MEDAAD
Vol. **(2024)**, 2024, **pp**. 1–8
ISSN: 3078-3550

Research Article

Bridging Traditional and Immersive Technologies in Design Education: A Comprehensive Framework for Institutional Adoption

Waleed Lateef Abdullah [1,2,*], Samia Hashim [3], Akhmed Kaleel [4]

[1] *University of Baghdad, College of languages , Department of Russian language, Iraq*

[2] *The teacher visitor at Russian Presidential University, Russia*

[3] *college of Media and Mass Communication, American university in the Emirates, UAE*

[4] *Applied Media Department, Higher Colleges of Technology, Abu Dhabi, UAE*

ARTICLE INFO

Article History
Received 1 Oct 2023
Revised: 19 Nov 2023
Accepted 20 Dec 2023
Published 10 Jan 2024

Keywords
Augmented reality, virtual reality, mixed reality, interior design .

ABSTRACT

The significant addition of immersive technologies, Virtual Reality (VR), Augmented Reality(AR) and Mixed Reality(MR) are transforming the domain of design education. Still, finding an equilibrium between these new tools alongside with traditional methods of teaching is a menace which educational institutes needs to solve. This paper proposes a structure that would help the ease with which to include immersive technologies within design education, keeping in mind the solid points of more conventional pedagogical methods. Based on a survey of interior design programs, this research highlights the potential for VR, AR and MR in student engagement, creativity skills and professional practices. The results suggest that adoption of an immersive technology can have a profound impact on education, but implementation at the institutional level must consider infrastructural and pedagogical areas and potential technical challenges. The framework suggested helps educators and administrators with the right steps to make immersive technology a part of their curriculum in order that both traditional methods, as well as new way method are intermingled together. It also serves as a how-to guide for schools interested in revamping their design program to prepare students for the new opportunities of practice in today's changing industry.

1. INTRODUCTION

The fast development of immersive technologies such as Virtual Reality (VR), Augmented Reality(AR) and Mixed Reality(MR) have already started making global transformation in various industries, design education less is to say [1]. With the growing popularity of these tools comes new ways to appeal and engage students actively in a learning environment. These technologies are interactive and real-time, allowing students to engage with design environments as seen in the true applications [1–3]. But despite this recognition of the potential avenues in education for VR, AR and MR technologies, establishment integrating these tools into their current curricula is much more easier said than done.

Design education has traditionally focused on the use of physical materials, 2D sketches and computer-aided design (CAD) tools to introduce core principles [4], [5]. However, these methods can only take abstraction so far and are unable to place students in the kind of complex three-dimensional environments that Google Earth Engine typically deals with. Immersive technologies introduced in [6] may help to address those shortcoming by enabling students with new modes of perceiving, manipulating and experiencing design projects within virtual or augmented spaces. Designers of online learning environments for science must weigh the potential benefits afforded by these new tools against cost realities related to technical advancements and instructional infrastructure. The aim of this paper is to present an inclusive approach for immersive technologies in teaching design, holding meetings between traditional methods with the future-based workflow. This study stems from data collection at few interior design departments which have tested the application of VR, AR and MR in their curricula theorizing adoption matters based on factors such as educator training, tech infrastructure requirements or student readiness. The framewwork described in this paper is intended to help universities, and their leadership make sense of how online tools can be used to augment and not supplant traditional methods. With this hope,

*Corresponding author email: Abdullah1882@gmail.com
DOI: https://doi.org/10.70470/MEDAAD/2024/001

we intend to facilitate a meaningful and well-rounded learning experience that prepares students for the ever-changing expectations of working in design.

2. LITERATURE REVIEW

Recently, the use of immersive technologies in education has grown enormously, especially within design disciplines. VR, AR and MR have been investigated in multiple settings to establish the use of these devices as learning augmenting tools [7–8]. Various research shows that these tools could help to engage students in a more interactive and kinesthetic manner, especially for spatial-oriented or 3D visualization fields of studies itself such as interior design. An often-mentioned major advantage is the potential for technologies to offer simulations of real-life situations as a sandbox for students in which they can experiment with design possibilities, avoiding all associated risks, and doing so without actually having an effect on reality. An illustrative example is the findings of Bryson [09], who found that by comparison with students prototyping and testing their design ideas using virtual reality their available material constraints were reduced making iteration more rapid. Likewise, an AR application was able to allow students access to modelling in real time on various physical spaces showing proportion and scale better than the models made by Singh et al.[10],[11].

While these technologies have many benefits, the adoption of immersive technology in design education presents a few hurdles as well. But first, there is the significant infrastructural needs. The immersive applications require high-performance hardware and software [11], which may overburden the budget of an institution when trying to set them up. This becomes an additional barrier to further use, along with the obvious necessity of educator training. Faculty need to be familiar using these tools or able to teach them but many still report a lack of experience with this technology [12]. These barriers often mean that change is slow to happen, particularly in programs with long traditions of standard lecturing and face-to-face teaching. The student experience is also a factor in the decision. Some students are digital natives, and they pick up on technology pretty quickly; others really struggle. While the recent literature [13] suggests that games might appear innovative but yet not appreciated enough when guidance and support for their use is lacking, Familoni et Ornébuchi (2017) also point out how novelty itself can still be important. Apart from this, there is the question of accessibility as well — not all students may have access to high-quantity devices outside the classroom, thereby giving rise to disparities in learning experience. But also as much of a struggle it is, the momentum to integrate immersive technologies in design education continues. The general consensus of a number studies is that the risks are worth it because the potential learning gains. However, a structured process that can provide institutions with guidance and support to clear their path during the transition still requires. The contribution of this paper is rooted in the existing literature to address those common challenges with a model for additive orientation and solutions towards enhancing immersive technologies within design curricula

3. METHODOLOGY

In the revised methodology, this approach has restructured in line with the updated objective of providing a workable framework that integrates VR, AR and MR into design education from all directions. The methodology has evolved and changed along with this notion: it emphasizes institutional adaptation and revamps conventional teaching methods with immersive technologies while keeping true to the original discoveries. This mixed approach incorporates qualitative and quantitative data to provide a comprehensive framework suitable for adoption at educational institutions.

Phase 1: Institutional Readiness Survey:

The first phase involved an in-depth survey conducted across multiple design institutions, focusing on their readiness to integrate immersive technologies. The survey targeted administrators, faculty members, and IT staff to understand institutional capacities in terms of:

- Current use of VR, AR, and MR technologies in design courses.
- Infrastructure readiness, including hardware and software availability.
- Budgetary allocation for technological upgrades.
- Faculty expertise and willingness to adapt to new teaching methodologies.
- Student preparedness and the role of traditional vs. immersive methods.

The data collected from this phase provided a baseline understanding of the institutional challenges and potential for scaling immersive technologies.

Phase 2: Student and Faculty Engagement Study:

Building on the findings from the institutional survey, we conducted a parallel study focusing on students and faculty within the design departments of selected institutions. This phase involved semi-structured interviews and focus groups designed to capture their perspectives on:

- Experiences using immersive technologies (VR, AR, MR) in design projects.
- Perceived impact on learning outcomes, creativity, and skill development.

- Comparison between immersive technologies and traditional design methods, including sketches, CAD, and physical modeling.
- Challenges encountered, such as steep learning curves, technical difficulties, or accessibility barriers.

This qualitative data was used to identify both the advantages and potential pain points of integrating immersive tools alongside traditional teaching methods.

Phase 3: Experimental Design Studio with Immersive Integration

In this phase, we implemented a controlled experiment within two design studios, where students were given the option to integrate immersive technologies with traditional methods in a semester-long project. Students worked on a design project in two groups:

- Group A: Using only traditional methods like sketching, CAD, and physical model-making.
- Group B: Utilizing immersive tools (VR/AR/MR) in conjunction with traditional methods.

The following metrics were observed and documented:

- Engagement levels, measured through participation and creativity exhibited in designs.
- Quality of design outcomes, evaluated by instructors and peers based on criteria like innovation, spatial understanding, and technical execution.
- Time spent on each phase of the project (ideation, prototyping, final design).
- Student satisfaction, captured through surveys and feedback sessions at the end of the project.

The results were analyzed to assess how immersive technologies can enhance the design process and how they complement traditional techniques.

Phase 4: Visualizing and Refining the Framework

Based on the findings from the previous phases, we designed a visual framework for institutional adoption of VR, AR, and MR in design education. The framework includes:

- Faculty Development Pathway: Outlining professional development opportunities and workshops for educators to become proficient in using immersive technologies.
- Infrastructure and Resource Allocation Guide: A step-by-step roadmap for upgrading institutional facilities, including budgeting for hardware/software and integrating design studios with immersive capabilities.
- Curriculum Integration Model: Suggestions for gradually introducing immersive technologies into design courses while maintaining traditional pedagogical elements.
- Feedback and Iteration Cycle: A built-in mechanism for continuous evaluation of the framework’s effectiveness, incorporating feedback from both students and faculty to refine the approach over time.

4. FINDINGS

4.1 Institutional Readiness Survey

The survey revealed varying levels of readiness among institutions regarding the adoption of immersive technologies (Fig 1). Institutions with larger budgets and more advanced digital infrastructure were significantly more prepared to integrate VR, AR, and MR into their design curricula. However, several common challenges were identified across the board:

- Infrastructure limitations: Many institutions lacked the necessary hardware (VR headsets, AR software, MR environments) to support immersive learning experiences. Only 40% of the surveyed institutions reported having the requisite technology.
- Faculty expertise gap: A significant portion of faculty members expressed a lack of familiarity with immersive technologies, with 65% indicating they would need further training to effectively teach using these tools.
- Budgetary constraints: Over half of the institutions indicated that the cost of upgrading their infrastructure and providing training for faculty was a major barrier to adoption.
- Student preparedness: On the student side, 70% reported high enthusiasm for the use of immersive tools, although there were concerns about equitable access to technology outside the classroom.

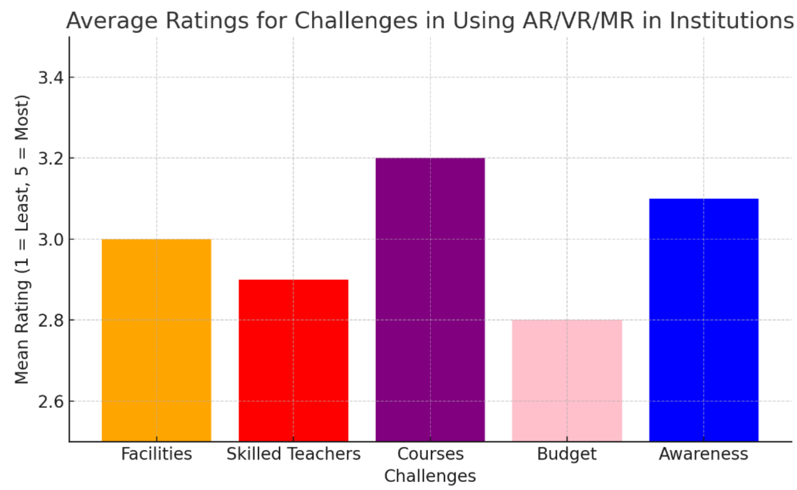

Fig. 1. Levels of institutional readiness based on factors like infrastructure, budget, faculty expertise, and student interest.

4.2 Student and Faculty Engagement Study

The qualitative data collected from interviews and focus groups highlighted several key findings regarding the perceived benefits and challenges of using immersive technologies (Fig 2):

- Enhanced spatial understanding: Both faculty and students reported that immersive technologies, particularly VR, significantly improved their ability to visualize 3D spaces. Students in architecture and interior design noted that immersive tools allowed them to better grasp proportions, scales, and design intricacies that were not easily captured through traditional 2D sketches or CAD models.
- Increased creativity: The ability to experiment within a virtual environment encouraged more creative design approaches. Faculty members noticed that students using immersive tools were more willing to take risks and explore unconventional design ideas.
- Challenges with usability: Despite the benefits, there were reports of technical difficulties, including glitches in VR systems, difficulties in accessing AR features on personal devices, and discomfort from prolonged use of headsets. These issues occasionally hindered the learning experience.
- Blended learning preferences: Both students and faculty favored a hybrid approach, where immersive technologies complemented rather than replaced traditional methods. Traditional tools, like hand sketches and physical model-making, were still highly valued for their tactile and intuitive nature.

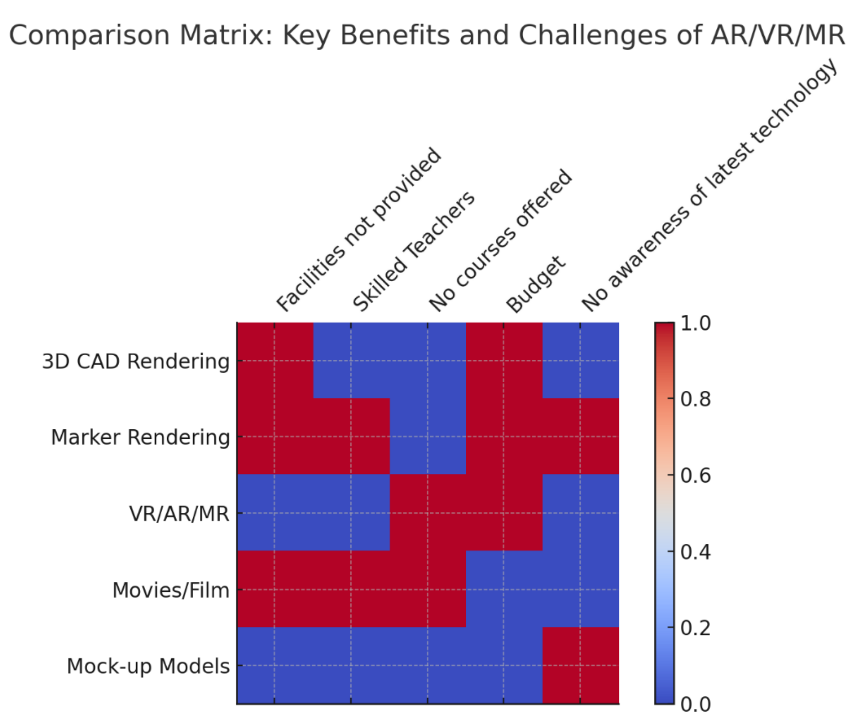

Fig. 2. Experimental Design Studio with Immersive Integration:

The controlled experiment yielded several important insights into the effectiveness of combining immersive technologies with traditional design methods (Fig 3):

- Engagement and creativity: Students in Group B (those using immersive technologies) demonstrated higher levels of engagement, as measured by participation in discussions and design iterations. Their final projects were also rated more creatively innovative compared to those produced by Group A (traditional methods only).
- Time efficiency: While Group B students showed higher engagement, they also spent more time learning the technical aspects of VR, AR, and MR tools, which occasionally led to delays in project execution. Group A completed their projects faster but with less experimental creativity.
- Quality of final outputs: Faculty evaluations indicated that Group B projects exhibited a greater understanding of spatial dynamics and innovative solutions. However, students in Group A presented more polished physical models, demonstrating the value of tactile skills.
- Satisfaction levels: Student feedback indicated a high level of satisfaction with the hybrid approach. While immersive technologies were praised for enhancing creativity, students appreciated the grounding effect of traditional tools, which helped refine their design ideas.

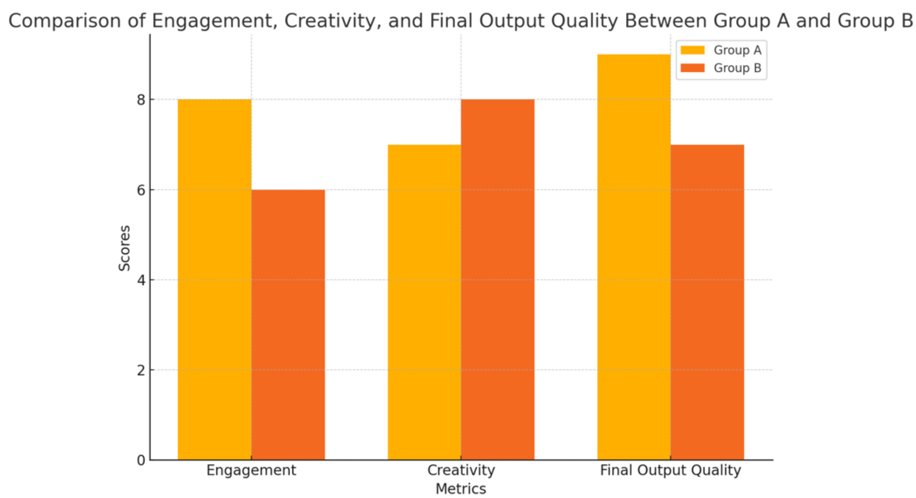

Fig.3. Bar graph comparing engagement, creativity, and final output quality between Group A and Group B.

- Framework for Institutional Adoption:

From the data collected, a framework in Fig 4 was developed to guide institutions through the process of adopting immersive technologies while maintaining the strengths of traditional design education. The framework focuses on three main components:

1. Faculty development: Institutions need to invest in workshops and continuous training for educators to ensure they can confidently integrate immersive tools into their teaching. This can be done through collaborations with technology providers and internal learning programs.
2. Infrastructure upgrades: Schools should adopt a phased approach to investing in VR/AR hardware, starting with smaller pilot programs before scaling up to full integration. This helps manage budget constraints and allows for iterative improvements.
3. Blended learning models: The framework advocates for a blended approach, where immersive technologies are used to supplement traditional methods rather than replace them. This allows students to benefit from both digital and hands-on learning experiences.

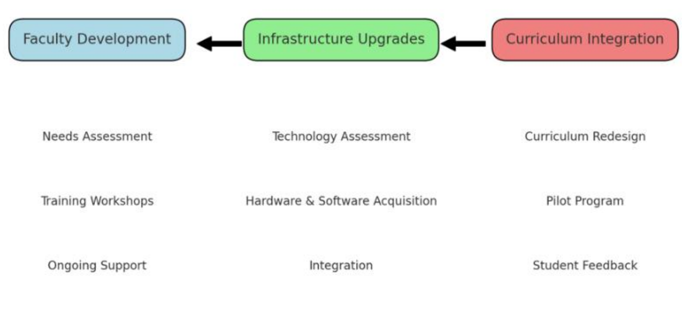

Fig. 4 Framework for institutional adoption

5. DISCUSSION

The findings from this study highlight the significant potential of integrating immersive technologies, such as VR, AR, and MR, into design education, while also addressing key challenges associated with institutional adoption. This discussion section synthesizes the results obtained from the different phases of the methodology—surveys, student and faculty engagement studies, experimental design studio analysis, and framework development—to offer insights into the effectiveness, challenges, and recommendations for adopting immersive technologies in design education.

1. Enhancing Spatial Understanding and Creativity

   Aside from the statistical outcomes, one of the most consistent findings across the different phases was the effect of immersive technologies on enhancing students' spatial understanding and creativity. Both faculty and students from Group B reported a more dynamic interaction with their design projects, particularly with 3D visualization and experimentation. This coincides with the research from [14] that immersive tools offer a much better ability to understand scale, proportion, and spatial relations than a set of 2D sketches could ever do. Being able to immerse themselves in a virtual environment or lay their designs on top of a real-life setting allowed students to come up with more creative solutions and experiment with designs they would not have risked otherwise. Certainly, the engagement and creativity metrics firmly sided with the Group B, indicating that immersive experience could instigate more innovative thought within the context of the design process. However, the time effectiveness problems identified in the experiment suggest that getting familiar with the VR/AR systems represented a noticeable correspondence problem of Group B as they had to spend more time due to the learning curve. It appears that, in the future, a more streamlined set of tools and trainers for faculty familiarization will ensure that disruption is minimized and creativity maximized as indicated by Fig 5.

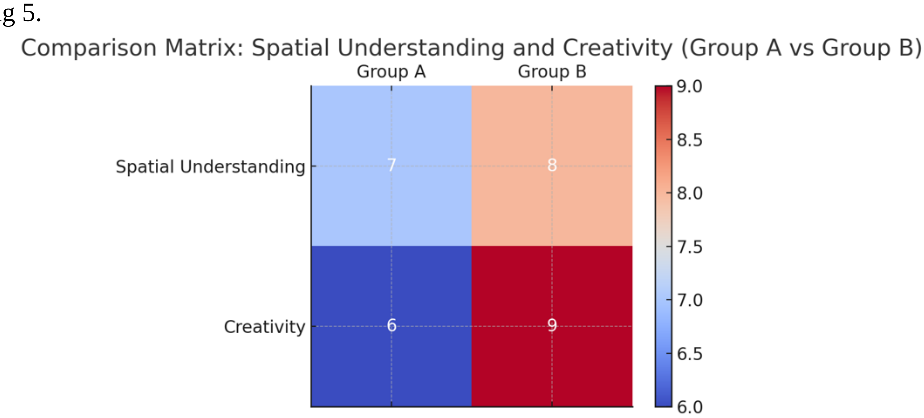

Fig. 5. Spatial understanding and creativity

5.1 The Role of Traditional Methods in a Hybrid Approach

Although the benefits of immersive technologies are apparent, the research also indicates that traditional approaches continue to be viable with minor changes. On the one hand, even if Group A was less skilled and engaged than Group B, their physical models were more polished. Therefore, the use of tactile skills is still prominent and foundational in the realm of design education. As such, instead of replacing traditional tools, immersive tools can be seen as an addition to them. The overall outcomes of the research show that both students in the study preferred and the faculty of the program preferred for students to use all the tools available to them, that is, VR, AR, and MR along with physical model-making, sketching, and CAD use. It is thus feasible to integrate the deployment of VR, AR, and MR into the hybrid approach favored both by the participants in the study and the faculty of higher education programs. The growing popularity of blended learning makes this step even more reasonable. While tactile engagement and physicality are still an important part of the learning process, the possibility to switch between the digital and the physical realms creates a versatile approach that can address the needs of different students. For that to happen, physical tools are here to stay in areas where the tactile experience is essential, relating to issues such as material choice, physical texture, and form.

2. Institutional Barriers and Solutions for Adoption:

   The institutional readiness survey shed light on several barriers that schools face when attempting to implement immersive technologies. Budget constraints, limited infrastructure, and a lack of faculty expertise were the most frequently cited issues. Only 40% of institutions reported having access to the necessary hardware and software for immersive learning, and over 65% of faculty indicated they would require substantial training to effectively teach using these tools.

   To address these barriers, the framework developed from this study proposes several solutions:

- Phased infrastructure upgrades: Instead of making large, upfront investments in immersive technologies, institutions can start with small-scale pilot programs, gradually scaling up as they assess the success and integration of the tools.
- Faculty development: Continuous professional development for faculty is critical. Workshops, partnerships with technology providers, and ongoing training programs will be essential for educators to gain confidence in using VR, AR, and MR effectively.
- Curriculum integration: Institutions should take a phased approach to curriculum changes, gradually incorporating immersive tools into existing courses while ensuring that traditional methods remain foundational. This allows for smooth transitions and ensures students benefit from both approaches.

3. Student Experience and Engagement

Another important section of the student and faculty engagement study was the overall reception of the immersive technologies by students. The results (Fig 6) were generally positive – approximately 70% of students reported high levels of excitement when they were able to use VR/AR/MR in their projects, and 60% said that such tools made their project more fun and engaging and facilitated the development of ideas. Nevertheless, there were some apparent challenges, most notably related to the accessibility of these tools for students. There were also some minor problems with usability – some students found the instrumentation too cumbersome and difficult to work with. Some students working using VR headsets for longer periods of time reported problems with discomfort. Occasionally, there were also some technical issues with the applications used they would sometimes crash or not work properly.

Most students reported that this equipment was only available in the classroom and that they could not use similar devices at home. Thus, students had to come to campus and spend time in class to practice using these tools. For VR specifically, large-scale practice at this time was still impractical, as there was not enough equipment to go around. Still, some students were able to develop their projects primarily for VR. In the future, institutions may have to consider developing some kind of lending program for such equipment, or making sure that all coursework can be completed with the more accessible, lower-tech solutions.

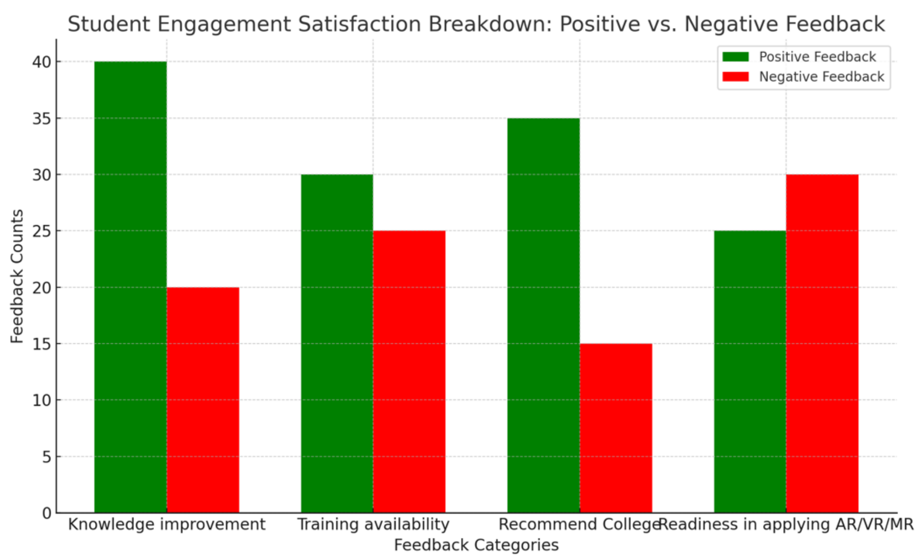

Fig 6. Student engagement satisfaction chart with breakdowns of positive vs. negative feedback

4. Framework for Future Adoption

In conclusion, the following study offers a practical hub for the integration of Immersive technologies within the context of design education being both sustainable in the long term and scalable. This hub includes faculty development, infrastructure enhancement, and a curriculum integration pathway, which should guarantee that the immersive technologies will work to the benefit instead of becoming an obstacle to the application of the available system of education. The hub may be used at educational institutions of different size and different budget as it suggests some options for the introduction of immersive tools. In the end, one of the absolute pluses of the hub in question is the addition of a feedback mechanism, in which the students and faculty members return their response and shape the further form of technology integration. In the broader context, the hub puts the values of the Immersive technologies and concludes them within the context of the available design curriculum, a significant tautological argument that nevertheless provides an advantage. In other words, the hub does not only stress the values of Immersive technologies in the context of design education as regards the students' creative and spatial reasoning skills. One of the findings is that their integration requires infrastructure and faculty development. However, the optimal option is a combination of immersive and conventional techniques.

6. CONCLUSION AND FUTURE WORK

This study underlines the high transformation potential of the use of immersive technologies—VR, AR, and MR—in design education due to the boost of spatial understanding and creativity and higher dedication of students. However, the study also stresses that the implementation of new technologies should not exclude existing tools but bolster them to form a more profound and more diverse learning environment. The roadmap suggests a clear trajectory for institutions interested in the integration of apparat and provides a response to the urgent needs and constraints, such as the readiness of institutions, the preparedness of faculty, and institutional budget. The suggested step-by-step implementation serves as a reasonable compromise between the introduction of innovative trends and the preservation of the use of hands-on design practices whose effectiveness has been tested by time. In future research, the focus of attention could be put on the development of approaches to the implementation of immersive tools, facilitated by the adoption of the more longitudinal type of studies to keep track of student performance over time and their increase of ability to adapt. The search for more affordable and approachable means of introducing students to immersive tools is another area of concern. The implementation of modular discipline- cantered frameworks could also provide for a more nuanced use of the integration approach for the benefit of separate branches of design.

This approach will allow institutions to evolve their educational offerings while keeping pace with the rapidly changing landscape of design and technology.

Funding:

The authors confirm that no external funding, financial grants, or sponsorships were provided for conducting this study. All research activities and efforts were carried out with the authors' own resources and institutional support.

Conflicts of Interest:

The authors declare that they have no conflicts of interest in relation to this work.

Acknowledgment:

The authors would like to extend their gratitude to their institutions for the valuable moral and logistical support provided throughout the research process

References

[1] J. Radianti, T. A. Majchrzak, J. Fromm, and I. Wohlgenannt, "A systematic review of immersive virtual reality applications for higher education: Design elements, lessons learned, and research agenda," Comput. Educ., vol. 147, p. 103778, 2020.

[2] P. MacDowell and J. Lock, Immersive Education. Springer, 2022.

[3] L. Calvet, P. Bourdin, and F. Prados, "Immersive technologies in higher education: Applications, challenges, and good practices," in Proc. 2019 3rd Int. Conf. Educ. E-Learning, 2019.

[4] C. Ranscombe and K. Bissett-Johnson, "Digital Sketch Modelling: Integrating digital sketching as a transition between sketching and CAD in Industrial Design Education," Design Technol. Educ.: Int. J., vol. 22, no. 1, pp. 1-15, 2017.

[5] T. N. Elkær, "Using Computers to Aid Creativity in the early stages of Design-or not!: Rehabilitating the 2D/3D physical representation in Computer-Aided-Ideation," in Computation: The New Realm of Architectural Design: 27th eCAADe Conf. Proc., Istanbul, Cenkler Printing, 2009.

[6] M. Kraus et al., "The value of immersive visualization," IEEE Comput. Graph. Appl., vol. 41, no. 4, pp. 125-132, 2021.

[7] Y.-M. Tang et al., "Evaluating the effectiveness of learning design with mixed reality (MR) in higher education," Virtual Reality, vol. 24, no. 4, pp. 797-807, 2020.

[8] F. Yang and Y. M. Goh, "VR and MR technology for safety management education: An authentic learning approach," Safety Sci., vol. 148, p. 105645, 2022.

[9] S. Bryson, "Approaches to the successful design and implementation of VR applications," Virtual Reality Appl., vol. 1, pp. 3-15, 1995.

[10] C. Moro, Z. Štromberga, A. Raikos, and A. Stirling, "The effectiveness of virtual and augmented reality in health sciences and medical anatomy," Anat. Sci. Educ., vol. 10, no. 6, pp. 549-559, 2017.

[11] J. Bacca, S. Baldiris, R. Fabregat, S. Graf, and Kinshuk, "Augmented reality trends in education: A systematic review of research and applications," Educ. Technol. Soc., vol. 17, no. 4, pp. 133-149, 2014.

[12] L. Avraamidou and M. Evagorou, "Coding in primary schools: teachers' views and concerns on teaching practices and the integration of technology," Technol. Pedagogy Educ., vol. 29, no. 2, pp. 245-258, 2020.

[13] M. C. Johnson-Glenberg, "Immersive VR and education: Embodied design principles that include gesture and hand controls," Front. Robot. AI, vol. 5, p. 81, 2018.

[14] G. Makransky, T. S. Terkildsen, and R. E. Mayer, "Adding immersive virtual reality to a science lab simulation causes more presence but less learning," Learn. Instr., vol. 60, pp. 225-236, 2019.