

## ORIGINAL RESEARCH

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**AUGMENTED REALITY IN MEDICAL EDUCATION: MEASURING IMMERSION, PERCEIVED BENEFITS, AND BARRIERS TO EQUITABLE ACCESS**

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**Introduction:** Augmented reality (AR) provides interactive and immersive experiences that enrich medical training by enhancing learners' spatial understanding, clinical decision-making, and engagement [1-3]. However, the uptake of AR across educational institutions remains inconsistent due to variations in infrastructure, cost, and training. This study aimed to explore medical students' experiences with AR, measure their immersion levels, and identify perceived benefits and barriers, particularly those linked to digital inequality.

**Methods:** A cross-sectional survey was conducted in 2024-2025 at a UK medical school following an AR-enhanced simulation session using HoloLens headsets and the HoloPatient application. Ninety-three medical students participated voluntarily. The Augmented Immersion Measurement Index (AIMI) was used to assess engagement across cognitive, emotional, and behavioural domains. Students also reported AR usage frequency, perceived educational benefits, technological limitations, and concerns about equitable access. Descriptive and correlational analyses were performed.

**Results:** Students reported moderate immersion (mean AIMI score: 3.9/5), with emotional engagement highest (4.2/5) and behavioural engagement lowest (3.5/5). Key benefits included enhanced diagnostic reasoning (32%), improved patient interaction skills (28%), and increased surgical confidence (20%). However, 30% cited limited access to AR-enabled devices, and 27% reported lack of institutional support as major barriers. Over half (53%) expressed concern that AR could widen digital inequality. Subgroup analysis showed students with regular AR access had higher confidence in spatial awareness and technical skills. Conversely, those from lower-income backgrounds reported limited access, lower immersion scores, and less perceived benefit. Despite challenges, students valued AR's ability to visualise complex anatomy, simulate clinical encounters, and reinforce theoretical learning.

**Discussion:** This study confirms that AR can improve learner engagement and perceived clinical preparedness. However, barriers related to access, affordability, and institutional readiness may hinder equitable implementation. AR should be adopted as a supplemental tool within blended learning models. Institutions must invest in infrastructure, faculty training, and accessibility schemes—such as device loans or subsidies—to maximise educational benefit and mitigate the digital divide. Future studies should examine long-term skill retention, impact on clinical performance, and cost-effectiveness of AR-based medical education.

**Ethics Statement:** As the submitting author, I can confirm that all relevant ethical standards of research and dissemination have been met. Additionally, I can confirm that the necessary ethical approval has been obtained, where applicable.

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