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RESEARCH ARTICLE
Art

The Effect of Perception and Experience of Students Toward VR in Architectural Education

Mimarlık Eğitiminde Öğrencilerin Sanal Gerçekliğe Yönelik Algı ve Deneyimlerinin Etkisi

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ABSTRACT

This study investigated the potential of integrating Building Information Modeling (BIM) and Virtual Reality (VR) to enhance spatial perception and the design process in an architectural design studio setting. Undergraduate students at Karabük University designed the interior of a historical leather factory to be converted into a library using Revit and Unreal Engine 5. The findings revealed that VR technology significantly improved students' understanding of design details, spatial relationships, and the overall design process. Students were able to visualize their designs in a more immersive and interactive way, leading to more informed decision-making. Interactive elements, such as lighting controls and material selections, contributed to a more realistic and engaging experience. While visual realism played a role in the effectiveness of VR, the study also highlighted the importance of factors beyond visual realism, such as user experience and presence. These factors can influence how students interact with and learn from the VR environment. Future research is needed to further explore these factors and identify strategies for optimizing VR integration in design education. Overall, this study demonstrates the potential of BIM and VR to transform architectural education by providing students with a more immersive and interactive learning experience. However, it is essential to consider factors beyond visual realism to ensure the effective integration of VR into the design process.

Keywords: Virtual Reality, Architectural Education, Building Information Modelling, Real-Time Render, Interior Design.

ÖZET

Bu çalışmada, mimari tasarım stüdyosu ortamında mekansal algıyı ve tasarım sürecini geliştirmek için Bina Bilgi Modellemesi (BIM) ve Sanal Gerçeklik'in (VR) entegre edilmesinin potansiyeli araştırılmıştır. Karabük Üniversitesi'ndeki lisans öğrencileri, Revit ve Unreal Engine 5 kullanarak kütüphaneye dönüştürülecek tarihi bir deri fabrikasının iç mekanını tasarladılar. Bulgular, Sanal Gerçeklik teknolojisinin öğrencilerin tasarım ayrıntıları, mekansal ilişkiler ve genel tasarım süreci anlayışını önemli ölçüde geliştirdiğini ortaya koydu. Öğrenciler, tasarımlarını daha sürükleyici ve etkileşimli bir şekilde görselleştirebildiler ve bu da daha bilinçli karar almalarına yol açtı. Aydınlatma kontrolleri ve malzeme seçimleri gibi etkileşimli öğeler, daha gerçekçi ve ilgi çekici bir deneyime katkıda bulundu. Görsel gerçekçilik, Sanal Gerçekliğin etkinliğinde rol oynarken, çalışma ayrıca kullanıcı deneyimi ve varlık gibi görsel gerçekçiliğin ötesindeki faktörlerin önemini de vurguladı. Bu faktörler, öğrencilerin Sanal Gerçeklik ortamıyla nasıl etkileşime girdiğini ve bu ortamdan nasıl öğrendiğini etkileyebilir. Bu faktörleri daha fazla keşfetmek ve tasarım eğitiminde VR entegrasyonunu optimize etmek için stratejiler belirlemek için gelecekte araştırmalara ihtiyaç vardır. Genel olarak bu çalışma, BIM ve Sanal Gerçekliğin öğrencilere daha sürükleyici ve etkileşimli bir öğrenme deneyimi sağlayarak mimarlık eğitimini dönüştürme potansiyelini göstermektedir. Ancak, Sanal Gerçekliğin tasarım sürecine etkili bir şekilde entegre edilmesini sağlamak için görsel gerçekçiliğin ötesindeki faktörleri dikkate almak önemlidir.

Anahtar Kelimeler: Sanal Gerçeklik, Mimarlık Eğitimi, Bina Bilgi Modellemesi, Gerçek Zamanlı Render, İç Tasarım.

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INTRODUCTION

Nowadays, visualization plays an essential role in helping scientists and engineers understand and analyses complex data (Ömer Özeren et al., 2023; Qurraie and Havva, 2023), and they can use it to create the best methods for promoting and advertising their designs (Shete and Khobragade, 2023). Visualization can be a valuable tool for improving knowledge.

Computer visualization and 3D modelling play an important role in architectural designs (Gezer and Qurraie, 2021; Hamzeh et al., 2019). In the case of architectural education, students have the ability to interact with three-dimensional (3D) objects, providing them with the opportunity to explore a variety of architectural environments, transcending the use of traditional sketches (Ticllacuri et al., 2023). Virtual reality (VR) is a promising tool for architecture education, offering a way to deliver hands-on learning experiences (Olbina and Glick, 2023).

Virtual Reality (VR) involves simulating reality, immersing users in a non-existent yet convincingly illusionary artificial environment. Its fundamental components include the virtual world, immersion, interactivity, and the involvement of individuals on both the creating and receiving ends (Won et al., 2023). Combining such modern technology with a learning process can give us an effective outcome. For example, with the help of VR, one can share the data with other decision-makers to enable them to explore more comprehensive viewpoints and potentially

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come up with quicker and more accurate conclusions (Cheng and Teizer, 2013). It offers a heightened sense of reality during the planning phase, enabling clients to virtually navigate through the interiors before starting the project (Jessen et al., 2020). VR can help to identify and resolve design issues early on, improving communication and collaboration between engineers (Wolfartsberger et al., 2018). Since VR can be used to create immersive experiences of historical sites and monuments, it has the potential to transform the way to understand the environment, and it can give us the chance to travel to different locations worldwide. Additionally, virtual reality can be used to preserve and conserve culture (Guerra et al., 2015; Ömer Özeren et al., 2024).

Continuing to rely on traditional educational methods or conventional design and visualization approaches fails to adapt to the evolving world. Therefore, embracing this progress and moving forward in tandem with development is imperative (AlGerafi et al., 2023; Ömer Özeren and Sultan Qurraie, 2022). Instructors must foster student interest to ensure effective learning, and the technology should be implemented based on the needs of the students (Omar et al., 2018). The integration of new technology influences students by enhancing motivation and participation, thereby yielding a positive impact on academic achievement (Fonseca et al., 2014). Utilizing VR as a tool in the field of study, akin to an industrial revolution innovation, has been found to enhance student motivation. By providing access to new tools and resources, VR can enhance student learning, enabling them to engage in novel learning experiences and prepare for the complexities of the global marketplace.

Architectural visualization has evolved from traditional rendering to using game engines to create interactive 3D environments. Integrating 3D visualization with the construction material is an essential step in the design procedure to make the material selection easier and clear visualization of the design outcomes. Because game engines contain powerful feature sets that allow developers to create realistic and immersive worlds, these days become increasingly popular for creating highly realistic environments in a variety of fields, such as architecture visualization, filmmaking, and video games (Belaroussi et al., 2023). The VR system empowers users by facilitating a virtual walkthrough process, enabling them to navigate and explore architectural spaces or designs seamlessly (Ehab et al., 2023). VR can potentially redefine howe approach learning and training, but further research is necessary before widespread adoption can occur.

Technological innovations like 3D printing, virtual reality, artificial intelligence, and others will impact education by enhancing conventional classroom instruction (Van Dooren et al., 2014). Virtual Reality (VR) technologies have gained rapid recognition in the field of architecture education because of their ability to enhance the caliber of architectural programs (Wang et al., 2018). VR is recognized for its exceptional capacity to use computer-based technologies for 3D graphical depiction to duplicate some aspects of the actual world through virtual environments (Ahmad et al., 2020; Alvarado & Maver, 1999; Craig et al., 2009; Fuchs et al., 2011; Ibrahim et al., 2021; Latif Rauf and S Shareef, 2019; Nisha, 2019). VR may offer a (1:1) full-scale, making the user (student) feel as though they have entered the virtual environment. By giving students a sense of presence, virtual environments may also create dynamic educational environments that are rich in sensory experiences (Latif Rauf and S Shareef, 2019; Messner et al., 2003). VR has already been investigated in several studies to see if it may be used to visualize architecture design (Campbell and Wells, 1994; Fathallah et al., 2022; Frost and Warren, 2000; Lin and Hsu, 2017; Ruslan et al., 2023). Bashabsheh et al.(2019) concluded that virtual reality may be used in a range of architectural education programs, from rudimentary to complex and advanced courses, as well as in training initiatives. According to Frost veWarren (2000) Virtual Reality (VR) in collaborative architectural design processes improves idea formulation, analysis, and testing, ultimately leading to better laboratory layouts. VR may also be utilized as a collaborative medium, allowing students from various regions to interact, study, and collaborate in groups inside the same virtual environment (Fuchs et al., 2011; Nisha, 2019). Because of this, virtual reality VR is seen as a technology that might improve education by giving students a richer sensory experience and improving their comprehension of volume, size, and space through interaction, navigation, and immersion.

Globa et al.(2022) built an immersive VR environment and compared it to traditional paper-based methods for pre-occupancy evaluation of architectural designs. They found that VR led to more diverse and nuanced assessments, with professionals being more likely to change their minds after experiencing the space virtually. According to Alsafouri veAyer (2019), there are five different types of virtual reality (VR) technologies that are used in architectural education: immersive VR, 3D game-based VR, desktop-based VR, BIM-enabled VR and Augmented Reality (AR). Gomez-Tone et al.(2022) submitted an application that uses mixed methodology. It was determined that teachers found the immersive and interactive virtual reality (VR) to be useful in the early stages of architectural design, while students can use it as a pedagogical tool to get feedback from their own spatial experience to correct and improve their designs.

This study attempts to address this issue by studying the effect of adopting VR in architectural education at the bachelor level. To do so, early visualization of interior design possibilities as part of a rehabilitation project for conserving an old leather factory in the city of Safranbolu was provided for students in the VR environment. By providing real-time insights into spatial dimensions, interior layouts, and design alternatives based on BIM and VR techniques, students were enabled to explore and make decisions early on in the design process. In order to investigate the significant effect of VR on students' understanding, a Likert-based survey was conducted among 30 students after finishing the course. The survey was designed using two main dimensions to measure students' perception of VR and their previous experience with VR technology. Based on the normality result of the collected data, an independent sample t-test and Mann-Whitney U test were conducted to investigate whether there is any significant difference between students who found VR effective in enhancing their understanding of multiple subjects and those who did not find VR useful in their education.

MATERIAL AND METHOD

This study involved undergraduate students enrolled in the Interior Design Studio course offered by Karabük University during the first semester of 2023. The students' primary objective was to design and conceptualize an interior space for a library situated within a historical building in Safranbolu city.

The research aimed to investigate the potential of seamlessly integrating Building Information Modelling (BIM) and Virtual Reality (VR) technologies to enhance the students' spatial perception and design process. To achieve this, the project leveraged the combined functionalities of Revit and Unreal Engine 5 (UE5). Specifically, the software versions employed were Revit 2021 and Unreal Engine 5.2.1. Given the real-time rendering capabilities of Unreal Engine, a laptop equipped with an NVIDIA RTX 4060-8G graphics card was utilized.

This synergistic approach sought to exploit the strengths of both BIM and VR, ultimately aiming to create a comprehensive and immersive design experience for users (as illustrated in Figure 1). The project began with the creation of a 3D model of the historical leather factory in Revit. This model was based on existing as-built plans and supplemented by a site visit to the project location (Figure 2). Subsequently, the model was seamlessly integrated into Unreal Engine using the Data Smith exporter plugin. This facilitated compatibility and enabled the synchronized development and visualization of the design within the virtual environment.

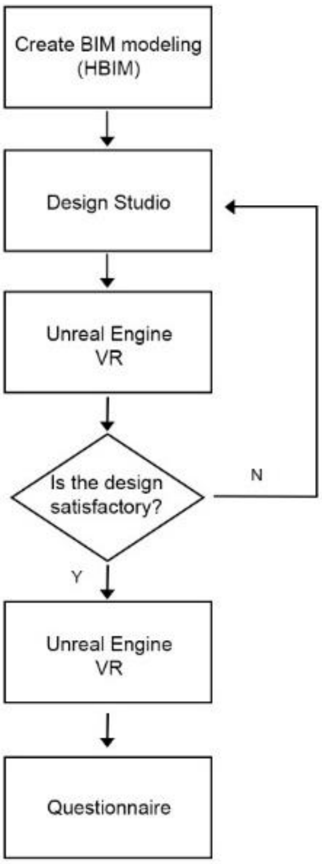

Figure 1: Overview of the proposed method

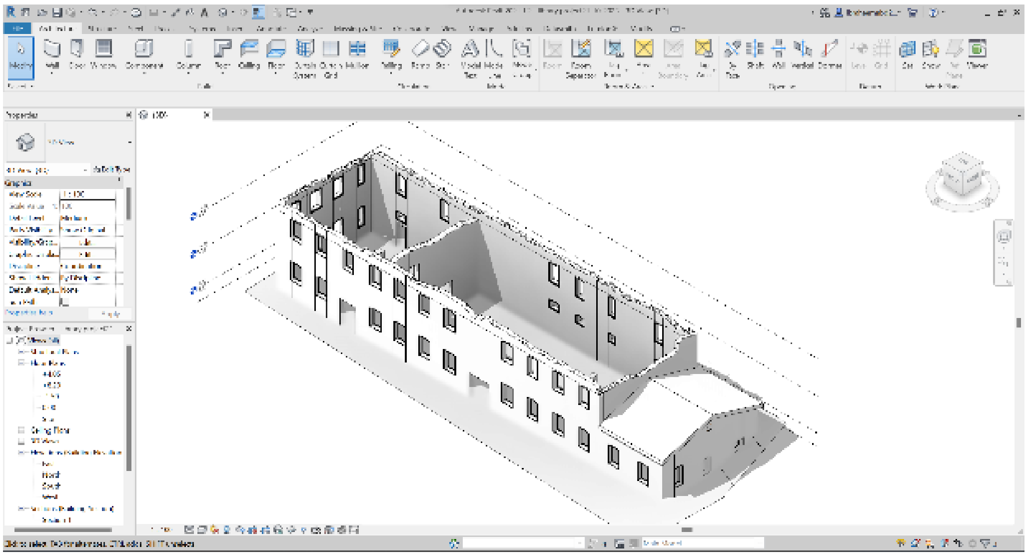

Figure 2: 3D model by Revit

The process of synchronizing BIM data between Revit and Unreal Engine (for BIM and VR applications) can be characterized by a primary and a secondary environment. This compatibility feature facilitates the real-time replacement of the building's virtual environment within Unreal Engine, even while the program is running (as depicted in Figure 3).

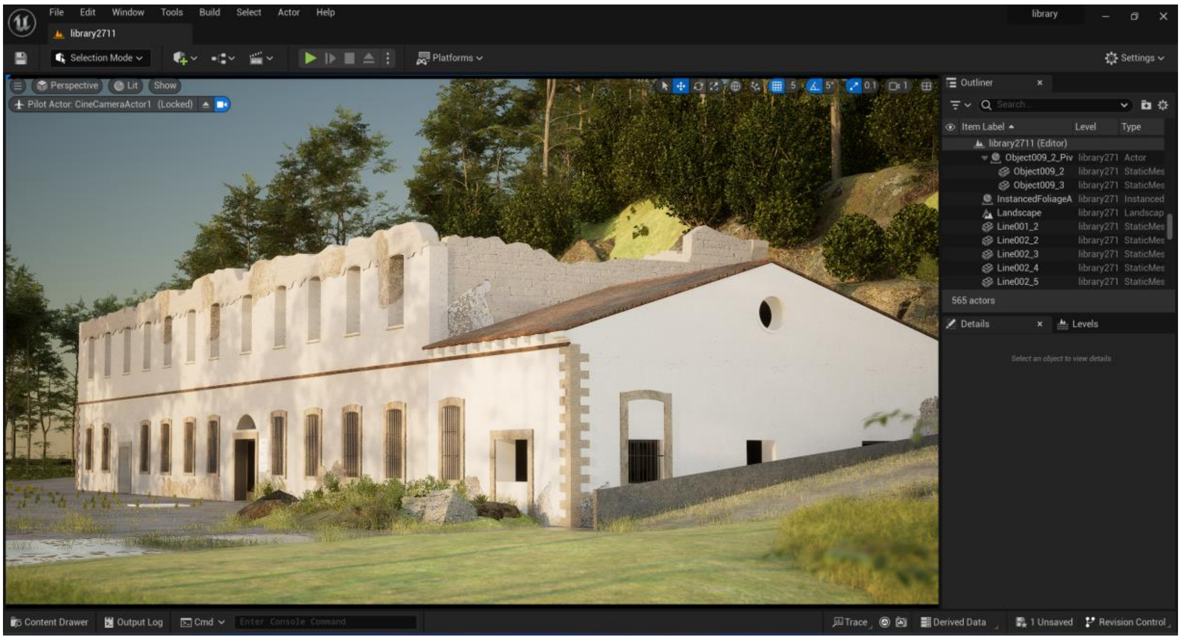

Figure 3: 3D model in Unreal Engine environment

Interactive elements were incorporated into the application to serve two primary purposes: to facilitate user-driven design modifications and to enhance the realism and immersion of the virtual experience. These elements included features such as toggling lights on and off to illustrate their impact on the design, as well as allowing users to select and replace textures and materials for wall coverings, flooring, and furniture. This functionality empowered students to realistically visualize the suggested materials and make informed decisions regarding their suitability for the virtual design. To achieve a higher degree of design accuracy, custom furniture models were created. However, certain elements, such as plants and some light fixtures, were incorporated from the Megascan Quixel Bridge library.

Beyond material selection, the simulation incorporated various interactive effects designed to enrich the virtual experience and cultivate a more lifelike environment. These functionalities included:

- ✓ Door-opening animationsMovable equipment, allowing users to interact with objects.
- ✓ Interactive lighting controls, enabling users to turn lights on and off.
- ✓ Realistic object motion simulations, such as dropped objects falling or users performing actions within the library space (borrowing a book, moving to a reading area, returning the book)

The synchronization between Revit and Unreal Engine 5 (UE5) facilitated effortless design modifications and texture replacements within the virtual environment.

Case study

The Safranbolu Leather factory building (Tabakhane) embodies Safranbolu's industrial heritage and the power of historic preservation (Ömer Özeren and Korumaz, 2019). Revitalization offers the potential to restore its identity and invigorate the city's cultural and economic landscape. Constructed in the 1920s, the two-story building with exterior walls, an interior dividing wall, and supporting columns is currently disused and overgrown. A single-story technical service building adjoins the main structure (Küçükkara et al.).

Despite suffering deterioration over time, the Safranbolu Leather factory building retains a monumentally aesthetic appearance at both the detailed and overall architectural scale. This project prioritizes the preservation of this aesthetic value through minimal intervention. New functions, such as a library, will be strategically incorporated within suitable volumes of the existing building mass (Gezer and Qurraie, 2021; Merlino, 2018) (Figure 4).

The integration of Virtual Reality (VR) technology serves to enhance the architectural design process for educational purposes within an architectural education studio setting. A three-dimensional (3D) model of the building will be meticulously crafted using Building Information Modelling (BIM) software, specifically Revit. This BIM model will provide students with a comprehensive understanding of the structure's intricate details and spatial relationships. Subsequently, students will leverage VR technology to virtually inhabit the space and create an interior design for the proposed library. This immersive virtual environment allows for informed design decisions while fostering a deeper appreciation for the historical significance of the building.

Figure 4: photos for the project

Experimental Procedures

The integration of student-designed interiors into Unreal Engine 5 (UE5) marked a significant step forward, fostering an immersive experience and heightened realism. Material properties were meticulously refined to elevate the virtual environment's visual fidelity. Base textures remained consistent with the original student designs, while adjustments were made to enhance realism through properties like reflections, refractions, bump mapping, and roughness. These details played a crucial role in enriching the overall visual experience and creating a more believable sense of space within the project. Notably, achieving realistic glass material properties presented a challenge. This involved meticulously managing parameters like transparency, refractivity, refractive index, and color to closely approximate real-world glass behavior.

Another key aspect of refinement involved lighting. While students initially placed light fixtures within their designs, the project leveraged UE5's capabilities to fine-tune their placement and characteristics for optimal illumination. This dynamic adjustment ensured not only a visually appealing composition but also underscored the value of UE5 in handling complex lighting scenarios. Importantly, the early integration of this module into the design workflow presented several advantages. It facilitated the identification and correction of potential issues such as unsuitable furniture or overly complex plant models. In such instances, UE5 emerged as a valuable tool for design optimization. For instance, unsuitable plants from student files were replaced with high-quality assets from the extensive Megascan library readily accessible within UE5. This addition not only streamlined the design process but also significantly enhanced the scene's realism and sense of movement through the inclusion of detailed, high-fidelity plant life (Figure 5).

Moreover, this early integration of VR technology proved beneficial in proactively addressing design shortcomings. For example, misplaced window decorations or unsuitable shelving arrangements could be identified and addressed within the virtual environment. This empowered students to make informed decisions and refine their designs iteratively within UE5. This proactive approach not only streamlined the design process but also served as a pre-emptive measure against potential design challenges, ultimately leading to a more efficient and visually compelling final outcome.

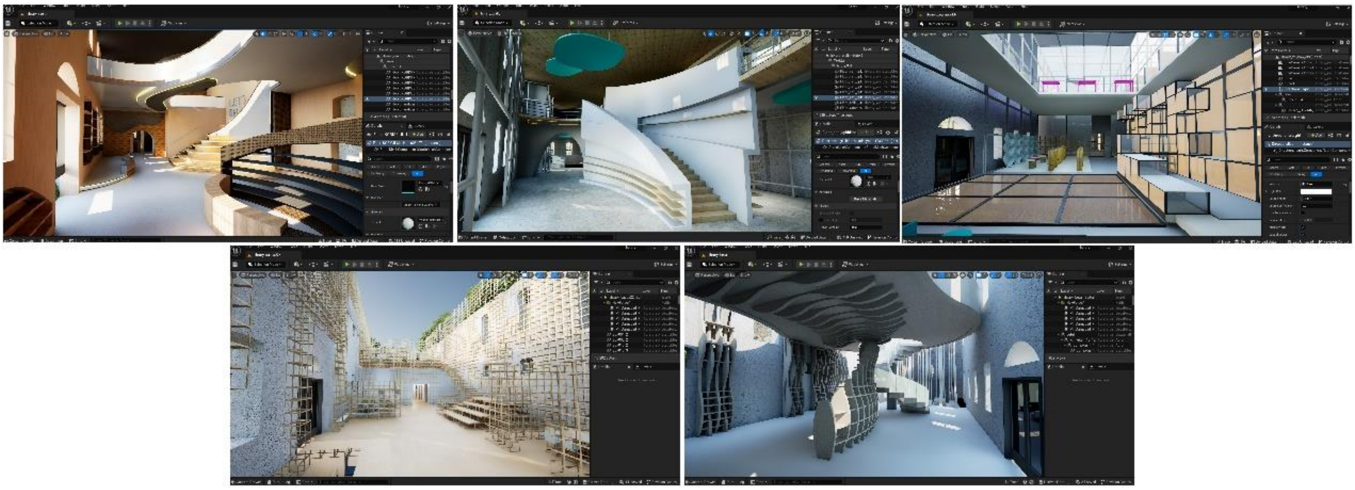

Figure 5: Adding the interior design to the UE5 by Data smith

Following instructor feedback, a design refinement process was initiated. This process categorized feedback into three main areas: development, detail enhancement, and material personalization. Development encouraged deeper exploration of initial concepts. Detail enhancement emphasized the iterative design process and adding subtle elements for visual richness. Material personalization leveraged Unreal Engine 5's library and editing capabilities to empower student choice and foster a deeper connection with their designs. This iterative process, with some students engaging in extensive refinement, resulted in a collection of unique designs reflecting each student's vision (Figure 6).

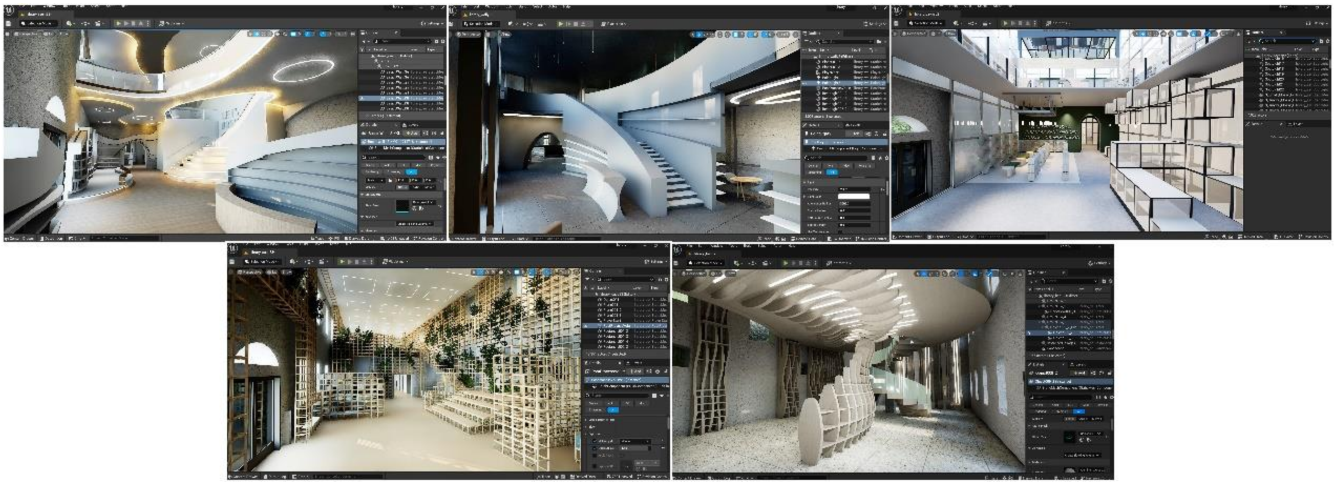

Figure 6: Readding the interior design to the UE5 by Data smith

Upon completion of the design process, encompassing design approval, lighting adjustments, material selection, and final project acceptance, a comprehensive survey was administered to all 30 students throughout the semester. This survey aimed to evaluate the impact of virtual reality (VR) on the design process and its educational implications. The survey explored the multifaceted aspects of utilizing VR as a transformative tool within the field of design education.

RESULTS

The analysis of collected data was conducted with IBM SPSS Statistics 25. The questionnaire was designed in a way that it explores the effect of past VR-experience and VR-perception on students' understanding regarding three-dimensional spaces, volume awareness, material selection, and awareness of details.

Past VR-experience and VR-perception of participants were measured by three and four items, respectively, through the Likert scale. The mean value for each variable was calculated and tested against two categories. The first category was students who found the usage of VR useful in enhancing their understanding, and the second category was those who did not find VR effective.

As illustrated in Table 1, the normality test of collected data reveals that data for VR-perception is normally distributed while the VR-experience is not normally distributed. A Shapiro-Wilk test shows a significant departure from normality for VR-experience, W (30) =0.921, p=0.029. As a result, a non-parametric test (Mann-Whitney U test) was conducted for VR-experience while doing a one sample t test for VR-experience.

Table 1: Test of Normality

	Kolmogorov-Smirnova			Shapiro-Wilk		
	Statistic	**df**	**Sig.**	**Statistic**	**df**	**Sig.**
VR-Perception	.119	30	.200*	.935	30	.066
VR-Experience	.185	30	.010	.921	30	.029
*. This is a lower bound of the true significance.						
a. Lilliefors Significance Correction						

VR-Experience

The Mann-Whitney U test was applied to evaluate the difference between two groups in their understanding of 3D-dimensional spaces, volume awareness, detail awareness, and material section and those who did not find VR effective. The below table (Table 2) represents the stated results. The results can be summarized as follows:

- ✓ Considering the experience of participants with VR, there is a significant difference between those who have found VR effective for a better understanding of 3D dimensional space and those who do not (Z=-1.854, p<0.05).
- ✓ There exists a significant difference between the two groups (Yes or NO) regarding the VR experience and having better awareness of volumes for students (Z=-2.079, p<0.05).
- ✓ There exists a significant difference between the two groups (Yes or NO) regarding the VR experience and creating better awareness of details for students (Z=-2.915, p<0.05).
- ✓ There is no significant difference between the two groups (Yes or NO) regarding the VR experience and providing a better selection of materials for students (Z=-1.287, p>0.05).

Table 2: Analysis of Spatial Perception and Material Selection: A Study on Three-Dimensional Learning Impact

	Group	N	Mean Rank	Sum Rank	Wilcoxon W	Mann-Whitney U	Z-Value	Exact Sig
Better understanding of three-dimensional spaces	Yes	25	17.55	351	114	59.00	-1.854	0.074
	No	5	11.4	114				
Better awareness of volumes	Yes	19	17.94	341.5	123.5	57.50	-2.079	0.042
	No	11	11.23	123.5				
Better awareness of details	Yes	18	19.22	346	119	41.00	-2.915	0.004
	No	12	9.92	119				
Better selection of materials used	Yes	25	16.4	410	55	40.00	-1.287	0.229
	No	5	11	55				

VR-Perception

In order to measure the VR-perception of participants, the following statements were asked in a point Likert Scale format.

- ✓ I found the VR conditions (scale, size, orientation, etc.) accurate.
- ✓ I was able to effectively perceive the three-dimensional aspects of the virtual environment.
- ✓ The graphics quality of VR helped my ability to perceive the 3D elements.
- ✓ Perceiving the spatial features of the virtual environment was error-free.

The mean value for all four items was calculated and it was used to investigate whether VR perception significantly affects students' understanding toward 3D-dimensional spaces, volume awareness, detail awareness, and material section. An independent sample t-test was conducted to compare the role of VR perception for students who found VR beneficial on asked concept (Yes group) and those who did not find it effective (No group).

An independent t-test was conducted to compare the mean value of understanding toward 3D-dimensional spaces for both groups. There were no significant differences (t (27) =2.152, p=0.209), in scores for group Yes (M=4.08, SD=0.74) and group NO (M=3.36, SD=3.36). The magnitude of the differences in the means (mean difference = 0.072, 95% confidence interval: 0.034 to 1.405) was very small. The Table 3 represents this result.

Table 3: Levene's Test and t-test Analysis for VR-Perception (Understanding of 3D-Dimensional Spaces)

Levene's Test for Equality of Variances							t-test for Equality of Means				
Better understanding of 3D-dimensional spaces	**N**	**Mean**	**SD**	**F**	**Sig**	**t**	**Sig (2- tailed)**	**Mean Difference**	**Std. Error Difference**	**95% Confidence Interval of the difference**	
										Lower	Upper
YES	20	4.08	0.74	1.65	0.209	2.152	0.04	0.072	0.334	0.034	1.405
NO	10	3.36	1.07								

The results for better awareness of volumes are illustrated in below table (Table 4). The result shows a significant difference for t (28) =2.542 and p=0.017 in the scores with mean score for Yes group (M=4.136, SD=0.771) which was higher than No group (M=3.327, SD=0.951). The magnitude of the differences in the means (Mean

Difference=0.809, 95% confidence interval: 0.157 to 1.461) was significant. Below table (Table.4) represent the stated results.

Table 4: Levene's Test and t-test Analysis for VR-Perception (Awareness of Volumes)

Levene's Test for Equality of Variances							t-test for Equality of Means				
Better awareness of volumes	**N**	**Mean**	**SD**	**F**	**Sig**	**t**	**Sig (2-tailed)**	**Mean Difference**	**Std. Error Difference**	**95% Confidence Interval of the difference**	
										Lower	Upper
YES	19	4.136	0.771	0.27	0.607	2.542	0.017	0.809	0.318	0.157	1.461
NO	11	3.327	0.951								

The results for better awareness of details are illustrated in the table below (Table 5). The result shows a significant difference for t (28) =3.218 and p=0.03 in the scores with mean score for Yes group (M=4.222, SD=0.859) which was higher than No group (M=3.266, SD=0.689). The magnitude of the differences in the means (Mean Difference=0.955, 95% confidence interval: 0.347 to 1.563) was significant. Below table (Table 5) represent the stated results.

Table 5: Levene's Test and T-test for VR-Perception (Awareness of Details)

Levene's Test for Equality of Variances							t-test for Equality of Means				
Better awareness of details	**N**	**Mean**	**SD**	**F**	**Sig**	**t**	**Sig (2-tailed)**	**Mean Difference**	**Std. Error Difference**	**95% Confidence Interval of the difference**	
										Lower	Upper
YES	18	4.222	0.859	0.741	0.397	3.218	0.003	0.955	0.296	0.347	1.563
NO	12	3.266	0.689								

An independent t-test for better selection of material shows no significant differences (t (28) =1.773, p=0.046), in scores for group Yes (M=3.968, SD=0.949) and group NO (M=3.2, SD=0.244). The magnitude of the differences in the means (mean difference= 0.768, 95% confidence interval: -0.119 to 1.655) was very small. Table 6 represents this result below.

Table 6: Levene's Test and T-test for VR-Perception (Material Selection)

Levene's Test for Equality of Variances							t-test for Equality of Means				
Better selection of material	**N**	**Mean**	**SD**	**F**	**Sig**	**t**	**Sig (2-tailed)**	**Mean Difference**	**Std. Error Difference**	**95% Confidence Interval of the difference**	
										Lower	Upper
YES	25	3.968	0.949	4.365	0.046	1.773	0.087	0.768	0.433	-0.119	1.655
NO	5	3.2	0.244								

DISCUSSION

This study examines the interesting relationship between how we perceive and feel in a 3D environment through virtual environments and its impact on learning and design. While past research explored these elements separately, this study tried to bridge the gap. The research gap in this study lies in its limited focus on the immediate effects of VR in architectural education. Future research could explore the long-term impact of VR on learning outcomes, conduct comparative analyses with traditional methods, explore scalability and accessibility issues, investigate pedagogical integration strategies, and prioritize student-centered approaches. Addressing these gaps would provide a more comprehensive understanding of VR's potential to revolutionize architectural education.

The current study aligns with existing research on the role of visualization tools, such as game engines, in architectural design studied by Lewis veJacobson (2002). The integration of BIM and VR, as demonstrated in this study, offers a seamless transition from design to immersive experience, echoing the findings of previous studies by Olbina veGlick (2023); Ticllacuri et al.(2023).The study's emphasis on interactive elements, such as lighting controls and material selections, aligns with the growing recognition of the importance of realism and immersion in VR experiences as mentioned by Jessen et al.(2020); Won et al.(2023). The findings also support the potential of VR to enhance understanding of design details and spatial relationships, as suggested by prior research (Cheng and Teizer, 2013; Wolfartsberger et al., 2018).

However, the study's findings also diverge from some existing literature. While previous research by Belaroussi et al.(2023); Guerra et al.(2015) has highlighted the importance of visual realism in VR experiences, this study suggests that factors beyond visual realism, such as user experience and presence, may play a more significant role in determining the effectiveness of VR in architectural education. The study's findings also contribute to the growing body of research on the use of VR in education. Previous studies (Fonseca et al., 2014; Omar et al., 2018) have demonstrated the positive impact of VR on student motivation and engagement. This study further supports these findings by highlighting the potential of VR to enhance students' understanding of complex architectural concepts.

In conclusion, this study provides valuable insights into the potential of VR to transform architectural education. By integrating BIM and VR, students can benefit from a more immersive and interactive learning experience. However, future research is needed to explore the factors beyond visual realism that contribute to the effectiveness of VR in architectural education.

CONCLUSION

This study examined the fundamental relationship between virtual reality (VR) technology and its effect on the educational design prosses, which find that the using this relationship has shown great potential in revolutionizing the way students' approach and understand architectural spaces. this study hypothesized that the use of this technology supports the academic and imaginative process for the students, and this was proven when we made a questionnaire for students during the design process, as the students showed that VR plays a very important role in design choices, enabling students to going into the details of design and knowing various feeling that might not be known in traditional design processes, which helped the students within three-dimensional (3D) environments heightens their thinking of spatial relationships, lighting and lighting effects, volume and its relation with the designed space and the selected material and its details.

The study also highlighting the factors, which are basic for visual environment, such as materials and lighting, in building the VR environment. The feedback provided by the students underscored the importance of detail in establishing a realism sense of feeling within virtual environments. Realistic reflections, textures, and close understanding of 3D elements were identified of the VR environment. The questionnaires did not find a direct connection between the users and there their individual differences, such as gender and previous experience in the 3D environment and the simulated surroundings, except that they showed the factor association between the regularity of computer using and the level of being and feeling with 3D virtual settings. This implies that more computer usage heightens the ease and familiarity of users in virtual reality environments.

REFERENCES

Ahmad, L., Sosa, M., & Musfy, K. (2020). Interior design teaching methodology during the global COVID-19 pandemic. Interiority, 3(2), 163.

AlGerafi, M. A., Zhou, Y., Oubibi, M., & Wijaya, T. T. (2023). Unlocking the potential: A comprehensive evaluation of augmented reality and virtual reality in education. Electronics, 12(18), 3953.

Alsafouri, S., & Ayer, S. K. (2019). Mobile augmented reality to influence design and constructability review sessions. Journal of Architectural Engineering, 25(3), 04019016.

Alvarado, R. G., & Maver, T. (1999). Virtual reality in architectural education: defining possibilities. Acadia Quarterly, 18(4), 7-9.

Bashabsheh, A. K., Alzoubi, H. H., & Ali, M. Z. (2019). The application of virtual reality technology in architectural pedagogy for building constructions. Alexandria Engineering Journal, 58(2), 713-723.

Belaroussi, R., Dai, H., González, E. D., & Gutiérrez, J. M. (2023). Designing a Large-Scale Immersive Visit in Architecture, Engineering, and Construction. Applied Sciences, 13(5), 3044.

Campbell, D. A., & Wells, M. (1994). A critique of virtual reality in the architectural design process. University of Washington HITL Technical Report R-94, 3(2).

Cheng, T., & Teizer, J. (2013). Real-time resource location data collection and visualization technology for construction safety and activity monitoring applications. Automation in construction, 34, 3-15.

Craig, A. B., Sherman, W., & Will, J. (2009). Introduction to virtual reality. Developing Virtual Reality Applications: Foundation of effective Design. Morgan Kaufmann, 1-32.

Ehab, A., Burnett, G., & Heath, T. (2023). Enhancing Public Engagement in Architectural Design: A Comparative Analysis of Advanced Virtual Reality Approaches in Building Information Modeling and Gamification Techniques. Buildings, 13(5), 1262.

Fathallah, N. A., Rashed, R., Afifi, S., & Hassan, G. F. (2022). Virtual Reality: A Paradigm Shift in Architecture and Urban Design Education. Paper presented at the 2022 IEEE 1st Industrial Electronics Society Annual On-Line Conference (ONCON).

Fonseca, D., Martí, N., Redondo, E., Navarro, I., & Sánchez, A. (2014). Relationship between student profile, tool use, participation, and academic performance with the use of Augmented Reality technology for visualized architecture models. Computers in Human Behavior, 31, 434-445.

Frost, P., & Warren, P. (2000). Virtual reality used in a collaborative architectural design process. Paper presented at the 2000 IEEE Conference on Information Visualization. An International Conference on Computer Visualization and Graphics.

Fuchs, P., Moreau, G., & Guitton, P. (2011). Virtual reality: concepts and technologies: CRC Press.

Gezer, A. M. S., & Qurraie, B. S. (2021). Karabük Kent Meydanı'ndaki "Meydan" Deneyimini Mekân Dizimi Yöntemi ile Değerlendirme. Uluslararası Doğu Anadolu Fen Mühendislik ve Tasarım Dergisi, 3(1), 43-54.

Globa, A., Wang, R., Tokede, O., & Khoo, C. K. (2022). Pre-Occupancy evaluation of buildings in VR: development of the prototype and user studies. Architectural Science Review, 65(5), 407-419.

Gomez-Tone, H. C., Alpaca Chávez, M., Vásquez Samalvides, L., & Martin-Gutierrez, J. (2022). Introducing Immersive Virtual Reality in the Initial Phases of the Design Process—Case Study: Freshmen Designing Ephemeral Architecture. Buildings, 12(5), 518.

Guerra, J. P., Pinto, M. M., & Beato, C. (2015). Virtual reality-shows a new vision for tourism and heritage. European Scientific Journal.

Hamzeh, F., Abou-Ibrahim, H., Daou, A., Faloughi, M., & Kawwa, N. (2019). 3D visualization techniques in the AEC industry: the possible uses of holography. J. Inf. Technol. Constr., 24, 239-255.

Ibrahim, A., Al-Rababah, A. I., & Bani Baker, Q. (2021). Integrating virtual reality technology into architecture education: the case of architectural history courses. Open House International, 46(4), 498-509.

Jessen, A., Hilken, T., Chylinski, M., Mahr, D., Heller, J., Keeling, D. I., & de Ruyter, K. (2020). The playground effect: How augmented reality drives creative customer engagement. Journal of business research, 116, 85-98.

Küçükkara, M. Y., Özacar, K., & Ortakci, Y. Mimarlık Öğrencilerinin Sanal Gerçeklik Ortamında Safranbolu Tabakhanesinde Rölöve Alma Deneyimi. Fırat Üniversitesi Mühendislik Bilimleri Dergisi, 36(1), 35-47.

Latif Rauf, H., & S Shareef, S. (2019). Understanding the relationship between construction courses and design in architectural education. international journal of recent technology and engineering, 8(3), 3201-3207.

Lewis, M., & Jacobson, J. (2002). Game engines. Communications of the ACM, 45(1), 27.

Lin, C.-H., & Hsu, P.-H. (2017). Integrating Procedural Modelling Process and Immersive VR Environment for Architectural Design Education. MATEC Web Conf., 104.

Merlino, K. R. (2018). Building reuse: sustainability, preservation, and the value of design: University of Washington Press.

Messner, J., Yerrapathruni, S., Baratta, A., & Whisker, V. (2003). Using virtual reality to improve construction engineering education. Paper presented at the 2003 Annual Conference.

Nisha, B. (2019). The pedagogic value of learning design with virtual reality. Educational Psychology, 39(10), 1233-1254.

Olbina, S., & Glick, S. (2023). Using integrated hands-on and virtual reality (VR) or augmented reality (AR) approaches in construction management education. International Journal of Construction Education and Research, 19(3), 341-360.

Omar, M., Ali, D., Mokhtar, M., & Abdullah, A. (2018). The use of virtual environment and augmented reality to support engineering education and enhance visualization skills. Journal of Fundamental and Applied Sciences, 10(6S), 977-988.

Özeren, Ö., & Korumaz, M. (2019). Karar destek sistemleri kullanarak safranbolu tabakhane binasının yeniden kullanım olanaklarının değerlendirilmesi. Erciyes Üniversitesi Fen Bilimleri Enstitüsü Dergisi.

Özeren, Ö., Özeren, E. B., TOP, S. M., & Qurraie, B. S. (2023). Learning-by-Doing Using 3D Printers: Digital Fabrication Studio Experience in Architectural Education. Journal of Engineering Research, 100135.

Özeren, Ö., Qurraie, B. S., & Eraslan, M. H. (2024). The Role of Digital Design in Cultural Transmission: An Architectural Studio Experience. DEPARCH Journal of Design Planning and Aesthetics Research, 3(2), 161-175.

Özeren, Ö., & Sultan Qurraie, B. (2022). Evaluation 0f Architectural Students' thoughts on Transformation And Re-Use Projects Using Ahp Method Transformation in Architecture (pp. 173-191): Generis Publication.

Qurraie, B. S., & Havva, K. (2023). The Energy Performance of Shading Element and Double Skin Facade System Integration into Office Buildings in Turkey. Journal of Materials and Engineering Structures «JMES», 10(2), 293-309.

Ruslan, F. A., Mahamarowi, N. H., Mustapha, S., & Aman, F. B. (2023). Virtual Reality (VR) - The Effectiveness in Interior Architecture Technical Drafting. IOP Conference Series: Earth and Environmental Science, 1217(1), 012011. doi:10.1088/1755-1315/1217/1/012011

Shete, D., & Khobragade, P. (2023). An empirical analysis of different data visualization techniques from statistical perspective. Paper presented at the AIP Conference Proceedings.

Ticllacuri, Y., de Osambela, J. E. S., & Pimentel, J. F. F. (2023). Application of Revit Software to Improve Spatial Intelligence in Architecture Students in a Private University–Huancayo. International Journal of Professional Business Review: Int. J. Prof. Bus. Rev., 8(10), 36.

Van Dooren, E., Boshuizen, E., Van Merriënboer, J., Asselbergs, T., & Van Dorst, M. (2014). Making explicit in design education: Generic elements in the design process. International Journal of Technology and Design Education, 24, 53-71.

Wang, P., Wu, P., Wang, J., Chi, H.-L., & Wang, X. (2018). A critical review of the use of virtual reality in construction engineering education and training. International journal of environmental research and public health, 15(6), 1204.

Wolfartsberger, J., Zenisek, J., & Sievi, C. (2018). Chances and limitations of a virtual reality-supported tool for decision making in industrial engineering. IFAC-PapersOnLine, 51(11), 637-642.

Won, M., Ungu, D. A. K., Matovu, H., Treagust, D. F., Tsai, C.-C., Park, J., . . . Tasker, R. (2023). Diverse approaches to learning with immersive Virtual Reality identified from a systematic review. Computers & Education, 195, 104701.