starting from the 20th century. How teaching and learning occur in the design and what kind of environment supports this act cannot be free from its protagonists; students and teachers. One of the studies coming to the forefront proposes a new student-centered approach regarding the agents of the design studio. The proposed model focuses on a new continuous role-playing studio and how this influenced the distribution of power in the studio and the students gained more control over their learning experience (Austerlitz & Sachs, 2006).

As Lueth pointed out, this 'design studio culture' can result in positive factors and negative experiences such as those addressed by the report of the Studio Task Force of the American Institute of Architecture Students (2002) (Lueth, 2008). The key lies in the interactions between the study participants that will define the classroom climate.

The interest in the classroom climate in terms of the design studio environment comes from a direct transfer from traditional teaching to architectural training. Classroom climate and interactions (between students or between tutor and students) are directly related, and both significantly affect individual student performance on various levels (Hill, 2007). Numerous quantitative and qualitative

studies focus on the nature of interactions in traditional teaching settings, but few are addressed in the field of design studio (Hill, 2007) (Lueth, 2008) (Obeidat & Al-Share, 2012). Interactions are face-to-face or online moments for communication between people. When analyzing their nature, the medium takes on particular relevance: it is not only about an oral exchange but about everything that accompanies it. In other words, the drawings and what is stated during the reviews of a project are paced to transmit the ideas of a design.

Over the past century, design practice has changed under the influence of globalization and computer science. The use of computer technologies in design practice has led to the emergence of various design environments (Chiu, 1998), (Maher, et al., 1997). Besides these emergences, design representations and communication has started to evolve inevitably (Ozer & Akcay Kavakoglu, 2017). With this development, the first question that comes to mind is how thinking / producing habits will change in the design environments that have transformed into work.

This question has been investigated to integrate new communication and computing technologies into the design process through virtual design studios established in many architectural education institutions (Kolarevic, et al., 2000), (Kvan, 2000). Studies conducted through virtual design studios focused on the process of design collaboration, group work, design environment, organization, communication and pedagogy (Simoff & Maher, 2000) (Gabriel & Maher, 2002) (Chiu, 2002). In addition to questioning the design environment, design tools have also become the focus of research. It can be said that sketches are the most studied of these tools. Sketch interpretation (Stacey, et al., 1999) study in design communication is crucial in systematizing and interpreting graphic expressions in communication.

In the studies conducted by Gerard Cesar Gabriel and Mary Lou Maher in the design studios of Sydney University, communication coding and modeling studies were carried out; face-to-face designs were compared with those made in a virtual environment. The experimental method used in this study has been adopted as an initial stage. It has been developed, and the infrastructure has been established to compare different design environments. In other words, the environment of design communication has focused on researchers' attention and the method.

Even before the pandemic caused by COVID-19, some studies suggested updating the design studios to reflect professional environments more. In this sense, an evolution tending to transform the design studio into a new participatory and delocalized learning space was the initial goal. The introduction of online learning opens a window to understand the design studio as timeless and not confined to the physical environment. It positively impacts possible new collaborations (not directly related to the students' school) and helps 'blurring' the image of the tutor as the only reference (Masdéu & Fuses, 2017).

Since the spring 2020 confinement, the Association of Collegiate Schools of Architecture (ACSA) has held a series of webinars in which different American schools have presented their online learning experiences in the design studio. These resources are based on experiences before the health emergency where the advantages and disadvantages of online communication were already revealed, and pedagogical nuances were introduced. However, they also delved into the difficulties of a sudden 'pivot to online learning.' Some of the discussions pointed out that the combination of face-to-face learning with online learning seems to be more advantageous since it allows students to adjust learning to specific objectives. In other cases, when synchronous online teaching is not always possible in virtual studios, asynchronous activities turned out to be an opportunity to develop certain

parts of the project process. In addition, the gallery of virtual tools for activities related to the studio is increasingly broad. Many of these webinars insist on how to maintain communication with students through various types of interactions that allow them not only to continue teaching but also to create a sense of belonging to a community in the studio: the richness of the different media put into practice makes it possible (ACSA, 2020). (ACSA, 2020).

Regarding these, it can be said that starting from the 80s, the interest in design communication to unfold the design process (Schön, 1987); (Schön & Wiggins, 1992) switched to the quest of the tool shift in the 90s (McCullough, 1996). Afterward, the medium of the design communication, whether virtual or real, has been questioned densely. Therefore, identifying design communication components in architectural design gains importance to decode the relationship between content, tool, and medium in the 21st century, especially after the COVID-19 pandemic. As shown in studies carried out in different architecture schools during the pandemic, the potential of some online tools has been glimpsed (Ceylan, et al., 2021) despite low satisfaction about the effectiveness of representational software (Varma & Jafri, 2021). Additionally, reasons for feelings of disengagements in the design studio online teaching were due to the lack of familiarity with some digital tools and limitations of peer interactions (Alnusairat, et al., 2021).

## 3. Material and Method

### *3.1. Architectural Design Communication (ADC)*

Architectural Design Communication (ADC), a terminology addressed by authors, can be described as the overall communication methods and mediums to transfer a design idea. Since this study focuses on an educational basis, this transfer happens between student-student, student-instructor, or instructor-student. Student-student interaction in online education is a weak spot in the chain, essential to consider, but it is not in the scope of this paper. Mainly, this research focuses on student-instructor -one way- communication.

ADC is an essential subject to architectural design education. In order to enable students to use ADC more effectively, it is crucial to understand, categorize, and analyze this language for its correct use. The results obtained from the study will contribute to the architectural design communication that will be developed to support and research architectural education. The components of ADC have been defined and categorized in the following section.

### *3.2. Components of ADC*

The definition of the ADC components are as follows:

*(1) Effective use of language* requires good and effective use of the spoken language. Being able to express ideas accurately, fluently and clearly in any language is the most important communication key. Regardless of the language, students are expected to know the architectural terminology of that language, be proficient in the language, and express their ideas fluently and clearly. The main problem is that in universities that provide education in English, students generally do not have enough command of English and have difficulties expressing themselves. Not all the schools of architecture in Turkey and Spain give English education, but some schools are committed to teaching at least a group at each level in Spain and some schools have solely or both English or Turkish programs in Turkey.

*(2) Effective use of handcrafts,* whether in real or virtual environment; requires skillful, fast and correct use of hands. Although drawing or making models by hand

are skills that exist but can be improved; Drawing and modeling with computers are skills that can be learned and developed with practice.

*(3) Effective knowledge of technical drawing***,** requires gaining the knowledge of drawing, reading and perceiving 2D and 3D drawings like orthographic projection set (plan/section/views), axonometry, perspective, etc. and learning the accurate architectural notation system and technical drawing details in terms of tectonics, material and structure.

*(4) Effective knowledge of architectural software* requires using various software in drawing, modeling, presentation, measurement, analysis and documentation, etc., correctly and fast. Nowadays, students need to use at least one software well in every field to communicate effectively. The critical point here is that this software sometimes can turn into a design environment rather than just being used as a tool. Users can develop and individualize software to get their designs in the direction they want through writing scripts to generate add-ons.

*(5) Outcomes* can be evaluated in two categories as virtual and real. Virtual outcomes are models and drawings obtained in a computer environment. Real outcomes can be made by hand, such as paper-pencil, paste, model cardboard, etc. The resulting products produced by hand are passive and the self-renewal period is long when changes are required; Virtual printouts can be produced by printing them many times, and they also allow changes in a short time.

ADC components are labeled according to the survey structure in which the questions were asked on (a) Personal Information for demographic data, (b) Effective Language Use, (c) Effective Hand Skills, (d) Effective Technical Drawing Knowledge, (e) Effective Architectural Software Knowledge, and (f) Outcomes. The labeled ADC components can be seen from B to F, wherein in section A, demographic data is collected in the survey as aforementioned (**Figure 1**).


**Figure 1.** Five Components of Architectural Design Communication labeled according to the survey structure

### *3.3. Structure of the Research*

This pilot study tries to develop the first proposal for a supplementary education model in architectural education by identifying the gaps in architectural education while measuring architecture students' architectural design communication skills from the first to the fourth and fifth grades.

As mentioned in the previous section, it is decided to measure the correlations of ADC components with quantitative research methods, namely surveys. In order to understand different universities' approaches, this study is conducted internationally. Students from Altınbaş University (AU) in Turkey and Universitat Politecnica de Valencia (UPV) participated in the study.

This study dates back to 2017, where the survey was applied to Altınbaş University, Architecture and Interior Architecture and Environmental Design students. The results were analyzed at the end of this face-to-face education phase to compare them with 2020 online education results. Educational method comparison study will be published as another paper in the future.

Related to this paper, in 2020 Fall, one semester after the COVID-19 pandemic started, since education is mostly going online, the survey is applied to both the Architecture Departments of Altınbaş University and Universitat Politecnica de Valencia. The students are asked to evaluate the previous semester (2019-2020 Spring Term), where ERT emerged. This international comparison also shows how design communication changes during online education between different universities (**Figure 2**).

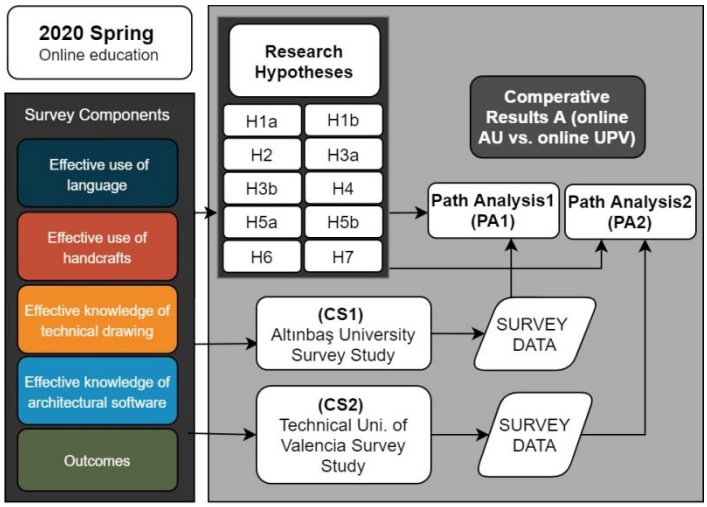


**Figure 2.** Research process flow diagram

As stated in the previous section, survey questions presented to the target audience are based on five components that make up the architectural design communication. These components are (b) Effective use of language, (c) Effective use of handcraft skills, (d) Effective knowledge of technical drawing, (e) Effective knowledge of architectural software, and (f) Outputs (**Table 1**). The surveys are applied in Survey Monkey online platform, where statistical SPSS data is gathered. Depending on research hypotheses, the path analysis method describes the directed dependencies among the set of variables.

| | label | Initial items |
|---|---|---|
| ***Effective Handcrafts*** | | Drawing with pencil on paper, |
| | C1 | ...I can express my design idea. |
| | C2 | ...I am able to use it technically. |
| | C3 | ...i feel like it is the best tool for me to realize my thoughts. |
| | C4 | ...i cannot use it as I want it to. |
| | C5 | ...i feel like it restricts my communication. |
| | C6 | ... I feel like it restricts my design thinking. |
| | C7-C12 | Model making with cardboard, razor knife, wood etc. |
| | C13-C18 | Clay, plastirin, plaster, mud like reformable materials. |
| | C19-C24 | Computer based tools like mouse, 3d mouse, sketch pad pen. |
| ***Effective Technical Drawing Knowledge*** | | 2D perception, |
| | D1 | ...I can read plans, can imagine it in 3 dimensional space, easliy express my design ideas. |
| | D2 | ...I can read sections, can imagine it in 3 dimensional space, easliy express my design ideas. |
| | D3 | ...I can read elevations, can imagine it in 3 dimensional space, easliy express my design ideas. |
| | D4 | ...I am having a difficulty in expressing the 2D drawings of a 3D object. |
| | D5 | ...I am having a difficulty in understanding comments on 2D drawings. |
| | | 3D perception, |
| | D6 | ...I can imagine a 3D form from its 2D drawings. |
| | D7 | ...I can express my design ideas in 3D. |
| | D8 | ...I cannot express my design ideas on 3D drawings while discussing. |
| | D9 | ...I am having a hard time to understand the critics given in 3D drawings. |
| | D10 | ...when i design an object/structure, i imagine it in 3D in the first time. |
| | | Technical Drawing notations, |
| | D11 | ...I have knowledge on 1/1000 scaled technical notations in order to draw site plan/site section/siluets |
| | D12 | ...I have knowledge on 1/500 scaled technical notations in order to draw plan/section/elevation |
| | D13 | ...I have knowledge on 1/200 scaled technical notations in order to draw plan/section/elevation |
| | D14 | ...I have knowledge on 1/100 scaled technical notations in order to draw plan/section/elevation |
| | D15 | ...I have knowledge on 1/50 scaled technical notations in order to draw details |
| ***Efficient Architectural Software Knowledge*** | | Via computer, |
| | E1 | ...I can effectively use 2D drawing software, ex. Autocad. |
| | E2 | ...I can effectively use 3D drawing software, ex. Autocad, Skecthup, Archicad, Design 4d, Maya, 3Dmax. |
| | E3 | ...I can effectively use 2D visualization/representation software, ex. Photoshop, Indesign, Illustrator. |
| | E4 | ...I can effectively use 3D visualization/render software, ex. Vray, Lumion. |
| | E5 | ...I can effectively use 2D animation software, ex.Adobe premier, After Effects, Photoshop. |
| | E6 | ...I can effectively use 3D animation software, ex.Maya. |
| | E7 | ...I can effectively use performance analysis software, ex. Autodesk Ecotect, Energy10. |
| | E8 | ...I can effectively code for production and design, ex.Rhino Grasshopper, Processing. |
| ***Outcomes*** | | Virtual outcomes, |
| | F1 | ...via computer, I can effectively model 3d solids. |
| | F2 | ...via computer, I can effectively render the scenes. |
| | F3 | ...via computer, I can effectively use BIM modelling software. |
| | | Real outcomes, |
| | F4 | ...I can express my design thoughts via model making. |
| | F5 | ...I can print the drawings effectively, with good quality, lineweights and resolution. |
| | F6 | ...I can produce a design effectively with laser cutter, Cnc etc. |
| | F7 | ...I can effectively use 3D printers to print a 3D model. |

**Table 1.** Among the overall survey, the list of items used in path analysis

### *3.4. Statistical Analysis Method*

In order to analyze the survey results between two universities, the path analysis method was chosen to describe the directed dependencies among a set of variables. *Path analysis* is a statistical method that allows investigating patterns of effect within a system of variables. It is one of the general linear models that examine the impact of a set of predictor variables on multiple dependent variables (Allen, 2017).

Path analysis is used to unfold relationships to evaluate the effects through correlation linked to multiple regression. There are notations about displaying and naming. Arrows display the assumption of causal relations—a single-headed arrow shows a relationship path from cause to effect. The direct effect of the *cause* variable on the *effect* variable is called a *path coefficient*. Subscripts are used while showing the path coefficients. In addition, the path from 1 to 2 is written as p21 (Brannick, n.d.). (**Figure 3**).

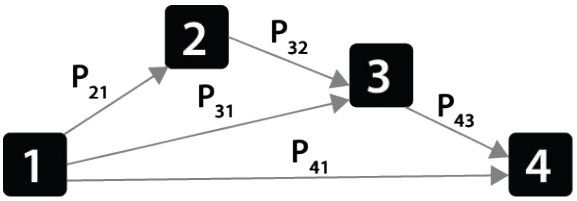


**Figure 3.** Path analysis showing which component effects which

*3.5. Research Hypotheses*

The research aims to discover the correlation between technology-oriented skills and handcraft skills in ADC during online education. According to that, four ADC components are initially determined as the primary set of variables. The correlation between the sub-components of (c) Effective use of handcraft skills, (d) Effective knowledge of technical drawing, (e) Effective knowledge of architectural software, and (f) Outputs are measured and evaluated to test the hypotheses.

Selected sub-components are; communication skills with paper and pencil, model making and computer-based tools, self-expression with the 3D perception, 2D/3D drawing/visualization tools in architectural software, real and virtual outcomes. The set of variables include seven ingredients connected through a directional relationship. The hypotheses below are tested according to the **Figure 4** diagram that shows which skills/knowledge affect which.

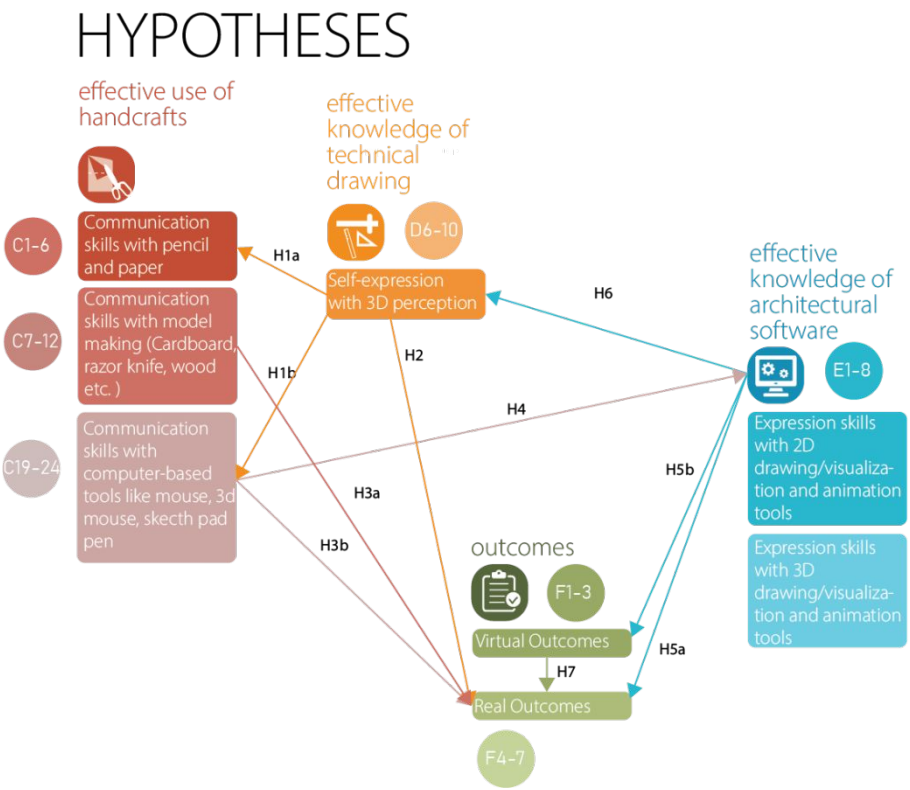


**Figure 4.** Hypotheses diagram for path analysis

Due to **Figure 4** diagram, the hypotheses are below:

**H1a.** Effective Technical Drawing knowledge (3D perception) has a positive effect on effective use of handcrafts (drawing with pencil on paper).
**H1b.** Effective Technical Drawing knowledge (3D perception) has a positive effect on effective use of handcrafts (computer-based tools like mouse, 3d mouse, sketch-pad).
**H2.** Effective Technical Drawing knowledge (3D perception) has a positive effect on real outcomes.
**H3a.** Effective use of handcrafts (Model making with cardboard, razor knife, wood etc.) have a positive effect on real outcomes.
**H3b.** Effective use of handcrafts (computer-based tools like mouse, 3d mouse, sketch-pad) have a positive effect on real outcomes.
**H4.** Effective use of handcrafts (computer-based tools like mouse, 3d mouse, sketch-pad) have a positive effect on effective architectural software knowledge
**H5a.** Effective architectural software knowledge has a positive effect on real outcomes.
**H5b.** Effective architectural software knowledge has a positive effect on virtual outcomes.
**H6.** Effective architectural software knowledge has a positive effect on Effective Technical Drawing knowledge (3D perception)
**H7.** Virtual outcomes have a positive effect on real outcomes.

## 4. Case Study

An online survey has been prepared to measure ADC through architecture students. The study was carried out in Altınbaş University (AU) (CS1) and Universitat Politecnica de Valencia (UPV) (CS2) in the 2019-2020 Spring Term to make a comparative analysis. The education was switched to online in the 2020 Spring due to the COVID-19 pandemic. The survey results are compared through two case studies to explore the online learning mediums effects on ADC. The structure of the survey was designed according to the defined components of ADC.

In the survey, nine questions were asked on Personal Information for demographic data, twelve on Effective Language Use, twenty-four on Effective Hand Skills, fifteen on Effective Technical Drawing Knowledge, eight on Effective Architectural Software Knowledge, and seven on Outcomes.

The surveys are sent to all undergraduate students via Survey Monkey online platform. Out of 615 surveys collected, 308 fully completed surveys are included in path analysis for evaluation. 133 surveys are from AU (CS 1); 175 surveys are from UPV (CS 2).

### *4.1. CS1*

Case Study 1 (CS1) was conducted in the 2019-2020 Spring Term in the Department of Architecture at AU in Turkey

#### *4.1.1. General Information of the educational structure of AU*

The Department of Architecture in AU was founded in 2011 and the program's education language is English. Afterward, another architecture program with Turkish language education was founded in 2016 in AU. The study is carried out with the Architecture Program in English, where most students are International. The students need to be successful from *The Higher Education Institutions Examination* (YKS)- the national central exam in Turkey- to be placed into a university program (Eurydice , 2020). Students who succeed from YKS, select the

programs according to their preferences (Eurydice , 2020). Architecture programs are linked to students' mathematics and science grading due to this exam. International students need to have a successful completion score of High School Studies and English proficiency to apply to the AU Department of Architecture.

The architecture education curriculum's first-year design and communication courses were also served to Interior Architecture students during the first year of their education until 2020. The program has eight compulsory semesters, and the courses' total ECTS credits are 60 per year, including summer internships. There are two basic design and six architectural design courses supported by theoretical and technological courses during four-year architecture education. The studios are mandatory. During the first and second year, Basic Design I, II and Architectural Design I, II courses have a load of 10 ECTS for each per semester (two days a week, total 8h). Architectural Design III, IV and V have a load of 12 ECTS for each (two days a week, total 8h). The Architectural Design VI as the final graduation project has a load of 14 ECTS (two days a week, total of 8h). All design studio courses have prerequisites. For example, to register to Basic Design II, a student must be successful from Basic Design I. Studio section numbers differ due to student numbers each year. Students choose according to the announced studio content every semester. Each section consists of 12-15 students.

After 2017, the current curriculum has started to integrate computational thinking and digital design toolset and medium development by positioning Introduction to Digital Drawing course to the first semester and by repositioning the Digital Design and Representation Techniques course to the second semester in the first year to support Basic Design I, II and Graphic Communication and Introduction to Materials courses. In the second year, rather than focusing on digital as a toolset, the Architectural Design Studio course is supported in questioning the digital as a medium through integrating the Introduction to Digital Design course into the curriculum. To sum up, the first-year works as the foundation of knowledge and skillset in tool use. The second-year works as the exploration and develops the ability to use digital medium as a design driver. Design, technology, and communication-related courses support ADC, where the learning outcome of these courses aims to construct critical thinking, learning technical skills, and gaining knowledge in these areas (**Table 2**).

AU has had the Distance Learning Research and Application Centre (UZEM) since 2015, but it has never been used for the ARCH and CVE coded courses in the architecture curriculum. UZEM offers many undergraduate and master's degree programs, besides seminar programs through web-based distance learning methods. The common courses in the architecture curriculum like Culture and Society and History have been conducted via UZEM's online learning platform since 2016. When the education switched to online due to the COVID-19 pandemic at the 2019-2020 Spring Semester, UZEM had initiated a seminar series to train the academics about ERT and online distance learning systems immediately. It had been two weeks since the semester started. The theoretical courses in the architecture curriculum have initially started to be conducted online after the training period is over. After initiating the ERT and experiencing the medium through theoretical courses, the department initiated online studio courses two weeks later. The transition was not easy, especially for the design studios at first, where both tutors and students declared that they do not want to carry out the design studio on an online platform. As the pandemic became more apparent and urgent, the design studio's dynamics started to be restructured according to the online platform needs.

### *4.2. CS2*

Case study 2 was conducted at UPV about the 2019-2020 Spring Term.

#### *4.2.1. General Information of the educational structure of UPV*

Universitat Politecnica de Valencia, Department of Architecture was founded in 1968. During its more than 50 years of experience, up to 5 study plans have been taught: the current one, approved in 2014 and adapted to the regulations of the European Space of Higher Education, integrates a Degree in Fundamentals of Architecture, of 5 years and 300 ECTS (60 ECTS per year) and a Master in Architecture, of one year and 60 ECTS, that qualifies for professional practice.

Students need to be successful from *Spanish University Access Tests* (PAU) to apply to the Department of Architecture. In Spain, during high school, students select the discipline branch for their university education. Besides math, physics and painting, they can get history of art and technical drawing courses (3D perception) starting from upper secondary school education. The students who want to apply to architecture programs need to succeed in mathematics, science, history of art or technical drawing exams besides language, literature and history/ philosophy to study in the Department of Architecture in UPV (SpainEducation.info, 2021).

The architectural studios are taught in all undergraduate courses and are compulsory. During the first year, the subject of 'Project 1' is located in the second semester (15 weeks) and has a load of 5 ECTS (two days a week, sessions of 1h30-2h). From the second to fifth year, the annual subjects of 'Project 2, 3, 4, 5' have a load of 15 ECTS (two semesters of 15 weeks, two days a week, 2h30 per session).

All studio teaching is carried out by the Department of Architectural Projects department, the largest in the school with 85 tutors. Tutors are organized according to teaching units, and up to 12 different groups are offered for each level of projects. Subjects are taught Monday-Wednesday (6 groups), Tuesday-Friday (4 groups), or afternoons (2 groups), and students choose according to their convenience. Each group consists of 20-25 students.

Students at the Valencia School of Architecture also receive specific training in design communication. There are three subjects with solid graphic content in the first year (Analysis of Architectural Forms, Architectural Drawing and Descriptive Geometry), which are reinforced by a subject of 'Architectural Graphic Expression' in the second semester of the second year. Regarding technical training, from the third year onwards, students take annual courses in the Calculation of Structures, Architectural Construction and Installations (**Table 2**).

DOI 10.1108/OHI-07-2021-0144

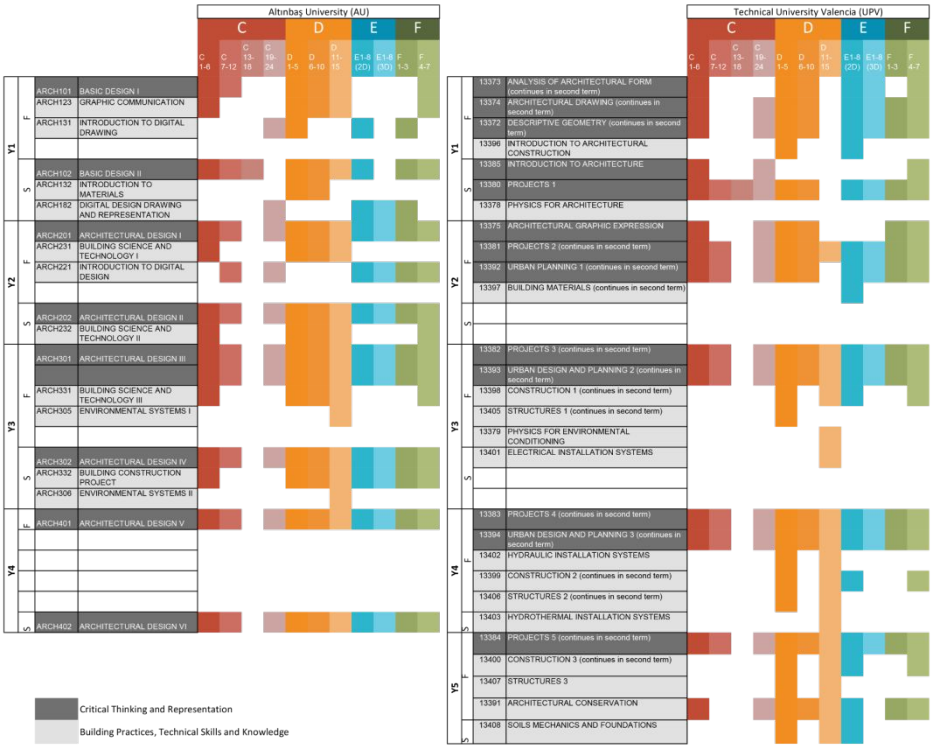


**Table 2.** Structure of the curriculum supporting ADC in terms of design, technology and communication-related courses

The Valencia school of architecture does not have a distance education background and the lockdown derived from the COVID-19 pandemic in spring 2020 highlighted the absence of a reflection on remote teaching. The emergency measures adopted by the university (platforms and digital tools) and the availability of the teaching staff solved a particular situation. The study groups, already set up and teaching started in March 2020, continued teaching by going online in a rush. The results were not bad, but the effort of teachers and students showed some wear and tear since many more hours were invested in teaching than those stipulated by the curriculum. After this period, the school faces the challenge of being able to optimize teaching methods. During the 2020-2021 academic year, as far as possible, face-to-face teaching has returned.

## 5. The Results of Path Analysis

Path analysis is made on the hypotheses model constructed upon the effects of four components and their sub-components on each other which are variables. Among (c) Effective use of handcraft skills, three sub-components included in the path as variables are; communication skills with paper and pencil and communication skills with model making and computer-based tools. From d) Effective knowledge of technical drawing component self-expression with 3D perception sub-component is selected as a variable. While (e) Effective knowledge of architectural software has been taken directly as a variable, the subcomponents of (f) Outputs; real and virtual outputs placed on the path as variables. Ten hypotheses are planned to be tested accordingly, both for AU and UPV surveys.

*5.1. Correspondence Analysis of the path model for AU*

The correspondence analysis is made regarding the hypotheses model in **Figure 4.** The chi-square value calculated for the model is 7,740 and the degrees of freedom are 9. The 0.86 value obtained by dividing the chi-square value by the degrees of freedom is less than 2. This shows that the established model can be an excellent alternative to the saturated model. It has the values of IFI=1.000>0.97, CFI=1.000>0.97 and RMSEA=0.000<0.05, which are among the criteria of good fit obtained from the model. As a result of the evaluation of the criteria, the existence of perfect correspondence is clearly seen.

To create an equivalent model to saturated model, two new relationships are added to the initial hypotheses. These relationship assumptions are: Communication skills with model making affects communication skills with paper and pencil (Hx) and self-expression with 3D perception (Hy). Hypotheses 1a, 1b, 2, 5a, 5b, 6 and 7along with Hx are confirmed according to the analyzed path model. In particular, the paths from the self-expression with 3d perception to communication skills with paper and pencil (H1a, 0.167), to computer-based tools (H1b, 0.513) and real outcomes (H2, 0.217), from communication skills with model making to communication skills with pencil and paper (Hx, 0.246), from effective knowledge of architectural software to real (H5a, 0.271) and virtual (H5b, 0.942) outcomes and self-expression with 3D perception (H6, 0.232) and from virtual outcomes to real outcomes (H7,0.301) have significant path coefficients.

The final path analysis model for AU, according to the SEM analysis (**Figure 5**) reveals that communication skills with model making has insignificant effects on both self-expression with 3D perception (Hy,0.090) and real outcomes (H3a, 0.092). Along with this, communication skills with computer-based tools like mouse, 3d mouse and sketch pad ,etc. has no significant effects on expression skills with 2D/3D drawing/visualization and animations tools (H4, 0.119) and real outcomes (H3b, 0.019).

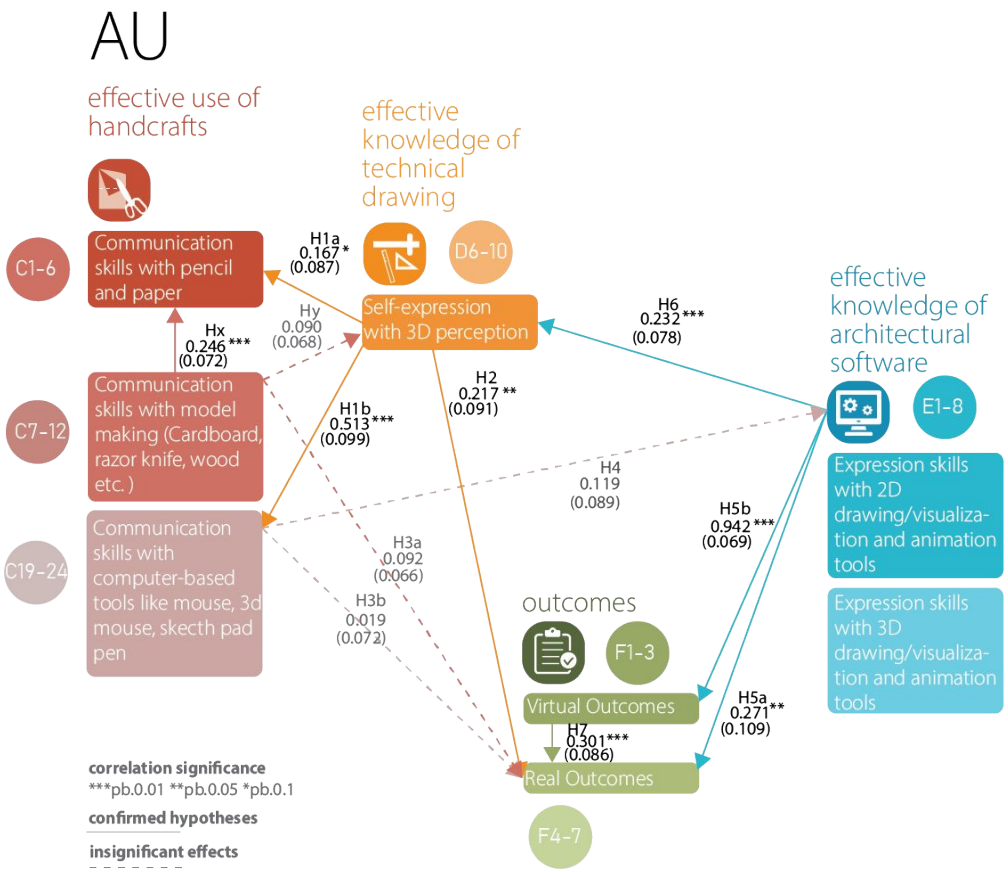


**Figure 5.** The final path analysis model for Altınbaş University according to the SEM analysis.

### 5.2. Correspondence Analysis of the path model for UPV

The correspondence analysis is made regarding the hypotheses model in **Figure 4**. The chi-square value calculated for the model is 6.059 and the degree of freedom is 8. The value of 0.757 obtained by dividing the chi-square value by the degrees of freedom is less than 2. This shows that the established model can be an excellent alternative to the saturated model. Goodness of fit criteria obtained from the model have IFI=1.000>0.97, CFI=1.000>0.97 and RMSEA=0.000<0.05 values. As a result of the evaluation of the criteria, the existence of a perfect fit is clearly seen.

To create an equivalent model to saturated model, three new relationships are added to the initial hypotheses. These relationship assumptions are: Communication skills with model making affect communication skills with paper and pencil (Hx) and self-expression with 3D perception (Hy) and Communication skills with computer-based tools affect virtual outcomes (Hz). According to the analyzed path model, hypotheses 1b, 2, 3a, 4, 5a, 5b and 6 along with Hx, Hy and Hz are confirmed. In particular, the paths from the self-expression with 3d perception to communication skills with computer-based tools (H1b, 0.282), to real outcomes (H2, 0.149), from communication skills with model making to communication skills with pencil and paper (Hx, 0.554), to self-expression with 3D perception (Hy, 0.133) and real outcomes (H3a, 0.314), from communication skills with computer-based tools to effective knowledge of architectural software (H4, 0.205), virtual outcomes (Hz,

0.346) and from effective knowledge of architectural software to self-expression with 3D perception (H6, 0.188), real (H5a,0.349) and virtual outcomes (H5b,0.738) have significant path coefficients.

The final path analysis model for UPV, according to the SEM analysis (**Figure 6**) reveals that self-expression with 3D perception has insignificant effects on communication skills with paper and pencil (H1a, 0.091). Along with this, communication skills with computer-based tools like mouse, 3d mouse and sketch pad ,etc. has no significant effects on real outcomes (H3b, 0.050).

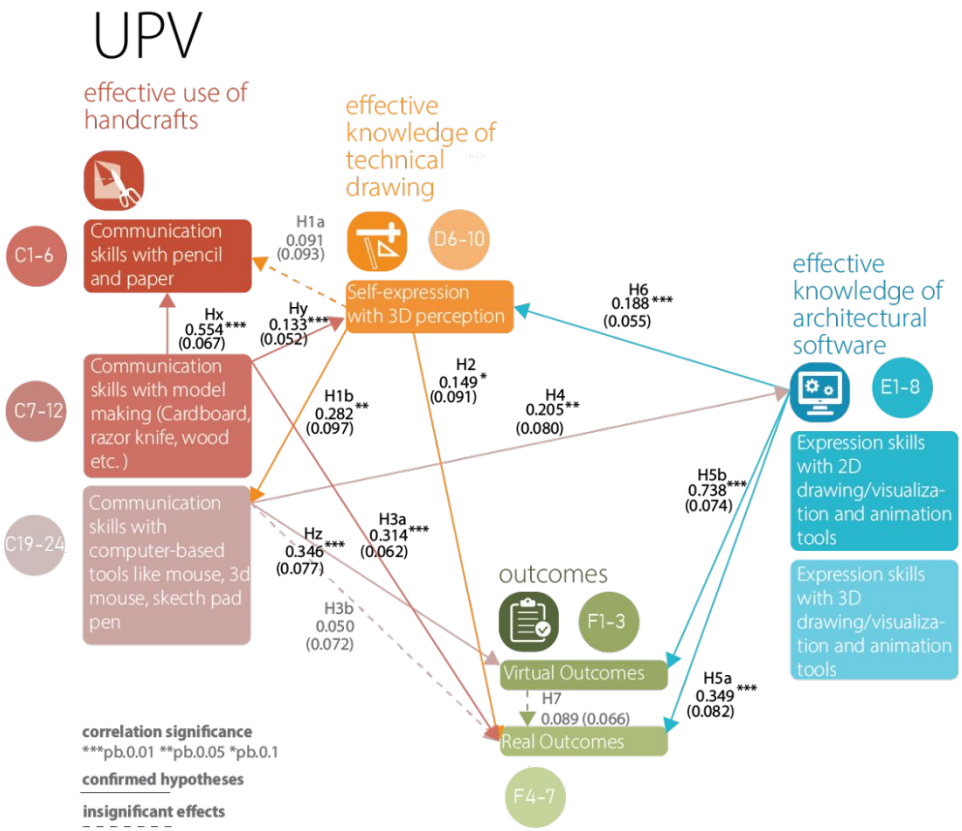


**Figure 6.** The final path analysis model for Universitat Politecnica de Valencia according to the SEM analysis.

## 6. Conclusion

The study aimed to investigate the concept of Architectural Design Communication (ADC) for updating design studio dynamics in architectural education after the COVID-19 pandemic during online education. The rapid transformation of the education medium and its effects on architectural education, thinking, representation and production are examined through the components of ADC. Four components of ADC are selected as variables in this study are; (b) Effective Use of Handcrafts, (c) Effective Technical Drawing Knowledge, (d) Effective Architectural Software Knowledge and (e) Outputs. In particular, this study examined the structural relationships among ADC components through two universities- AU (Turkey) and UPV (Spain)-Departments of Architecture. The hypothesized structural path model was tested using SEM, and as the previous section revealed, several patterns appeared. Regarding these results, discussions and implications are presented in the below section.

### 6.1 Comparison of hypothesized models for AU and UPV

This study examined the hypothesized model, covering the impacts of the ADC components to each other, which is also related to curriculum and circumstances of the architecture education regarding the knowledge and skill generation. The hypothesized models both for AU and UPV are non-recursive. The SEM results indicated that the proposed path model provided an excellent fit to the data. While many hypotheses are confirmed in UPV, AU showed a different case. The comparison of the two universities is below.

It has been observed that Effective Technical Drawing knowledge has a positive effect on the effective use of handcrafts and outcomes in both universities. However, these relationship structures differ in terms of sub-components of ADC in AU and UPV. While the 3D perception ability of technical knowledge has a strong positive impact on using computer-based tools like mouse, 3d mouse, sketch-pad in both universities, its effect on drawing with pencil on paper differs in AU and UPV. The results reveal that the 3D perception ability of technical knowledge strongly influences communication through drawings with pencil on paper in AU but not in UPV. This can be interpreted as the educational background and existing skill set of the students before starting to the architecture department at university. The students' drawing abilities, such as free-hand drawing, are not required while applying to an architecture department in Turkey. There is a standard student selection exam to place the students to university. Accordingly, the structure of the curriculum and content of the courses can also have an impact on this result. In Spain, the university entrance exam is individualized according to the trajectory followed by the student in the last three high school years. A first-year architecture student has a minimum of experience in artistic drawing and technical drawing. This fact indeed determines certain confidence in the use of drawing to communicate.

While the relationship of 3D perception and drawing with pencil abilities differ in AU and UPV, it has been recognized that 3D perception ability as a sub-component of effective technical drawing knowledge has a positive effect on real outcomes in both universities. This result can be interpreted as expected.

Another interesting result is about the effects of communication skills with model making, which differs in AU and UPV. The path analysis model shows that effective use of handcrafts like model making with cardboard, razor knife, wood, etc. have a substantial effect on 3D perception ability, pencil and paper use and real outcomes in UPV. However, the students in AU think that model making has no impact on 3D perception and real outcomes in the end. This result also can be related to the course contents and outputs as well as the online medium. After first

year basic design education which concentrates on physical model making not solely to represent the final work but as the medium for developing design thinking, communication, and skills, the students do not want to make physical models in Architectural Design courses generally in AU. Also, during online education, since physical model is not obligatory, very few students have submitted a final physical model at the end of the semester in AU. They always prefer virtual outputs instead of real ones during the design process. Another reason for this can be the curriculum that supports technology-oriented skills, especially in the first and second years. In the case of the UPV, students are required to work with physical models at all levels of the design studio. In lower grades, models are a work tool and in higher grades, they increasingly become a deliverable that shows the final image of the design. Students also have a tendency to substitute physical models for digital representations, however in the final and midterm submissions, the model is mandatory, and in the jury sessions, particular emphasis is placed on generating a discussion with the model (which can be touched or open to see the interior…).

Besides the impacts of model making, the other sub-component of effective use of handcrafts, which is communication skills with computer-based tools like mouse, 3d mouse, and sketch-pad, strongly positively affects effective architectural software knowledge and virtual outcomes in UPV but not in AU. This was an unpredicted result. A further study can focus on the effective use of handcrafts in ADC, considering the curriculum and course contents' outcomes.

As predicted, effective architectural software knowledge is positively correlated with real and virtual outcomes, and it has a strong effect on self-expression with 3D perception in both universities. Finally, according to the analysis where UPV students declare that the virtual outcomes have a crucial effect on the real outcomes, AU students do not relate these two. As aforementioned, the reason for this can be about the students' approach in AU during COVID-19 pandemic, which is not producing physical models constantly during the design process.

The tested hypotheses demonstrate that the correlation of technology-oriented and handcraft skills in ADC differs during online education. It can be said that the communication capabilities of students in UPV in means of technological use and representational tools are more developed than students in AU. One of the reasons for this can be the educational background of students as aforementioned in case study section. In last two years of high school, the students are able to choose technical drawing and history of art courses due to their future preferences in Spain. In Turkey, there is not an elective course system depending on the branch for skill and knowledge development.

This study has been developed within a concise framework of variables related to ADC, aiming to catalog its components and visualize the varied interactions. Therefore, the conclusions aroused here are valid for the surveys carried out in the two universities. However, they attend to a first introspection within premeditated isolation of the ADC concerning broader contexts. In this sense, the comparisons between both institutions will be the object of future stages of the investigation that will aspire to integrate questions related to the different background education of students. The cultural environment that underlies architectural training in Turkey and Spain is different. Since the basic process of spatial development is not independent of cultural factors (Malec, 2018), those conditions are indeed being embedded in design communication. Determining how the reference models provided in the design studio intervene, how they are interpreted from one's own cultural identity, and how they affect the ADC in general, or the interaction of its components, in particular, are future goals to be addressed.

Consequently, ADC components and their relationship during online education, which have been examined through two cases, show that another further study can be a comparison of before and after the COVID-19 pandemic to enlighten the changing behavior of the students in terms of ADC.

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