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Impact of AR/VR in Healthcare: A Study of Effectiveness and Adoption.

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Abstract - *Augmented Reality (AR) and Virtual Reality (VR) are emerging technologies with the potential to support healthcare education, medical training, anatomy visualization, simulation, and rehabilitation. AR overlays digital information on the real-world environment, whereas VR creates computer-generated immersive environments. This study examines respondents' perceptions of the effectiveness and adoption of AR/VR in healthcare. A quantitative descriptive approach was followed using primary data collected through a structured Google Forms questionnaire. The study includes 51 responses and analyses eight selected five-point Likert-scale questions using frequency distributions, percentages, mean scores, and a One-Sample Wilcoxon Signed-Rank Test against the neutral value of 3. The reported findings show generally positive perceptions: positive responses ranged from 46.0% to 56.9% across the eight questions. Anatomy visualization recorded the highest reported mean score (3.54), followed by medical procedure simulation (3.51). Respondents also indicated willingness to use AR/VR and recognized the importance of training and technical support. All eight reported Holm-adjusted p-values were below 0.05. The findings represent perceptions within a convenience sample and do not establish clinical effectiveness. The paper discusses adoption considerations, limitations, and directions for further evaluation.*

Key Words: Augmented Reality (AR), Virtual Reality (VR), Healthcare Education, Medical Training, Anatomy Visualization, Rehabilitation, Technology Adoption

1. INTRODUCTION

Augmented Reality (AR) and Virtual Reality (VR) are increasingly being explored in healthcare, medical education, patient care, and rehabilitation. AR enhances the real-world environment by overlaying digital information, three-dimensional models, and visualizations. VR creates immersive computer-generated environments in which users can interact with simulated clinical situations. In healthcare education and training, these technologies provide opportunities for anatomy learning, surgical and clinical procedure simulation, emergency-response practice, and practical skill development.

Beyond education, AR and VR are being explored in patient care and rehabilitation through interactive therapeutic activities, visual feedback, and simulated environments. Such applications may encourage patient participation and support exercises related to stroke, lower-limb conditions, and postoperative recovery. Their wider adoption, however, involves cost, accessibility, usability, infrastructure, technical requirements, and clinical integration. This study therefore focuses on perceived effectiveness, learning applications, rehabilitation, willingness to adopt, and the importance of training and technical support.

1.1 Problem Statement

Although AR/VR offers immersive and interactive learning experiences, its effectiveness and adoption in healthcare depend on more than the availability of headsets or software. Institutions must consider whether users perceive improvements in understanding, simulation, anatomy learning, and rehabilitation, and whether adequate training, infrastructure, and technical support are available. There is also a need to distinguish positive user perceptions from objectively measured educational or clinical outcomes.

1.2 RESEARCH GAP

The literature reviewed in the source paper reports promising applications of AR/VR in healthcare training, rehabilitation, clinical assessment, anatomy education, and immersive learning. At the same time, the reviewed studies identify varying outcomes, costs, usability issues, motion sickness, technical challenges, and limited evidence of long-term effects. The present study contributes a small-sample perception-based assessment covering multiple application areas and adoption considerations in a single questionnaire. It does not replace clinical or controlled learning-outcome evaluation.

1.3 Research Objectives

O1. Assess respondents' perceptions of understanding medical concepts through AR/VR.
O2. Evaluate perceived effectiveness in healthcare education, medical procedure simulation, anatomy visualization, and rehabilitation.
O3. Examine perceptions of AR/VR-based healthcare learning experiences.
O4. Analyse willingness to use and recommend AR/VR technologies.
O5. Examine the perceived importance of training and technical support in AR/VR adoption.

1.4 Research Question

RQ1. How do respondents perceive the contribution of AR/VR to understanding complex medical concepts?
RQ2. How effective do respondents perceive AR/VR to be for healthcare education, simulation, anatomy visualization, and rehabilitation?
RQ3. What are respondents' attitudes toward AR/VR-based healthcare learning experiences?
RQ4. Are respondents willing to use and recommend AR/VR for healthcare education and training?
RQ5. How important are training and technical support for AR/VR adoption?

2. BACKGROUND AND LITERATURE REVIEW

AR and VR provide different but complementary forms of immersive interaction. AR supplements the physical environment with digital information and visual objects, while VR places the user inside a simulated digital environment. In healthcare, the reviewed literature covers virtual patients, rehabilitation exercises, clinical assessment, anatomy education, and immersive clinical training.

Table 1. Overview of AR and VR in the healthcare context

Aspect	Augmented Reality (AR)	Virtual Reality (VR)
Core concept	Overlays digital information, 3D models, or visualizations onto the real-world environment.	Creates a computer-generated immersive environment for simulated experiences.
Healthcare learning use	Can support visual guidance and interactive learning alongside the physical environment.	Can provide controlled simulated clinical situations and immersive practice.
Applications discussed in this study	Rehabilitation, visual learning, and interactive healthcare activities.	Anatomy education, clinical assessment, procedure simulation, and training.
Adoption considerations	Usability, equipment, accessibility, technical support, and integration.	Equipment cost, usability, motion sickness, technical issues, and assessment reliability.

2.1 Review of Related Studies

Table 2. Summary of literature reviewed

Study	Coverage / Method	Key findings reported	Challenges reported
Chahartangi et al. [1] (2025)	Scoping review of 27 studies on AR and virtual patients in healthcare education.	Interactive simulations and 3D visualizations can support clinical learning, decision-making, and student engagement.	High costs and limited evidence of long-term outcomes.
Modlin and Kuo [2] (2025)	Review of 26 studies on AR-based rehabilitation involving stroke, knee injuries, and movement-related conditions.	Some studies reported improvements in physical performance and patient participation.	Results varied; AR was not consistently more effective than conventional rehabilitation.
Neher et al. [3] (2025)	Systematic review of 26 studies on VR-based clinical assessments.	VR offers controlled environments for evaluating patient care, emergency response, and clinical decision-making.	Equipment costs and assessment reliability.
Adnan, Benson and Xiao [4] (2025)	Systematic review of 15 studies involving 1,229 participants in anatomy education.	Immersive VR and 3D anatomical models may improve spatial understanding of complex structures.	Learning outcomes varied across studies.
Quah et al. [5] (2025)	Mixed-studies systematic review of 93 studies involving nursing and allied health students.	Immersive VR was associated with improved engagement and opportunities for practical clinical learning.	Motion sickness, technical issues, equipment costs, and usability.

3. RESEARCH METHDOLOGY

The study follows a quantitative and descriptive research design to examine respondents' awareness, perceived effectiveness, adoption, and views on AR/VR applications in

healthcare. Primary data were collected through a structured Google Forms questionnaire containing demographic, multiple-choice, and five-point Likert-scale questions.

Table 3. Research design and data-collection profile

Parameter	Description
Research approach	Quantitative, descriptive study.
Primary data source	Structured Google Forms questionnaire.
Number of responses	51 responses.
Sampling method	Non-probability convenience sampling.
Respondent group	Students and other accessible participants who volunteered to respond.
Questionnaire analysis	Eight selected five-point Likert-scale items.
Secondary sources	Research papers, academic journals, systematic reviews, and conference publications.
Literature databases named	Google Scholar, PubMed, IEEE Xplore, and ScienceDirect.

The questionnaire used a five-point scale: Strongly Disagree = 1, Disagree = 2, Neutral = 3, Agree = 4, and Strongly Agree = 5. Frequency distributions and percentages were used to summarize responses. A One-Sample Wilcoxon Signed-Rank Test was applied to each selected item to assess whether responses were more positive than the neutral score of 3. The significance level was set at 0.05, and the Holm adjustment was used to account for eight statistical tests.

3.1 Respondent Profile

The source paper reports that 72% of respondents were aged 21–23, 14% were aged 18–20, and 12% were aged 24 and above. Postgraduate students formed the largest reported educational group (74%), followed by undergraduate students (18%). The reported categories do not account for all respondents; therefore, the percentages below are reproduced as reported and are not normalized.

Table 4. Demographic profile (reported percentages)

Profile variable	Category	Percentage
Age	18–20 years	14%
Age	21–23 years	72%
Age	24 years and above	12%
Education level	Postgraduate	74%
Education level	Undergraduate	18%

4. DATA ANALYSIS AND INTERPRETATION

The analysis is based on 51 Google Forms response entries and eight selected Likert-scale questions. For each question, responses are grouped into positive (Agree + Strongly Agree), neutral, and negative (Disagree + Strongly Disagree) categories. The percentages below are the values reported in the supplied research document.

Table 5. Distribution of responses across the eight study dimensions

No.	Question / Dimension	Positive	Neutral	Negative
1	Understanding complex medical concepts	46.0%	36.0%	18.0%
2	Quality of healthcare education and training	54.0%	32.0%	14.0%
3	Practice of medical procedures in simulation	56.9%	27.5%	15.7%
4	Visualization of human anatomy	56.0%	24.0%	20.0%
5	Support for rehabilitation and recovery	56.9%	25.5%	17.6%
6	Willingness to use AR/VR for healthcare education or training	52.9%	31.4%	15.7%
7	Willingness to recommend AR/VR-based learning	49.0%	33.3%	17.6%
8	Importance of training and technical support	54.9%	25.5%	19.6%

The highest positive-response percentages were reported for medical procedure simulation and rehabilitation/recovery (both 56.9%). Anatomy visualization also received a positive response from 56.0% of respondents. The lowest positive percentage was for understanding complex medical concepts (46.0%), where 36.0% of respondents selected a neutral response. Willingness to recommend AR/VR-based learning (49.0%) was lower than willingness to use it (52.9%), suggesting that acceptance and recommendation are related but distinct attitudes.

4.1 Interpretation by Application Area

Table 6. Interpretation of the descriptive findings

Dimension	Reported positive response	Interpretation
Medical concept understanding	46.0%	A positive group perceived that immersive visualization and interactive learning may support understanding; the relatively high neutral share indicates that views were not uniformly positive.
Healthcare education and training	54.0%	More than half of respondents viewed AR/VR favourably as a way to provide interactive, technology-supported learning.
Medical procedure simulation	56.9%	Respondents recognized the potential of simulated environments to provide practice opportunities in a controlled setting.
Anatomy visualization	56.0%	Three-dimensional and immersive visualization was perceived as useful for understanding complex anatomical structures.
Rehabilitation and recovery	56.9%	Respondents recognized the potential for interactive exercises and patient engagement, subject to appropriate design and supervision.
Willingness to use	52.9%	A majority expressed willingness to use AR/VR for healthcare-related learning or training.
Willingness to recommend	49.0%	Views were favourable overall, although recommendation was less pronounced than personal willingness to use.
Training and technical support	54.9%	Respondents indicated that guidance and technical assistance are important considerations for adoption.

5. STATISTICAL TESTING AND HYPOTHESES EVALUATION

A One-Sample Wilcoxon Signed-Rank Test was applied to each of the eight Likert-scale items, using the neutral score of 3 as the reference value. The significance level was 0.05. Holm adjustment was applied to the p-values to account for multiple testing. The supplied document reports mean scores and adjusted p-values, but does not provide the Wilcoxon test statistics, raw p-values, confidence intervals, or item-level response distributions.

Table 7. Reported statistical results

No.	Study dimension	Mean score	Holm-adjusted p-value	Decision at 0.05
1	Understanding medical concepts	3.42	0.0086	Reject H_0
2	Healthcare education and training	3.48	0.0074	Reject H_0
3	Medical procedure simulation	3.51	0.0074	Reject H_0
4	Anatomy visualization	3.54	0.0071	Reject H_0
5	Rehabilitation and recovery	3.47	0.0058	Reject H_0
6	Willingness to use AR/VR	3.43	0.0071	Reject H_0
7	Recommendation of AR/VR learning	3.39	0.0074	Reject H_0
8	Adoption with training and support	3.39	0.0086	Reject H_0

All eight reported adjusted p-values are below 0.05; accordingly, the source paper rejects the corresponding null hypotheses and interprets the responses as significantly more positive than the neutral reference. The highest mean score was reported for anatomy visualization (3.54), while the lowest means were reported for recommendation and adoption with training/support (both 3.39). These results describe respondent perceptions in this sample and should not be interpreted as proof of improved clinical outcomes.

5.1 Hypotheses

For each objective, the null hypothesis (H_0) states that respondents do not demonstrate a significantly positive perception of the relevant AR/VR application or adoption factor. The alternative hypothesis (H_1) states that respondents demonstrate a significantly positive perception. The eight-item statistical results are summarized in Table 7. The source paper groups these items under five broader objectives: understanding medical concepts; effectiveness across education, simulation, anatomy, and rehabilitation; learning experience; willingness to use and recommend; and training and technical support.

6. MAJOR FINDINGS

- Medical concepts: 46.0% of respondents expressed a positive perception of AR/VR for understanding complex medical concepts.
- Healthcare education: 54.0% recognized the potential of AR/VR to improve healthcare education and training.
- Medical simulation: 56.9% responded positively to practising procedures in simulated environments.
- Anatomy visualization: 56.0% viewed AR/VR as helpful for visualizing human anatomy.
- Rehabilitation: 56.9% perceived potential for supporting rehabilitation and recovery exercises.
- Technology adoption: 52.9% expressed willingness to use AR/VR for healthcare education and training.
- Recommendation: 49.0% expressed willingness to recommend AR/VR-based learning activities.
- Training and support: 54.9% agreed that training and technical support are important for adoption.

7. DISCUSSION

The findings indicate generally favourable perceptions of AR/VR across healthcare education, simulation, anatomy visualization, rehabilitation, and technology adoption. The strongest descriptive support was reported for medical procedure simulation and rehabilitation/recovery. The highest mean score, however, was for anatomy visualization. These results are consistent with the themes in the reviewed literature, which identifies interactive simulations, 3D visualization, controlled clinical environments, and immersive learning as potential benefits.

The findings also show that positive perception does not automatically translate into recommendation or adoption. Willingness to use AR/VR was 52.9%, while willingness to recommend it was 49.0%. In addition, 54.9% highlighted the importance of training and technical support. This reinforces the need to address usability, infrastructure, affordability, and user readiness alongside the design of immersive content. The literature review similarly reports cost, motion sickness, technical issues, and variable learning outcomes as adoption barriers.

A key distinction is that this study measures perceptions rather than actual clinical or educational performance. Positive survey responses can indicate acceptance and perceived usefulness, but they do not establish that AR/VR produces better patient outcomes or superior learning compared with conventional methods.

8. RECOMMENDATIONS FOR IMPLEMENTATIONS

Table 8. Practical recommendations for AR/VR adoption

Area	Recommendation	Purpose
Affordability	Healthcare institutions should consider cost-effective AR/VR solutions.	Reduce financial barriers to adoption.
Professional training	Provide structured training for students and healthcare professionals.	Improve user confidence and appropriate use.
Infrastructure	Provide suitable devices, software, connectivity, and technical support.	Support reliable and accessible use.
Safety and privacy	Address patient safety and protection of health-related data.	Support responsible use in healthcare settings.
Performance evaluation	Assess learning outcomes and user feedback before wider adoption.	Determine whether the technology meets local needs.
Collaboration	Encourage cooperation among academic institutions, healthcare providers, and technology developers.	Align technology design with educational and clinical requirements.

9. LIMITATIONS

- Sampling limitations: Convenience sampling may not represent the wider healthcare population.
- Sample size: The study is limited to 51 respondents.
- Self-reported data: Responses may be influenced by personal opinions, awareness, and expectations.
- Variation in familiarity: Respondents may have different levels of prior exposure to AR/VR.
- Cross-sectional design: Data collected at one point in time cannot establish cause-and-effect relationships.
- Limited clinical measurement: The study examines perceptions and does not directly measure clinical effectiveness or patient outcomes.
- Reporting detail: The supplied results do not include raw response counts, item-level distributions, Wilcoxon test statistics, or unadjusted p-values; these should be retained in future reporting for reproducibility.

10. FUTURE SCOPE OF RESEARCH

Future studies should include larger and more diverse samples involving students, healthcare professionals, and

patients from different regions. Controlled clinical and educational evaluations could compare AR/VR-based methods with conventional healthcare practices and measure learning retention, practical performance, rehabilitation outcomes, and user experience over time. Further work may also examine AI integration, mixed reality, haptic feedback, cost-effectiveness, accessibility, and long-term adoption.

Table 9. Suggested measures for future evaluation

Evaluation dimension	Potential measures
Learning effectiveness	Knowledge assessment, skill performance, retention, and transfer to practical settings.
Clinical / rehabilitation outcomes	Functional performance, exercise adherence, patient participation, and recovery-related measures appropriate to the condition.
Usability and user experience	Task completion, user satisfaction, comfort, motion-sickness reports, and usability ratings.
Technology performance	System reliability, latency, tracking accuracy, and technical failure rates.
Adoption and implementation	Training time, willingness to use, actual usage, infrastructure requirements, and support needs.
Economic feasibility	Initial equipment and software costs, maintenance, training costs, and cost-effectiveness compared with conventional methods.
Safety and privacy	Adverse events, data protection practices, consent, and secure handling of patient information.

11. CONCLUSION

This study examined the perceived impact of Augmented Reality and Virtual Reality in healthcare education, medical training, procedure simulation, anatomy visualization, rehabilitation, and technology adoption. Based on 51 questionnaire responses, the findings indicate generally positive perceptions, with positive-response percentages ranging from 46.0% to 56.9% across the eight selected dimensions. Medical procedure simulation and rehabilitation/recovery recorded the highest positive-response percentages, while anatomy visualization recorded the highest reported mean score.

Respondents also indicated willingness to use AR/VR and recognized the importance of training and technical support. The reported One-Sample Wilcoxon Signed-Rank Test results, after Holm adjustment, were below the 0.05 significance level for all eight items. Nevertheless, the study is based on convenience sampling and self-reported perceptions; it does not directly measure clinical effectiveness or establish causal effects. AR/VR therefore appears promising as a supportive healthcare learning and rehabilitation technology, but broader adoption should be accompanied by appropriate training, infrastructure, safety and privacy measures, and systematic evaluation of practical outcomes

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