

## EXPLORING IMMERSION IN VIRTUAL REALITY: OVERVIEW AND RESEARCH PERSPECTIVE

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**Purpose:** The aim of this article is to review the definition and understanding of the immersion phenomenon in virtual reality (VR) and identify research gaps related to the definition, understanding, and measurement of immersion. The paper also aims to demonstrate, initially, that immersion is a real-world phenomenon, empirically observable in various VR contexts and intuitively evaluated by users.

**Design/methodology/approach:** The first part of the article is a review, as the author has conducted an overview of the definition and understanding of immersion phenomenon. Furthermore, the author presents the initial results of her own research based on surveys. Based on the review and surveys, the author identifies a research gap and formulates research questions that will serve as a starting point for practical research.

**Findings:** The results of the literature review show that immersion is defined differently across disciplines, and various factors that may influence it are identified. There is a lack of research on the factors that influence immersion and how to measure immersion levels. There is also a lack of comprehensive practical research on immersion with users. The paper identifies the research gap and formulates research questions based on the literature review and initial surveys.

**Research limitations/implications:** This article is exploratory in nature and concerns the phenomenon of immersion in virtual reality. It presents the first stage of research, namely literature research. It is therefore an introduction to the discussion on defining and understanding immersion, as well as an introduction to practical research.

**Practical implications:** The article identifies a research gap based on a literature review and the authors' preliminary studies. Furthermore, the article formulates research questions that will be addressed in subsequent studies.

**Originality/value:** This article adds value by combining a literature review with empirical results from authors' own research conducted in various VR contexts. The article identifies a research gap and research questions, which serves as a starting point for further practical research on immersion in virtual reality.

**Keywords:** virtual reality, immersion, immersive, VR goggles, immersive technologies, VR.

**Category of the paper:** Research paper.

## 1. Introduction

Key developments in immersive technologies, like virtual reality (VR), have changed them into widely accessible tools for entertainment and professional use over recent years. They are not only of interest to users for entertainment purposes, such as interactive and experimental games and activities but VR can be used also in education, industry, medicine, tourism, sports and many different fields. One of the key characteristic features of VR is phenomenon called immersion. Thus, VR users can immerse themselves in a different reality, experience a strong sense of presence in a three-dimensional virtual world, and forget themselves. It often leads to a loss of sense of real space and time. Users just need to put on VR goggles. As experience progresses, a user becomes increasingly deeply involved with the created environment. Virtual reality allows users to engage not only the mind but also the body. VR users can have different interactions. They usually use controllers but in the case of the latest technologies, there is even no need for controllers anymore – technology enables tracking of hand movements. VR users can lift, throw and touch virtual objects. At a certain stage, they lose awareness of the physical environment they are actually in. Because they see the unreal 3D world around them and cannot see the real space, their perception is entirely filled with a virtual environment. Then a strong sense of "being somewhere else" emerges. This is the essence of immersion.

This article addresses the topic of immersion in virtual reality. The first part of the article is a review, as the author has conducted an overview of the definition and understanding of immersion phenomenon. Furthermore, the author presents the initial results of her own research based on surveys. Based on the review and surveys, the author identifies a research gap and formulates research questions that will serve as a starting point for practical research. This article, therefore, serves as a starting point for further research and opens a discussion on defining and measuring immersion in virtual reality.

## 2. Review of Immersion in Virtual Reality

This chapter reviews the definition of the concept of immersion in virtual reality. The research was based on literature searches conducted in Scopus and Google Scholar. References were made to literature that presented the definition and understanding of immersion from various perspectives. The author refers not only to theoretical definitions and descriptions of immersion but also to the results of practical (experimental) research. The chapter is divided into two subchapters. The first sub-chapter presents the mentioned definitions and general concept of immersion in VR. The second sub-chapter presents the conclusions drawn from the conducted review.

## 2.1. An Overview of Definitions

The concept of immersion is metaphorical and originates from the bodily experience of physical immersion, for example, in water (Murray, 2017). It refers to the subjective feeling of being in a radically different environment – similar to the difference between air and water. In such a state, the individual feels fully surrounded by a new reality that dominates their attention and perception.

In the literature, the concept of immersion appears in numerous research contexts and is used across various scientific disciplines. It applies to both technical sciences, where it is analyzed in the context of designing interactive systems, virtual environments, and user interfaces, and to the social sciences, where it is considered in relation to communication, digital media, and user experience. The concept also holds a significant place in psychology and cognitive sciences, where immersion is described as a state of cognitive, emotional, and perceptual engagement. Furthermore, the term also appears in research in education, art, computer games, and even therapy, demonstrating its interdisciplinary nature. Various definitions and perspectives on immersion are discussed below.

In the context of psychological experiences, immersion is described as a state of deep cognitive engagement in which mental processes – regardless of the intensity of sensory input – lead to a significant shift in attentional focus. This results in a partial or complete detachment from awareness of the physical world and a focus on the experienced alternative reality (Agrawal et al., 2019). In other words, immersion is a state of concentration and cognitive engagement that depends on the ability to control attention and minimize distractions (Witmer, Singer, 1998). It is worth noting that this approach does not address emotional or physiological aspects.

Research on emotion analysis in virtual reality environments indicates that eliciting emotional responses in users promotes increased attention and engagement in the VR experience (Baños et al., 2004). Further analyses also demonstrated a relationship between social emotions and the experience of immersion. According to Bailenson and Yee's (Bailenson, Yee, 2008) research, social interactions and collaboration with other participants in the virtual environment lead to intensified emotional engagement, which indirectly translates into a deeper sense of immersion. Weibel et al. (Weibel et al., 2010) emphasize the role of individual emotional predispositions, suggesting that the level of immersion may be related to specific personality traits, such as neuroticism or openness to new experiences. Users characterized by greater emotional sensitivity are more likely to achieve a high level of immersion in the virtual environment. At the same time, the authors emphasize that some existing research focuses primarily on psychological factors, omitting the technical and visual aspects of VR applications, such as the quality of object representation, haptic stimuli, and system technological parameters.

In the literature on immersion in virtual reality, a significant portion of research focuses on its technical dimension. The authors of these studies analyze immersion primarily in relation to VR system parameters, such as graphic quality, sound realism, and user tracking precision (Bowman et al., 2012; Cummings, Bailenson, 2016; Kwon et al., 2016; Slater, Wilbur, 1997). In such approaches, the emphasis is primarily on the hardware and visual aspects of virtual environments, with less consideration given to users' subjective experiences, including their emotional reactions and level of psychological engagement. Cummings and Bailenson (Cummings, Bailenson, 2016) even gives the term of “technological immersion”. According to their research, increased levels of user-tracking, the use of stereoscopic visuals, and wider fields of view of visual displays are significantly more impactful on user experience of presence than improvements to most other immersive system features, including quality of visual and auditory content. Slater and Wilbur (Slater, Wilbur, 1997) propose that the degree of immersion can be objectively assessed as the characteristics of a technology. Immersion also has different dimensions: the extent to which a display system can deliver an inclusive, extensive, surrounding and vivid illusion of virtual environment to a participant; the extent of body matching; the extent to which there is a self-contained plot in which the participant can act and in which there is an autonomous response.

The literature also includes interdisciplinary studies that attempt to comprehensively address the phenomenon of immersion. These studies often combine technological, psychological, and cognitive perspectives, but in many cases, they are limited to theoretical considerations or laboratory experiments, without the participation of actual users in natural VR environments (IJsselsteijn et al., 2000; McMahan, 2013; Slater, 2003). Despite the fact that a meta-analysis conducted by Cummings and Bailenson (Cummings, Bailenson, 2016) demonstrate that a high level of technological immersion promotes a stronger subjective sense of presence in a virtual environment, but the impact of individual factors remains ambiguous and poorly organized. Therefore, a coherent, integrated model that combines the various determinants of the immersion experience, such as technological, design, emotional aspects, and individual user characteristics, is still lacking. The literature emphasizes that measuring immersion levels and the sense of presence in a virtual world is a complex issue.

There are also conclusions suggesting a lack of practical experiments on this topic (Degenhard et al., 2025; McGowin, Fiore, 2024; Zhang et al., 2025). As McGowin and Fiore (McGowin and Fiore, 2024) point out, quantifying immersion poses a significant research challenge, primarily due to the lack of standardized and systematic measures relating to the technical capabilities of virtual reality systems. The authors note that existing measurement approaches often do not allow for a clear and comparable assessment of the level of immersion across different VR solutions. Degenhard et al. (Degenhard et al., 2025) emphasize that due to the multidimensional and subjective nature of the sense of presence, the most commonly used tools for its measurement are questionnaires. At the same time, the authors note that the number of studies verifying the validity of these tools with respect to specific dimensions of presence

and their sensitivity to individual perceptual differences among users remains limited. Additionally, a literature review conducted by Zhang et al. (Zhang et al., 2025) reveals significant terminological inconsistencies and a lack of standardization in both the definitions of immersion and presence and the methods used to measure them. The authors emphasize the need to clarify concepts and develop a common methodological framework that would enable comparable and replicable research in the future.

## **2.2. Conclusions resulting from the review**

The diversity of applications makes immersion a multidimensional concept, and its definitions and operationalizations vary depending on the theoretical perspective and the purpose of the research. Despite the growing interest in the phenomenon of immersion, there is still a lack of consistent and unambiguous research explaining which factors most significantly determine the intensity of this experience in virtual reality. This applies to both technological conditions, such as the quality of visuals and audio or the dynamics of application performance, as well as psychological, cognitive, and emotional factors, and individual user characteristics. Although the literature on the subject contains numerous definitions and models describing immersion, there is significant inconsistency in methodological approaches and a lack of consensus regarding which variables should be considered crucial for its occurrence and measurement.

Furthermore, the rapid development of VR technology in recent years has led to significant changes in both application quality and hardware capabilities, meaning that the results of studies conducted a decade ago may not reflect current user experiences. Therefore, there is a clear need for contemporary empirical research utilizing the latest technological solutions to better understand the interactions occurring within human-machine systems. At the same time, there is a noticeable research gap regarding the development of reliable, standardized, and replicable measurement tools that enable precise assessment of the level of immersion in VR environments.

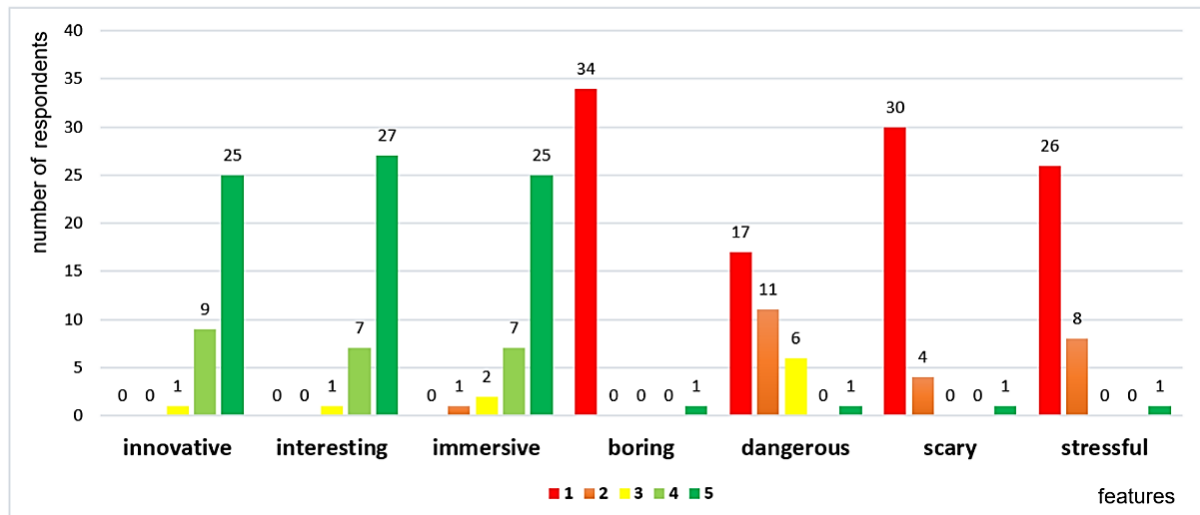
A significant limitation of existing research is the insufficient number of experiments conducted with real users, which would allow for empirical verification of the influence of specific factors – technological, psychological, and physiological – on the intensity of immersion experienced. Furthermore, these studies are often based on the analysis of single applications, which limits the generalizability of results. Using diverse VR applications, such as games, simulations, or training tools, with varying levels of quality and character, can significantly increase the objectivity and validity of conclusions. In particular, differences in the perception of immersion between different user groups remain poorly understood, suggesting the need to consider variables such as personality type, level of empathy, digital literacy, experience and frequency of gaming and VR use, physiological responses (e.g., heart rate changes), as well as age and gender.

Conducting research on the phenomenon of immersion in virtual reality is therefore crucial given the development of immersive techniques. They are currently outpacing scientific research on their psychological and cognitive impact on users. Reliable, practical, and multidimensional analyses are lacking in understanding what actually influences the depth of immersion and how to accurately measure it.

### **3. Results and Remarks regarding Immersion from Authors own Research using VR Technology**

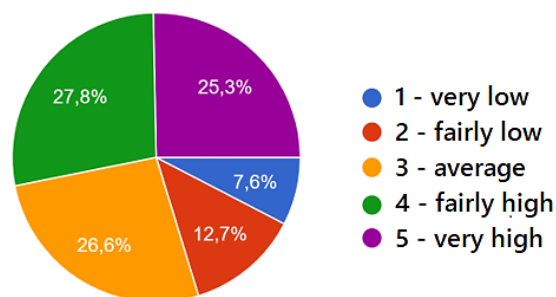
The author has already conducted several exploratory and applied studies using virtual reality technologies in various contexts, including entertainment, tourism, and vocational training. Although these studies were conducted independently and were not originally designed as a single research program, they provide valuable preliminary insights into how users perceive and evaluate immersion in VR environments. Importantly, these studies were conducted with diverse samples, using different applications and scenarios, allowing for the identification of recurring patterns rather than application-specific effects.

In the first study presented in this article, respondents using virtual reality were asked to rate selected features of VR and VR games. Respondents used entertainment gaming applications. The VR users were participants of the Researchers' Night (pl Noc Naukowców). The author of this article led VR workshops, and participants voluntarily completed a survey after the workshops. The survey listed various features, which were to be rated on a Likert scale of 1 to 5 after using VR. The results (Figure 1) show that features such as innovation, attractiveness, and immersiveness received the highest ratings. This indicates that immersion is intuitively recognized by users as one of the fundamental attributes of virtual reality experiences. Even without a precise definition provided to respondents, immersion emerged as a relevant and meaningful concept. This finding suggests that immersion functions as a perceptually accessible and experiential construct, warranting further theoretical refinement and systematic research.



**Figure 1.** Responses to the question "How would you describe the features of virtual reality and its games?" (where 1 – I disagree; 5 – I agree) for  $n = 35$ .

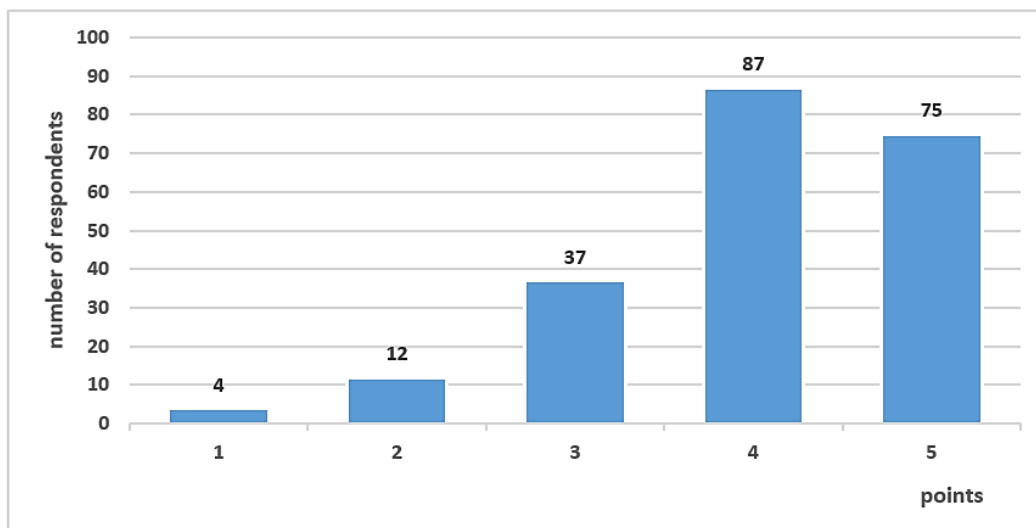
Further evidence of immersive potential was obtained in a study involving a VR-based training application for gantry crane operators. This was a larger study that involved participants assuming the role of a gantry crane operator. Here, too, participants completed a survey after the VR session. One question asked participants to rate the extent to which they felt present in the operator's cabin and forgot that they were interacting with a virtual environment. In other words, this was a question about VR immersion, but the phenomenon of immersion was not explicitly articulated in a one word but rather was included in the question descriptively. As shown in Figure 2, nearly 80% of respondents rated this sense of presence and immersion as at least 3 out of 5, and over 50% rated it as 4 or 5. These results demonstrate that high levels of immersion can be achieved not only in entertainment-oriented VR applications but also in professional training scenarios focused on hard technical skills. This finding highlights the practical importance of immersion and supports the need to identify the factors that enable such deep engagement in applied VR contexts.



**Figure 2.** Percentage of responses to the question "To what extent did you feel like you were in the operator's cabin of a gantry crane, forgetting that it was virtual reality?" (where 1 – very low, 5 – very high) for  $n = 79$ .

Another exploratory author's study, partial results of which can be read in articles (Naramski, Stecula, 2025; Stecula, Naramski, 2025), involved site visits using the Google Earth VR application. Participants used VR to visit real-world locations of their choosing, such as

cities, buildings, or monuments. They then assessed selected features of VR and VR experience in a survey. One question asked respondents about their level of engagement. The VR experience evaluation revealed a high level of engagement, with most respondents rating the VR travel experience as engaging (40,5% of participants) or very engaging (34,9% of participants). Figure 3 shows the results. The average value of this evaluation is 4,01. These results suggest that even applications of an exploratory nature, devoid of dynamic action or elements of competition, can generate a high level of engagement. According to some definitions cited in the literature (above), the level of engagement is also related to immersion. Therefore, it would be worthwhile investigating precisely what factors influence immersion.



**Figure 3.** Responses to the question "How engaging was the VR experience for you?" (where 1 – not at all engaging, 5 – very engaging) for n = 215.

The results from these various author studies (Scientific Night, gantry crane operator training and VR visiting place) show that immersion in VR (whether explicitly named or not) is a phenomenon rated quite highly by those using this technology. As the above studies show, VR immersion was intuitively recognized and assessed by the participants. It can be concluded that immersion is a significant and recurring phenomenon in the VR experiences discussed.

The presented results of the authors' research, although conducted in different research contexts and using different VR applications, create a coherent picture of the virtual reality user experience. Their common denominator is the fact that participants – regardless of the purpose of using VR (entertainment, vocational training, virtual tourism) – consistently rated the experience of immersion in the virtual environment highly. Importantly, immersion was recognized and assessed by the participants both directly (through the use of the term "immersive") and indirectly, through descriptive questions referring to the sense of presence, engagement, and "forgetting" the real world. Immersion is not a phenomenon limited to entertainment applications but also occurs in training environments and in cognitive and exploratory applications.

Another important finding from the analyses is that immersion was assessed intuitively, without prior definition or explanation of the concept. Participants used their own understanding of immersion, referring to aspects such as engagement, sense of presence, emotions, and attention span. This indicates that immersion functions in the user experience as a subjectively experienced, yet multidimensional and heterogeneous construct. At the same time, it highlights a fundamental limitation of previous research, discussed in the literature section: immersion is measured fragmentarily, often using single questions or intuitive scales, without distinguishing between its cognitive, emotional, and physiological components.

#### **4. Identification of the research gap**

All the presented results therefore serve as exploratory studies that do not aim to provide definitive answers to the question of what immersion is, but rather indicate that it is a real, repeatable, and important element of VR experiences. At the same time, they reveal a methodological gap consisting in the lack of consistent, standardized, and multidimensional tools for measuring immersion that would enable comparisons between different applications, contexts, and user groups.

In this sense, the authors' research provides empirical support for the need for further, in-depth analyses of immersion in virtual reality. They demonstrate that immersion is a universally experienced phenomenon, but, as the literature review demonstrates, it remains poorly operationalized.

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It should be emphasized that there are no scientifically developed measures that allow for a reliable and unambiguous determination of the level of immersion. In practice, it is common to hear statements that a given VR application is "immersive". However, the meaning of this concept is imprecise, and the use of the term itself is often intuitive. Therefore, there is a need to precisely define what immersion actually is and how it can be described, classified, and – particularly important from a research perspective – measured. For comparative and

evaluation purposes, it is necessary to develop an indicator or set of indicators that would allow for a quantitative and repeatable assessment of the level of immersion. This could include both subjective methods (e.g., standardized questionnaires) and objective measurement techniques (e.g., biometric data: heart rate, eye gaze analysis), as well as analysis of user behavior in the VR environment. The following research questions should therefore be addressed in future research:

- How to define immersion in virtual reality?
- How do users experience immersion in the virtual world?
- What are the key variables influencing immersion in virtual reality?
- What influences the level of immersion in virtual reality?
- What are the latent factors of immersion in virtual reality?
- How to operationalize immersion in virtual reality?

This article, therefore, is a discussion of the definition and measurement of immersion. It also serves as a starting point for practical research.

## 5. Conclusions

This paper discusses the issue of the immersion concept in virtual reality. It presents the overview of definition and understating of immersion in different scientific disciplines. The aim of this article was to collect and organize existing definitions of immersion, identify the main research directions, and identify research gaps related to the understanding and understanding of immersion. The literature review confirms that immersion is a multidimensional and interdisciplinary concept, functioning simultaneously in technical, social, and psychological sciences. Despite numerous attempts to define it, there is still no single, coherent, and universally accepted definition of immersion or a unified model explaining the mechanisms of its development. Research most often focuses on either technological aspects (e.g., graphics quality, sound, interaction) or selected psychological factors, rarely integrating these two approaches comprehensively. The lack of standardized tools for measuring immersion in VR remains a significant research gap. Furthermore, there is a noticeable shortage of empirical studies conducted with real users in near-natural conditions, using various types of VR applications. In this context, the author's own research results, presented in the article, are of particular importance. They were conducted in various contexts of virtual reality use, such as entertainment, training, and virtual tours. Although these studies were exploratory in nature and conducted independently, their results demonstrate a consistent trend: immersion is intuitively recognized and rated relatively highly by users.

The results and observations presented in this article provide a starting point for practical research on the phenomenon of immersion in VR. Further, in-depth research should be undertaken into the mechanisms of immersion, its technological, psychological, and emotional determinants, and the development of tools enabling its comparable measurement.

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