

First Exposure to Virtual Reality in Medical Education: Insights From *Meta Quest 2* Use

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ABSTRACT: **Introduction:** Virtual reality (VR) is increasingly integrated into medical education, yet its impact on student engagement and learning outcomes is not fully defined. This study evaluated medical students' experiences with VR (*Meta Quest 2*) for procedural skills training. **Methods:** A cross-sectional survey was conducted with third-year medical students at the Faculty of Medicine, University of Lisbon over one semester. Participants trained in intubation, arterial line placement, thoracentesis, paracentesis, and central line insertion using *Meta Quest 2* headsets. The survey assessed familiarity, engagement, perceived realism, quality, effectiveness, helpfulness for understanding procedures, and preference for VR over traditional methods. Descriptive statistics were calculated, and chi-square tests explored gender differences. **Results:** Of 298 respondents (81% response rate), 5% were very familiar with VR, while 60% were not familiar at all. Engagement was high, with 54% feeling very engaged and 37% somewhat engaged. Realism was rated somewhat realistic by 56% and very realistic by 20%. VR was considered somewhat effective by 58% and very effective by 30%. Fifty-five percent preferred VR over traditional methods, and 67% supported its integration into the curriculum. For procedural understanding, 64% found VR very helpful and 31% somewhat helpful. **Conclusion:** VR training improved students' confidence and procedural understanding despite limited prior exposure. While improvements in realism and technical accuracy are needed, the high engagement and positive perceptions support VR's role as a valuable adjunct to traditional teaching in medical education.

KEYWORDS: Virtual reality; Medical education; *Meta Quest 2*; Simulation Training; Clinical Competence.

INTRODUCTION

Virtual Reality (VR) is a digital educational tool that leverages computer technology to create immersive three-dimensional (3D) environments that users can interact with in seemingly real ways^[1]. Virtual worlds are three-dimensional settings built around multiplayer on-

line games that let players communicate without time or place restrictions^[2]. These environments can simulate clinical settings for training emergency personnel in managing mass-casualty incidents^[3], with avatars representing patients to create realistic simulations. VR provides a more immersive experience than traditional methods^[1,4], enhancing spatial understanding and student motiva-

tion. Studies show that VR-based learning can be as effective, if not more so, than traditional methods like lectures, textbooks, and cadaveric dissection^[1,4,5].

Several studies have underscored the potential of VR in medical education, highlighting its ability to improve student engagement, knowledge retention, and the acquisition of clinical skills^[4-6]. The immersive nature of VR makes it a powerful tool for enhancing the learning experience, offering a dynamic and interactive platform for students to practice and refine their skills^[4,6-8].

VR in medical education primarily focuses on two areas: developing technical competencies and teaching soft skills. Meta Quest 2 mainly focuses in developing technical competencies, allowing learners to engage in surgical procedures with simulated patients^[4-7].

This research intends to build on these findings by providing a comprehensive analysis of MS feedback on VR use to teach technical skills^[9]. The study aims to systematically gather and analyze feedback from medical students on their firsthand experiences with virtual reality (VR) technologies, focusing on the use of Meta Quest 2.

METHODOLOGY

This study was designed as a cross-sectional observational study conducted during a semester at the Faculty of Medicine, University of Lisbon. A total of 368 third-year medical students were enrolled in the "Introduction to Clinical Practice" course and were included without exclusion criteria.

During the teaching period, students participated in a 50-minute VR training session using Meta Quest 2 headsets with NP Skills Lab software. Students could choose to practice one of the following procedures: intubation with direct laryngoscopy, arterial line insertion, thoracocentesis, paracentesis, or central line placement. All procedures were performed in a VR environment with visual support from ghosted hands, clear procedural protocols, and a guidance mode. These techniques were also taught during in-room lectures and integrated into clinical case discussions over the semester.

The survey instrument was developed with the support of artificial intelligence (chatgpt, GPT-4) to evaluate familiarity with VR, engagement level, perceived realism, and preference for VR compared to traditional teaching methods. The questionnaire contained both closed-ended items using 5-point Likert scales and open-ended questions for qualitative feed-

back. Participation was voluntary and responses were anonymous.

The survey was distributed immediately after the VR session via a QR code, allowing real-time data collection to capture impressions while the experience was fresh. Data were analyzed using IBM SPSS Statistics, version 29.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics (means, standard deviations, frequencies, and percentages) were calculated, and Pearson's chi-square test was used to examine associations between categorical variables. A significance level of $p < 0.05$ was adopted. [Institutional Ethics Committee (Reference No. 241/24).]

RESULTS

The study population consisted of 297 third-year medical students, with a response rate of 81%. The majority of participants were under 21 years of age, and 70% were female, reflecting the overall demographic profile of third-year students.

Survey responses are summarized in Table 1. The results indicate that only 5% of the students were very familiar with VR technology, while the majority (60%) were not familiar at all. A closer look at gender distribution shows that 40 women and 139 men rated themselves as not familiar at all, while only 9 women and 6 men reported being very familiar. Chi-square analysis confirmed a statistically significant association between gender and familiarity. The p-value of <0.0001 for this question indicates a highly significant difference between female and male participants in their familiarity with virtual reality technology, with male respondents more frequently reporting being "very familiar" compared to their female counterparts.

Regarding engagement with VR, 54% of the students reported being very engaged, 37% somewhat engaged, 6% neutral, and 2% somewhat disengaged. Among them, 110 women and 51 men reported being very engaged, while 77 women and 32 men were somewhat engaged.

When it comes to the perceived realism of VR technology, 56% of the students found it somewhat realistic, 20% very realistic, 15% neutral, and 9% not very realistic. Perceived quality was also explored, with 50% rating the experience as good and 41% as excellent (Figure 1). Gender analysis showed that 106 women and 43 men rated it as good, **while** 83 women and 38 men rated it as excellent.

TABLE 1. Survey responses

Survey question	N	Percentage (%)	Female n(%)	Male n(%)	P-value	
How familiar are you with virtual reality technology?	Very familiar	15	5	6 (3,4%)	9 (10,2%)	< 0,0001
	Somewhat familiar	102	35	62 (29,8%)	40 (44,9%)	
	Not familiar at all	179	60	139 (66,8%)	40 (44,9%)	
How often do you use virtual reality technology?	Daily	0	0	0	0	0,403
	Weekly	5	1	3 (1%)	2 (2,2%)	
	Monthly	8	3	5 (2,4%)	3 (3,4%)	
	Rarely	80	27	51 (24,5%)	29 (32,6%)	
	Never	205	69	150 (72,1%)	55 (61,8%)	
How do you rate the quality of virtual reality experience?	Excellent	121	41	83 (39,9%)	38 (42,7%)	0,9
	Good	149	50	106 (51,9%)	43 (48,3%)	
	Average	23	8	16 (7,7%)	7 (7,9%)	
	Poor	2	0	1 (0,5%)	1 (1,1%)	
How effective do you think virtual reality is as a tool for practicing surgical procedures?	Very poor	0	0	0	0	0,286
	Extremely effective	88	29	62 (29,8%)	26 (29,2%)	
	Somewhat effective	173	58	123 (59,3%)	50 (56,2%)	
	Neutral	20	7	13 (6,3%)	7 (7,9%)	
	Somewhat ineffective	13	4	9 (4,6%)	4 (4,5%)	
How engaged did you feel during the virtual reality experience?	Completely ineffective	2	1	0	2 (2,2%)	0,557
	Very engaged	161	54	110 (52,9%)	51 (58,6%)	
	Somewhat engaged	109	37	77 (37%)	32 (37%)	
	Neutral	16	6	14 (6,7%)	2 (2,2%)	
	Somewhat disengaged	7	2	5 (2,4%)	2 (2,2%)	
Did you find the virtual reality surgical experience helpful in understanding the procedure better?	Very disengaged	1	0	1 (1%)	0	0,696
	Yes, very helpful	191	64	133 (64%)	58 (65,2%)	
	Somewhat helpful	92	31	63 (30,5%)	29 (32,6%)	
	Neutral	7	3	6 (3%)	1 (1,1%)	
	Not very helpful	6	2	5 (2,5%)	1 (1,1%)	
Would you prefer to learn using virtual reality technology instead of traditional methods such as textbooks or lectures?	Not helpful at all	0	0	0	0	0,954
	Yes, definitely	164	55	113 (54,3%)	51 (57,4%)	
	Somewhat	79	27	56 (26,9%)	23 (25,8%)	
	Neutral	30	10	22 (10,6%)	8 (9%)	
	Not really	21	7	15 (7,2%)	6 (6,7%)	
Would you prefer to practice procedures using virtual reality technology instead of traditional methods such as cadavers or animal models?	No, not at all	2	1	1 (1%)	1 (1,1%)	0,075
	Yes, definitely	53	18	32 (15,4%)	21 (23,6%)	
	Somewhat	85	29	67 (32,2%)	18 (20,2%)	
	Neutral	69	23	43 (20,7%)	26 (29,2%)	
	Not really	62	21	47 (22,6%)	15 (16,9%)	
How would you rate the realism of the virtual reality experience?	No, not at all	28	9	19 (9,1%)	9 (10,1%)	0,516
	Very realistic	58	20	41 (19,7%)	17 (19,1%)	
	Somewhat realistic	167	56	119 (57,2%)	48 (53,9%)	
	Neutral	45	15	29 (14%)	16 (18%)	
	Not very realistic	26	9	19 (9,1%)	7 (7,9%)	
How likely are you to recommend virtual reality technology for practicing surgical procedures to your peers?	Not realistic at all	0	0	0	1 (1,1%)	0,396
	Very likely	144	48	104 (50%)	40 (44,9%)	
	Somewhat likely	112	38	72 (34,5%)	40 (44,9%)	
	Neutral	23	8	17 (8,2%)	6 (6,7%)	
	Not very likely	16	5	13 (6,3%)	3 (3,5%)	
Do you think virtual reality technology for practicing procedures should be incorporated into medical school curriculums?	Not likely at all	2	1	2 (1%)	0	0,131
	Yes, definitely	200	67	141 (67,8%)	59 (66,3%)	
	Somewhat	73	25	48 (23,1%)	25 (28,1%)	
	Neutral	15	5	14 (6,7%)	1 (1,1%)	
	Not really	8	3	5 (2,4%)	3 (3,4%)	
In your opinion, at what stage of the medical curriculum is this technology most useful?	No, not at all	1	0	0	1 (1,1%)	0,907
	Since 1st year	143	49	100 (48%)	43 (50,3%)	
	Since 2nd year	3	1	2 (1%)	1 (1,7%)	
	In clinical years (> 3rd year)	147	50	106 (51%)	41 (48%)	

In terms of VR's effectiveness as a learning tool, around 90% of students responded positively. Regarding helpfulness, 64% found it very helpful and 31% somewhat helpful, with 133 women and 58 men in the first category and 63 women and 29 men in the second.

A majority of 55% of students indicated they would prefer to learn using VR instead of traditional methods. Interestingly, 50% believed VR is most useful in the clinical years (after the third year), while 48% found it useful from the first year. For curricular integration, 141 women and 59 men stated VR should definitely be incorporated into medical education.

When asked if they would recommend VR for practicing surgical procedures to peers, 48% were very likely and 38% somewhat likely to do so. Furthermore, 67% felt VR should be incorporated into medical school curriculums. These findings reinforce the perception of VR as a credible and desirable adjunct to traditional medical training.

Regarding qualitative feedback, students particularly appreciated the ability to repeatedly practice procedures, which significantly boosted their confidence before real-life applications. They felt more prepared and less anxious about performing actual procedures.

Students suggested several improvements to improve the VR experience. 40% recommended increasing the realism of procedures, particularly in gesture recognition, while 30% emphasized the need for more dynamic elements such as responsive vital signs. Additionally, 35% suggested that the tools should be more interactive and less guided to enhance realism and learning value, as their experience was based on the learning mode.

Several students also mentioned the need for better ergonomic design of VR equipment to reduce discomfort during long sessions.

Non-structured feedback included recommendations to incorporate finer details and precise movements in VR simulations to mimic real-life procedures better. Many students emphasized the need for more VR practice hours and suggested integrating VR into the curriculum from the first year to familiarize them with procedural steps early on. There were also calls for simulating real-life complications to teach how to handle them effectively, making the learning experience more comprehensive and realistic.

These findings underscore a strong interest in and positive reception of VR as a learning tool among medical students. They also highlight specific areas where improvements could further enhance student satisfaction and realism.

DISCUSSION

The results of this study provide insightful data on medical students' familiarity, engagement, and perceptions of VR technology as a learning tool. The study identifies three main points: first, there is a high level of student engagement with VR despite limited prior experience with the technology. Second, students believe that VR can significantly enhance learning. Third, several limitations were identified that must be addressed when planning to implement VR in medical education.

Although only 5% of students were very familiar with VR, 54% reported high engagement with the technology. Despite limited initial familiarity, this high level of engagement suggests that VR has an intrinsic appeal and usability that can quickly draw students in. The findings support the idea that VR can be an engaging educational tool even for those with minimal prior exposure. The p-value of < 0.0001 for familiarity indicates a highly significant difference between female and male participants, with male respondents more frequently reporting being "very familiar" compared to their female counterparts. Interestingly, gender-based analysis for engagement showed no statistically significant difference between genders ($p = 0.557$), suggesting that once exposed to VR, both male and female students demonstrated comparable levels of engagement.

The students considered VR to have improved learning, with 58% finding it somewhat effective and 29% highly effective in increasing their knowledge of the

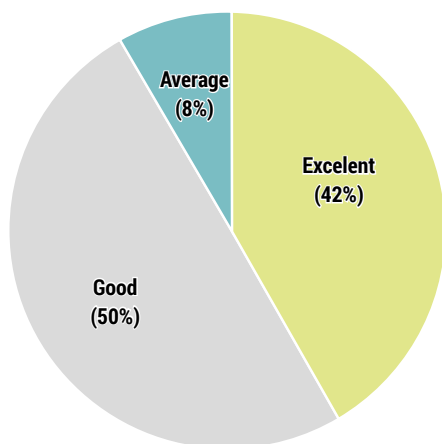


FIGURE 1. Medical students' ratings of the quality of the virtual reality experience.

procedure. No statistically significant gender differences were found for perceived effectiveness ($p = 0.286$) or helpfulness ($p = 0.696$), indicating a shared perception of VR's educational value across genders. Although we did not test the student performance in these skills, this survey suggests that VR can significantly enhance confidence in learning, particularly in developing technical competencies. The preference for VR over traditional methods was clear, with 55% of students prefer VR-based learning.

The ability to repeatedly practice procedures in a VR environment was particularly valued, as it boosted confidence and reduced anxiety before performing actual procedures. This repeated practice and hands-on experience are critical in medical education, where confidence and preparedness can significantly impact performance^[4,6-8,10].

Regarding limitations, VR in medical education has specific challenges that need to be addressed. One significant limitation is the lack of tactile feedback, crucial for performing real-life medical procedures. This highlights the need for advancements in haptic technology to enhance the realism of VR simulations. Additionally, some students noted the need for better gesture recognition and more dynamic elements, such as responsive vital signs, to increase realism. Prolonged use of VR equipment also caused discomfort for some students, indicating a need for better ergonomic design for longer training sessions.

Compared to similar studies on VR platforms in education, our findings align with existing research demonstrating immersive technologies' effectiveness in increasing student engagement and learning efficacy. *Cheung et al.* Emphasise that VR allows students to train under safe and controllable conditions, which aligns with our findings that Meta Quest provides a secure environment for learning^[7]. We found similar levels of satisfaction and increased learning perspective compared to previous studies^[4,5,7,11]. Our study also reflects high engagement and positive perceptions among students using Meta Quest, underscoring its effectiveness as a learning tool. However, unlike some reports, our results did not show significant gender differences in engagement or perceived usefulness, except for familiarity, where male students had higher prior exposure.

However, gender-based differences in perception should be considered in future implementations,

as our data show that male and female students may experience and evaluate VR-based tools differently.

Mistry et al. (2023) highlighted that VR enables students to learn at their own pace and enhances procedural confidence, which aligns with our findings that students appreciated the flexibility and repeated practice opportunities provided by Meta Quest. However, while our study also noted students' preference for VR over traditional methods, it suggests room for improvement in enhancing the realism of VR simulations—a point that complements Mistry et al.'s report on the need for ongoing development in VR technology^[5,7].

The strength of this study lies in its comprehensive approach and robust dataset, derived from nearly 300 third-year medical students, which provides a broad and representative sample for analysis. The methodical collection and analysis of feedback offer detailed insights into various aspects of VR technology in medical education, such as familiarity, engagement, perceived realism, and effectiveness as a learning tool. This rigorous evaluation ensures that the findings are well-grounded and reliable, highlighting the significant potential of VR to enhance medical training. The study's large sample size and thorough methodology contribute to its credibility and the applicability of its results to similar educational settings. Gender differences were also found in preferences for curricular integration, with more men than women stating VR should definitely be included in the curriculum.

Despite providing valuable insights, this study has several limitations. Notably, it lacked a control group for comparing feedback from participants who did not use the system or used alternative learning tools. As a result, we cannot determine whether this method is superior to traditional teaching approaches, such as lectures and case discussions. Additionally, the study's findings are based on participant evaluations, which may not always provide an objective measure of learning effectiveness. The results may only apply to medical students at the University of Lisbon and may not be generalizable to other populations. Moreover, despite efforts to maintain consistency in the study environment, there could have been unavoidable teaching variations, including differences in students' engagement levels and concentration. Although we achieved a high response rate of 81%, it is possible that students who were more motivated or engaged were more likely to participate, introducing a potential response bias.



CONCLUSION

This study offers important information about the efficiency and practicality of VR technology for University of Lisbon medical students. It thoroughly assesses how virtual reality improves their educational experiences and looks at their opinions on incorporating this technology into the medical curriculum. From the students' perspective, we have identified areas of strength and need for progress, including specific VR components that require further development. By emphasizing these results, the study hopes to encourage the broader use of VR as a meaningful teaching tool. It also provides valuable suggestions for planning medical education activities integrating VR.

In summary, our findings support the integration of VR into medical curricula as a complementary tool, while highlighting the importance of addressing technical, ergonomic, and pedagogical aspects to optimise its impact on learning outcomes.

The authors declare no conflicts of interest.

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

REFERENCES

- Haowen J, Vimalasvaran S, Myint Kyaw B, Tudor Car L. Virtual reality in medical students' education: a scoping review protocol. *BMJ Open*. 2021;11(5):e046986. Doi:10.1136/bmjopen-2020-046986
- Ducheneaut N, Yee N, Nickell E, Moore R.J. "Alone together?" In: *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. ACM; 2006:407-416. Doi:10.1145/1124772.1124834
- Duan Y yu, Zhang J yao, Xie M, Feng X bo, Xu S, Ye Z wei. Application of Virtual Reality Technology in Disaster Medicine. *Curr Med Sci*. 2019;39(5):690-693. Doi:10.1007/s11596-019-2093-4
- Kolla S, Elgawly M, Gaughan JP, Goldman E. Medical Student Perception of a Virtual Reality Training Module for Anatomy Education. *Med Sci Educ*. 2020;30(3):1201-1210. Doi:10.1007/s40670-020-00993-2
- Mistry D, Brock CA, Lindsey T. The Present and Future of Virtual Reality in Medical Education: A Narrative Review. *Cureus*. Published online December 26, 2023. Doi:10.7759/cureus.51124
- Kononowicz AA, Woodham LA, Edelbring S, et al. Virtual patient simulations in health professions education: Systematic review and meta-analysis by the digital health education collaboration. *J Med Internet Res*. 2019;21(7). Doi:10.2196/14676
- Cheung VYT, Tang YM, Chan KKL. Medical students' perception of the application of a virtual reality training model to acquire vaginal examination skills. *International Journal of Gynecology and Obstetrics*. 2023;161(3):827-832. Doi:10.1002/ijgo.14670
- Watari T, Tokuda Y, Owada M, Onigata K. The utility of virtual patient simulations for clinical reasoning education. *Int J Environ Res Public Health*. 2020;17(15):1-9. Doi:10.3390/ijerph17155325
- Mccooy L, Pettit RK, Lewis JH, Allgood JA, Bay C, Schwartz FN. Evaluating medical student engagement during virtual patient simulations: A sequential, mixed methods study. *BMC Med Educ*. 2016;16(1). Doi:10.1186/s12909-016-0530-7
- Pieterse AD, Hierck BP, de Jong PGM, Ginn TF, Hamoen EC, Reinders MEJ. User experiences of medical students with 360-degree virtual reality applications to prepare them for the clerkships. *Virtual Real*. 2023;27(2):1381-1389. Doi:10.1007/s10055-022-00731-6
- Krishnamurthy K, Selvaraj N, Gupta P et al. Benefits of gamification in medical education. *Clinical Anatomy*. 2022;35(6):795-807. Doi:10.1002/ca.23916