Perceptions of academics on the integration of extended reality tools in undergraduate education at the Universidad de Tarapacá

Percepción de los académicos sobre la integración de herramientas de Realidad Extendida en la educación de pregrado en la Universidad de Tarapacá

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ABSTRACT

The integration of Extended Reality (XR) technologies, including Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR) into higher education demonstrates significant potential to transform pedagogical approaches. XR technologies create immersive, interactive environments that promote active student engagement, deepen understanding of complex concepts, and provide safe spaces for experiential learning. However, their effective adoption is hindered by critical challenges, such as resistance to change, infrastructural limitations, and the necessity for specialised academic training. This study examines the perceptions of academics at the Universidad de Tarapacá regarding the use of XR, specifically Meta Quest 3 devices, in their teaching practices. The findings reveal strong academic acceptance of XR, highlighting its potential to address educational issues such as limited resources and risks inherent in laboratory activities. Nevertheless, the study also identifies ongoing impediments, including the need for tailored applications, improved institutional infrastructure, and continuous faculty development. In conclusion, while the academic community shows a clear predisposition toward XR adoption, successful implementation requires a strategic approach to overcoming these barriers. Future initiatives should prioritize the development of discipline-specific XR solutions and the establishment of robust support mechanisms to enable the widespread, effective use of this technology across academic fields.

Keywords: Mixed reality, higher education, collaborative environments, virtual reality.

RESUMEN

La integración de las tecnologías de Realidad Extendida (XR) que abarcan la Realidad Virtual (VR), la Realidad Aumentada (AR) y la Realidad Mixta (MR) en la educación superior posee un potencial significativo para transformar la pedagogía. Estas tecnologías crean entornos inmersivos e interactivos que fomentan la participación activa de los estudiantes, mejoran la comprensión de conceptos complejos y proporcionan espacios seguros para el aprendizaje experiencial. Sin embargo, su adopción efectiva se ve obstaculizada por desafíos críticos, tales como la resistencia al cambio, las limitaciones de infraestructura y el requerimiento de capacitación académica especializada. Este estudio investiga las percepciones de los académicos de la Universidad de Tarapacá respecto al uso de la XR, específicamente de los dispositivos Meta Quest 3, en sus prácticas docentes. Los hallazgos revelan una sólida aceptación

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académica de la XR, destacando su potencial para abordar problemas educativos como la limitación de recursos y los riesgos inherentes a las actividades de laboratorio. No obstante, el estudio también identifica impedimentos persistentes, incluyendo la necesidad de aplicaciones personalizadas, una mejora en la infraestructura institucional y el desarrollo docente continuo. En conclusión, si bien la comunidad académica muestra una clara predisposición hacia la adopción de la XR, su implementación exitosa requiere un enfoque estratégico para superar estas barreras. Los esfuerzos futuros deben dirigirse hacia el desarrollo de soluciones de XR específicas para cada disciplina y el establecimiento de mecanismos de apoyo robustos para facilitar el uso generalizado y efectivo de esta tecnología en diversos campos académicos.

Palabras clave: Realidad mixta, educación superior, entornos colaborativos, realidad virtual.

INTRODUCTION

The integration of immersive technologies has created new opportunities to enhance teaching and learning in higher education [1]. Extended Reality (XR), including Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR), facilitates the creation of highly interactive environments that promote active student engagement. These technologies improve comprehension of complex concepts, provide safe spaces for experiential learning, and support the acquisition of practical skills across multiple disciplines [2].

However, the effective integration of XR into university education faces significant barriers [3]. Key institutional challenges include the need for robust infrastructure and specialized pedagogical training for faculty members [4]. Additionally, academic staff's perceptions are a critical factor influencing the success of these initiatives, as their acceptance and commitment are vital for sustainable integration [5]. This context highlights a significant research gap: understanding faculty members' practical perceptions of new technologies is essential for developing effective implementation strategies.

The study investigates how academics at the Universidad de Tarapacá perceive the use of XR tools, specifically Meta Quest 3 devices, within their teaching practices. The study explores the technology's potential benefits, the challenges faculty encounter during its implementation, and the broader implications for institutional educational innovation. This research aims to provide valuable insights for other academic institutions considering adopting similar technologies.

LITERATURE REVIEW

Extended Reality (XR), which includes Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR), has become a significant catalyst for change in educational contexts. The ability of XR to create immersive and interactive environments has been widely studied for its potential to enhance student engagement, knowledge retention, and practical skill acquisition [6]-[8]. The availability of advanced, accessible hardware platforms, such as the Meta Quest 3, enables the scalable implementation of XR in university settings. However, because XR represents a significant departure from traditional pedagogical approaches, a thorough analysis of critical implementation factors is essential to ensure its appropriate and effective use.

Adequate faculty training is an essential prerequisite for successful XR integration. Studies emphasise that academics must become proficient with technological tools and develop robust pedagogical strategies to integrate these tools effectively into curricula [9]. This training should span both technical aspects (e.g., configuration and software management) and didactic considerations (e.g., designing immersive learning activities), aligning with the course's specific educational goals.

The educational impact of XR has been thoroughly assessed across various disciplines. For instance, a meta-analysis conducted by Merchant *et al.* [10] demonstrated that the use of VR can significantly improve learning outcomes compared to traditional instructional methods. Within the university context, applications like virtual simulations, immersive laboratories, and 3D tours have proven particularly effective in fields such as medicine, engineering, and social sciences [11], [12].

Recent advancements in hardware and software have facilitated the widespread adoption of XR technologies. The Meta Quest 3, recognized for its high-quality immersive capabilities, provides an affordable, accessible platform for developing XR-supported learning environments [13]. The synergy between development platforms such as Unity, programming languages like C#, and the Meta Quest Developer Hub (MQHD) has streamlined the development of tailored virtual and XR experiences [14]-[16]. These technological advancements have enabled promising applications across diverse fields, including medical simulations for surgical procedures [17], aeronautics and robotics education [18], [19]

Despite these promising developments, integrating XR in education settings faces several significant barriers. One major challenge is the steep learning curve for academics and students [20]. Additionally, the initial cost of equipment and the need for robust technological infrastructure pose significant obstacles to widespread adoption [21]. Crucially, studies caution against using technology as a mere novelty. The design of XR experiences should be meticulously aligned with defined learning objectives to ensure a meaningful pedagogical outcomes [22]. This fact underscores the fundamental importance of understanding the perceptions and opinions of teaching staff when implementing such innovative initiatives.

METHODOLOGY

A structured methodological process was developed to gather the opinions of academics at the Universidad de Tarapacá regarding the integration of Extended Reality (XR) technologies in the classroom. This approach was designed to systematically collect and analyse faculty perceptions, ensuring the data's rigor and relevance in alignment with the previously discussed literature review. The complete process is detailed in the following sections and is visually summarized in Figure 1.

Workshop definition

The initial phase of the methodology involved defining the workshop type and its associated activities. Given that Extended Reality (XR) technologies were not widely familiar to academics at the Universidad de Tarapacá, an initial training session was designed to introduce the core concepts of XR and its various categories; this was followed by a practical familiarisation with the functionalities of Meta Quest 3 devices. The workshop was structured into four stages, designed to guide academics from theory to practical application:

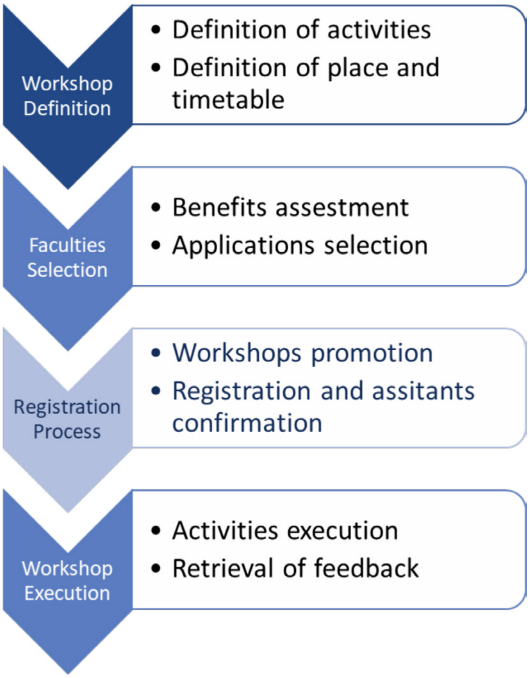

Figure 1. Methodology for collecting academics' opinions on XR and its use in the classroom.

1. **Conceptual Introduction:** An overview of the fundamentals of Mixed Reality (MR), its classification, and technical requirements.
2. **Technical Demonstration:** An examination of the technical and functional features of the Meta Quest 3 headsets.
3. **Educational Applications:** A presentation of case studies and practical examples illustrating virtual reality use to teach specific subjects.
4. **Research Projects:** An exploration of the research opportunities offered by this technology aimed at fostering interdisciplinary collaboration.

A hands-on experience was developed to complement the presentations, enabling academic participants to interact directly with the XR technologies. Two types of applications were selected: one facilitating individual interaction with virtual educational elements and another supporting collaborative participation. Both experiences were designed in a Mixed Reality (MR) environment to provide safe, practical on-screen visualization, a key feature of the Meta Quest 3. Technical limitations, such as connectivity, device availability, and laboratory space, restricted the maximum number of participants per workshop to ten. The duration and activities for each phase of the workshop are detailed in Table 1.

Faculty selection

In line with the workshop structure, the subsequent phase involved identifying the faculties that would benefit most from Extended Reality (XR) integration. The selection process was guided by two primary criteria: the potential for XR applications to reduce risks and costs, and the direct relevance to current classroom practices. Accordingly, the Faculty of Health Sciences, the Faculty of Medicine, and the Faculty of Engineering were selected for their intensive engagement with physical devices and real-world elements in their respective fields.

Participants engaged in hands-on activities using two distinct applications selected for the workshop. For individual interaction, Human Anatomy VR [23]-[25] was used to demonstrate effective engagement with interconnected virtual objects. Although this application is primarily designed for health and medicine, its design principles are applicable to a range of disciplines, including engineering. For the collaborative component, the Discover [26] application was selected, with a focus on its bicycle assembly activity. This activity, although seemingly simple, effectively demonstrated the Meta Quest 3 device's collaborative capabilities.

Table 1. Activities and time allocation for XR training using Meta Quest 3.

Activity	Duration (approx.)
Participant reception and laboratory introduction.	15 minutes
Concept presentation.	30 minutes
Meta Quest 3 hands-on activities.	45 minutes
Discussion and satisfaction survey.	30 minutes

Registration process

After selecting the relevant faculties and applications, the registration process for academic participants was initiated. Workshops were promoted at the departmental level within the selected faculties to encourage broad participation. A total of 56 academics registered, and their distribution across faculties is presented in Figure 2. The Faculty of Health Sciences recorded the highest number of registrants, followed by the Faculty of Engineering and the Faculty of Medicine.

After registrations were completed, the workshop dates were coordinated with deans and department heads. The finalized schedule is shown in Table 2. Upon notification of the scheduled dates, 52 academics confirmed their attendance.

Workshop execution

The workshops were conducted as scheduled in Laboratory 300 of the DGDT at the Velásquez Campus. This location was chosen for its specialised facilities and the availability of trained technical staff. Following the workshops, the structure and survey results are presented in the following section.

PRESENTATION AND ANALYSIS OF RESULTS

Survey structure

The survey administered to academic participants was designed to assess their perceptions regarding

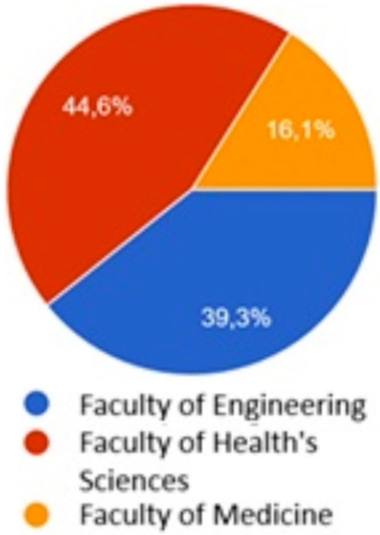

Figure 2. Distribution of registrants by faculty.

Table 2. Workshop dates by faculty and department.

Faculty	Department	Workshop Date
Engineering	Computers and Informatics.	July 11th
	Mechanical/Mechatronics.	July 19th
	Electrical and Electronics.	July 23th
	Industrial and Systems.	July 25th
Health Sciences	Nursing.	July 30th
	Kinesiology and Nutrition.	August 1th
	Obstetrics and Pediatrics.	August 6th
	Medical Technology.	August 8th
Medicina	Biomedical Sciences.	July 31th
	Clinical Sciences.	July 31th

the integration of Extended Reality (XR). A Likert scale was employed, a method widely recognized for its effectiveness in evaluating user interfaces and experiences due to its simplicity and clarity [27]-[29]. The survey was administered online via Google Forms and consisted of two main sections.

The first section used a 5-point Likert scale ranging from "strongly disagree" (1) to "strongly agree" (5) to assess core perceptions of the technology. Key questions examined the relevance of integrating mixed reality into the classroom, the perceived ease of use of the Meta Quest 3 device, and the faculty perception of its suitability for enhancing learning. This section also explored students' anticipated adaptability to the technology, drawing on findings from prior experiences discussed in the literature review. The questions for this section were:

1. I consider the integration of mixed reality in the classroom relevant.
2. I found the Meta Quest 3 device easy to understand.
3. I had no issues using the Meta Quest 3 device.
4. I believe my students will quickly adapt to this technology.
5. I consider the use of VR headsets an appropriate tool for enhancing classroom learning.

The second section assessed faculty's willingness to adopt the technology and included a dichotomous question about considering using the Meta Quest 3 for course integration. Respondents who answered affirmatively were prompted to specify the types of activities for device integration, such as high-cost or hazardous laboratory experiences, collaborative projects, or non-conventional educational activities. The questions of this section were:

6. Would you like to use the Meta Quest 3 in any of your course activities?
   Options: "Yes," "No," or "Maybe".

For those who answered affirmatively, a follow-up question was asked:

7. If your answer was YES, in which activities might you like to use the device?

Options:

a. Laboratory experiences with limited resources.
b. Laboratory experiences with high-cost, failure-prone, or hazardous equipment.
c. Non-conventional educational experiences.
d. Collaborative educational experiences.
e. Practice and/or training for knowledge review.
f. Other.

Results first section: Satisfaction with the experience.

Among the 52 academics who confirmed their attendance, 44 completed the voluntary survey, resulting in a completion rate of 84.6%. The age distribution of the participants was evenly spread across 30 and 60 years. The results of the first section of the survey are presented below.

The initial section of the survey yielded highly positive results. A significant majority (97.8%) of academics considered integrating mixed reality into their courses to be relevant, with no participants expressing a negative opinion.

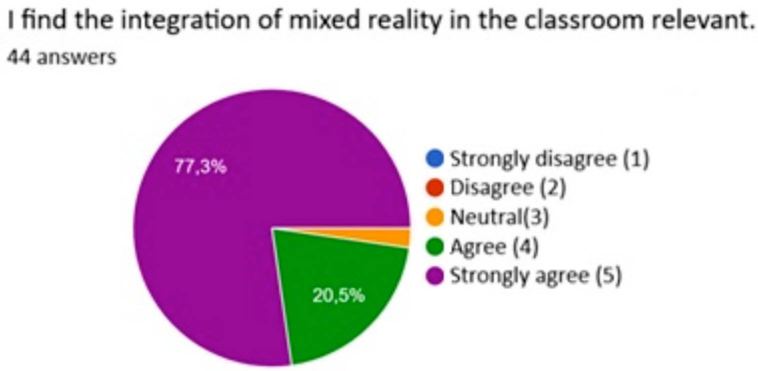

Figure 3. Results for Question 1.

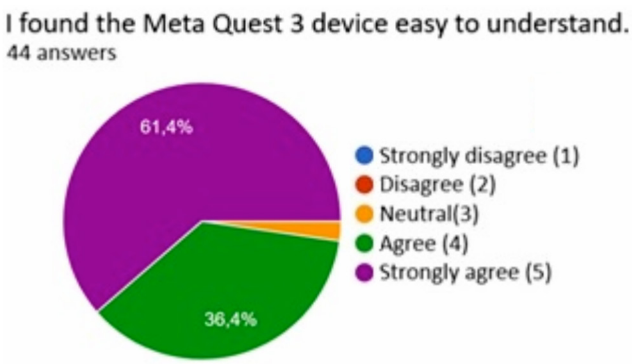

Figure 4. Results for Question 2.

Perceptions of the device's user-friendliness were highly favorable. A significant majority of academics (97.8%) reported that the Meta Quest 3 headset was easy to understand. Furthermore, the data revealed a complete absence of negative feedback, indicating a strong consensus on the device's intuitive nature.

A strong majority of the participants (~90%) reported a seamless user experience, with no issues during the device's operation. These results underscore the Meta Quest 3's high usability and suggest strong potential for broad adoption with minimal technical frictions.

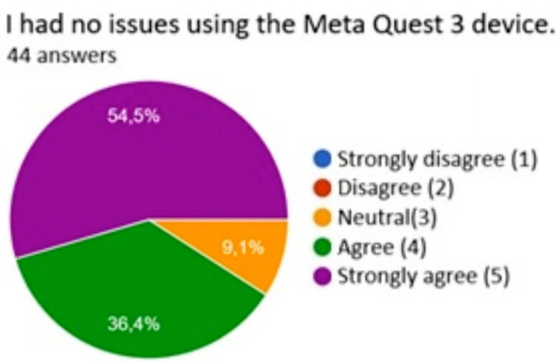

Figure 5. Results for Question 3.

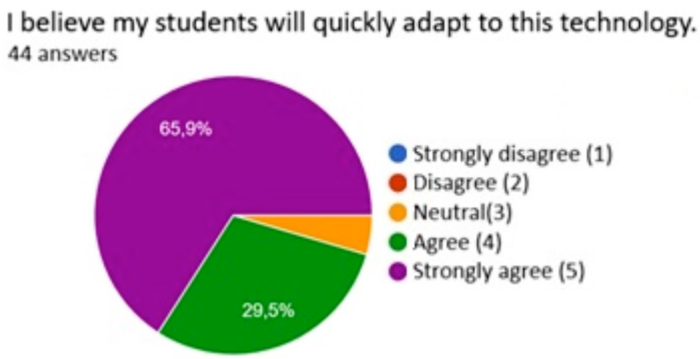

Figure 6. Results for Question 4.

A significant majority of participants (over 95%) expressed confidence in their students' ability to rapidly adapt to the technology. This finding suggests that faculty perceive the students' learning curve as minimal, a critical factor for successful implementation.

The survey revealed a near-unanimous consensus regarding the educational value of VR headsets, with 97.7% of academics agreeing that these devices are suitable tools for enhancing classroom learning. This finding highlights a strong faculty belief in the pedagogical potential of immersive technologies.

Results second section: Integration of MR into Courses

A large majority of academics expressed their willingness to use the Meta Quest 3 in their courses. A notable 84.1% provided an affirmative response, and no negative feedback was recorded (Figure 8).

Among respondents interested in integrating the technology, the most frequently identified applications were:

- *Practice and training for knowledge review* represented the most common intended use, cited by 58.1% of respondents.
- *Laboratory experiences with limited resources* ranked second-most popular option, selected by 51.2% of respondents.

These and other results are shown in Figure 9.

Analysis of results and discussion

The workshops received highly positive feedback from participating academics, who expressed significant interest in integrating Extended Reality (XR) technologies into their courses. Faculty members' disciplines expressed a strong willingness to adopt these technologies to enhance student learning outcomes.

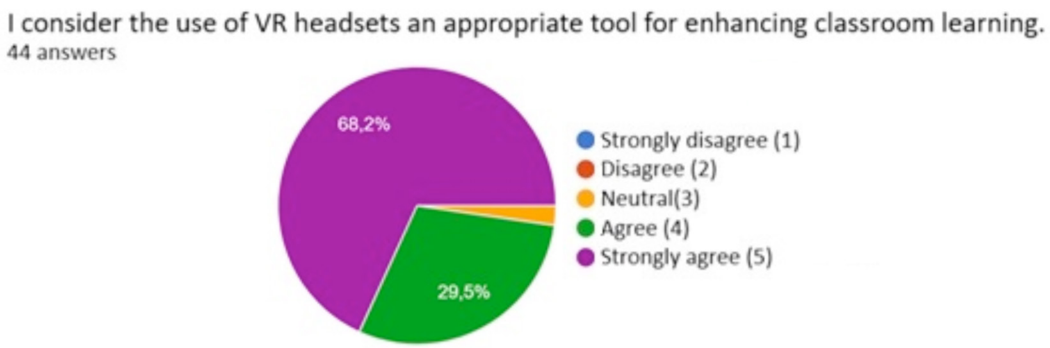

Figure 7. Results for Question 5.

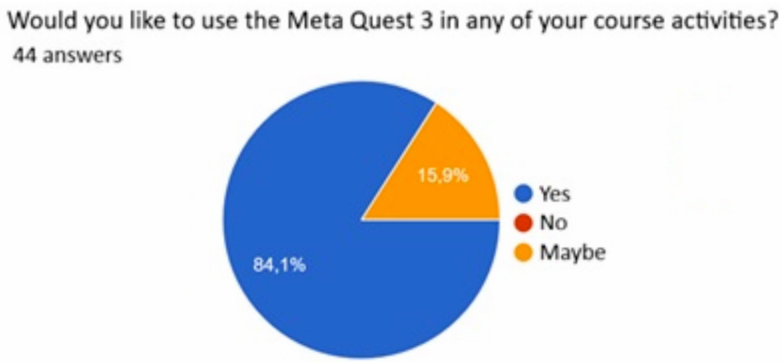

Figure 8. Results of Question 6.

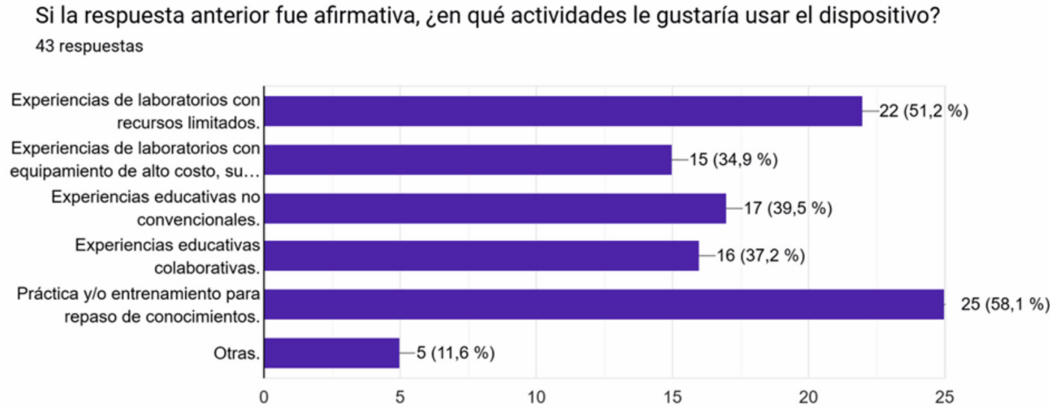

Figure 9. Results of Question 7.

Key findings

A majority of academics recognized the relevance of integrating XR technologies into classroom settings, with 97.8% agreeing that Mixed Reality (MR) serves as a valuable tool for enhancing learning. This finding highlights the increasing acceptance of immersive technologies as effective solutions to traditional educational challenges, including limited resources and the need for hands-on practice.

Furthermore, the Meta Quest 3 was regarded as highly user-friendly, with over 97% of participants reporting no difficulties in understanding or operating the device. This ease of use is critical for widespread adoption, as it reduces the learning curve for both educators and students. Consequently, academics expressed strong confidence (over 95%) in their students' ability to rapidly adapt to XR technologies. This finding suggests that students, who are often more familiar with digital tools, are likely to embrace immersive learning environments, thereby supporting the integration of XR into curricula.

The most frequently suggested applications for XR included practice and knowledge review (58.1%) and laboratory experiences in settings with limited resources (51.2%). These findings indicate that XR can address specific educational needs, such as providing safe, cost-effective alternatives to high-risk or high-cost laboratory activities. Additionally, the collaborative application Discover received particularly positive feedback, underscoring XR's potential to enhance teamwork and problem-solving skills in a virtual environment. This aligns with the growing emphasis on collaborative learning in modern education.

Discussion

The predominantly positive findings regarding academic perceptions of XR integration align significantly with the general potential previously established in the literature. Specifically, the strong academic endorsement for XR as a tool for enhancing classroom learning (97.7% agreement) aligns with the meta-analysis by [10], which demonstrated that VR can significantly improve learning outcomes compared to traditional methods. The data confirms that the perceived pedagogical value is a substantial driver for faculty adoption.

A critical point of convergence between this study and the existing body of work is the recognition of XR's potential to address practical limitations. The high interest in using Meta Quest 3 for laboratory experiences with limited resources (51.2%) and for simulation involving hazardous or high-cost equipment provides strong support for XR's demonstrated efficacy in applied fields, such as the medical simulations discussed by [17] and the engineering applications cited by [18] and [19]. Faculty-identified needs further corroborate the literature's emphasis on XR as a cost-effective and safe alternative for practical skill development.

The study's results mitigate one of the major barriers highlighted in the literature review: the technical learning curve. The near-unanimous agreement (97.8%) that the Meta Quest 3 device was easy to understand and operate stands in direct contrast to the steep learning curve reported by [20] and [21] for general XR adoption. This positive perception of usability suggests that the current generation of hardware, as exemplified by the Meta Quest 3's affordability and accessibility [13], is effectively bridging the technical gap and accelerating the potential for widespread uptake among academics at the Universidad de Tarapacá.

Conversely, the identified limitations in the current study reinforce challenges previously established in academic discourse. The reliance on commercial applications, recognized as a methodology constraint, underscores the caution issued by Zwoliński *et al.* [22] regarding the need to align XR experiences with specific learning objectives. While faculty acceptance is high, developing discipline-specific content remains essential to achieve the pedagogical impact sought by Meccawy [9].

In summary, the perspectives of academics at the Universidad de Tarapacá corroborate the foundational benefits of XR established in the literature while providing validation of the usability of modern, accessible hardware. The subsequent phase of successful integration should address the ongoing infrastructural and content development barriers identified by [4], ensuring that faculty training progresses from basic technological familiarization to the development of advanced pedagogical strategies.

Challenges and limitations

Despite the study's positive outcomes, it identified several challenges. A primary limitation was the reliance on commercial applications like Human Anatomy VR and Discover, which revealed constraints on customization and adaptability to specific course requirements. Developing locally tailored solutions may address this limitation.

A further issue is that the successful implementation of XR technologies depends on adequate infrastructure, including high-performance devices and reliable connectivity. Ongoing training for academic staff is essential to ensure effective integration into teaching practices. Participants identified the need for enhanced visual elements, such as higher-quality animations and avatars, to improve the realism and engagement of XR experiences.

CONCLUSIONS

The findings of this study highlight the transformative potential of Extended Reality (XR) technologies in advancing higher education at the Universidad de Tarapacá. The overwhelmingly positive feedback from academics in the Faculties of Health Sciences, Medicine, and Engineering underscores the relevance and applicability of XR across diverse educational contexts.

Building on the success of this study, several avenues for future research and implementation are proposed, including creating XR applications tailored to the specific needs of different faculties and courses to enhance relevance and effectiveness. For instance, engineering applications could simulate complex machinery, while medical applications could focus on surgical training. Currently, some tailored applications have already been developed under the authors' guidance.

Although this study focused on Health Sciences, Medicine, and Engineering, future research could explore the application of XR across the humanities, social sciences, and business education. Conducting long-term studies to assess the impact of XR on student learning outcomes, retention rates, and skill development will provide valuable insights into its effectiveness as an educational tool.

The Meta Quest 3 represents a significant advancement in XR technology; however, future studies should examine the use of even more advanced devices, such as haptic feedback systems or augmented reality glasses, to further enhance immersion and interactivity. Additionally, implementing comprehensive training programs for academics, including workshops, online courses, and peer mentoring, will ensure the effective integration of XR technologies into their teaching practices.

The findings of this study have broader implications for the future of education. As XR technologies become increasingly accessible and affordable, they have the potential to democratize access to high-quality educational experiences, particularly in regions with limited resources. XR facilitates immersive, interactive, and collaborative learning environments that bridge the gap between theoretical knowledge and practical application, better preparing students for the challenges of the modern workforce.

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