



CLASSIFICATION OF METAVERSE APPLICATIONS IN DENTISTRY AND HEALTHCARE

An overview and classification of metaverse applications across dentistry and healthcare domains

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Introduction to the Metaverse in Healthcare and Dentistry



Metaverse Overview

The metaverse uses immersive technologies like virtual and augmented reality to create interactive virtual environments. These environments support education, patient care, collaboration, and research in healthcare and dentistry.



Virtual Education and Training in Dentistry

01

Simulated Practice

Dental students use VR headsets to practice procedures in a controlled virtual environment.

This allows safe skill development without patient risk.

02

Procedure Rehearsal

VR platforms enable rehearsal of complex dental treatments.

This enhances confidence and precision before actual procedures.

03

Assessment and Feedback

Virtual dental labs provide real-time feedback on performance.

Students receive evaluations to improve technique and knowledge.

Treatment without and with AR



Telemedicine and Remote Consultations in Dentistry



Virtual Check-Ups

Initial dental diagnosis and treatment advice are delivered remotely through virtual consultations, enhancing accessibility and convenience for patients.



Postoperative Monitoring

AR and VR tools enable dentists to supervise patients' recovery after procedures without requiring in-person visits, ensuring timely care and feedback.

Surgical Planning and Simulation in Dentistry

01

3D Modeling and Preoperative Rehearsal

Virtual reality enables detailed 3D models for dental anatomy visualization.

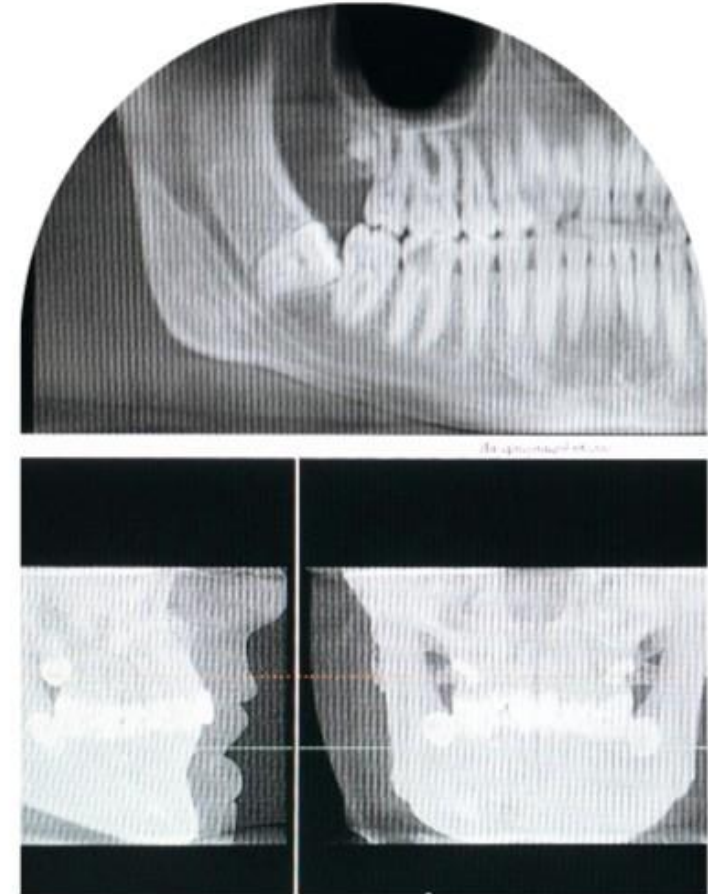
Surgeons can rehearse complex procedures before the operation to improve outcomes.

02

AR Intraoperative Navigation

Augmented reality provides real-time guidance during dental surgeries.

This enhances precision in implant placement and other interventions.



Patient Rehabilitation and Therapy in Dentistry



Prosthetic Training

Virtual rehabilitation supports training for dental prosthetics and implants, enhancing patient recovery and function.



TMJ Therapy

Immersive therapy programs assist patients with temporomandibular joint disorders to improve comfort and mobility.



Remote Rehab Monitoring

Virtual platforms enable clinicians to remotely monitor rehabilitation progress and adjust therapy as needed.

Patient Support and Mental Health in Dentistry



VR Exposure Therapy

Virtual reality environments are used to address dental anxiety by gradually exposing patients to treatment scenarios to reduce fear and improve compliance.



Peer Support and Relaxation

Virtual support groups and guided relaxation environments help patients manage dental anxiety and provide mental health support.

Collaborative Dentistry and Expert Consultations



Multidisciplinary Case Review

Virtual meetings enable dental teams to collaborate in real time on complex cases through shared platforms.



Remote Expert Consultations

International experts consult remotely to support case evaluation and decision-making.

Augmented Reality in Dental Diagnostics and Treatment

01

AR Diagnostics

AR tools overlay visual information onto oral anatomy to help detect cavities and gum disease, enhancing diagnostic accuracy.

02

Patient Education

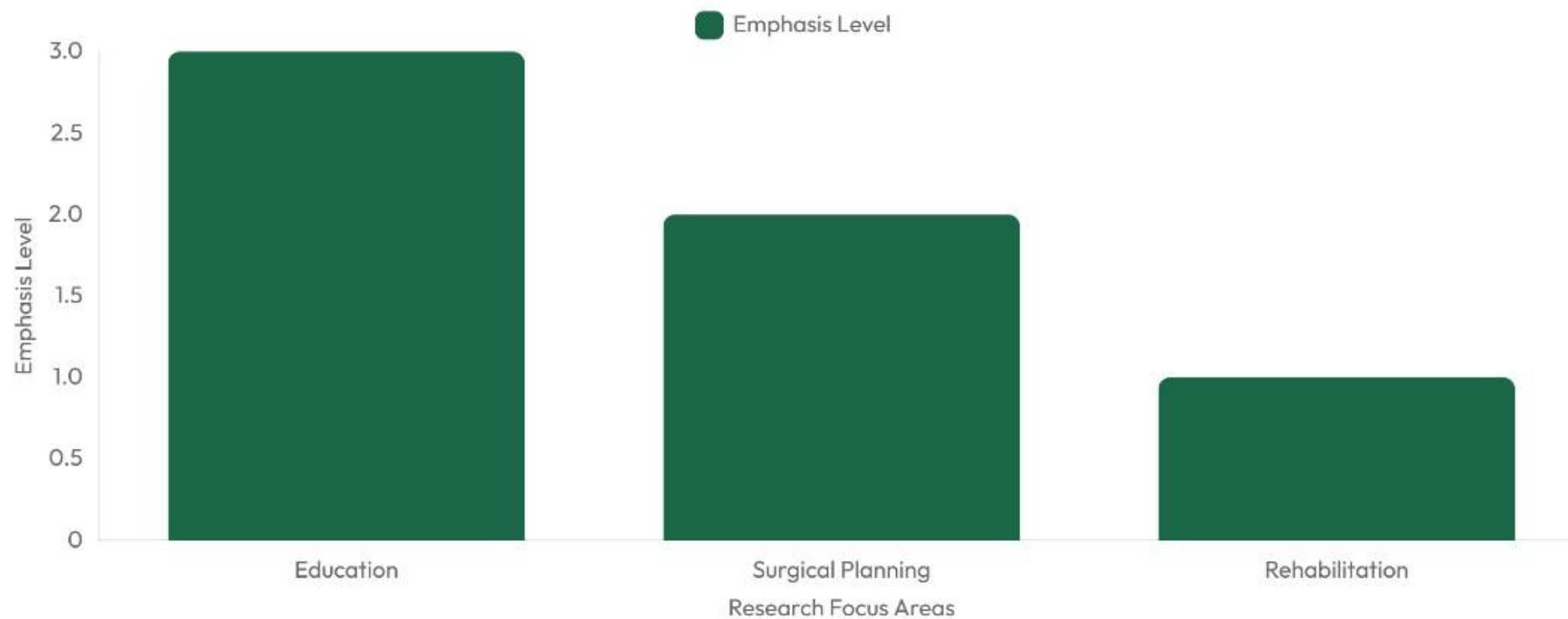
AR visualizations assist patients in understanding planned treatments by showing realistic treatment previews.

03

Benefits

These technologies improve diagnostic precision and foster better patient consent through enhanced understanding.

Research focus areas in Dentistry



Healthcare Marketing and Patient Engagement in Dentistry



Virtual Clinics

Immersive virtual walkthroughs allow patients to explore dental clinic environments and services remotely.



Interactive Education

AR and VR tools provide engaging and personalized patient education for dental health.



Gamified Engagement

Reward-based programs encourage patients to adhere to treatment plans and follow-up care.

Virtual Education and Training in Healthcare

01

Anatomy Immersion

Explore 3D interactive models for detailed understanding of human anatomy enhancing spatial awareness.

02

Procedure Rehearsal

Practice surgical techniques in realistic VR simulations to build skills before real operations.



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Telemedicine and Remote Consultations in Healthcare



Immersive Consultations

Virtual face-to-face visits enable direct interaction between patients and healthcare providers in a fully immersive environment.



AR-Assisted Exams

Remote visualization of patient anatomy is enhanced with augmented reality overlays to support diagnosis and treatment planning.



Remote Monitoring

Continuous tracking of vital signs and rehabilitation progress improves patient care and follow-up.

Surgical Planning and Simulation in Healthcare

01

3D Modeling

Three-dimensional models of organs aid in detailed visualization and surgical planning before operations.

02

Pre-surgical Rehearsal

Simulated practice and team drills help prepare surgeons and staff for complex procedures to improve outcomes.

03

AR Intraoperative Guidance

Augmented reality overlays assist surgeons during operations by guiding incisions and instrument placement for precision.





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Patient Rehabilitation and Therapy in Healthcare



Motor Recovery

VR programs facilitate recovery of motor skills through guided physical exercises and progress tracking.



Pain Management

Interactive VR exercises assist in managing chronic pain and improving patient comfort.



Elderly Care

Customized VR therapy supports mobility and cognitive function in elderly patients.

Patient Support and Mental Health in Healthcare

01

Therapeutic Programs

VR environments provide exposure therapy, guided relaxation, and cognitive behavioral modules to treat anxiety, PTSD, and stress.

These programs are designed to improve mental health outcomes through immersive experiences.

02

Support Networks

Virtual support groups offer peer interaction and emotional support.

They expand access to mental health assistance beyond traditional clinical settings.

Collaborative Healthcare and Global Conferences

Virtual Conferences

Host immersive, virtual global conferences to facilitate knowledge sharing and networking among healthcare professionals worldwide.

Multidisciplinary Case Review

Enable virtual meetings where experts from multiple disciplines collaborate on complex patient cases in real time.

Shared Virtual Labs

Provide virtual laboratories for collaborative healthcare research, clinical trials, and innovation development.

Real-time Research Collaboration

Support live interactions and data exchange among researchers to accelerate healthcare advancements globally.

Augmented Reality in Healthcare Diagnostics and Treatment

01

Tumor/Lesion Visualization

3D AR overlays enable precise localization of tumors and lesions for diagnosis and treatment.

02

Fracture and Orthopedics

AR assists clinicians in planning and guiding fracture fixation and orthopedic procedures.

03

Patient Education

AR visualizations help explain medical procedures to patients for better understanding.

Research and Data Analysis in Healthcare

01 Virtual Research Environments

Immersive spaces enable collaborative research and data sharing to accelerate healthcare innovations and reproducible studies.

02 Clinical Trial Simulations

Virtual labs facilitate realistic simulations for testing treatments under controlled conditions.

03 Data Analytics and Modeling

Advanced analytics support the training of AI models and evaluation of rehabilitation protocols.





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Healthcare Marketing and Patient Engagement



Virtual Onboarding

Interactive orientation sessions guide patients through services and protocols before visits.



Immersive Campaigns

AR and VR events promote healthcare services and educate the community effectively.



Patient Journey Mapping

Virtual walkthroughs provide patients with a clear understanding of the care process to ease anxiety.

Conclusion: Future Prospects of the Metaverse in Dentistry and Healthcare



Training & Education

Immersive learning improves skills and retention through realistic simulations and practice.



Clinical Care

Remote access and AR-guided interventions expand reach and precision in patient treatment.



Research & Collaboration

Virtual labs and conferences accelerate innovation and knowledge sharing globally.



Kashwani et al. Classification of Metaverse in Dentistry

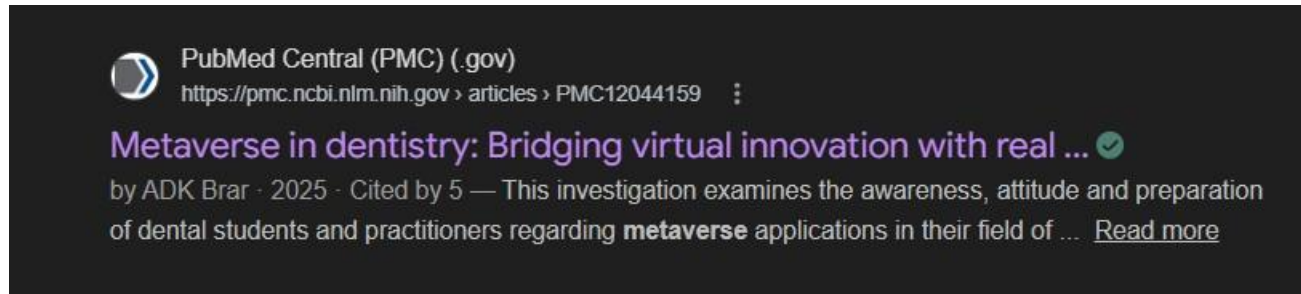
Category	Application in Dentistry
Virtual Education and Training	Virtual dental simulation and immersive learning environments; training for complex procedures (<i>root canal therapy, implant placement</i>); <i>virtual dental check-platforms</i>
Telemedicine and Remote Consultations	Virtual consultations for diagnosis and treatment planning; post-operative monitoring <i>and follow-ups</i> ; <i>remote dental consultations for underserved areas</i>
Surgical Planning and Simulation	VR-based treatment planning; <i>AR-assisted real-time navigation during dental surgeries</i>
Patient Rehabilitation and Therapy	Virtual rehabilitation for prosthetics and implants; <i>VR-assisted therapy for temporomandibular joint (TMJ) disorders</i>
Patient Support and Mental Health	Virtual support for dental anxiety and fear; <i>mental health support during dental treatments</i>
Collaborative Dentistry	Virtual multidisciplinary meetings; <i>international expert consultations for complex dental</i>
AR in Diagnostics and Treatment	AR-based tools for <i>visualization of caries and gum disease</i> ; <i>treatment visualization for patients</i>
Research and Data Analysis	Virtual research environments for clinical trials; <i>data-driven and AI-based dental advancements</i>
Healthcare Marketing and Patient Engagement	Virtual dental clinics; patient education platforms; <i>metaverse-based marketing strategies</i>

Table 2: Kashwani et al. Metaverse Classification in Healthcare

Category	Application in Healthcare
1. Virtual Education and Training	• VR and AR platforms for medical training and surgical procedure practice. • Immersive learning for understanding anatomy, diagnostics, and surgical techniques.
2. Telemedicine and Remote Consultations	• Remote consultations between patients and healthcare providers. • AR/VR for real-time examination and treatment planning. • Virtual health clinics providing fully immersive patient care experiences.
3. Surgical Planning and Simulation	• VR surgery planning, 3D modeling of organs, and presurgical simulations. • AR-guided surgeries for precision in complex procedures.
4. Patient Rehabilitation and Therapy	• VR rehabilitation for patients recovering from surgery or injury, especially for motor skills and mobility. • Interactive VR exercises for physical therapy and elderly care.
5. Patient Support and Mental Health	• VR therapeutic environments for mental health treatments, like phobias or stress. • VR-based mental health interventions for anxiety, PTSD, and depression.
6. Collaborative Healthcare	• Remote collaboration for case discussions, consultations, and research between healthcare professionals. • Virtual global conferences for knowledge sharing, research collaboration, and symposia.
7. Augmented Reality in Diagnostics and Treatment	• AR diagnostics for visualizing internal body conditions (e.g., tumors, fractures). • AR-assisted treatment planning and patient education.
8. Research and Data Analysis	• Virtual labs for healthcare research, clinical trials, and data analysis. • Real-time collaboration on research findings and development of new healthcare technologies.
9. Healthcare Marketing and Patient Engagement	• Virtual healthcare marketing, promoting services and educating the public. • VR-based patient engagement for stress reduction and improving the patient experience during hospital visits.

Papers Published

1. <https://pubmed.ncbi.nlm.nih.gov/40322712/>



2. <https://idjsronline.com/archive/volume/11/issue/3/article/11744>



- <https://idjsronline.com/archive/volume/12/issue/3/article/11792>

**International Dental Journal of Student's Research**
Official Publication of Cephorb Medline International Pvt. Ltd.

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International Dental Journal of Student's Research. 12(3):157-160, 2024. |
<https://doi.org/10.18231/jidjsr.2024.030>

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To the Editor

This Letter explores the multifaceted applications of the metaverse in dentistry, emphasizing how virtual reality (VR), augmented reality (AR), and mixed reality (MR) are reshaping various departments, including oral and maxillofacial surgery, orthodontics, periodontics, prosthodontics, and pediatric dentistry. By providing immersive simulations for dental students, facilitating complex surgical planning, and enabling real-time patient engagement, the metaverse is poised to become a cornerstone of modern dental practice.

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TITLE: CLASSIFICATION OF METAVERSE APPLICATIONS IN DENTISTRY AND HEALTHCARE

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The classification of Metaverse applications in Dentistry and Healthcare categorizes the various ways in which immersive technologies, such as Virtual Reality (VR) and Augmented Reality (AR), are being used to transform these fields.

In Dentistry, the Metaverse is primarily enhancing:

- Education and Training:** Virtual simulations allow dental students and professionals to practice procedures in a controlled, risk-free environment.
- Telemedicine:** Remote consultations enable dentists to advise patients and monitor post-operative care without in-person visits.
- Surgical Planning:** VR and AR tools aid in precise treatment planning and real-time guidance during dental surgeries.
- Patient Rehabilitation:** Virtual platforms support recovery, particularly for those with dental implants or temporomandibular joint (TMJ) disorders.
- Patient Support:** Virtual support groups and mental health interventions help manage dental anxiety and improve treatment compliance.

In Healthcare, the Metaverse is impacting:

- Medical Education:** VR and AR are used for immersive learning experiences, from basic anatomy to complex surgical procedures.
- Telemedicine:** Virtual consultations with healthcare professionals and immersive health clinics are improving access to care.
- Surgical Planning:** Surgeons can practice surgeries using VR simulations and AR during actual procedures for better precision.
- Patient Rehabilitation:** VR-based physical therapy programs are helping patients recover from injuries, surgeries, or chronic conditions.
- Mental Health:** VR environments are being used for therapeutic treatments, addressing mental health issues like anxiety, PTSD, and depression.

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- Collaboration:** Healthcare professionals are utilizing the Metaverse for real-time collaboration on complex cases and research, breaking down geographical barriers.

Overall, the Metaverse in both fields offers a blend of virtual education, patient care, collaboration, and support systems, revolutionizing traditional methods and enhancing outcomes for both practitioners and patients.

Category	Application in Dentistry
1. Virtual Education and Training	- Virtual dental simulation and learning environments for students. - Training for complex dental procedures like root canal therapy, implant placement. - Virtual dental check-ups and advice.
2. Telemedicine and Remote Consultations	- Virtual consultations for basic diagnosis and treatment advice. - Post-operative care through virtual consultations. - Remote dental consultations for advice, basic diagnostics, and follow-ups.
3. Surgical Planning and Simulation	- VR-based treatment planning for dental procedures. - AR for real-time navigation and guidance during dental surgeries.
4. Patient Rehabilitation and Therapy	- Virtual rehabilitation for dental prosthetics and implants. - Therapy for temporomandibular joint disorders (TMJ).
5. Patient Support and Mental Health	- Virtual support groups for dental anxiety and fear. - Mental health support for patients with dental treatment concerns.
6. Collaborative Dentistry	- Virtual multidisciplinary team meetings for complex dental cases.

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	- International consultations with experts on complex dental cases.
7. Augmented Reality in Diagnostics and Treatment	- AR diagnostic tools for visualizing dental problems (e.g., cavities, gum disease). - Treatment visualization for patients through AR-based visualizations.
8. Research and Data Analysis	- Virtual research environments for dental innovation and clinical trials. - Data-driven analysis in virtual environments for dental advancements.
9. Healthcare Marketing and Patient Engagement	- Virtual dental marketing campaigns and patient education. - Patient engagement through virtual dental offices or health centers.

Table 1: Kashwani et al. Metaverse Classification in Dentistry

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3. Surgical Planning and Simulation	- VR surgery planning, 3D modeling of organs, and pre-surgical simulations. - AR-guided surgeries for precision in complex procedures.

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