

Virtual Reality (VR) Technology in Patient Education: A Conceptual Framework from a Healthcare Management Perspective

Hasta Eğitiminde Sanal Gerçeklik (VR) Teknolojisi: Sağlık Yönetimi Perspektifinden Kavramsal Bir Çerçeve

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Abstract

This study examines Virtual Reality (VR) technology's potential in patient education from a healthcare management perspective, proposing a conceptual framework. Traditional methods lack interactivity and personalization, while VR offers immersive, tailored learning. A literature review highlights VR's use in surgical training, rehabilitation, and therapies, with emerging patient education applications (e.g., diabetes management). Benefits include improved self-efficacy and adherence, but challenges like cost and scalability persist. The framework integrates interactive learning, personalized content, and system coordination, aligning with value-based care. Implementation involves needs assessment, content development, infrastructure, and evaluation, engaging healthcare institutions, tech firms, clinicians, and patients. Future research should explore cost-effectiveness and adaptability. VR promises to transform patient education, enhancing healthcare delivery.

Key Words: Healthcare management, patient education, value-based care, virtual reality

Özet

Bu çalışma, sanal gerçeklik (VR) teknolojisinin hasta eğitimindeki potansiyelini sağlık yönetimi perspektifinden kavramsal bir çerçeve sunarak incelemektedir. Geleneksel yöntemlerde etkileşim ve kişiselleştirme sınırlı kalırken, VR teknolojisi sürükleyici ve bireye özel bir öğrenme deneyimi sunmaktadır. Yapılan literatür taraması; VR'nin cerrahi eğitim, rehabilitasyon ve terapötik uygulamalardaki kullanımına ek olarak, diyabet yönetimi gibi hasta eğitimine yönelik uygulamalardaki rolünü ortaya koymaktadır. VR'nin sağladığı başlıca faydalar arasında hastaların öz yeterliliğinde artış ve tedaviye uyumda iyileşme yer almaktadır. Bununla birlikte, maliyet ve ölçeklenebilirlik gibi bazı zorluklar da mevcuttur. Önerilen kavramsal çerçeve; değer temelli bakım anlayışıyla uyumlu olacak şekilde, etkileşimli öğrenme, kişiselleştirilmiş içerik ve sistem düzeyinde koordinasyonu bir araya getirmektedir. Uygulama süreci; sağlık kuruluşlarını, teknoloji firmalarını, klinisyenleri ve hastaları kapsayan çok paydaşlı bir yaklaşım ile ihtiyaç analizini, içerik geliştirmeyi, teknik altyapının kurulmasını ve değerlendirme aşamalarını içermektedir. Gelecekte yapılacak araştırmaların, VR tabanlı hasta eğitiminin maliyet etkinliğini ve farklı sağlık hizmeti bağlarına uyarlanabilirliğini incelemesi gerekmektedir. VR teknolojisi, hasta eğitimi dönüştürme potansiyeli ile sağlık hizmeti sunumunun kalitesini artırma vaadi taşımaktadır.

Anahtar Kelimeler: Hasta eğitimi, kavramsal çerçeve, sanal gerçeklik, sağlık yönetimi

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1. Introduction

Patient education is a cornerstone of modern healthcare, empowering individuals to manage their health conditions effectively, thus improving personal outcomes and healthcare system efficiency. The World Health Organization (WHO) predicts a 57% rise in chronic disease prevalence globally by 2030, highlighting the pressing need for innovative educational strategies (World Health Organization [WHO], 2020). From a healthcare management perspective, effective patient education enhances treatment adherence, reduces hospital readmissions, improves cost-effectiveness, and boosts patient satisfaction (Porter & Teisberg, 2006). Traditional methods such as printed brochures, face-to-face consultations, and instructional videos remain prevalent but often lack interactivity, accessibility, and customization, especially for diverse patient groups like those with low literacy or mobility constraints. Virtual Reality (VR), defined as an immersive, three-dimensional digital environment, offers a transformative solution to these shortcomings.

VR has gained momentum in healthcare, with applications ranging from surgical simulations to psychological therapies (Slater & Sanchez-Vives, 2016). For instance, surgeons use VR to practice complex procedures, while therapists employ it to treat phobias via controlled exposure. Yet, its potential in patient education remains underexplored. Imagine diabetic patients practicing insulin injections in a virtual setting, cardiovascular patients visualizing lifestyle changes, or asthma sufferers mastering inhaler techniques all enabled by VR's interactive capabilities. Mayer's multimedia learning theory (2014) suggests that combining visual and auditory stimuli improves comprehension and retention. VR takes this further, transforming patients from passive learners into active participants, fostering engagement and skill development.

From a healthcare management lens, VR promises significant opportunities alongside challenges. It can simulate intricate medical processes in 3D, personalize content to patient needs, and overcome barriers like limited hospital access during pandemics or mobility issues. However, high costs, infrastructure demands, and adoption difficulties especially among elderly or less tech-savvy patients pose hurdles (Bailenson, 2018). Recent studies, such as those post-COVID-19, underscore VR's role in remote education, amplifying its relevance (Lee & Lee, D, 2021). This study investigates VR's potential to revolutionize patient education, proposing a practical framework rooted in healthcare management principles.

This research uniquely contributes by developing a conceptual model integrating VR into patient education, evaluated through a systematic literature review. It assesses VR's current applications, benefits, and limitations, offering a roadmap for implementation. Using a literature-based approach, this study requires no ethical approval, providing a robust theoretical and practical analysis to advance patient education in healthcare systems. Virtual Reality (VR) has reshaped healthcare over the past two decades, evolving from its 1990s origins in surgical simulation to a versatile tool across medical domains (Riva, 2005). This section systematically reviews VR's healthcare applications, focuses on patient education studies, and identifies gaps and opportunities from a healthcare management perspective. Sources are drawn from PubMed, Google Scholar, and Springer databases..

2. Method

This study was designed as a systematic conceptual literature review aimed at identifying, synthesizing, and interpreting the existing body of knowledge on the use of Virtual Reality (VR) technologies in patient education from a healthcare management perspective.

A comprehensive literature search was carried out using four major scientific databases: PubMed, Scopus, Web of Science, and Google Scholar. The search strategy was developed to capture both foundational and contemporary studies and therefore included publications from 2010 through 2025. Various Boolean combinations of key terms were employed to ensure broad yet relevant coverage of the topic. These terms included "virtual reality" or "VR" combined with "patient education," "health education," "healthcare management," "chronic disease education," and "digital health education." An example of the applied search syntax was ("virtual reality" OR "VR") AND ("patient education" OR "health education") AND ("healthcare management").

The inclusion criteria consisted of peer-reviewed journal articles published in English that focused on VR-based patient education or digital educational health interventions and addressed healthcare management, organizational, economic, or patient outcome dimensions.

Studies were excluded if they were conference abstracts, editorials, non-peer-reviewed publications, focused exclusively on professional medical training without a patient education component, written in languages other than English, or lacked full-text availability.

The initial database search yielded a total of 397 records. After removing 83 duplicate entries, 314 articles remained for title and abstract screening. Following this stage, 92 full-text articles were assessed for eligibility

based on the predefined inclusion and exclusion criteria. Ultimately, 41 studies met all selection criteria and were included in the qualitative synthesis that informed the development of the proposed conceptual framework.

2.1. Current Applications of VR in Healthcare

VR’s earliest success was in surgical training. Gallagher et al. (2005) showed that VR simulations outperform traditional methods, enhancing surgeons’ skills in procedures like laparoscopy. By practicing in a risk-free virtual environment, surgeons reduce errors, improving patient safety. Beyond surgery, VR aids physical rehabilitation. Weiss et al. (2014) found that VR-based exercise programs for stroke patients boost motivation and recovery compared to conventional physiotherapy, blending education with therapy.

In psychological care, VR excels in exposure therapy for anxiety disorders. Rothbaum et al. (2006) demonstrated its efficacy in treating fear of flying, leveraging VR’s realism and control (Slater & Sanchez-Vives, 2016). These applications highlight VR’s transformative potential across healthcare.

2.2. VR-Based Studies on Patient Education

Patient education empowers individuals to understand and manage their health, yet traditional methods like brochures or verbal instructions often lack interactivity. VR offers a dynamic alternative, though research remains nascent. Fertleman et al. (2018) developed a VR program for parents facing pediatric emergencies, finding it improved knowledge retention over conventional training.

Participants felt better prepared for real-life scenarios, showcasing VR’s ability to simulate complex situations. In chronic disease management, Lim et al. (2020) reported that diabetic patients using VR to practice insulin injections gained self-efficacy, reducing injection-related fears. Similarly, Li et al. (2011) found cancer patients trained via VR for pain management reported higher satisfaction than those using traditional methods.

Recent studies reinforce these findings. VR’s role in post-COVID-19 patient education, noting its effectiveness in teaching respiratory techniques remotely. However, most studies are small-scale pilots, lacking broad evaluation. Data on VR’s impact on tech-averse groups, like the elderly, are limited, and healthcare management aspects cost-effectiveness, resource allocation are often overlooked. Table 1 summarizes key domains where VR has demonstrated significant impact, particularly in patient training and chronic disease management.

Table 1. Applications of Virtual Reality (VR) in healthcare

Medical Area	VR Application Example	Reported Benefit
Surgical Training	Laparoscopic simulation using VR	Increased precision and reduced error rates
Rehabilitation	VR-based stroke rehabilitation exercises	Enhanced motivation and motor recovery
Psychological Therapy	VR exposure for phobia (e.g., fear of flying)	Controlled environment, better outcomes
Pediatric Emergencies	VR training for parents on emergency response	Improved preparedness and knowledge retention

2.3. Gaps and Opportunities

Several gaps emerge from the literature. First, studies focus narrowly on specific conditions (e.g., diabetes, emergencies), lacking a generalized patient education model. This restricts VR’s adaptability across diverse populations. Second, scalability and accessibility are underexplored. Bailenson (2018) highlights high equipment costs e.g., an Oculus Rift headset averages \$300-\$500 plus software as a barrier, especially in low-income settings. Third, technological adaptation among elderly or less proficient patients is understudied, raising inclusivity concerns (Li et al., 201). Hypothetically, this gap may stem from funding shortages or skepticism about VR’s practicality. From a healthcare management view, VR aligns with Porter and Teisberg’s (2006) value-based care model, potentially reducing readmissions and improving adherence. For example, better-educated patients may need fewer hospital visits, easing system burdens. A 2024 study by Kim et al. suggests VR’s cost-effectiveness improves with scale, offering a promising avenue for investigation.

2.4. The Potential of VR in Patient Education

VR surpasses traditional patient education by offering immersive, interactive learning. This section examines its advantages, challenges, and healthcare management implications within a theoretical framework. VR's strength lies in presenting complex medical concepts in 3D. Mayer's multimedia learning theory (2014) posits that visual-auditory integration enhances retention. VR advances this by engaging patients actively. Lim et al. (2023) found diabetic patients using VR for insulin practice improved self-efficacy, while Fertleman et al. (2018) noted better preparedness among VR-trained parents. Personalization is another asset: VR can tailor content e.g., dietary advice for heart patients boosting relevance and motivation (Slater & Sanchez-Vives, 2016). Cost is a major hurdle. VR systems, including headsets and software, demand significant investment Weiss et al. (2014) estimate 30% higher costs than traditional methods. Technological adaptation poses another challenge, especially for elderly patients. Li et al. (2011) noted some required pre-training, suggesting inclusivity issues. Motion sickness from prolonged use further complicates adoption (Slater & Sanchez-Vives, 2016). Psychologically, trust in technology may also affect uptake, though data are limited.

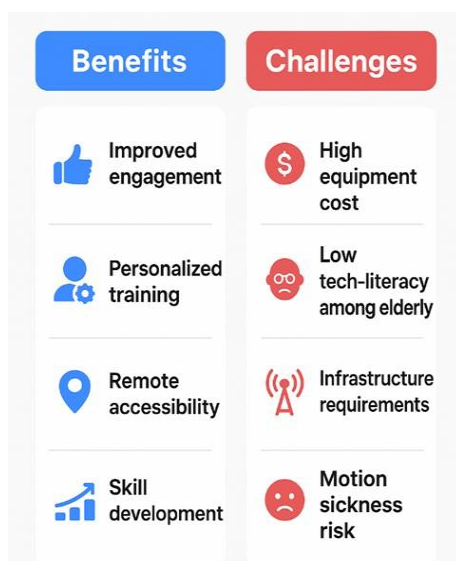


Figure 1. Summary of main benefits and challenges associated with VR-based patient education in healthcare.

2.5. Conceptual Framework Proposal

The proposed framework is composed of several interrelated components designed to optimize educational outcomes (Table 2).

Table 2. Framework component

Framework Component	Explanation	Example Scenario
Interactive Learning	Patients engage in real-time simulation and practice	Asthma patients mastering inhaler use
Personalized Content	Customization based on patient diagnosis and demographics	Diet guidance for cardiac patients
System-Level Integration	Embedding VR programs into healthcare workflows	VR in hospital discharge training
Feedback and Evaluation	Monitoring performance and tailoring content accordingly	Provider adjusts education plan post-session

Integrating VR into patient education requires a structured framework. This section proposes a model, detailing components, implementation, and stakeholder roles from a healthcare management perspective.

Proposed Model: VR-Based Patient Education Framework

The model blends Mayer's multimedia learning theory (2014) and Porter and Teisberg's value-based care (2006). It includes: (1) Interactive Learning Environment, engaging patients via VR simulations; (2) Personalized Content, customizing education (e.g., asthma inhaler training); and (3) Healthcare System Integration, embedding VR into hospital workflows. A cyclical process engage, interact, receive feedback, refine treatment drives learning. Fertleman et al. (2018) showed feedback in VR improves outcomes, supporting this approach.

2.6. Proposal Implementation Steps and Stakeholder Roles

Needs Assessment: Target groups (e.g., chronic disease patients) and topics (e.g., medication use). **Content Development:** Clinicians, technologists, and designers create evidence-based VR scenarios. **Infrastructure Setup:** Procure equipment, train staff, and establish support teams

Evaluation: Assess outcomes, satisfaction, and costs, refining the model.

Stakeholders include: (1) Healthcare Institutions, funding and policymaking; (2) Technology Firms, developing affordable systems; (3) Clinicians, validating content; (4) Patients, providing feedback; and (5) Patient Advocacy Groups, ensuring inclusivity (Bailenson, 2018). Pilot studies can test feasibility across settings.

3. Results

The growing integration of Virtual Reality (VR) into patient education has prompted a new wave of research exploring its potential to improve health outcomes, particularly from a healthcare management perspective. Recent studies highlight that VR enhances knowledge acquisition, engagement, and patient empowerment across various clinical contexts. For example, a 2024 meta-analysis demonstrated that VR-based simulations significantly outperformed traditional learning materials in conveying complex medical information, increasing patient comprehension and reducing procedural anxiety (Avery et al., 2024, *Journal of Medical Internet Research*). The immersive nature of VR enables experiential learning that fosters stronger retention and more personalized understanding, especially in high-stakes areas such as pre-operative education or chronic disease management.

Beyond cognitive outcomes, VR has been shown to impact physiological and emotional responses. A randomized crossover study published in *NPJ Digital Medicine* in 2025 found that chronic pain patients using a telehealth VR intervention experienced substantial reductions in pain intensity, anxiety, and sleep disturbances over a five-week period (Cerda et al., 2024). Similarly, in oncology care, virtual environments have been effectively used to manage procedural anxiety and acute pain, with patients reporting improved tolerance during chemotherapy and radiotherapy sessions (Harvie et al., 2024). These findings support the therapeutic utility of VR not only in education but also in symptom relief, making it a versatile tool within a broader value-based care model.

VR also plays a transformative role in rehabilitation by increasing patient motivation, adherence, and physical outcomes. For instance, recent clinical trials investigating stroke recovery have confirmed that VR-based motor training significantly improves upper-limb function and balance compared to standard physiotherapy. These benefits are especially pronounced when the VR content is interactive, gamified, and customized to the patient's specific limitations. In telerehabilitation, VR has proven particularly effective for patients with limited mobility or those in remote settings, offering structured exercise programs with real-time feedback and adaptive progression (Hao et al., 2023). Such features align closely with Mayer's multimedia learning theory, suggesting that engaging both auditory and visual channels not only supports memory retention but also motivates sustained behavioral change.

Importantly, VR is not limited to patient-facing applications. It has demonstrated substantial impact in clinical training for healthcare professionals. A 2024 umbrella review revealed that VR-based education improved diagnostic accuracy, procedural skills, and situational awareness in emergency simulations. These studies emphasized that medical students and residents who trained using immersive VR scenarios performed better in skill-based assessments compared to peers trained through lectures or paper-based case studies (Lee et al., 2024). Furthermore, VR contributes to the development of soft skills such as empathy, clinical communication, and teamwork. For example, scenario-based VR training helped improve clinician-patient interactions and enhanced emotional intelligence among nursing students, suggesting that VR can address both technical and relational competencies in healthcare education.

VR-based educational interventions have also demonstrated strong effects on rehabilitation-related patient education by increasing motivation, adherence, and functional recovery outcomes. Clinical studies in stroke rehabilitation indicate that VR-supported motor training significantly improves upper-limb function, balance, and task performance compared to conventional physiotherapy, particularly when the educational content is interactive, gamified, and adapted to the patient's individual functional limitations (Hao et al., 2023). In telerehabilitation contexts, VR has further been shown to facilitate structured home-based education and exercise programs with real-time feedback and adaptive progression mechanisms, enabling patients with limited mobility or those living in remote areas to sustain effective self-management behaviors. These outcomes are theoretically

supported by Mayer’s multimedia learning theory, which emphasizes that multisensory engagement enhances cognitive processing, retention, and sustained behavioral change (Mayer, 2014).

Beyond patient-facing applications, VR-based educational environments also indirectly strengthen patient education through improved clinical training outcomes. An umbrella review demonstrated that immersive VR education significantly enhances diagnostic accuracy, procedural competence, and situational awareness among medical trainees in emergency care settings, leading to improved educational transfer into clinical practice (Tene et al., 2024). Furthermore, VR has been associated with measurable improvements in empathy, communication skills, and teamwork competencies among nursing and medical students, thereby contributing to higher-quality clinician–patient interactions and more effective delivery of patient-centered education. Despite these advantages, important implementation barriers remain, including high infrastructure costs, cybersickness, and limited long-term evidence derived from heterogeneous and small-sample studies (Gómez Bergin et al., 2023). From a healthcare management perspective, these findings underscore the necessity for future VR-based patient education initiatives to incorporate scalable, cost-effective implementation models, inclusive design principles, and adaptive personalization supported by backend analytics systems (Nguyen et al., 2025). Despite its growing promise, several implementation barriers persist. High setup costs, including hardware, software, and training infrastructure, pose challenges for scalability, particularly in low-resource settings. Additionally, cybersickness characterized by dizziness, nausea, and fatigue continues to affect a subset of users, especially among older adults and those unfamiliar with digital interfaces. A 2023 scoping review underscored that the majority of studies on VR in healthcare suffer from small sample sizes, limited long-term follow-up, and heterogeneous measurement tools, which complicates generalizability (Kumar et al., 2023). There is also limited evidence on how VR can be effectively scaled and integrated into existing healthcare workflows without disrupting continuity of care. From a healthcare management standpoint, these findings present both opportunity and caution. VR clearly aligns with the principles of value-based care by enhancing patient understanding, promoting adherence, and potentially reducing unnecessary hospital visits. However, real-world adoption requires robust cost-benefit analyses, cross-sector collaboration, and inclusive design that considers digital literacy, language, and cultural context. Studies suggest that future VR implementations should include adaptive content personalization based on patient profiles and clinical pathways, as well as backend analytics to monitor learning outcomes and system efficiency (Nguyen et al., 2025).

In summary, the evidence suggests that VR holds transformative potential in both patient education and professional training. Its benefits ranging from improved learning and symptom relief to enhanced clinical communication are well-documented across diverse populations and health settings. Future research should prioritize longitudinal studies with standardized methodologies, explore AI-powered VR personalization, and investigate ways to integrate VR sustainably into mainstream healthcare delivery. In light of the synthesized findings and identified research gaps, the proposed conceptual framework presented in the following section is introduced as an integrative model to support the systematic and sustainable implementation of VR-based patient education within healthcare organizations.

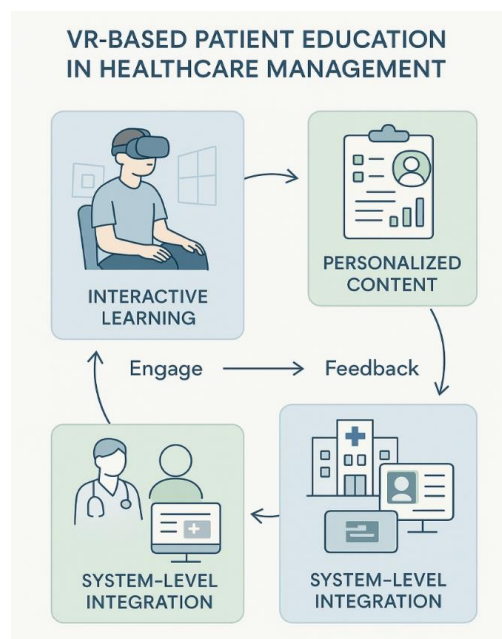


Figure 2. Conceptual framework for VR-based patient education

4. Conclusion

This review examined the potential of Virtual Reality (VR) technology in enhancing patient education from a healthcare management perspective, and proposed a conceptual framework based on current literature. The findings suggest that VR can significantly improve both cognitive and behavioral learning outcomes in patients. Specifically, VR-based educational interventions have been shown to increase engagement, reduce pre-procedural anxiety, enhance self-efficacy, and improve disease management skills particularly in areas such as chronic illness education, preoperative preparation, psychological support, and rehabilitation. VR applications also contribute to increased patient satisfaction and adherence to treatment plans, aligning well with the principles of value-based healthcare delivery.

In addition to its benefits for patients, VR has demonstrated strong potential in training healthcare professionals. Immersive simulations have been associated with improved clinical reasoning, enhanced procedural accuracy, and the development of essential soft skills such as communication and empathy. These outcomes highlight VR's capacity to support both technical proficiency and patient-centered care among clinicians.

However, despite its promising advantages, several challenges remain. High implementation costs, the need for robust technological infrastructure, limited digital literacy among certain patient populations, and adaptation difficulties in older adults continue to hinder widespread adoption. Moreover, much of the current evidence is based on small-scale studies with limited follow-up, and there is a lack of standardized methodologies for evaluating VR's long-term effectiveness in healthcare settings.

Based on the insights derived from this review, the following recommendations are proposed:

VR integration into patient education should be approached through scalable, cost-effective models that consider both clinical and demographic diversity. Policymakers and healthcare institutions must collaborate with technology developers to design inclusive, adaptive, and accessible VR platforms tailored to various patient needs. Furthermore, future research should prioritize large-scale, longitudinal studies with consistent outcome measures, including cost-benefit analyses and implementation feasibility. Finally, combining VR with other digital health tools such as artificial intelligence, biofeedback systems, and electronic health records may further enhance its utility in modern, data-driven healthcare environments.

In conclusion, VR represents a transformative innovation in patient education and professional training. When strategically implemented, it holds the potential to improve learning outcomes, optimize resource use, and elevate the overall quality and efficiency of healthcare services.

Future research should focus on developing AI-driven adaptive VR education systems, conducting multicenter longitudinal trials, and establishing standardized outcome metrics to support evidence-based policy formulation and large-scale institutional adoption.

Conflict of Interest

The author declares that there is no conflict of interest regarding the publication of this article. No financial, personal, or institutional relationships exist that could have inappropriately influenced the content, interpretation, or presentation of the research. The study was conducted independently and was not supported by any commercial organization or funding agency that might gain financially or non-financially from the results.

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Author Contributions

Conceptualization: U.B.K.; Study design: U.B.K.; Data collection: U.B.K.; Data analysis: U.B.K.; Data interpretation: U.B.K.; Manuscript writing: U.B.K.; Critical review: U.B.K.; Final approval: U.B.K.

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