



## The Impact of Virtual Reality on Children

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### Abstract

Virtual reality emerges as a technological revolution widely used and frequently resorted to in various fields worldwide. The effects of virtual reality on children from different perspectives are not often addressed. It is quite evident that children are one of the groups significantly affected by virtual reality. In this study, research exploring the effects of virtual reality on children from different perspectives is conducted. The impacts of virtual reality on children in terms of health, language and communication skills, mathematical thinking, obtaining enriched experiences, privacy, and security are investigated. This study examines the multifaceted impact of Virtual Reality (VR) technology on children, focusing on its educational benefits, effects on social and emotional development, health implications, and privacy and security concerns. VR technology, widely used across various sectors, offers immersive, interactive experiences by simulating real-world environments. In education, VR enhances learning by making abstract concepts more tangible, particularly in subjects like mathematics, and improves language and communication skills through engaging digital content. Health-wise, VR has been shown to alleviate stress and pain in medical settings, although concerns about its potential negative effects on eye health and the risks of excessive use remain. Privacy and security issues, including data protection, cyberbullying, and the need for parental controls, are critical when considering children's use of VR. The study underscores the importance of balanced, safe, and supervised use of VR technology to maximize its benefits while mitigating its risks, providing valuable insights for educators, parents, and policymakers.

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### How to Cite

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## 1. Introduction

Virtual reality (VR) technology has become increasingly widespread across various fields, including education, tourism, media, and healthcare. VR is a computing technology that enables users to transition from the physical world into digitally constructed environments, allowing immersive interaction within three-dimensional spaces that can be explored, manipulated, and reshaped. With the rapid development of VR-compatible applications, particularly games designed for computers, tablets, and mobile devices, users are now able to experience simulated environments through head-mounted displays and interactive interfaces (Bayraktar and Kaleli, 2007). Through these systems, individuals can virtually inhabit any desired location and actively shape their surroundings using digital tools.

The use of virtual reality in childhood contexts presents both opportunities and challenges. On the one hand, VR environments can be deliberately designed and controlled by experts in terms of structure, stimulus density, and task difficulty, enabling tailored experiences aligned with specific educational or developmental goals (Emmelkamp, Krijn, Hulsbosch, de Vries, Schuemie, and van der Mast, 2002). On the other hand, as VR-based computer games have become increasingly popular among large segments of society, concerns have emerged regarding excessive use and the parallel rise in digital addiction, particularly among children and adolescents (Rajan, Babu, and Reddy, 2018).

Within the scope of this study, the effects of virtual reality on children are examined across multiple dimensions, including educational opportunities, social and emotional development, physical and psychological health, as well as issues related to privacy and data security. The study also evaluates the effectiveness, benefits, potential risks, and limitations of VR applications in childhood contexts. In the framework of 21st-century skills, particular emphasis is placed on information, media, and technology literacy. Contemporary educational paradigms increasingly prioritize the ability to access, evaluate, use, produce, and share information rather than rote memorization. However, traditional teaching methods often fail to adequately address the demands of a rapidly evolving digital world, resulting in significant gaps in children's learning experiences.

In this context, highlighting the role of virtual reality in education, teaching practices, and child development is essential for informing the organization and structuring of learning environments that respond to contemporary societal needs. In recent years, the use of VR in early childhood education has expanded rapidly and diversified in form. Current global trends in this field can be summarized as follows: (1) the use of VR applications to enhance social and sensory skills among children with special edu-

cational needs, particularly those on the autism spectrum; (2) the integration of VR-based simulations into teacher education and professional training; (3) the pedagogical application of semi-immersive and fully immersive learning environments; (4) the improvement of accessibility through mobile and wireless VR solutions; and (5) the growing focus on ethical considerations, child safety, and health-related issues. These trends are increasingly supported by systematic reviews and empirical research in the literature (Everri and Heitmayer, 2024).

## 2. Literature Review

### 2.1 Exploring the Impact of Virtual Reality on Children

Virtual Reality (VR) technology represents a significant paradigm shift, rapidly emerging as a powerful tool across multiple domains and fundamentally transforming interaction within digital environments. While its applications are often associated with innovation and positive learning outcomes, the use of VR by children has also become a subject of increasing debate and concern. Understanding both the potential benefits and risks of VR exposure is therefore essential for parents, educators, and policymakers.

In earlier generations, children predominantly engaged in direct social interaction with their peers in physical environments such as streets, playgrounds, or home surroundings (Güleç, 2018). However, with rapid technological advancement, children have begun to spend increasing amounts of time interacting with digital devices, including televisions, smartphones, tablets, social media platforms, and immersive media tools (AAP Council on Communications and Media, 2016). According to recent national digital usage reports, internet use among children and adolescents in Turkey continues to rise, with measurable increases across all age groups. Media usage varies significantly depending on factors such as age, gender, educational background, family socioeconomic status, and parental attitudes (Eyimaya and Irmak, 2021). These trends highlight the growing relevance of immersive technologies, including VR, particularly in early childhood education contexts.

### 2.2 Educational Opportunities of Virtual Reality

One of the primary goals of contemporary education is to move beyond rote memorization and foster active, learner-centered environments that promote critical thinking and problem-solving skills (Özpolat, 2013). Within the framework of 21st-century competencies, VR offers unique pedagogical opportunities by enabling experiential, interactive, and context-rich learning experiences.

Empirical studies demonstrate that VR-supported learning environments increase learners' motivation, engagement, and curiosity. For example, a study conducted at Harran

University's Osmanbey Campus involved the development of a three-dimensional campus model integrated into VR and AR applications. The system, implemented using the Unity game engine and deployed on mobile devices, allowed students from various age groups to explore the environment interactively. Findings indicated that learners approached educational content with greater enthusiasm, likely due to the interactive and entertaining nature of VR technologies (Memduhoğlu, Şenol, Akdağ, and Ulukavak, 2020). Moreover, VR allows learners to experience phenomena that are otherwise inaccessible in the physical world, such as walking on the Moon or exploring historical events, thereby deepening understanding and making abstract concepts more concrete (Alfadil, 2020; Martín-Gutiérrez, Mora, Añorbe-Díaz, and González Marero, 2017). During periods of educational disruption, such as the COVID-19 pandemic, VR and digital technologies also contributed to sustaining educational continuity by offering alternative learning environments (Alan, 2021).

### 2.2.1 Enriched Learning Experiences

Experiential learning is widely recognized as one of the most effective learning approaches, as it actively involves learners in the learning process. Through VR-based experiences, children not only observe but also interact with learning content, enhancing motivation and engagement. Research suggests that children, particularly those under 24 months, experience difficulties learning from two-dimensional media; however, interactive digital tools, including VR, can support learning through repetition and engagement when used appropriately (Radesky and Christakis, 2016). VR environments encourage learning by doing, enabling children to construct knowledge through immersive experiences and active participation (Osypova, Kokhanovska, Yuzbasheva, and Kravtsov, 2020; Martín-Gutiérrez et al., 2017).

### 2.2.2 Mathematical Thinking and Spatial Reasoning

Mathematical thinking, encompassing estimation, prediction, and logical reasoning, is a fundamental component of cognitive development. VR technologies facilitate the comprehension of complex mathematical and geometric concepts by offering three-dimensional representations and interactive simulations. Studies indicate that VR enhances learners' spatial perception and understanding of abstract mathematical structures (Mikropoulos and Natsis, 2011). By providing realistic simulations, VR helps children connect mathematical concepts with real-life contexts, thereby supporting deeper conceptual understanding (Hussein and Nätterdal, 2015; Pasqualotti and Freitas, 2002).

### 2.2.3 Development of Language and Communication Skills

Language and communication skills are central to educational success. Activities such as storytelling, imaginative play, and structured dialogue support vocabulary

development and expressive abilities. Digital learning environments frequently incorporate multimedia elements, including visuals, sound, and three-dimensional content, to enhance language acquisition (Zhang and Zou, 2020). Research demonstrates that VR and AR applications positively influence children's listening, speaking, and overall language skills, particularly in early childhood education (Andika, Ekowati, İsmail, and Hierro, 2022; Frisby, Kaufmann, Vallade, Frey, and Martin, 2020; Tanrıverdi, 2022; Yıldırım, 2019). Furthermore, immersive VR environments have been shown to increase learners' willingness to communicate and improve oral proficiency in foreign language learning contexts (Chen, Chai, Jong, and Jiang, 2021; Ebadi and Ebadijalal, 2022). Evidence also suggests that VR-based interventions can reduce children's speech anxiety during public speaking tasks (Sülter, Ketelaar, and Lange, 2022).

### 2.2.4 Physical Health and Well-Being Considerations

Beyond educational outcomes, VR has demonstrated potential benefits in supporting children's physical and emotional well-being. Research indicates that immersive VR experiences can enhance concentration, reduce stress, and alleviate pain and anxiety during medical procedures. Cognitive-behavioral strategies often employ distraction techniques—such as music, cartoons, or play—to redirect attention away from distressing stimuli. VR offers a technologically advanced alternative by creating immersive environments that foster a sense of presence in calming virtual worlds (?). By engaging children's attention in enjoyable and interactive experiences, VR can serve as an effective tool for reducing anxiety and improving emotional regulation in healthcare and therapeutic settings.

## 3. Privacy and Safety Concerns

Virtual reality (VR) technology offers children both entertaining and educational experiences; however, it also introduces significant privacy and security concerns. Immersive virtual environments often involve data collection, online interaction, and prolonged screen exposure, all of which may pose risks for children if not properly regulated. Among the most commonly reported concerns in virtual environments are cyberbullying, excessive screen time, and internet addiction (Sirakaya and Seferoğlu, 2018). This section examines key privacy and security issues related to children's use of VR technologies.

### 3.1 Protection of Personal Data

Virtual reality applications are capable of collecting and storing extensive amounts of personal data, including user profiles, behavioral patterns, biometric signals, and interaction histories. When users are children, the collection, processing, and sharing of such data raise serious ethical and legal concerns. Children may unknowingly disclose

personal information in virtual environments, increasing their exposure to inappropriate content, cyberbullying, manipulation, or harassment (Kişisel Verileri Koruma Kurumu, 2024).

In many cases, parents create accounts on behalf of their children or permit access to VR platforms without fully understanding the scope of data collection practices, thereby increasing potential cyber risks. Consequently, transparent data policies, robust encryption mechanisms, and strict access controls are essential. Internationally, legal frameworks such as the *Children's Online Privacy Protection Act* (COPPA, 1998) in the United States establish rules governing the collection and protection of children's online data. Similar regulations emphasize the importance of informed parental consent and the minimization of data collection for minors.

### 3.2 Child Safety in Virtual Environments

Ensuring children's physical, psychological, and emotional safety in VR environments is a critical concern. The immersive nature of VR may intensify exposure to disturbing content, harmful social interactions, or inappropriate behavior from other users. From a legal perspective, several risks associated with VR environments may fall under the scope of *indirect cybercrimes* as defined by the Turkish Penal Code (TCK, 2004).

Relevant legal provisions include:

- Article 84 – Incitement to suicide,
- Article 103 – Sexual abuse of children,
- Article 104 – Sexual intercourse with minors,
- Articles 141 and 142 – Theft,
- Article 226 – Obscenity,
- Article 77 – Crimes against humanity,
- Articles 79 and 80 – Human trafficking,
- Article 90 – Experimentation on humans,
- Article 227 – Prostitution,
- Article 229 – Begging.

These legal considerations demonstrate that virtual environments are not exempt from real-world legal responsibilities. Therefore, VR platforms must integrate effective moderation tools, age-appropriate content restrictions, and reporting mechanisms to protect child users.

### 3.3 Parental Controls and Monitoring Mechanisms

Parental supervision plays a central role in ensuring the safe use of VR technologies by children. Implementing

parental control systems—such as content filters, time limitations, age-based access restrictions, and activity monitoring tools—can significantly reduce exposure to harmful content. These mechanisms allow parents to regulate children's VR usage while fostering a safer digital environment.

### 3.4 Education and Awareness

Beyond technical safeguards, education and awareness are essential components of child protection in virtual environments. Children should be educated about safe VR usage practices, potential online risks, and appropriate behavioral norms in digital spaces. Developing digital literacy skills from an early age can help children recognize threats and adopt responsible usage habits. Awareness programs targeting both children and parents are therefore critical for promoting long-term safety.

### 3.5 Gaming and Entertainment-Oriented Applications

A large proportion of VR applications designed for children focus on gaming and entertainment. While these applications can support creativity and engagement, their content design, interaction models, and reward mechanisms require careful evaluation. Research into best practices for secure VR game design—such as limiting social interaction with unknown users, preventing addictive design patterns, and ensuring age-appropriate narratives—is necessary to safeguard children's privacy and well-being.

Overall, research on the privacy and security aspects of VR technologies provides essential guidance for parents, educators, policymakers, and developers. By integrating legal safeguards, technical protections, parental involvement, and educational strategies, it is possible to ensure that children benefit from VR technologies in a safe, ethical, and developmentally appropriate manner.

## 4. Method

### 4.1 Research Design

This study was designed as a qualitative systematic review aimed at examining the multifaceted impacts of Virtual Reality (VR) technology on children from multiple perspectives, including education, language and communication development, mathematical thinking, health, privacy, and safety. The systematic review approach was selected to identify, analyze, and synthesize the most relevant and up-to-date research findings in this field. Rather than collecting new empirical data, this study focuses on interpreting existing literature, thereby enabling a comprehensive understanding of global trends and implications associated with VR use among children.

### 4.2 Data Collection Process

To ensure the comprehensiveness and credibility of the dataset, a systematic literature search was conducted be-



tween June 2024 and July 2025 using multiple academic databases, including Scopus, Web of Science, ERIC, Google Scholar, and ResearchGate. The search strategy employed a combination of the following keywords: *virtual reality, children, early childhood education, child development, language and communication, mathematical thinking, health effects, privacy, and cyber safety*.

Boolean operators (AND, OR) were used to refine search results, and predefined inclusion and exclusion criteria were applied to identify studies directly relevant to the research objectives.

### 4.3 Inclusion and Exclusion Criteria

**Inclusion criteria** were as follows:

- Peer-reviewed journal articles, conference papers, and book chapters published between 2015 and 2025,
- Studies focusing on children aged between 3 and 11 years,
- Research addressing educational, developmental, or health-related contexts of VR use,
- Publications written in English or Turkish.

**Exclusion criteria** included:

- Studies unrelated to children or focusing exclusively on adult VR experiences,
- Articles lacking empirical evidence or theoretical grounding,
- Duplicate publications or studies with insufficient methodological detail.

### 4.4 Data Analysis

Following the application of inclusion and exclusion criteria, the selected studies were subjected to qualitative content analysis. Thematic coding was employed to categorize findings into five major dimensions:

1. Educational benefits,
2. Enriched learning experiences and engagement,
3. Development of mathematical, language, and communication skills,
4. Health-related outcomes,
5. Privacy and safety concerns.

Each theme was analyzed in terms of its positive contributions, potential risks, and identified research gaps. Descriptive synthesis was used to integrate findings and highlight emerging global trends, with particular emphasis on early childhood education contexts.

### 4.5 Reliability and Validity

To enhance the reliability of the review process, the literature selection and screening procedures were independently reviewed by three researchers. Any disagreements were resolved through collaborative discussion and consensus-building. All included studies were critically evaluated based on academic credibility, methodological rigor, and relevance to the research objectives. In addition, triangulation was achieved by comparing findings across multiple disciplines, including education, psychology, and computer science.

### 4.6 Ethical Considerations

Since this study relied exclusively on secondary data obtained from previously published sources, no direct interaction with human participants occurred, and no ethical risks were involved. Academic integrity and transparency were ensured by accurately citing all sources in accordance with APA (7th edition) guidelines.

## 5. Discussion, Findings and Suggestion

Today, virtual reality (VR) technology is widely utilized across various domains, including education, tourism, media, and healthcare. By transferring real-world contexts into immersive digital environments, VR enables users to interact with three-dimensional simulations in ways that are not possible through traditional media. When applied to children, however, VR presents both significant opportunities and notable challenges. Its effectiveness largely depends on the duration of exposure, the purpose of use, and the developmental appropriateness of the content.

Overall, the impact of VR technology on children is multifaceted and context-dependent. While VR can enhance learning experiences, communication skills, and engagement, its uncontrolled or excessive use may pose developmental, health, and privacy-related risks. Therefore, it is essential for educators and parents to implement informed strategies that promote safe, balanced, and purposeful use of VR technologies. This study contributes to the growing body of literature by offering a comprehensive framework for understanding and evaluating the effects of VR on children's development.

### 5.1 Discussion of Findings

Recent studies indicate that VR has a positive influence on children's mathematical reasoning, language acquisition, and social interaction by providing immersive and interactive learning environments (Chen et al., 2021; Ebadi and Ebadijalal, 2022). These environments promote active engagement and experiential learning, which are particularly beneficial in early childhood education. However, concerns persist regarding potential overstimulation, increased screen dependency, and risks related to data pri-

vacy and online safety (Sirakaya and Seferoğlu, 2018; AAP Council on Communications and Media, 2016).

Moreover, the pedagogical effectiveness of VR is strongly influenced by teacher involvement, instructional design, and age-appropriate implementation (Osypova et al., 2020; Hsieh and Lee, 2008). Semi-immersive VR systems, in particular, appear to offer a balanced approach by fostering engagement while minimizing cognitive overload in young learners (Everri and Heitmayer, 2024). Despite these advantages, ethical and developmental issues—such as data collection practices, behavioral monitoring, and safeguarding children in virtual environments—remain insufficiently explored (Kişisel Verileri Koruma Kurumu, 2024; COP, 1998).

## 5.2 Limitations

This study is limited by its reliance on secondary data and previously published research. A significant limitation is the predominance of studies conducted in Western contexts, with limited representation from non-Western or developing countries, including Türkiye. Cultural and socio-economic differences may substantially influence technology access, parental attitudes, and educational practices related to VR use (Eyimaya and Irmak, 2021).

Additionally, there is a lack of longitudinal research examining the long-term developmental consequences of VR exposure in early childhood. Most existing studies employ experimental or quasi-experimental designs that focus on short-term cognitive or emotional outcomes rather than sustained developmental effects over time (Radesky and Christakis, 2016; Ghaddaripouri, Mousavi Baigi, Noori, and Mazaheri Habibi, 2022).

## 5.3 Future Research Directions

Future research should address these limitations through longitudinal, cross-cultural, and mixed-method approaches. In particular, studies examining the neurocognitive effects of prolonged VR use—such as attention regulation, sensory integration, and executive functioning—are critically needed. Further investigation into child-centered VR design frameworks that prioritize safety, ethical data use, and pedagogical adaptability is also recommended (Pasqualotti and Freitas, 2002; Martín-Gutiérrez et al., 2017).

There is also growing interest in exploring VR-based interventions for children with special needs, especially those with autism spectrum disorder (ASD), as immersive technologies may support social communication and sensory regulation (Everri and Heitmayer, 2024). Finally, future studies should examine parental mediation strategies and digital literacy education to ensure that children's VR use remains developmentally appropriate, safe, and balanced. Strengthening policy frameworks and ethical oversight mechanisms will be essential as VR technologies become

increasingly integrated into children's everyday lives and educational settings (AAP Council on Communications and Media, 2016; Kişisel Verileri Koruma Kurumu, 2024).

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