A Comparative Study on the VR Experience of Students in a Digital Documentary Game

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Abstract— VR technologies, which are used in many fields today, have also started to be used in education through the game platforms with the realistic and interactive environments they provide. The 'Following the Traces of Sedad Hakkı Eldem in Istanbul project, developed within the scope of a scientific project jointly carried out by the Architecture and Digital Game Design Departments at the host university, is an architecture-themed documentary game designed for educational purposes. Within the game's scope, three different projects of architect Sedad Hakkı Eldem, whose name is frequently mentioned in the history of the Early Republic period and in the modernization processes, were selected. The game's scenario was developed to perceive these architectural spaces by experience. However, this experience may vary according to the different department users due to their focal points and educational structures. According to this, this study conducted a research with the students at the host university to see how this documentary game was perceived and evaluated by students from two different departments. In order to conduct a comparative research, a questionnaire was directed to the students after their game experience. Especially the results of the third part proved the differences in the students' perceptions of different departments. On the other hand, although students from these two departments revealed some differences in their focus and approach to evaluating the game, the results also showed that the game provided an overall beneficial educational experience.

Keywords— Virtual Reality, Digital Game, Documentary, Education, Sedad Hakkı Eldem

I. INTRODUCTION

With the development of technology, there has been an increase in the variety and usage of digital tools in recent years. Undoubtedly, Virtual Reality (VR) is one of the digital technologies that came to the fore in this period. Virtual Reality (VR) can be characterized as a meta-medium, like the Internet, encompassing various media, technologies, and processes that facilitate communication, content sharing, and information exchange among individuals. [1]. In this context, it can be characterized as a multifunctional digital tool. In many domains, the benefits of VR stem from the ability to create recognizable, three-dimensional facsimiles of real objects in space [2]. VR technologies, defined as 'virtual reality,' create scenes, objects, and virtual spaces where people can interact through computer simulations. Thus, they involve users in the process by providing an experienceable environment.

Today, VR technologies are used in many areas through different platforms. One of the platforms where VR technologies are included is digital games. Digital games are software that is based on human interaction with an interface and played through devices such as computers, phones, and tablets. The inclusion of VR in the game process causes the game to turn into an experience and the user to become a participant. Spatial immersion in VR technology is a perception of being physically present in a non-physical world [3]. This defines an area where the components and spatiality of the game gain importance. Today, games that can be played online or offline have many different contents, such as adventure, horror, strategy, etc. In addition to these, documentary games are among the prominent digital media productions of the last period. The combination of the documentary, which has a content based on a specific data or document in its essence, with the game technologies has revealed the concept of the documentary game as a new representation method. Documentary games, which are designed differently than standard games, provide an interactive experience while also giving references to reality. These references based on various themes such as history, culture, architecture, and art also define the virtual space created in the game. "Created virtual space" refers to the playground, background, environment, and atmosphere that make up the virtual location of the game [4]. All this content is related to the theme and story of the game. In this type of game, in which the narrative comes to the fore, the content, level, and fiction of the experience differ according to the chosen themes.

Virtual reality (VR), which is widely used in many fields, draws attention as a useful technology that offers various opportunities to support teaching and learning processes in the field of education [5]. Recently, there have been many studies on the inclusion of games in education. For example, Hu-Au and Lee [6] provided examples of how the possibilities provided by virtual reality lead to new opportunities that

support learners. Martín-Gutiérrez et al. [7] briefly explained how the latest virtual technologies can be integrated into newer educational scenarios and teaching practices. Oyelere et al. [8] researched various articles to reveal the technological, pedagogical and game features of contemporary educational virtual reality games. In these studies, answers are sought to the question of how the experience that comes with the inclusion of VR technology in the game can provide a useful interface to the education sector. Undoubtedly, with technological developments, the changing structure and actors of the education sector are also crucial at this point. In particular, the attitudes and motivations of today's youth towards learning are quite different from the traditional understanding. For this group, who actively uses technology in daily life, it is imperative that the education methods be updated accordingly. Therefore, the integration of games supported with VR technologies into education offers an alternative new learning-teaching method and environment.

Developed as part of a scientific project by the Departments of Architecture and Digital Game Design at Host University, 'Following the Traces of Sedad Hakkı Eldem in Istanbul' is a documentary game based on the history of architecture. Sedad Hakkı Eldem is one of the leading architects who has been influential in Turkey's urban and architectural development within the framework of the modernization movements at the beginning of the 20th century. Eldem has an important place in the history of architecture with his unique style, which he developed by integrating the forms and elements of traditional Turkish housing into modern architecture. Therefore, the buildings he designed have the characteristics of an important cultural heritage as the representatives of the Early Republican Period architecture. The play 'Following the Traces of Sedad Hakkı Eldem in Istanbul' is based on three buildings of Sedad Hakkı. These buildings, which are significant within the cultural heritage framework, were selected from three different periods of the architect's career. In addition, in order to provide spatial diversity in the game, it is aimed that the buildings have three different functions. Accordingly, Ceylan Apartment built in 1933, Taşlık Kahvesi built in 1947, Atatürk Library built in 1973 were chosen for the game. Recently, uncontrolled interventions to urban space and buildings have resulted in the loss of quality of some buildings and the complete destruction of some buildings. The theme of the game has been developed in this direction in order to protect these structures, which are important for cultural heritage, and to transfer them to future generations.

Although they have many common subjects, Architecture and Game Design are departments that have different educational structures. Therefore, educational processes, contents, and primary concerns differ from each other. For this reason, while designing the documentary game "Following the Traces of Sedad Hakkı Eldem in Istanbul," which was developed by the joint work of the two departments, it was also emphasized how the game could be useful in educational processes. For this purpose, attention was paid to the development of the content and fiction of the game accordingly, while providing spatial competencies, and preserving the effectiveness as a game.

Accordingly, in this study, a research was conducted with the students at the host university to see how the documentary game "Following the Traces of Sedad Hakkı Eldem in Istanbul" was perceived and evaluated by students from these two different departments. In the study, which is based on comparative research, a three-part questionnaire was directed to the students after their game experience. In the first part, students were asked about their general impressions about the game, and in the second part, their guesses about the physical attributes of each building. In the last part, they were asked to evaluate each building their spatial quality, circulation quality regarding lighting quality, connections with exterior elements, visual quality, furniture and objects quality, interactive objects quality, materials, color, and texture quality, and interaction with the urban context. Especially the results of the third part reveal the differences in the perceptions of the students in different departments about the game more clearly. On the other hand, although students from these two different departments revealed some differences in their focus and approach to evaluating the game, the results also showed that game provided an overall beneficial educational experience.

II. VR Experience as an Educational Tool

Like in many aspects of life, the field of education is also evolving in response to technological advancements. With ideas such as artificial intelligence, augmented reality, and virtual reality, the demand for change in teaching techniques has risen, and alternative, technology-integrated approaches have begun to be employed alongside the traditional ways that have been used for decades. There are examples of this in today's education system, but there are still questions about whether technology and its advantages have achieved their full potential. It can be argued that the notion of Virtual Reality, which is becoming increasingly popular in many aspects of life, is also utilized in the field of education, but the research addressing these topics are not exactly proportionate to the rate at which these technologies are developing. In this section of the study, a literature review was undertaken on the educational applications of virtual reality. Nonetheless, it was determined that it would be more accurate to analyze VR within the framework of gamification.

A. Educational Games

Constantly, the terms educational games and serious games are used interchangeably. In a broad sense, these definitions encompass games that are employed not just for entertainment, but also for the purposes of imparting knowledge and instructing. Educational games may be defined as the use of game technology for the goals of learning and teaching, with the inclusion of particular subject matter and the goal of achieving the desired educational outcomes for students [9]. This learning style is the impact of constructivist learning theory, which encourages teachers to create learning environments in which students actively engage with the offered information.

It might be claimed that the ways of acquiring information must alter as technology advances. Thus, it is evident that such tactics have begun to be utilized. Act [10], who introduced the notion of serial games to the literature for the first time,

asserted that such games offer significant advantages due to risk-free active exploration. Achieving the objective, which is the primary objective of games, and rewarding the player for achieving this objective are also applicable to serious games. This circumstance is constrained by the game's rules. The characteristic that most differentiates the distinction between serious games and regular games comes into play at this stage. Whereas the primary objective of traditional games is to entertain the player, the primary objective of serious games is to educate the player. When doing so, entertainment and other considerations should be considered. There must be a balance between the user's attention, curiosity, and ability to learn. Some researchers believe that serious games not only aid in the process of learning but also increase users' knowledge of the virtual world or virtual space in which the game takes place [11]. These games may reduce anxiety and improve learning; therefore, most academics think they might be utilized as reinforcement for conventional learning [12].

According to De Freitas, game science is beginning to surpass the idea of serious games [13]. It is feasible to speak about a multidisciplinary "science" approach that begins with why and how individuals play games and attempts to understand how learning approaches might be applied. In this regard, he notes that it interacts directly with "education science." Even a prominent expert in the field of education research, such as Piaget, emphasizes the significance of play in the learning process.

B. VR in Educational Games

While some games mentioned above may be played on a computer, some can also be played in the real world. In addition to these games, it has been observed that VR-based games have begun to be utilized in the field of education. With the introduction of virtual reality in educational games, students may now study in an immersive and interactive environment, which can increase their interest in and comprehension of complicated topics. Virtual reality in educational games can give students with a more realistic and immersive learning experience. Virtual reality enables history students, for instance, to explore historical locations and events in a way that was previously inconceivable. Similarly, science students may utilize virtual reality to investigate intricate scientific topics and phenomena, such as the human body or the solar system, in an interactive and engaging manner. The use of virtual reality in educational games can also improve students' comprehension and retention of material. Virtual reality settings may provide students a multimodal experience that allows them to see, hear, and engage with the subject matter. This can aid in reinforcing the topics being taught and enhancing content memory. With educational games, virtual reality may also give pupils with a more individualized learning experience. Customizable virtual reality environments allow students to learn at their own speed and concentrate on the areas in which they require the greatest assistance. This can improve student performance and raise their interest in the subject matter.

It is feasible to discuss several research pertaining to this topic. For example, one research indicated that changing from traditional to experiential teaching was the biggest advantage of virtual reality educational games. Standard memorization makes pupils passive. Yet, experience training makes them more engaged and determined to accomplish problems autonomously and instinctively. One of the studies examined educational gaming advantages. The questionnaire found that students like the educational game's non-traditional experiential learning and chance to explore virtual reality equipment [14]. Another study's goal was to describe the creation of an educational simulation virtual reality game to educate students about the design review process. Research made a game on VR environment about finding the mistakes of the related building. It was easier for students to spot building mistakes or construction detail problems on VR rather than 2D drawings [15]. In separate research, a game has been developed so that architecture students may have a comprehensive understanding of structural elements. The objective of this game is for students to create a bridge to span a gap [16].

III. CONTENTS OF THE VR EXPERIENCE

The VR game experience in the scope of this study consists of two aspects. The first aspect is about the storyline and the context: the story of the architect, the story of the period, and the story of the place. Those are considered as issues about narration. The second aspect is about the technical quality of the game, including elements such as gameplay, navigation, and visualization.

A. Storyline

In game design, the association of the story with the quality of the place and the narrative is crucial for the success of a game. The stronger the harmony between these concepts, the higher the interest in the game. Recently, the scenarios and contents of the games have changed considerably. Previous games with mostly abstract or exaggerated scenarios have been replaced by games in which historical events and situations are represented and/or recreated [17]. The recent games' stories reference real people, places, and events and interact with the player in a more 'real' or 'familiar' world. These types of games, also called documentary games, have recently attracted attention with their connections with reality, spatial qualities, and stories designed based on lived events. With the developments in technology, the fact that the games can be experienced with VR technologies also causes these games to attract more attention. The opportunity to be involved in lived stories and to experience the place increases the interest in these games. Moreover, making the documentary into a game causes individual to exist in time and space as active participants beyond the linear narrative of the documentary. In this context, these games have been activated and started to be used in the field of education as well.

Game designers do not simply tell stories; they design worlds and sculpt spaces [18]. Especially in games where the architectural space comes to the fore, this situation draws more attention. "Following the Traces of Sedad Hakkı Eldem in Istanbul" was designed as an architecture-oriented documentary game with its content, story, and spatial qualities. In addition, it has been designed as a game open to use in the field of education in terms of modern Turkey's architectural history, cultural heritage, and preservation. Architect Sedad Hakkı Eldem, who is the subject of the play, has been one of

the most important architects in the history of the Early Republican Period. Eldem, who can be claimed to be the most influential architect of modern Turkey, has gained his reputation by leading the search for national expression in modernism [19]. The establishment of the New Turkey brought about a change in every aspect of life, leading to the development of a new understanding both in the urban space and the architectural environment. During this period, many architects used modern architecture's elements, forms, and design approaches in their buildings and contributed to the modern architecture of the new Turkey. However, Sedad Hakkı's distinctive national architectural style, which blends traditional architectural elements with modern approaches, distinguishes him from other architects. Eldem, who designed his buildings with this approach throughout his life, has become one of the most important architects in the history of the Republic of Turkey.
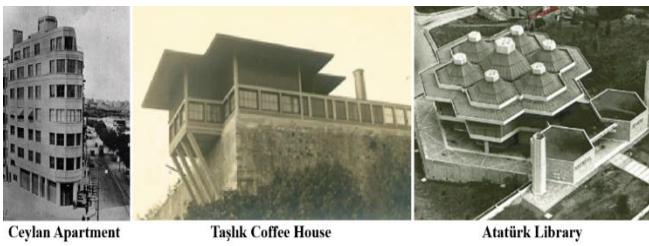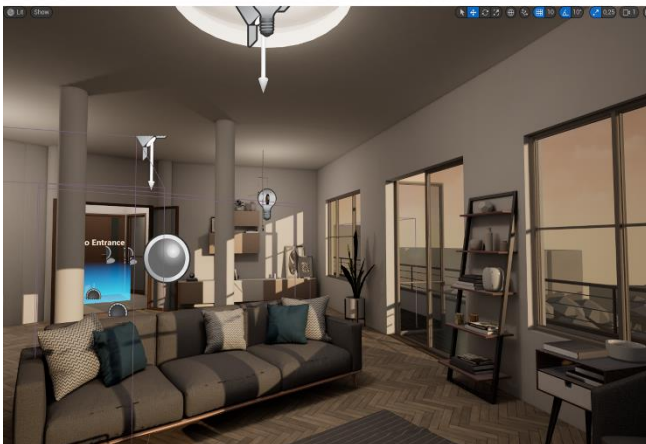

Fig. 1. Building photos.

Fig. 2. Ceylan Apartment, photo-model comparison.

Within the scope of the docu-game project, three projects of Sedad Hakkı Eldem with different functions were selected
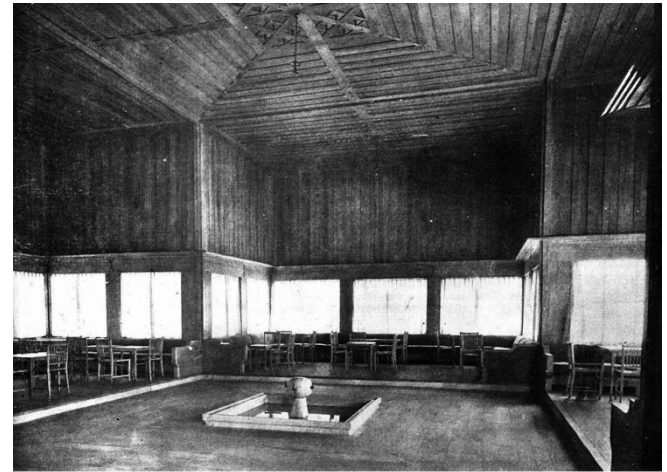
from different periods of his career. The first of these is Ceylan Apartment, which was designed in 1932-1933. Ceylan Apartment is the first significant, large, and carefully detailed building of Sedad Hakkı [20]. In addition, the building is also important because the apartment-type structures were considered the symbol of the modern life of the period. Ceylan Apartment is located in Taksim, across Gezi Park, on a triangular corner plot adjacent to Cumhuriyet Street. Eldem mentioned in the Arkitekt Magazine of the period (1933) that planning was difficult due to the form of the plot. The apartment, built with a reinforced concrete construction system, consists of a basement floor, a ground floor with shops, five standard floors with an apartment in each, and an attic with a terrace retracted from the facade. The facade of the building consists of large windows. Over the main entrance, there are balconies that create a kind of oriel (cumba) effect [20]. Although it has undergone various changes, additions, and interventions over time, Ceylan Apartment, which coincides with the first periods of Sedad Hakkı's professional life, is still in its place today.

Fig. 3. Taşlık Coffee House, photo-model comparison.

The second building of the game is Taşlık Coffeehouse, built in 1947-1948. Sedad Hakkı Eldem designed Taşlık Coffeehouse inspired by the seventeenth-century building Amcazade Köprülü Hüseyin Paşa mansion, which he saw as the paradigm of the traditional "Turkish house" [19]. With this attitude, Eldem, in a way, wanted to indicate the modern features of a Turkish civil architectural building that was not known and appreciated at that time [20]. The building, which was built as reinforced concrete, shows several similarities

with Amcazade Köprülü Hüseyin Paşa mansion with its plan and facade approaches. Moreover, the building is also crucial in terms of expressing the modern public space and socialization understanding of the period. Unfortunately, Taşlık Coffeehouse, one of the essential representatives of the Early Republican period, was demolished in the 1980s during hotel construction. Later, it was rebuilt by changing its location and dimensions, and after a while, it was demolished too. As a result, Taşlık Coffeehouse, one of the important buildings of the Early Republican Period and Sedad Hakkı's career, has not been preserved. For this reason, Taşlık Coffeehouse was included in the scope of the game, thus allowing the space to be experienced digitally. In addition, it was thought that the game would be beneficial in terms of documenting the building in a digital environment.

Fig. 4. Atatürk Library, photo-model comparison.

The last building of the game is the Atatürk Library, built in 1973-1975. The project was initially designed as a cultural complex; then only the library part was built. Sedad Hakkı applied the hexagonal plan scheme, which he had also experimented with in his previous sketches. The three-story building, consisting of six hexagonal modules positioned around a central hexagon, was constructed of reinforced concrete. The building generally consists of reading halls, conference and exhibition halls, book conservation, and administrative units. One of the most striking design decisions in the building is the use of daylight, which is frequently seen in different buildings of Sedad Hakkı. The spaces dominated by the central plan scheme receive daylight from the skylights on the hexagonal modules as well as the windows. The Atatürk library is one of the designs of Sedad Hakkı that corresponds to the last period of his architectural career. In this context, it was important to add it to the game's scope.

B. Technical Qualities

Virtual Reality is a medium for simulation of experiences using the tracking of physical posing and displaying of three-dimensional visuals in near-eye displays. These experiences create worlds users can enter and immerse themselves in. They present many possibilities for experience designers to present different instances of virtual worlds for users to experience environments and gain new understandings regarding education and preservation of real-life locations [21,22]. The immersion and interactivity virtual reality creates is a tool already used in education of architecture and the preservation of cultural heritage sites. These experiences are also open to improvement with the usage of video game tools of narrative and gamification [23,24,25].

These experiences can be amplified with the player experience-oriented flow of video game design. Video games are structured with the player experience in mind which focuses on creating an educational process which lets players improve their mechanics with repetitive completion of tasks, continuous exposure to environments through exploration, and relatable narratives creating interest and setting goals like goals of educational programs.

To create similar goals between the player and the playable character, a story of an architecture student going on a school trip has been used as the narrative of this experience [26,27]. Throughout this school trip, the player is tasked with the collection of important artifacts and manuscripts as well as measurements of Sedad Hakkı Eldem's buildings included in the game. Throughout this gameplay loop the student's assignment goals align with the player's gameplay goals which are structured around the controls virtual reality tools provide.

The game includes three locations featuring Sedad Hakkı Eldem's architecture and these locations all feature mechanics and characteristics which can be related with the experiences the player character can interact. The player's interests are navigated through these buildings throughout the tasks assigned to them to further the narrative as well as collectible elements, highlighted with the use of different colors. These locations also feature detailed models in contrast to buildings and environment featured in the background.

Virtual reality allows players to immerse through virtual environments from the first-person perspective which opens new mechanical possibilities in gameplay [28,29]. In this project, these tools are used to create the spatial presence of the player to interact with these locations which wouldn't be possible in other mediums which wouldn't be able to replicate the experience of being in these locations firsthand. This gameplay is also emphasized with instinctive mechanics that fit the narrative such as getting assignment updates from the player character's phone and the collection of items using a backpack.

The player experience is emphasized in the design with the uses of navigation in game, how the sense of presence is created, the interactivity and background architecture of environments, the overall narrative used to combine these aspects, how color is used in exploration, mission design

throughout levels to create engagement, and the usage of time and setting in terms of storytelling.

To limit the feeling of motion sickness experienced in virtual reality experiences, player navigation through levels is done via teleporting the player from the location they are currently standing to their selected location. This helps limit nausea experienced by some users.

Throughout the game, the location of Atatürk Library is used as a hub to express the levity and gravity the location holds both in the works of Sedad Hakkı Eldem and the narrative. The library is the starting location of this game and the field trip for our player character. This is the location players return to after completing their objectives in Ceylan Apartment. The player is also transformed to Taşlık Kahvesi after they fall asleep on their desk in the Atatürk Library.

In Ceylan Apartment, the player is teleported to the apartment from the building elevators to create an ease of use in the experience focusing on Sedad Hakkı Eldem's work. This location's size creates an attention to detail as the player needs to navigate through the objects of the interior loft. The player is also allowed to navigate to the balcony to convey the locational importance of this building. The player is also exposed to the contrast between the highly detailed buildings of Sedad Hakkı Eldem and the rest of the environment and the buildings in the background. To further emphasize this sense of presence, the player is not allowed to navigate over walls.

The nature of virtual reality requires the development of environments to focus on their spatial presence which is accomplished with the usage of 360 degrees' visual fidelity inside these locations. The player is incentivized to move to certain parts of these levels with the usage of narrative, lighting, and visual cues. The movement through the levels navigates the player in circular shapes to begin the level where they have started like existing museum tours. The moveable locations in these levels feature different textured models to further guide the player. And the player's instinctive need for roaming inside a game environment is rewarded with hidden collectible versions of the buildings highlighted in this experience.

The location of Taşlık Kahvesi takes place in a dream sequence and as such includes non-realistic elements such as floating paper notes for the players to collect. As this situation allows, the building of Taşlık Kahvesi is designed as its historic version and can give a contrast between Sedad Hakkı Eldem's historic work and the current versions of these architectural works such as Ceylan Apartment. This location includes only the building and the courtyard garden in a floating island and the background is open sky, further reinforcing the dream feeling of the location. A flying bell navigates the player and opens walkable areas to create the narrative limits of the location.

The player character is an architecture student who arrives late to their project field trip about Sedad Hakkı Eldem's architectural works. When the player arrives late to the introductory class in the Atatürk Library, they come upon the recording of their assignment for this trip. The player is then tasked with navigating through this location and collect necessary information for their project. This allows the player to get familiar with the location. After gaining the necessary tools and information, the player is then tasked with the second part of the student's project, measurement of the building of Ceylan Apartment. During this field research, the player encounters the current state of the apartment and is informed about on the changes that occurred in the apartment. This showcases the longevity of Sedad Hakkı Eldem's architecture. Here, the player is tasked with the measurement of the rooms inside Ceylan Apartment as they get acquainted with the location. Completion of this task returns the player to a now night-time version of the Atatürk Library. After going through their tasks in the Atatürk Library, the player sits down at their designated table and the students starts dreaming which transports the player into the dream sequence which includes Taşlık Kahvesi. The building is a place the player will get the task of retrieving the pieces of notes from Sedad Hakkı Eldem's personal notebook, as well as being a place to rest and sit down. After the completion of this task the character will wake up and the player finds themselves back in the library. The player can then go to the showcase room in the Atatürk Library and check through the process of their experience, with real life images and items collected throughout the narrative showcased.

IV. THE COMPARATIVE USER EXPERIENCE QUESTIONNAIRE

Games are mostly about creating experience for users. In educational games, the aim of informing and educating the user is added to the experience. Additionally, new generations familiar with being and interacting in virtual environments are born and their daily activities are shifting towards virtual environments [30]. Considering practical aspects, digital gaming experiences prioritize the interaction of digital entertainment systems with users. When virtual reality environments are involved in the process, the interaction between them becomes even more remarkable. All in all, gaming experience is unique and individual, affected by many different factors [31]. Therefore, user experience evaluation is an important method to improve the experience. It is important to identify the elements or criteria that shape the effective or appropriate game design according to individual players' affective response patterns [32]. Accordingly, it was important for the authors to conduct a study on the user experience evaluation of the created VR game to receive feedbacks from different user groups. As the game has educational purposes embedded to the gaming experience, it was aimed to test its effects on student groups from different educational backgrounds and professions. The questionnaire was conducted among two groups of students, first one being students from interior design department, and the second student group is from digital game design department. Outcomes of the questionnaire were used constructively to develop the game structure both for contextual and technical matters.

A. Structure of the Questionnaire

To participate in the comparative user experience questionnaire, total of 24 third-year students were selected, 12 from interior design and 12 from digital game design departments. Considering the number of registered students in the third year of both departments, which is 126 for interior

design and 84 for digital game design department, the number of participants in the questionnaire is more than 10% of the total, thus it is statistically acceptable. Attention was given on the participants to be technologically literate and have previous experience with head mounted display and control devices (HMD) for immersive virtual reality environments. The HMD device used was HTC Vive Pro, and each student was given 10 to 15 minutes to explore all three buildings. After the VR experience, the students were asked to fill the online questionnaire form created on google forms. The questionnaire consisted of three sections.

First section questioned the overall impressions of the students about their experience in the VR game environment. The questions were about how much they felt like they have been a part of the VR experience, how hard it was to navigate in the VR environment, if they felt any discomfort or dizziness during their VR experience, and if they felt any change in their perception of time during their experience. Additionally, at the end of this section they were asked to select the building that provided the best VR experience for them.

In the second section of the questionnaire, students were questioned about their guesses on the physical attributes of each building. This section included two questions, one asking about the average ceiling height of the buildings, and the other one questioning the total size of the explored area in squaremeters.

The third section of the questionnaire included the highest number of questions and they were repeated for each building, so there were subsections. The students were asked to evaluate each building regarding their spatial quality, circulation quality, lighting quality, connections with exterior elements, visual quality, furniture and objects quality, interactive objects quality, materials, colour, and texture quality, and interaction with the urban context. For these questions, an evaluation using a zero-to-ten scale was required.

In addition to the three sections, at the end of the questionnaire there was a short answer question where the students were able to express their additional opinions about their experience in the VR game. Some constructive feedback was received from the students in this question as well. In summary, the questionnaire was thoughtfully designed to include a wide range of VR experience components, from personal impressions to precise measurements and in-depth analyses of architectural features. In order to produce a complete dataset and enable a detailed analysis of the comparative user experience in the VR game environment, both structured and open-ended questions were included. The results and outcomes of the comparative user experience questionnaire are elaborated in the next chapter.

B. Results and Outcomes

The comparative user experience questionnaire revealed important results and outcomes about the variations in perceptions of different groups of students for the development of the VR game. Most significant results were caught from the third section of the questionnaire.

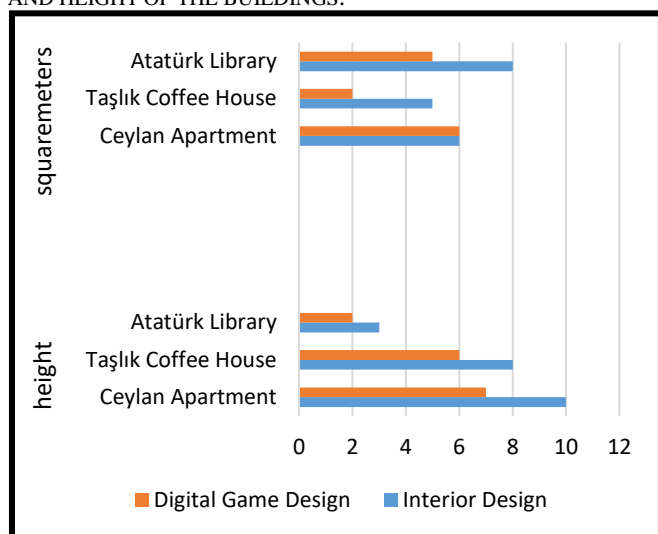The first section of the questionnaire did not provide remarkable information regarding the differences between the perceptions of student groups from two departments. The questions were asked using a 5 point Likert scale. In average, their responses to the questions revealed that they mostly felt like they have been a part of the VR experience (4,25/5); it was not hard to navigate in the VR environment (2,04/5), they did not feel much discomfort or dizziness during their experience (2,04/5), and they felt little change in their perception of time during their experience (2,96/5). The difference between two departments occurred in the last question of this section where the students had to choose the one building that provided the best VR experience. Digital Game Design students predominantly selected Ceylan Apartment (8/12), as the distribution of answers by the interior design students were more balanced. 5 students selected Ceylan Apartment, 4 students Taşlık Coffee House, and 3 of 12 students selected Atatürk Library as the building to provide best VR experience. The reason behind Digital Game Design students' answers may be that they find the residential building more familiar that the other two buildings with different functions. Interior design students on the other hand, did not have that kind of recognition, based on their educational background.

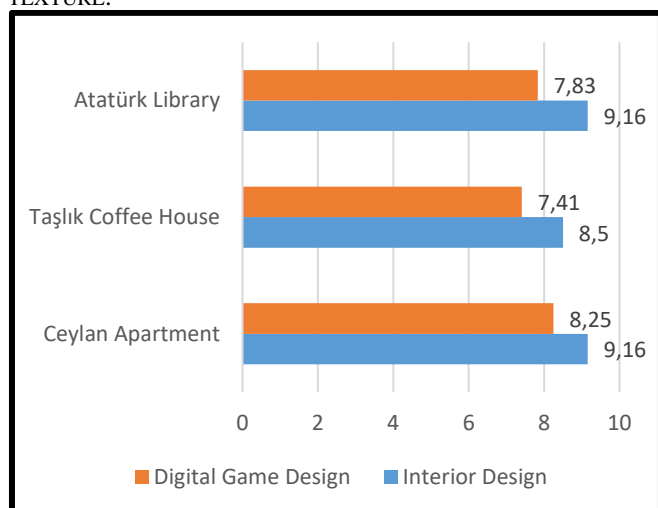TABLE I.   WHICH OF THE THREE PLACES DO YOU THINK PROVIDES THE MOST SUCCESSFUL EXPERIENCE ON VR?
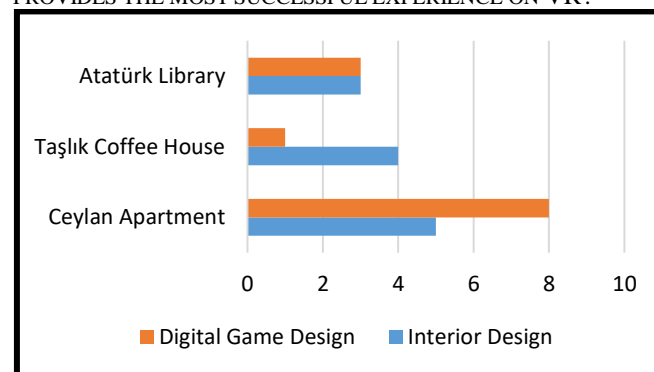
In the second section, where the physical attributes of the buildings were questioned, interior design students had better estimations, proving their skills in spatial perception. First question in this section was about the total squaremeters of the explored area in each building. In Ceylan apartment (120 m²), 10 interior design and 7 digital game design students guessed the size close enough to the right answer. In Taşlık Coffee House (190 m²) 8 interior design and 6 digital game design students had the right guess, and in Atatürk Library (780 m²) 3 interior design and 2 digital game design students' estimations were close to the right value. From this question we can also assert that the larger the space gets, the bigger margin of error grows. Peoples' perception is more successful in more human scale spaces. For the second question of this section, the questioned value was the average ceiling height of each space. The results were not very different from the previous question. In Ceylan apartment (h:320 cm), 6 students from both departments had the right estimation. In Taşlık Coffee House (h:500 cm), 5 interior design and 2 digital game design students managed to have the right guess, and in Atatürk Library (h:450 cm), 8 interior design and 5 digital game design students were close enough. In this question, there was no visible correlation between the numeric value of ceiling height and the number of people with right predictions.

TABLE II. RIGHT ANSWERS TO THE TOTAL SQUAREMETERS AND HEIGHT OF THE BUILDINGS.

the space itself more than the objects within, not recognizing their interactive features very much.

The quality of materials, colour, and texture also revealed important outcomes. Digital game design students were more critical about this issue, and the lowest result from this question for that department was for Taşlık Coffee House with 7,41/10. This might be caused by their previous experience with digital and VR games where the choice of colours and texture are more eye-catching with bright colours and strong lighting.

In the VR game in the scope of this paper, the visual rendering, especially the rendering of Taşlık Coffee House based on the scenario, was abstracted to reflect the historical essence of the project. This was not much anticipated by the students. For interior design students, the situation was different, as their results for all three buildings were quite high (8,94/10), reflecting their approach to those historic buildings. Finally, regarding the interaction with the urban context, there were significant differences between digital game design (7,74/10) and interior design students (8,66/10), simply reflecting the differences in their understanding of urban context.

Remarkable results and their outcomes for the questions in the third section are as follows: About circulation quality, digital game design students (8,16/10) were more critical than the interior design students (9,08/10). This might be about their action expectation from a game, more than a documentary. Regarding the connections with exterior elements, both student groups find Ceylan Apartment the weakest space (7,58/10 for digital game design students, 8,0/10 for interior design students). It is understandable because the space is in the top level of a 7-floors building, but obviously the students did not consider the terrace opening up to the park and square nearby the building as a connection with exterior elements. Probably they looked for physical connections more than visual ones.

V. CONCLUSION

The relationship between virtual reality and architecture gets stronger day by day. A similar bond applies to VR in education, as each year more virtual reality applications are being added either directly or indirectly to education curricula as learning and teaching instruments. The educational contents of many departments are being updated according to the emerging technologies and the requirements of the future market. Especially architecture and game design departments in higher education institutions are highly affected by the developments in virtual reality technology because it starts to become an initial element of digital games, as well as architectural design and representation.

The experiment in the scope of the study indicates that there are significant differences between the perceptions of students from two departments. Architecture students care more about the materiality and spatiality of the game scenes, as the students from the game design department are mostly interested in experience and interaction. The study also reveals that VR can have significant contribution to the education in both architecture and game design departments, either as an initial part of the curriculum or as additional exercises connected with particular courses or studios. However, there should be some differences in the proposed VR applications. The two departments have different program outcomes and different expectations from their graduates regarding their knowledge, skills, and competences. Therefore, the features and characters of the VR applications that aim to contribute to education must be composed according to the needs of the particular educational department.

TABLE III. THE QUALITY OF MATERIALS, COLOUR, AND TEXTURE.

Considering the quality of interactive objects, digital game design students were very critical. Their average answer for this question for three buildings was 5,36/10, with Taşlık Coffee House being the lowest one. Apparently, those students were expecting more objects with more interaction in the environment. Interior design students' average answer for this question was 7,61/10, which means they were concentrated in

For instance, in architectural education, VR applications that prioritize the spatial experience would be more effective. On the other hand, in the field of game design education, the focus moves to the VR experiences' usability and smoothness. Teachers in the gaming department place a high priority on integrating VR apps that smoothly complement the curriculum

since they understand the critical impact these aspects play in determining user interactions and overall engagement. This dualistic approach highlights how technology integration in education is multifaceted, with different disciplinary contexts having varying effects on the same technical tool (VR).

This method of creating VR applications has wider implications beyond just interior architectural and gaming departments. Such a methodology's flexibility to different education departments points to a paradigm shift in the creation of educational technology. Through the alignment of VR application design with the inherent characteristics of each profession and the specific requirements of their corresponding curriculum, this customized method becomes a model for promoting productive learning environments in a variety of academic fields. By carefully weighing the subtleties of each discipline, educators may fully utilize virtual reality technology to create richer learning environments, opening the door to a more creative and personalized educational environment.

AUTHORS` CONTRIBUTIONS

Conceptualization, P.Ş., G.Ç. and S.C.; methodology, A.Ç. and S.Z.M; investigation P.Ş and S.C.; resources, S.C., G.Ç. and Z.V.H.; writing—original draft preparation, Z.V.H. and P.Ş. writing—review and editing, S.Z.M, A.Ç. and G.Ç.; visualization, S.Z.M., Z.V.H. and A.Ç. All authors have read and agreed to the published version of the manuscript.

CONFLICT OF INTEREST

The authors declare that they have no conflicting interests.

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