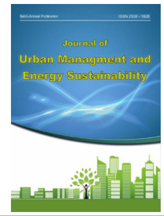
Int. J. Urban Manage Energy Sustainability, 6(2): 159-171, 2025

International Journal of Urban Management and Energy Sustainability (JUMES)

Homepage: http://www.ijumes.com



ORIGINAL RESEARCH PAPER

Explaining the model of key indexes affecting the psychological interactions between the designer and the user, with an approach based on sensory and visual perception of virtual space in architecture

Ali Modaberian[1], Sahar Toofan[2*], Nima Valizadeh[3]

1 Ph.D. Candidate, Department of Architecture, Faculty of Art and Architecture, Tabriz Branch, Islamic Azad University, Tabriz, Iran
2 Associate Professor, Department of Architecture, Faculty of Art and Architecture, Tabriz Branch, Islamic Azad University, Tabriz, Iran
3 Assistant Professor, Department of Architecture, Faculty of Art and Architecture, Tabriz Branch, Islamic Azad University, Tabriz, Iran

ARTICLE INFO

Article History:
Received 2025-05-02
Revised 2025-08-18
Accepted 2025-08-24

Keywords:
Cyberspace, architecture, technology, sensory and visual perception, designer-user interaction

DOI: 10.22034/ijumes.2025.2068123.1320

ABSTRACT

Cyberspace, as a new platform in the field of architecture, has provided the possibility of space creation, design, and evaluation of architectural projects in a digital platform. In this regard, one of the most important issues is creating a suitable platform for interaction between the user and the designer with a perceptual approach. This research is analytical-descriptive and applied in purpose, and the method of data collection is library and documentary. First, the initial concepts were examined using the content analysis method to examine the cause-and-effect relationships forming concepts, and then, the application of cyberspace technology in architecture as a learning environment was examined and the initial model was presented based on the initial effective factors. Finally, using the fuzzy Delphi method and using an elite panel of 15 people, in 4 rounds, using the Google Pot tool, the questionnaire was sent and its feedback was examined with regard to changes in accuracy and Kendall coefficient at each stage, and finally the final indicators were presented. The findings indicate that the design quality, user-designer interaction, and user interface indicators with average scores of 4.72, 4.52, and 4.51, respectively, have the highest scores and, consequently, the greatest impact on the realization of the mechanism model extraction. Consequently, this research presents a comprehensive picture of the type of impact of the concepts and components of psychological interactions and the impact of technology in cyberspace in architecture with a perceptual approach resulting in explaining appropriate infrastructure and creating a technology platform in academic environments. In studies, the relationships between the presented indicators can be examined and each case can be evaluated in case studies and the results can be generalized.

Running Title: The psychological interactions between the designer and the user, with an approach based on sensory and visual perception

NUMBER OF REFERENCES 27

NUMBER OF FIGURES 00

NUMBER OF TABLES 05

*Corresponding Author:
Email: *sahar.toofan@iaut.ac.ir*
Phone: +984133318681
ORCID: https://orcid.org/0000-0002-1298-513X

INTRODUCTION

In the present time and due to technology, the role of new technologies in shaping architectural spaces and user experiences has become increasingly important. Cyberspace, as a new platform in the field of architecture, has provided the possibility of space creation, design, and evaluation of architectural projects in a digital context. This field has not only led to changes in the design and implementation process, but also has a profound impact on users' understanding and perception of virtual environments. Therefore, a deep understanding of the psychological interaction between the designer and the user in these spaces is essential in order to improve the quality of the living experience (Anderson, 2023, Zitzler et al., 2003). In this context, sensory and visual perception are two key components in the formation of users' experience in virtual space. Sensory and visual processes play an important role in understanding virtual environments and can affect the level of satisfaction, participation, and interaction of users. In this regard, understanding the factors affecting these psychological relationships requires careful study and modeling in order to achieve better design and greater satisfaction (Alavi, & Leidner, 2005, Chi et al., 2020). Several studies have emphasized the importance of sensory and image-related indicators in virtual environments. These indicators include factors such as visual quality, sensory compatibility, and interaction design, each of which can affect the user's perception and psychological reactions. Understanding these indicators and their relationship to psychological interactions requires the development of conceptual models and detailed assessments (Azad, 2018, Ishibuchi et al., 2015). In recent studies, focusing on multimedia and multi-sensory paradigms in virtual space design has contributed significantly to improving the user experience. The use of modern technologies, such as virtual reality and augmented reality, provides the opportunity to create richer sensory and visual experiences. These technologies play a fundamental role not only in the representation of architectural spaces but also in the better understanding of these spaces by users (Baker & Siemens, 2024, Iqbal et al., 2020). Unlike traditional approaches, in this study, the emphasis is on indicators affecting the psychological interaction between the designer and the user, based on sensory and visual perception. The goal of this research is to identify and explain these indicators, and to present a comprehensive and practical model that can improve the design and evaluation process in the virtual space of architecture. Thus, future designs should be receptive to psychological and sensory factors to create more meaningful experiences.

Specifically, the development of such models can play an important role in improving the quality of psychological communication in digital platforms. This not only leads to improved user satisfaction and participation, but also makes the design and evaluation processes in virtual architecture more complex and efficient. Therefore, research in this area can help create human-centered design experiences and new standards in the architectural virtual space. Given the increasing importance of virtual space in the field of architecture and design, an effective understanding of psychological and perceptual indicators is the key to success in the development and optimization of these spaces. The development of a comprehensive and multidimensional model that affects psychological interaction can play a guiding and reference role in the design and evaluation of virtual architectural projects in the future. This path promises to create more humane virtual spaces that are more responsive to the needs of users. In the current situation of Iran, the use of technology in the field of virtual space and architectural education is developing and expanding, but it still has low momentum and requires special attention and appropriate infrastructure. Faculties of architecture, as institutions of knowledge production and educational processes, are trying to expand the process of education and design in a virtual context by utilizing new technologies such as virtual reality, 3D design, and interactive systems. However, this effort in the field of technology is generally not structured due to numerous problems, and except for a few institutions, there are practically no centers for platform development. However, the full and practical development of these technologies at the national level requires investment in hardware infrastructure, training of specialized personnel, and increased international cooperation. Unlike advanced countries, limitations in technological infrastructure and the lack of coherent operational policies have prevented the full exploitation of new technologies in the field of architecture and virtual space. Therefore, strengthening scientific and practical approaches in the field of virtual technologies will play an important role in improving the quality of education, design, and user experience in the field of architecture, which will lead to strengthening the psychological interaction between the designer and the user, and ultimately improving the quality of designed spaces. Clearly, explaining the application model for this issue is of great importance.

MATERIALS AND METHODS

In explaining the theoretical foundations of this research, we must first address the concept of virtual space in the field of architecture, because this space, as a digital and virtual environment, provides numerous possibilities for design, evaluation, and user interaction. Virtual space in the field of architecture includes tools such as 3D modeling, virtual reality, and augmented reality that allow architects to examine their designs in interactive environments without the need for physical presence (Durlach & Slamecka, 2000). In addition to facilitating the design process, these technologies provide users with a better understanding and sensory and visual perception of architectural environments, which is an important factor in creating positive and effective experiences (Freeman, 2014). At a theoretical level, sensory and visual perception are key elements in the user experience in virtual space. Sensory perception refers to an individual's physiological and psychological reactions to the surrounding environment, which is an important factor in creating a sense of presence and realism in virtual spaces (Gagné, 1985, Farhang-Mehr et al., 2004). In contrast, visual perception, which focuses on the reception and interpretation of visual information, plays a fundamental role in the transmission of spatial information and environmental design and affects user satisfaction and interaction (Garrison & Anderson, 2003). The concept of psychological interaction in cyberspace depends on the psychological relationships between the user and the design and includes factors such as a sense of presence, trust, and satisfaction. These interactions play a mediating role in the formation of a positive psychological experience and can affect the level of user participation and utilization of cyberspace (Hakkarainen, 2013, Cortellessa et al., 2023). Therefore, understanding the indicators affecting this interaction is of great importance in improving design and evaluation processes. In addition to psychological foundations, new technologies such as virtual reality and augmented reality play an important role in creating richer and multisensory experiences. These technologies provide features such as spatial simulation, interactive interaction, and sensory synergy that can greatly enhance the user's sensory and visual perception (Alberto, 2018). As a result, the aforementioned technologies in architecture not only enable the viewing and evaluation of preliminary designs, but also play a fundamental role in strengthening the emotional and psychological relationship between users and virtual environments. In the field of design, indicators such as visual quality, sensory compatibility, and interactive design are recognized as key factors in improving user perception and satisfaction (Jonassen et al., 2018). These indicators, based on the power of visual appeal, ease of interaction, and perceptual compatibility, can increase the effectiveness of virtual spaces in conveying architectural concepts. As a result, paying attention to these indicators in the design and evaluation process can lead to a human-centered process based on psychological needs (Küller, 2002). Also, the design of virtual spaces in architecture should focus on educational principles and the development of perceptual and sensory skills. Accordingly, virtual environments should provide facilities for interactive training, practicing different sensors, and promoting visual perception to improve the architectural learning process (Laurillard, 2023). This approach, especially in architecture education courses, helps students and users to better analyze and evaluate built environments. In the meantime, the role of interaction and user interface design in virtual space becomes multifold important. The user interface, as an intermediary between the user and the virtual space, should be designed in a way that is easy to understand and interact with, while at the same time creating a sense of satisfaction and trust in the user (Merrill, 2022 and Bavota et al., 2014). Accordingly, qualitative and quantitative assessments of these indicators can lead to the production of user-friendly virtual spaces and provide more accurate feedback in the design and development process of these spaces. Also, paying attention to user experiences and observing human design principles in these interfaces strengthens the psychological and perceptual connection between the user and the space and helps improve the quality of interaction (Mishra & Koehler, 2023). These interventions ultimately lead to increased user satisfaction, trust, and willingness to actively participate in architectural virtual spaces.

Another important issue in this area is the connection between new technologies and the development of architectural education. Virtual education, by utilizing virtual and augmented reality technologies, can improve the learning process of visual, spatial, and sensory skills in an interactive and sequential manner (Moore et al., 2011). In fact, these technologies are effective tools for simulating complex designs and transferring sensory perceptions in digital formats, which can play an important role in the education and training of architectural graduates. In addition to these topics, the development of indicators related to the compatibility and adaptation of design elements plays a vital role in creating an integrated and smooth perception in virtual spaces. Compatibility in design includes the compatibility of visual, sensory, and interactive elements, which can improve the level of space coordination and affect the level of user satisfaction and credibility (Shneiderman & Plaisant, 2020). Measuring and evaluating these indicators, through quantitative and qualitative methods, can be a good basis for continuous modification and improvement of designs in virtual spaces. On the other hand, the importance of developing evaluation models based on psychological and sensory indicators lies in better understanding the psychological interactions between the user and architectural virtual spaces. These models are analytical tools and decision-making systems suitable for analyzing data and explaining relationships and can be exploited in design and evaluation projects (Prince, 2004). The use of these models leads to the production of more human and user-centered virtual spaces that are designed in accordance with the psychological needs of users.

Finally, advances in technology and the development of new knowledge in the field of sensory and visual perception provide an opportunity to adopt new approaches in the design and evaluation of virtual spaces. These advances provide the possibility of improving psychological interaction, satisfaction and trust of users and can lead to the development of new standards and best design practices in virtual architecture (Reigeluth, 2015). Therefore, the development and explanation of comprehensive and practical models in this area can ultimately be an effective solution for improving the quality of architectural virtual spaces and enhancing user experiences. Accordingly, the theoretical framework of thematic studies in the field of the mechanism of psychological interactions between the designer and the user in the sensory and visual perception of virtual space in architecture can be presented as follows, which specifically about 19 factors can be extracted. (Tab. 1)

Table 1: theoretical framework to Developing the final indicators of the model of psychological interactions between the designer and the user in the sensory and visual perception of virtual space in architecture

No.	Domain of the Factor	Related Components	Theorists	Key References	Year(s)	Description / Notes	Main Factor (Original)
1	User–Designer Interaction	User interaction, design interaction with the user	Norman, PUI	"The Design of Everyday Things", Virtual Interaction Articles	1988 and 2000	Importance of effective negotiation between users and designers in the virtual space	User–Designer Interaction
2	Virtual Learning Environment	Learning environment, educational environment, virtual environment	Vygotsky, Luria	"Teaching and Learning in Virtual Environments"	1977 and 2012	The role of the environment in facilitating learning processes and interaction	Virtual Learning Environment
3	Architectural Design & Virtual Structure	Architectural design, educational structure, organizational structure	Le Corbusier, Allen	"Five Architectural Elements", "A Language of Pattern"	1999 and 2014	The impact of architecture and structure on interaction and user satisfaction	Architectural Design
4	Virtual Space Technologies	Virtual reality, AR, imaging technologies, smart tech	Norman, Sherman	"Interaction in Virtual Spaces", "Designing Virtual Reality"	1990 and 2012	Role of advanced technologies in improving user experience	Virtual Technology
5	User Interface	UI design, usability, visual appeal	Norman, Hassenzahl	"The Design of Everyday Things", 2008	2008 and 2011	Importance of UI design for effective interaction	User Interface
6	Sense of Presence & Spatial Engagement	Sense of presence, sense of being in space, realism	Kevin Lynch, Mokhitaryan	"Psychology of Space", "Presence and Virtual Reality"	1998 and 2013	Effective sense of presence in virtual space	Sense of Presence
7	Educational Participation	Participation in the learning process, multi-user collaboration	Takeman? (Takken) Vygotsky	"Group Dynamics", "Team Development"	2012 and 1988	Importance of active participation in virtual learning	Educational Participation
8	Simulation Process	Spatial simulation, virtual display, animation	Sherman, Finer	"Interaction in Virtual Spaces"	2004 and 2005	Role of simulation in better understanding architectural spaces	Simulation
9	Design Quality & Ergonomics	Ease of use, ergonomics, aesthetic quality	Alto, Norman	"Comfortable Architecture", "Aesthetics"	2018 and 2005	Impact of comfort and design quality on interaction	Design Quality
10	Adaptation & Conformity	Format adaptability, alignment with cultural/psychological needs	Hofstede, Hall	"Silent Language", "Cultural Communications"	1980 and 1970	Importance of adapting technology and design to user needs	Adaptation & Conformity
11	Structure & Organization	Information structure, hierarchy, user-friendly organization	Allen Renl? (Allen&Rl?)	"A Pattern Language", "Elements of User Experience"	1992 and 1978	Proper structure in virtual space design	Structure
12	Structural Sustainability & Integrity	Structural sustainability, durability, security	Le Corbusier, Pêche-Ren? (Pezogerin)	"Five Architectural Elements", "Structured Design"	2005 and 1995	Sustainability and security of virtual spaces	Sustainability

No.	Domain of the Factor	Related Components	Theorists	Key References	Year(s)	Description / Notes	Main Factor (Original)
13	Color, Light & Form	Color psychology, lighting, effective forms	Birn, Ching	"Color Psychology", "Space Design"	2015 and 2005	Impact of visual elements on feeling and perception	Color & Light
14	Mult-user Communications	Group chat, messaging, team collaboration	McLuhan, Takman	"Medium & Culture", "Group Dynamics"	1987 and 1990	Role of communications in boosting collaboration and interaction	Multi-user Communications
15	Educational Principles & Rules	Educational standards, teaching principles in virtual space	Schmiet, Luridar (Luridar)	"Educational Standards", "Digital Learning Principles"	2000 and 2015	Adherence to principles in virtual education design	Educational Principles
16	Learning Support Tools	Learning management systems (LMS), interactive software, authoring environments	Luridar, Siemens	"Education in the Digital Era", "Digital Learning Games"	2015 and 2018	Role of modern technologies in supporting and enhancing learning processes	Learning Support Tools
17	Learning Technologies	Learning tools, virtual training, LMS	Luridar, Siemens	"Education in the Digital Era", "Digital Learning Games"	2018 and 2019	Role of supportive technologies in strengthening learning and interaction	Learning Technologies
18	Design Quality & UI	Visual design, attractiveness, simplicity, clarity	Norman, Hassenzahl	"The Design of Everyday Things", "User Experience"	1998 and 1995	Importance of design quality in user experience	Design Quality
19	Security, Trust & Privacy	Security protocols, trust-building, privacy	Hofstede, McLuhan	"Silent Language", "Media & Culture"	1996 and 2000	Impact of perceived security on effective interaction and user satisfaction	Security & Trust

Methodology

This research is of an analytical-descriptive type and has an applied purpose. It can also be emphasized that the research is also developmental in nature. The method of data collection is library and documentary. First, the basic concepts were examined and, using the content analysis method, the causal relationships forming concepts such as psychological interactions and user-designer interaction in the sensory and visual perception approach in the context of cyberspace were pointed out. Next, the application of cyberspace technology in architecture as a learning environment was examined and the initial model was presented based on the initial effective factors. Next, according to the formed models, the final factor model on this issue was extracted globally and locally from the review of the research background and the collection of researchers' opinions and was finally examined in the fuzzy Delphi method. In the Delphi method, using elites and experts in the fields of architecture, energy, etc., approximately 15 people, in 4 rounds, using the Google Pot tool, the questionnaire is sent and its feedback is reviewed according to the changes in accuracy and Kendall coefficient at each stage, and finally the final indicators are presented. As a result, the proposed index model is presented as a model of psychological interactions between the designer and the user in the sensory and visual perception of virtual space in architecture.

DISCUSSION AND FINDINGS

Application of the Delphi method

The most important task in the Delphi method is to select experts and specialists in the field in question. In this way, the selected individuals are given information about the Delphi method and invited to participate in this research. Anonymity is an important component of this research approach, and questions from the selected experts and specialists are followed up by successive and consecutive questionnaires. In this research, first, the initial model is developed based on theoretical foundations and the use of existing models regarding concepts, especially psychological interactions between the designer and the user, as well as influential factors in the field of sensory and visual perception in the virtual space of architecture with an educational approach. After the initial design, this model was tested and developed through the Delphi method. The use of open questions in the Delphi questionnaire and their analysis in the subsequent stages was a judgment about reaching a consensus among experts and reaching theoretical saturation of the qualitative methods used in analyzing the data obtained in the present study. Field data collection in the present study began with the collection of questionnaires in the first stage of the research, and the extracted data were analyzed through descriptive statistics and qualitative analysis. The questions submitted were compiled based on the following questionnaire, which was sent digitally to the elites using the Google Pot tool.

Findings of the Delphi Method

In this study, the physical and visual perceptual dimensions in the field of architectural virtual space and the components of psychological interactions were used as assumptions in the first stage extracted from the theoretical foundations for the subject, and then the component dimensions and main criteria were presented according to the research hypothesis. These sub-components are based on the assumption of the experts' awareness dimension and the perceptual process, taking into account the architectural virtual space context and the educational-oriented structure in it. These factors were set up as a proposed package in the panel of experts and elites so that the Delphi method could be planned and applied to it. A total of 19 factors that were tested in this method to reach the final indicators include: user-designer interaction factor, learning environment, architectural design, virtual technologies, user interface, sense of presence, educational participation, simulation, design quality, compatibility, structure, sustainability, color and light, multi-user communication, educational principles, learning support tools, learning technologies, design quality, and security and trust.

Findings of the Delphi Method

First Round

In this round, the panel members identified 16 factors out of 19 factors extracted from successful research as having a medium, high, and very high impact on the development of the framework for developing the final indicators of the model of psychological interactions between the designer and the user in the sensory and visual perception of virtual space in architecture. The detailed results related to the implementation of the first stage of questionnaire distribution are given in the table below. The factors of sustainability, color and light, and security and trust were eliminated from the Delphi process due to their average importance of less than 2.5. (Tab. 2)

Second round

After the first stage of measuring and evaluating the panel experts' views on the factors proposed and extracted from the theoretical foundations and also receiving the suggestions of the panel members, in this round, in order to be cautious, all the factors extracted from the theoretical foundations, along with the average of the members' opinions in the first round and the previous opinion of the same member, were again made available to all the panel experts. The panel members identified 12 factors out of the 16 factors presented in the second round

Table 2: The first stage of the fuzzy method in developing the final indicators. Developing the final indicators of the model of psychological interactions between the designer and the user in the sensory and visual perception of virtual space in architecture

Row	Factor	Sample Size	Mean	Std. Deviation	Min	Max
1	User–Designer Interaction	15	38.4	0.52	1	5
2	Virtual Learning Environment	15	85.3	0.63	1	5
3	Architectural Design	15	11.4	0.45	1	5
4	Virtual Technologies	15	4.5	0.76	1	5
5	User Interface	15	32.4	0.51	1	5
6	Sense of Presence	15	1.98	0.34	1	5
7	Educational Participation	15	3.72	0.38	1	5
8	Simulation	15	3.90	0.45	1	5
9	Design Quality	15	4.58	0.65	1	5
10	Adaptation & Conformity	15	3.85	0.48	1	5
11	Structure	15	3.23	0.53	1	5
12	Multi-user Communications	15	3.95	0.71	1	5
13	Educational Principles	15	4.25	0.46	1	5
14	Learning Support Tools	15	3.45	0.35	1	5
15	Learning Technologies	15	4.44	0.54	1	5
16	Design Quality	15	4	0.34	1	5

as having a high and very high impact (with an average greater than 3.5) on the research framework. The detailed and extensive results related to the implementation of the second stage of questionnaire distribution are given in the table below. The Kendall coordination coefficient for the members' responses regarding the order of the 12 factors that had a high and very high impact in this round was 0.765. (Tab. 3)

Third round

In the third round of developing the research framework, the final indicators, along with the average of the members' opinions in the second round and the previous opinion of the same member, were made available to all panel experts. The detailed and extensive results related to the implementation of the third stage of questionnaire distribution are given in the table below. In this stage, all factors were recorded as having a very high impact by the elite panel with an average score above 4, and the Kendall coordination coefficient for the members' responses regarding the order of the 12 factors was obtained as 0.790. (Tab. 4)

Reasons for stopping the survey

The results of the four rounds of implementing the Delphi method in the research show that consensus was reached among the panel members for the following reasons and the rounds can be ended:

- In the second round, more than 50% of the members selected 19 factors that were effective in developing the final indicators of the model of psychological interactions between the designer and the user in the sensory and visual perception of virtual space in architecture, which had an average greater than 2.5, among their factors.
- The standard deviation of the members' responses regarding the importance of the factors in the third round has changed significantly compared to the previous rounds.
- The standard deviation of the members' responses regarding the importance of the factors in the fourth round has changed significantly compared to the previous rounds.

Table 3: Second stage of the fuzzy method in developing the final indicators. Developing the final indicators of the model of psychological interactions between the designer and the user in the sensory and visual perception of virtual space in architecture

Row	Factor	Sample Size	Mean	Std. Deviation	Min	Max
1	User–Designer Interaction	15	48.4	0.45	2	5
2	Virtual Learning Environment	15	95.3	0.55	2	5
3	Architectural Design	15	19.4	0.32	2	5
4	Virtual Technologies	15	15.4	0.52	2	5
5	User Interface	15	44.4	0.42	2	5
6	Educational Participation	15	85.3	0.35	2	5
7	Simulation	15	95.3	0.37	2	5
8	Design Quality	15	65.4	0.55	2	5
9	Adaptation & Conformity	15	92.3	0.38	2	5
10	Multi-user Communications	15	2.4	0.56	2	5
11	Educational Principles	15	29.4	0.36	2	5
12	Learning Technologies	15	56.4	0.54	2	5

Table 4: The third stage of the fuzzy method in developing the final indicators. Developing the final indicators of the model of psychological interactions between the designer and the user in the sensory and visual perception of virtual space in architecture

Row	Factor	Sample Size	Mean	Std. Deviation	Min	Max
1	User–Designer Interaction	15	52.4	0.40	3	5
2	Virtual Learning Environment	15	5.4	0.42	3	5
3	Architectural Design	15	25.4	0.28	3	5
4	Virtual Technologies	15	21.4	0.45	3	5
5	User Interface	15	51.4	0.35	3	5
6	Educational Participation	15	92.3	0.31	3	5
7	Simulation	15	2.4	0.27	3	5
8	Design Quality	15	72.4	0.41	3	5
9	Adaptation & Conformity	15	3.4	0.32	3	5
10	Multi-user Communications	15	1.54	0.47	3	5
11	Educational Principles	15	3.54	0.29	3	5
12	Learning Technologies	15	6.24	0.32	3	5

- The Kendall coefficient of agreement for the members' responses regarding the order of the factors in the third round is 0.790. Considering that the number of panel members was more than 10, this level of the Kendall coefficient is considered to be completely significant.
- Kendall's coefficient of agreement for the order of the 12 factors influencing the development of the research framework in the third round increased by only 0.025 compared to the second round, which does not show a significant increase in this coefficient or the level of consensus among the panel members between two consecutive rounds.
- The scores given to the factors by experts and elites indicate that the design quality indicators, user-designer interaction, and user interface have the highest scores and, as a result, the greatest impact on the realization of the mechanism model extraction.

RESULT AND CONCLUSION

In conclusion, the final table of indicators for developing a model of psychological interactions between the designer and the user in the sensory and visual perception of virtual space in architecture can be explained in the following table: (Tab. 5)

This table represents an attempt to gain a deep and comprehensive understanding of the key indicators in the model of psychological interactions between the designer and the user in the architectural virtual space. Each indicator is categorized based on its type, i.e., qualitative or quantitative, in order to perform a correct and appropriate analysis. Indicators such as user-designer interaction and educational participation are more qualitative and are assessed through methods such as interviews, questionnaires and observations. This approach allows the level of satisfaction, participation and active interaction of users with the creators and designed environments in the virtual space to be accurately measured and analyzed. In contrast, indicators such as learning environment, simulation, compatibility and multi-user communication are also considered quantitative, focusing more on the number, rate and extent of interactions and compatibility. These indicators provide a suitable tool for quantitatively assessing the effectiveness of architectural virtual spaces by analyzing quantitative data and counting samples. Using both methods together allow the researcher to obtain a more complete picture of the current situation and the strengths and weaknesses of the systems designed in cyberspace. Another case is indicators such as architectural design, design quality, educational principles and learning technologies, which are more qualitative and are measured through visual evaluation, expert judgment and qualitative surveys. These indicators are of great importance in evaluating aesthetics, creativity and compliance with educational standards and play an important role in improving the level of design and user satisfaction. This qualitative approach is of great value, especially in areas such as architecture and design, because it indicates the quality and creative thinking in the content production and design process.

Also, the evaluation unit in this model includes tools such as questionnaires, interviews, observation, image analysis and expert judgment, each of which is designed to collect accurate and reliable data. These methods help the researcher to examine different aspects of the research questions and ensure the validity and soundness of the hypotheses. In fact, evaluation methods are an important bridge between raw data and scientific analysis that help to accurately interpret the results and form the basis for strategic and practical decisions. Finally, the important point in this table is the simultaneous attention to quantitative and qualitative factors, each of which plays a complementary role and a comprehensive picture of the psychological interactions and impact of technology in cyberspace is built. This combined perspective enables the researcher to evaluate both quantitatively and quantitatively measurable trends and to monitor qualitative aspects such as aesthetic verification, creativity and user satisfaction. This multifaceted approach, ultimately, helps to develop balanced, practical and implementable models in modern spatial design.

REFERENCES

Alavi, M., & Leidner, D. (2005). Research Commentary: Technology-Mediated Learning—A Call for Greater Depth and Breadth. Information Systems Research.

Alberto, S. (2018). Exploring the factors influencing the sustainability of e-learning systems. Journal of Educational Technology.

Ali Farhang-Mehr and Shapour Azarm. 2004. An Information-Theoretic Entropy Metric for Assessing Multi-Objective Optimization Solution Set Quality. Journal of Mechanical Design 125, 4 (01 2004), 655–663. https://doi.org/10.1115/1. 1623186

Anderson, T. (2023). Designing Networked Learning Environments. Springer.

Table 5: The final key indexes in the model of psychological interactions between the designer and the user in the architectural virtual space

Factor	Indicator Element	Description	Measure	Evaluation Type	Evaluation Method
User–Designer Interaction	Level of participation and interaction	Evaluation of active user interaction with the designer in the virtual architectural space	Level of interaction and user satisfaction	Qualitative	Observation, Survey; Interview, Questionnaire
Learning Environment	Dynamism and accessibility	Effectiveness of the virtual environment in teaching and learning architecture	Level of accessibility and ease of use	Qualitative evaluation, Survey	Questionnaire, Observation
Architectural Design	Creativity, coherence, and efficiency	Evaluation of aesthetics and efficiency of architectural design in the virtual space	Design score, User satisfaction	Visual analysis, Survey	Expert review, Interview
Virtual Technologies	Variety and efficiency of technologies	Use and adaptation of virtual technologies in architecture and their impact on perception	Number of technologies used	Technology performance analysis	Data analysis, Interview
User Interface	User-friendliness and ease of use	Evaluation of UI design based on user experience	User experience score	Survey, Usability tests	Questionnaire, Usability testing
Educational Participation	Number of active users	Level of participation of users in educational processes in the virtual space	Number of activities performed	Counting, Data analysis	Data recording, Questionnaire
Simulation	Realism and accuracy	Degree of similarity of simulations to real-world samples in the virtual space	Level of similarity and accuracy	Visual assessment, Case study	Observation, Visual analysis
Design Quality	Coherence, creativity, aesthetics	Overall quality evaluation of architectural design in the virtual space	Qualitative design ranking	Survey, Expert judgment	Interview, Questionnaire
Adaptation	Quantity and type of adaptations	Extent of conformity and harmony of design elements with user needs	Number of adaptations	Conformity checking, Data analysis	Interview, Conformity analysis
Mult-user Communications	Number and type of interactions	Extent and type of communications among multiple users in the virtual architectural space	Number and type of interactions	Interaction data analysis	Interaction analysis, Questionnaire
Educational Principles	Adherence to educational standards	Evaluation of design compliance with learnability and instructional principles	Score of principle adherence	Qualitative evaluation, Survey	Interview, Survey
Learning Technologies	Variety, efficiency, and compatibility	Use and adaptation of modern technologies in the learning process in the virtual space	Number of technologies used and their effectiveness	Technology performance analysis	Data analysis, Questionnaire

Azad, N. (2018). The Role of Simulation-Based Learning in Enhancing Technical Skills. Educational Technology & Society.

Baker, R. S., & Siemens, G. (2024). Educational Data Mining and Learning Analytics. In Learning Analytics (pp. 3-16). Springer.

Chi Li, Shu Wang, Henry Hoffmann, and Shan Lu. (2020). Statically inferring performance properties of software configurations. In EuroSys '20: Fifteenth EuroSys Conference 2020, Heraklion, Greece, April 27-30, 2020, Angelos Bilas, Kostas Magoutis, Evangelos P. Markatos, Dejan Kostic, and Margo I. Seltzer (Eds.). ACM, Heraklion, Greece, 10:1–10:16. https://doi.org/10.1145/3342195.3387520

Durlach, N. I., & Slamecka, N. (2000). Technology and the illusion of presence: The influence of immersive environments. Journal of Educational Technology.

E. Zitzler, L. Thiele, M. Laumanns, C.M. Fonseca, and V.G. da Fonseca. (2003). Performance assessment of multi-objective optimizers: an analysis and review. IEEE Transactions on Evolutionary Computation 7, 2 (Apr 2003), 117–132. https // doi.org/10.1109/TEVC.2003.810758

Freeman, S. (2014). Active learning increases student performance in science, engineering, and mathematics. Proceedings of the National Academy of Sciences.

Gabriele Bavota, Massimiliano Di Penta, and Rocco Oliveto. 2014. Search Based Software Maintenance: Methods and Tools. In Evolving Software Systems, Tom Mens, Alexander Serebrenik, and Anthony Cleve (Eds.). Springer, 103–137. https://doi.org/10.1007/978-3-642-45398-4_4

Gagné, R. M. (1985). The Conditions of Learning and Theory of Instruction. Holt, Rinehart & Winston.

García, M., & Blanco, P. (2023). Ensuring Compatibility in E-Learning Platforms. Journal of Educational Technology.

Garrison, D. R., & Anderson, T. (2003). E-Learning in the 21st Century: A Framework for Research and Practice. Routledge.

Hakkarainen, K. (2013). The Changing Role of Learning Tools. Interactive Learning Environments.

Hisao Ishibuchi, Hiroyuki Masuda, Yuki Tanigaki, and Yusuke Nojima. (2015). Modified Distance Calculation in Generational Distance and Inverted Generational Distance. In Evolutionary Multi-Criterion Optimization (Lecture Notes in Computer Science, Vol. 9019), António Gaspar-Cunha, Carlos Henggeler Antunes, and Carlos Coello Coello (Eds.). Springer International Publishing, Cham, 110–125. https://doi.org/10.1007/978-3-319-15892-1_8

Jonassen, D., Peck, S., & Wilson, B. (2018). Learning with Technology: A Constructivist Perspective. Merrill.

Küller, R. (2002). The Impact of Light and Color on Psychological Well-Being. Lighting Research & Technology.

Laurillard, D. (2023). Rethinking University Teaching: A Conversational Framework for the Effective Use of Learning Technologies. Routledge.

Md Shahriar Iqbal, Jianhai Su, Lars Kotthoff, and Pooyan Jamshidi. 2020. FlexiBO: Cost-Aware Multi-Objective Optimization of Deep Neural Networks. CoRR abs/2001.06588 (2020), 1–37. arXiv:2001.06588 https://arxiv.org/abs/2001.06588

Merrill, M. D. (2022). First Principles of Instruction. Educational Technology Research and Development.

Mishra, P., & Koehler, M. J. (2023). Technological Pedagogical Content Knowledge: A Framework for Teacher Knowledge. Teachers College Record.

Moore, M. G., & Kearsley, G. (2011). Distance Education: A Systems View of Online Learning. Cengage Learning.

Prince, M. (2004). Does active learning work? A review of the research. Journal of Engineering Education.

Reigeluth, C. M. (2015). Instructional-design theories and models: An overview of their current status. Routledge.

Shneiderman, B., & Plaisant, C. (2020). Designing the User Interface: Strategies for Effective Human-Computer Interaction. Pearson.

Vittorio Cortellessa, J. Andres Diaz-Pace, Daniele Di Pompeo, and Michele Tucci. 2023. Towards Assessing Spread in Sets of Software Architecture Designs. In Software Architecture - 17th European Conference, ECSA 2023, Istanbul, Turkey, September 18-22, 2023, Proceedings (Lecture Notes in Computer Science, Vol. 14212). Springer, 133–140. https: //doi.org/10.1007/978-3-031-42592-9_9

HOW TO CITE THIS ARTICLE
Modaberian, A. , Toofan, S. and Valizadeh, N. (2025). Explaining the model of key indexes affecting the psychological interactions between the designer and the user, with an approach based on sensory and visual perception of virtual space in architecture. (e728614). International Journal of Urban Management and Energy Sustainability, ( ), e728614
DOI: 10.22034/ijumes.2025.2068123.1320