MASTERARBEIT | MASTER'S THESIS

Titel | Title

Feasibility of Virtual Reality as a Tool for Evaluating Cognitive and Affective Empathy in Primary School Children

verfasst von | submitted by

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angestrebter akademischer Grad | in partial fulfilment of the requirements for the degree of

Master of Science (MSc)

Wien | Vienna, 2025

Studienkennzahl lt. Studienblatt | Degree programme code as it appears on the student record sheet:	UA 066 840
Studienrichtung lt. Studienblatt | Degree programme as it appears on the student record sheet:	Masterstudium Psychologie
Betreut von | Supervisor:	Assoz. Prof. Giorgia Silani Privatdoz. PhD

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Introduction

Virtual Reality (VR) technology is currently undergoing a reemergence and is increasingly being utilized in mental health treatment, clinical and educational research contexts (Wang et al., 2021). VR experiences have demonstrated to profoundly influence adults' thoughts, behaviors, and attitudes, yet the effects of VR technology on childhood development remain largely unexplored, particularly in understanding empathy (Bailey & Bailenson, 2017). Empathy is the ability to share and understand the emotions of others (Xiang et al., 2022). It is a crucial aspect of interactions and healthy social and emotional development in childhood (Taylor et al., 2019; Scott & Graham, 2015). Empathy is a multidimensional construct that encompasses cognitive empathy (e.g., the ability to take on another person's perspective) and affective empathy (e.g., the emotional response to the emotions of others) (Bayne et al., 2023). Research suggests that VR technology may provide a new method of measuring empathy, as it is capable of stimulating empathy in individuals and potentially enhancing an user's overall empathy (Shin, 2017). For instance, Barreda-Angeles and colleagues (2021) observed an increase in empathy among 10-12 year-old participants who viewed VR bullying videos from the victim's perspective.

Limited research exists regarding the feasibility of virtual reality technology as an assessment tool in late childhood, and there is a notable absence of studies investigating its use for assessing cognitive and affective empathy in primary school children. Therefore, the present study investigates the feasibility of virtual reality (VR) technology as an assessment tool for evaluating empathy in primary school children. Moreover, this study seeks to examine the relationship between cognitive and affective empathy, positing that these dimensions of empathy are positively correlated (Knafo et al., 2009; Boele et al., 2018). This research may yield important findings regarding the acceptance of VR technology among children, along with its effectiveness in assessing constructs like empathy.

Theoretical Background

Empathy

Historically, there was greater disagreement among researchers on the precise definition of empathy, specifically whether it is primarily a cognitive or an affective construct (Neary, 2022; Reniers et al., 2011). Despite being a widely known and studied concept, researchers have yet to reach a consensus (Reniers et al., 2011). According to Xiang et al. (2022) empathy can be defined as the ability to recognize and understand the emotions of others and to respond appropriately.

Empathy is a multidimensional construct, which can be divided into cognitive, affective, moral, behavioral, and neurological aspects (Bayne et al., 2023). Of these, affective empathy, which includes sharing others' emotions (emotional contagion) or feeling concern for others (empathic concern), and cognitive empathy, the ability to take on another person's perspective, have received the most attention because these two constructs are easier to measure through surveys and self-reports (Bayne et al., 2023; Boele et al., 2018).

Cognitive empathy is typically understood to encompass conscious emotional processing, including mentalizing behaviors, perspective taking, imagination, and emotion recognition. In contrast, affective empathy is considered to primarily involve unconscious processes related to sharing emotions, such as personal distress, affective responsiveness, and emotional contagion, often described as an individual's instinctive reaction to emotional stimuli (Chrysikou & Thompson et al., 2016).

Cognitive and affective empathy are interrelated, suggesting that individuals who better comprehend others' emotions are also more likely to experience shared feelings or empathic concern. It is recognized that both responses are necessary for enabling empathic behaviors towards others, for instance offering comfort (Knafo et al., 2009; Boele et al., 2018). Although they are related and share complementary aspects, cognitive and affective empathy are distinct processes, each involving different neural networks (Boele et al., 2018; Noten et al., 2019)

Empathy Across Development

Classic research posits that fully developed empathy requires individuals to see themselves as independent, both physically and in terms of their emotions, personal identities and life circumstances (Neary, 2022). Piaget's theory of cognitive development suggests that children's cognition evolves in a series of hierarchical stages, which shape their ability to adapt to the environment and to understand themselves and others (Broke, 1971; Hanfstingl et al., 2019; Rowland, 2012). Piaget posits that children between the ages of 18 months and 7 years are primarily egocentric and unable to take another's point of view (Broke, 1971). Around the ages of 7-12 years children start to be able to see themselves as independent individuals and coordinate between their own and other viewpoints (Broke, 1971).

According to Hoffmans (2000) *four stage model of empathy development* an essential aspect of empathy is that individuals must understand how they themselves and others would feel in different situations. Empathizing individuals must also know that others can hide their true emotions regardless of their facial cues and nonverbal behaviors (Neary, 2022).

Even though young children lack these advanced abilities they can be empathically aroused through association, conditioning and mimicry which are more primitive mechanisms (Neary, 2022). According to Hoffman (2000), these primitive mechanisms can be combined with children's social-cognitive development, allowing the development of empathy in children to be divided into four stages: unclear or confused self-other differentiation, awareness of self and others as separate physical entities, awareness of self and others as having distinct internal states and awareness of self and others as having unique personal histories, identities, and lives (Hoffman, 2000; Neary, 2020). While Hoffman suggested specific age ranges for every stage, he also pointed out that these might vary significantly among children (Neary, 2020).

Hoffman (2000) describes the first stage of childrens' empathy development as *Global Empathy*, which is approximately developed from birth to 12 months of age. At this stage, infants do not distinguish clearly between self and others, for example they respond to others' distress by feeling genuine distress themselves, such as crying when hearing another baby cry (Neary, 2020).

In the second stage, *Egocentric Empathy*, children begin to become aware that they are physically distinct from others, but they still lack an understanding of others' internal states. This stage takes place between 1 to 3 years (Neary, 2020).

Between ages 3 to 8 years the third stage of empathic development takes place, *Empathy for Another's Feelings*. During this stage children develop an awareness that others' emotions can differ from their own. They become sensitive to others' emotional cues and use language to express and label emotions. This stage also includes empathy for individuals whom they do not have direct contact or interaction with, such as victims of distant natural disasters (Neary, 2020).

During late childhood and early adolescence the fourth stage, *Empathy for Another's Condition*, occurs. At this stage young indiviudals cognition becomes increasingly cognitive mature and complex, which enables them to empathize with individuals and groups whose identities, histories, and circumstances significantly differ from their own (Neary, 2020). A growing body of literature supports Hoffman's theory, demonstrating that empathy evolves from basic to more complex mechanisms, in line with and alongside other areas of human development (Neary, 2020).

In relation to the development of affective and cognitive empathy, researchers posit that cognitive empathy develops later than affective empathy (Bayne et al., 2023; Bray et al., 2021; Maxwell & DesRoches, 2010; Kanfo et al., 2009). While cognitive empathy may be viewed as a more complex and developmentally advanced skill compared to affective empathy, as it relies more heavily on the theory of mind and cognitive abstractions, affective empathy is commonly perceived as more accessible to younger children (Bayne et al., 2023). Evidence has shown that by the age of five to six, most children are capable of passing cognitive empathy tests (Bray et al., 2021). In addition, Fink and De Rosnay (2023) also posit that the first signs of empathy are affective reactions to the distress of others and that as children grow, these reactions evolve from self-focused distress to concern for others.

Furthermore, studies have shown that affective and cognitive empathy develop partially in different brain regions (Knafo et al., 2009). For example, the limbic and paralimbic brain systems, which are relevant for affective empathy, evolve earlier than the prefrontal and temporal cortices, which are important for cognitive empathy (Knafo et al., 2009).

Empathy Influences and Effects on Primary School Children

Evidence suggests that experiencing empathy towards others is a crucial aspect of everyday interactions during middle childhood (Taylor et al., 2019). Empathy plays an important role in improving children's social competence, reducing antisocial behavior, promoting healthy childhood development and overcoming crises (Scott & Graham, 2015; Qin et al., 2022; Lee et al., 2018). School children with high empathy typically show an understanding of their peers and teachers' emotions and are also open to sharing their own emotions. Additionally, they are easily liked by others in social interactions and have good relationships with their peers and teachers (Qin et al., 2022). Furthermore, studies indicate that empathy in childhood is a crucial predictor of prosocial behavior, as it improves children's social understanding and motivates them to consider the emotions and needs of other individuals (Taylor et al., 2019). In relation to that empathy also promotes sympathy, altruism, and helping behaviors (Scott & Graham, 2015). Research has shown that not only does high empathy improve social competence but it also promotes school children's learning engagement, academic achievement and problem-solving skills (Qin et al., 2022; Lee et al., 2018; Bayne et al., 2023).

Poor or lacking empathic skills in childhood can result in severe issues in social interactions, frequently leading to a diagnosis of antisocial behavior or conduct disorder (Bulgarelli

& Jones, 2022). The cause of this may be that individuals who cannot accurately recognize that they are causing distress to others are more likely to continue with their harmful behavior (Zonnevald et al., 2017). Evidence suggests that high empathy in school children is related to reductions in antisocial behaviors, delinquent attitudes, anger, externalized behaviors, as well as, levels of physical and verbal violence (Scott & Graham, 2015).

Furthermore, research shows that children's antisocial behavior correlates differently with affective and cognitive empathy (Quin et al., 2022). Evidence suggests that affective empathy is an essential aspect in inhibiting antisocial behavior (Zonnevald et al., 2017; Qin et al., 2022). However, research findings on the influence of cognitive empathy on antisocial behavior are mixed (Zonnevald et al., 2017; Qin et al., 2022). Some studies have shown that a lack of cognitive empathy is not associated with aggressive behaviors and various forms of bullying (Quin et al., 2022). Other research indicates a negative correlation between cognitive empathy and antisocial behavior (Quin et al., 2022). Additional studies suggest that aggressive children with high cognitive empathy may have an enhanced ability to understand the cognition and emotions of others and as a consequence are more able to manipulate and cause harm to others (Quin et al., 2022). The inconsistency in findings could be attributed to differences in measurement instruments and study participants, highlighting that cognitive empathy can manifest differently in individuals (Quin et al., 2022).

In general, research indicates that empathy is linked to beneficial outcomes in social and emotional development, affecting the quality of how children behave towards others and their social relationships (Scott & Graham, 2015; Xiang et al., 2022). Therefore, it is important to investigate the development of empathy and its expression across childhood and adolescence to ensure healthy social and emotional development in children.

Operationalization of Empathy

In addition to the ongoing debate on the definition of empathy, there is also a lack of consensus on how to accurately measure empathy (Neary, 2022; Reid et al., 2013). Methods for measuring empathy in children up to 11 years old include self-report, other-report, performance-based questionnaires, behavioral observations, physiological measures, and neurological measures (Neary, 2022). The most commonly utilized forms of empathy assessment are self-report, other-report, and performance-based instruments, as they are of low cost and easy to use (Neary, 2022).

However, recent research indicates that VR technology may offer an innovative approach to assessing empathy, as it is capable of stimulating empathy in individuals and potentially enhancing an user's empathy (Shin, 2017). The following sections will focus on VR technology and how it contributes to assessing empathy.

Feasibility of Virtual Reality (VR)

To explore the feasibility of it, it is first necessary to examine the general feasibility of VR applications for this age group. The feasibility of VR is influenced by several key factors, including the sense of presence, immersion, flow, and emotional responses of the participants, all of which can be essential for creating effective and meaningful VR experiences (Barreda-Angeles et al., 2021; Morasse et al., 2020; Hirt et al., 2020). However, it also encompasses challenges, such as physical constraints, ethical considerations, age restrictions, potential side effects, and organizational limitations (Araiza-Alba et al., 2022).

Virtual Reality (VR)

Virtual reality (VR) is a three-dimensional (3D), computer-generated environment that simulates real-world contexts and situations (Araiza-Alba et al., 2012; Morasse et al., 2020). The concept of virtual reality can be traced back to the mid-1960s when Morton Heilig, a cinematographer, created the *Sensorama Simulator*, designed to stimulate the senses of the film audience and enhance their engagement with the narrative (Araiza-Alba et al., 2022). The machine was capable of displaying a wide field of vision producing stereo sound, smells and wind through a fan, along with vibrations and body tilting through the seat to create a sense of motion (Araiza-Alba et al., 2022). In 1965, Ivan Sutherland attempted to define the concept of VR as a window through which users could experience a virtual world that appears to be real in terms of sight, sound, and touch, enabling them to interact within that environment in a realistic manner (Cipresso et al., 2018). In fact, today VR environments are recognized for inducing a sense of presence, wherein users experience a strong illusion of being physically present in the virtual scene and that the events are really happening (Barreda-Angeles et al., 2021). The heightened presence in VR has some important benefits, for example allowing the user to experience the first-person point-of-view (POV) of a character or a scene and generating thoughts, reactions, and emotions that would also be evoked in real-life situations (Barreda-Angeles et al., 2021; Morasse et al., 2020). Furthermore, presence can be described as an individual's acceptance of a virtual environment as real and it is often assessed by questionnaires (Hirt et al., 2020).

Besides presence, immersion is another crucial factor in VR environments (Hirt et al., 2020). In this context immersion refers to the measurable technological features of an application, while presence describes the user's reaction to immersion. Immersion is determined by the ability of a VR system to replicate real-world perceptions with those of the virtual environment, enabling users to interact using their natural sensorimotor abilities (Hirt et al., 2020; Di Natale et al., 2020). In particular, immersion refers to the extent of sensory stimulation, the types of interactions available, and how closely the simulated stimuli resemble real-world experiences (Cipresso et al., 2018). Furthermore, immersion depends on the characteristics of the technological system used to detach users from reality (Cipresso et al., 2018). Another important concept of VR is flow, which refers to an autotelic experience that encompasses cognitive, physiological, and affective states (Somarathna et al., 2023). During a flow state, individuals become fully immersed, concentrated, and find enjoyment from the activity itself (Somarathna et al., 2023).

Types of Virtual Reality: Levels of Immersion

There are various types of VR, each differing in the level of immersion they provide (Di Natale et al., 2020). According to Di Natale et al (2020) VR systems can be categorized in *non-immersive*, *semi-immersive* and *immersive virtual environments*:

- *Non- immersive VR*: Non-immersive VR systems, which are also called *desktop virtual reality* (DVR) systems, are the most basic and cheapest type of VR applications, where the user interacts with a 3D world generated on a computer, using different input devices (e.g., mouse, joystick, keyboards) (Cipresso et al., 2018; Di Natale et al., 2020).
- *Semi-immersive VR*: Semi-immersive VR systems increase the level of immersion by either intensifying sensory inputs (such as visual information) or improving the sense of embodiment by enabling users to interact actively with the VR environment. An example of that are *Fulldome systems*, which are displays that provide a wide field of view that increases viewer engagement and excitement.
- *Immersive VR*: According to Di Natale et al. (2020) the highest level of immersion is provided by *immersive virtual reality* (IVR) systems, which is a technology that creates environments that perceptually surround users, enhancing their sense of presence and allowing them to perceive the experience as real. One contributing factor to the high level of immersion in IVR is the egocentric navigation, which enables the user to view the virtual world from a first-person perspective, along with stereoscopic vision and

continuous updates of the scene that correspond to the user's head and body movements (Di Natale et al., 2020). An essential element in IVR technology are tracked head-mounted displays (HMDs), which are specialized headsets that cover the user's entire field of vision and allow binocular vision (Di Natale et al., 2020). Furthermore HMDs allow users to see different parts of the VR world by moving their heads (Mirault et al., 2021). Research has shown that with HMDs,VR technology can create immersion, a sense of presence, interactivity, flow, and isolate participants from external stimuli in cost-effective controlled experiments (Somarathna et al., 2023).

VR as a research tool in Psychology

Since the introduction of virtual reality, it has often been used in various fields, such as education, gaming, military training, social skills training, psychological treatments, and as a research tool for neuroscientists, psychologists, and biologists, to name just a few (Cipresso et al., 2018).With VR, researchers are able to design complex experimental scenarios that are difficult to be recreated in real-world settings (Cipresso et al., 2018; Marin Morales et al., 2020).

VR systems offer precise control over experimental conditions such as the selection of avatars, environments, sounds, and perspectives, thereby enhancing the experience and ecological validity (Morasse et al., 2020). Additionally, VR makes it feasible to efficiently isolate and modify variables, which would be challenging to manipulate in physical settings (Marin Morales et al., 2020). Moreover, VR technology enables the objective measurement of individuals' cognitive or emotional behaviors in real-life situations (Kim et al., 2020). While immersive VR experiences have been shown to highly influence adults' thoughts, behaviors, and attitudes, there is still a lack of research regarding the effects of VR on children (Bailey and Bailenson, 2017).

VR and Children. The research that exists on VR and children has been related to its use in therapeutic settings (e.g., for assessing ADHD and autism), medical settings (e.g., for pain distraction), and educational settings (e.g., for teaching emotion regulation skills to prevent risk-taking behavior) (Bailey & Bailenson, 2017; Verhoef et al., 2021). Research has shown that compared to adults and adolescents, older children report a stronger sense of presence in virtual reality. This may be due to the prefrontal lobe not being fully matured, which means they do not yet have the ability to control and monitor virtual experiences (Cadet et al., 2022). Furthermore, children have a strong sense of embodiment in VR compared to other mediums, because they are able to control avatars using their own body movements and their physical body

(Bailey & Bailenson, 2017). From an educational perspective, virtual embodiment and immersion can provide significant advantages for school children. For example, Arazia-Alba et al. (2022) demonstrated that virtual reality in classrooms leads to enhanced cognition, better learning outcomes, and increased interest in the study material. Moreover, Lee and Lee (2021) observed that elementary school children in the VR class condition had significantly increased concentration, attention and engagement compared to children in traditional school lesson settings. According to Arazia-Alba et al. (2021), virtual reality technology enables school children to have direct interactive experiences, which establishes a foundation for learners to remember and apply their learning in real-life situations. This leads to increased interest and motivation among school children to solve tasks, which results in improving their problem-solving skills. In addition, Liu et al. (2019) showed that VR classrooms led to higher academic achievement and lower cognitive load compared to traditional teaching methods for the same lessons.

Nevertheless, there are some barriers to using VR with children such as physical constraints, ethical limitations, age restrictions, potential side effects, and organizational limitations (Araiza-Alba et al., 2022). In general, the physical side effects of using HMD with children can be divided into short-term and long-term side effects (Araiza-Alba et al., 2022). Short-term side effects include motion sickness, eyestrain, headaches and discomfort, which may stem from the weight of the googles (Araiza-Alba et al., 2022). Additionally, children between the ages of two to twelve are the demographic most prone to experiencing symptoms of motion sickness (Hoeft et al., 2003). One key health concern regarding long term effects is linked to the effects of prolonged VR headset use on children's eyesight (Araiza-Alba et al., 2022).

Furthermore, another significant concern is simulator sickness or cybersickness, which manifests as symptoms of nausea, disorientation, and oculomotor issues during and/or after exposure to virtual environments in head-mounted displays (Kaimara et al., 2021). Nausea is characterized by a range of sensations, including general discomfort, stomach awareness, and potential vomiting (Kaimara et al., 2021). Symptoms of disorientation can involve difficulty concentrating, feelings of vertigo, and dizziness (Kaimara et al., 2021). Furthermore, symptoms affecting the oculomotor system can lead to fatigue, headaches, and eyestrain (Kaimara et al., 2021).

These potential physical side effects have led to age restrictions and product safety warnings being imposed on VR technology by several manufacturers. They state that the use of

VR headsets in children under the age of 12 or 13 years is prohibited (Araiza-Alba et al., 2020; Tychsen & Foeller, 2020). Although age restrictions are recommended, VR technology manufacturers have not presented a rationale or evidence to back their warnings (Araiza-Alba et al., 2022).

Regarding ethical limitations, one ethical concern related to the use of VR involves its ability to trick the brain, as demonstrated in studies that generated false memories and symptoms of post-traumatic stress disorder by using VR technology (Araiza-Alba et al., 2022).

Generally research has shown that children as old as 9 years old are likely to experience memory errors (Segovia & Bailenson, 2009). This could be a result of their deliberative and extended retrieval and reasoning skills not being fully developed yet, as these mental capabilities evolve gradually in humans, leading to difficulties with source monitoring (Segovia & Bailenson, 2009). Because VR is a rich form of media and VR environments, for instance, can be personalized to represent each user's individual characteristics, behaviors, and experiences, VR experiences may lead to difficulties in remembering the source of stored information (Segovia & Bailenson, 2009). Research suggests that VR experiences may be encoded into memory similarly to real-world experiences, resulting in mistakes in source monitoring when they are later retrieved (Segovia & Bailenson, 2009). Segovia and Bailenson (2009), for example, found that VR could create false memories in children by having them watch an avatar of themselves engaging in activities they had never experienced, such as swimming with orcas.

An additional ethical risk is the potential of VR to trick the subconscious brain into believing that the user is truly in a computer-generated environment, which can lead to triggering phobias like fear of heights or darkness (Araiza-Alba et al., 2022). However, VR can be also used in a safe and controlled therapeutic context to treat patients with phobias (Araiza-Alba et al., 2022). Therefore, it is essential that users perceive the VR environment as secure and that the content is designed to reduce emotional and physical distress (Araiza-Alba et al., 2022).

In terms of physical constrains, its important to note that most VR headsets require significant space for users to move freely in order to be fully immersed in the VR experience (Araiza-Alba et al., 2022). Using this technology in limited spaces may expose users to physical injuries, such as bumping into one another or the surrounding walls (Araiza-Alba et al., 2022). Additionally the cables that connect the headsets to the computer or the plug, can cause a tripping hazard or even strangulation (Araiza-Alba et al., 2022). According to all VR manufacturers children must be supervised by adults while using VR equipment. It is essential to create safe operating procedures prior to using this technology in schools to reduce potential risks to children (Araiza-Alba et al., 2022).

Organizational limitations that need to be considered with the use of VR with school children include technical, practical and budgetary barriers. One of the primary disadvantages of using VR in research is the substantial cost of the necessary hardware and content. Over the past few years, technology companies have released affordable VR technology, allowing greater access for researchers. However, producing new and high-quality VR content remains costly (Araiza-Alba et al., 2022). Additionally, the use of VR technology in any field demands high programming and technical skills to be able to fully exploit the capacities of this technology (Araiza-Alba et al., 2022).

VR and Emotions. In research, there are mainly two methods for emotion induction: passive and active (Somarathna et al., 2023). In passive elicitation, the subject acts as an observer of an emotional scenario (e.g., viewing a video or picture) whereas, in an active induction, the individual directly participates in the emotional experience (Somarathna et al., 2023). VR is considered one of the active emotion elicitation methods (Somarathna et al., 2023). Because, in contrast to the specific emotions that subjects feel when watching a movie, which are based on empathy for the main character, the level of presence that VR creates allows for the analysis of the specific emotions directly experienced by users in response to the scenarios (Somarathna et al., 2023; Marin-Morales et al., 2020). Thus, Somarathna et al. (2023) describe VR as an effective and powerful emotional induction mechanism, capable of eliciting a wide range of emotions. Additionally, due to the sense of presence that this technology creates for users, it has been proposed as an effective method for evoking emotions in laboratory environments (Marin-Morales et al., 2020).

Research has shown that emotions have an impact on the sense of presence and that VR is capable of generating emotions, such as anxiety and relaxation, heightened arousal in natural settings like parks, and different moods in social contexts involving avatars (Marin-Morales et al., 2020). Furthermore, VR content in research has often been used to elicit emotions such as joy, boredom, fear, relief, anxiety, amusement, stress, sadness, interest, anger, pleasure, and disgust (Somarathna et al., 2023). VR technology has also been used to evoke specific emotions in children, for example inducing fear of a phobic object during exposure therapy for phobias (Bailey & Bailenson, 2017).

Different materials in VR can be used to evoke a variety of emotions (Somarathna et al., 2023).:

- Virtual environments: Users can interact with virtual entities and move around. Studies, for instance, have created fantasy scenarios to induce joy and happiness or abandoned places to generate fear and anxiety.
- Videos: In VR, videos can be displayed as either 360-degree videos or clips, where participants engage with a narrative storyline.
- Games: Games are interactive experiences that require decision-making and engage participants both physically and mentally. Additionally, games in VR have the ability to evoke a variety of emotions.
- Tasks: During tasks users must participate in structured interactive activities. Research that uses tasks in VR mainly include emotion elicitation, cognitive training and decision making. The task content is often time manipulated, which means that it is impossible for participants to complete the scenario. Furthermore, the contents mainly focus on instructions to collect objects and complete tasks, as well as Stroop tasks and drawing activities. Studies using physiological measures show that VR tasks can evoke emotions with intense arousal and valence, like anxiety.
- Avatar: In avatar mediations users interact with a graphical representation of a person. Avatars in research can be used to study effects of full-body ownership illusions created by avatars, the influence of avatar facial expressions and the impact of storytelling with emotion embodiment and interactions. Research showed that using avatars in VR can induce emotions, like happiness, sadness, fear, anger, disgust, and neutrality. Additionally, interactions with avatars are recognized as a valuable method for fostering social communication and developing skills.

VR and Empathy. VR technology is often described as a powerful empathy machine because it facilitates the experience of viewing the world from the perspective of others, which can consequently generate empathy (Barreda-Angeles et al., 2021; Tan et al., 2022). Since the 2000s, virtual reality has been used as a tool for studying perspective-taking, as it enables users to shift their perspectives to different scenarios and worlds (Bertrand et al., 2018). VR content increases empathy by allowing users to have a better understanding of others. Empathizing can establish a stronger connection between VR and the physical world, leading to increased credibility (Shin, 2017). In VR environments, viewers can deeply resonate with another person's emotions or situation by being in the same space or near that character (Shin, 2017). Research has shown that immersion in VR has the potential to enhance empathy and such stimulated empathy can boost an user's overall empathy, as well as their perception that a virtual environment is realistic (Shin, 2017). Previous studies, such as one conducted by Barreda-Angeles and colleagues (2021), have shown that VR can influence empathic responses in children. Furthermore, Riner et al. (2022) utilized a mixed-methods approach to investigate the effects of both immersive and non-immersive virtual reality on ninth-grade social studies students. The results have shown that both types of VR experiences elicited historical empathy among the students (Riner et al., 2022). Another study demonstrated that children aged 11 to 13 who experienced a VR scenario from the perspective of a bullying victim showed greater empathy compared to children who learned about the topic through traditional methods (Ingram et al., 2019).

The Present study

Existing studies, as discussed in the previous sections, have highlighted some advantages and disadvantages of using VR with children (Araiza-Alba et al., 2022; Bailey & Bailenson, 2017; Verhoef et al., 2021). Moreover, studies have demonstrated the effects of VR on empathy and vice versa, illustrating how VR technology can be used to assess and enhance empathy (Barreda-Angeles et al., 2021; Tan et al., 2022; Shin, 2017). However, to the authors knowledge, there is currently no research on the feasibility of VR technology as an assessment tool in late childhood, and only a limited number of studies investigate its use for assessing empathy in primary school children (Malihi et al., 2020).

Therefore, the present study investigates the feasibility of VR technology as an assessment tool for evaluating affective and cognitive empathy in primary school children. The research may provide additional and new insights into the feasibility and acceptability of VR technology as an assessment tool for primary school children, as well as its effectiveness in measuring constructs such as emotions and empathy. Therefore the following exploratory research question in this paper is:

1) How feasible is virtual reality as an assessment tool for evaluating affective and cognitive empathy in primary school children?

In this study the feasibility of VR is assessed through the constructs: sense of presence, immersion, flow, emotions, simulator sickness, VR-Ratings and VR task performances.

Cognitive and affective empathy are assessed using qualitative questions, which will be presented in the methods section of this study. Additionally, quantitative analysis will be done to analyze whether the VR scenario was able to elicit both types of empathy, which leads to the following research question:

2) Does exposure to VR stimuli elicit cognitive and affective empathy in primary school children?

As discussed in the previous sections, research has shown that cognitive and affective empathy correlate (Knafo et al., 2009; Boele et al., 2018). Therefore, the hypothsis is as follows:
H1: There is a positive correlation between cognitive and affective empathy.

Methods

The present study is being carried out as part of the VR focus group in the COMET4KIDS research project, which aims to develop and evaluate a preventive mental health literacy (MHL) program for primary schools and to develop innovative methods such as VR technology to assess aspects of mental health in children. Two main phases are envisioned for the COMET4KIDS project: 1) the co-development phase, in which the MHL program will be developed and tested, and 2) the evaluation phase, in which the MHL program is implemented throughout the last school year of primary schools and its effects are scientifically evaluated. The current study only encompasses data from two VR workshops from the co-development phase.

Design

This study combined both qualitative and quantitative approaches to evaluate the feasibility of VR as a tool for assessing affective and cognitive empathy in primary school children. As this study is a cross-sectional design, each participant took part in the experiment only once. Data collection took place at arranged school locations. There were two workshops conducted for data collection, each involving different tasks and conditions.

Participants

The present study included third-year primary school children aged 8 to 9 years from a single class, as well as fourth-year school children aged 9 to 10 years from two different classes. All participants were recruited from two schools in Vienna as part of the COMET4Kids project. Ethical approval was obtained from the ethic committee at the Univeristy of Vienna, Vienna (EK-

Nr. 00825). Furthermore parental consent and child assent were obtained prior to participation. Children who were not fluent in German were excluded from this study. The full sample comprised of 53 primary school children, 20 individuals participated in the first workshop on the 27th of Februrary 2024 and 33 in the second workshop on the 10th of June 2024. Among the 20 participants in the first workshop, 8 were female (40%) and 12 were male (60%). In the second workshop, there were 19 females (57.6%) and 14 males (42.4%) out of the 33 participants.

Apparatus

The interactive 3D VR environment was generated using the cross-platform Unity Game Engine, utilizing an Oculus Meta Quest 3 as the Head-Mounted Display (HMD). The spatial resolution was 2064 x 2208 pixels per eye, totaling a combined resolution of 4128 x 4416 pixels.

Procedure

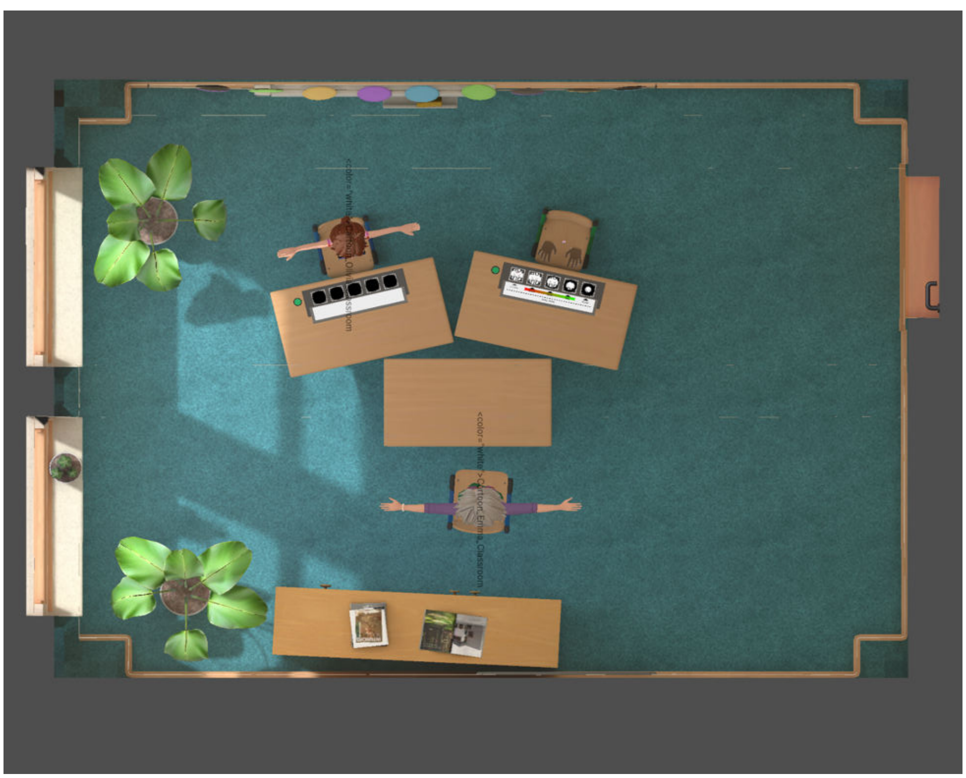
The workshops were conducted in a room habilitated for such purpose in the schools. The participants were asked to wear portable VR HMD headsets and, with the help of the experimenters, introduced to an immersive, and highly controlled virtual world. The scenarios that were shown in the VR, included a test and several emotion ratings. These VR contexts were ought to typically be challenging and stress-inducing for children and differed between the first and second workshop. Both VR scenarios were designed to take place within a virtual classroom environment (see Figure 1) and featured two non-player characters (NPCs): one teacher standing in front of the participant and a student named “Charlie” sitting next to the participant (see Figure 2). Both NPCs had neutral facial expressions, meaning they did not display a nonverbal emotional reaction. As depicted in Figure 2, the test and emotion ratings would appear on the participant’s desk in the VR setting. The following sections outline the approaches of both workshops and the VR scenarios in more detail. Additionally, the emotion rating, empathy rating, and the test conducted in VR will also be further described.

Figure 1

VR Classroom

Figure 2

VR Classroom with NPCs



Note. Two NPCs are depicted: a teacher with gray hair and a student, both seated across from each other. The VR Tests are placed on the student desks.

Workshop 1

The aim of the first workshop was to test whether VR is feasible and how the children react to the VR environment and task. Therefore, there was no empathy condition in this scenario. Two participants were selected one after the other to take part in the experiment and were assigned to one of the two HMD VR headsets. Before the children started the VR experience, the researchers explained that they were going to take a test in VR. Additionally, the researchers assured the children that they could ask questions at any time if they felt confused or needed help. During the VR experience the participants remained seated, while their head and hand tracking were ensured by the HMD. The researchers explained to the participants that they had to press the green button to start. Following the VR experience, a qualitative interview was conducted with each child to explore their insights and overall the feasibility of the VR.

VR Scenario 1. The VR experience started with a familiarization phase, allowing the participants to explore the virtual classroom for two minutes. This exploration enabled the participants to get used to the NPCs, which were one teacher and one boy named "Charlie". To start, the participants had to press a green button in the VR. Following this introduction, the VR teacher provided an explanation of the test and emotion rating process. This step also clarified, whether the participants could hear the characters properly and helped familiarize them with the voices and sounds in the VR. Additionally, to familiarize the participants with the emotion selection process, a baseline emotion rating was conducted. Before the test started, participants were given the opportunity to rehearse the task, followed by a 30-second preparation period along with a visual timeline. Participants then engaged in the task, during which the virtual teacher prompted them with phrases like, "Try to be faster", aimed at provoking an emotional response. After finishing the task, the participants rated their emotions once more. Finally, the VR experience ended with a relaxation period, giving the children the opportunity to calm down.

Workshop 2

The purpose of the second workshop was twofold: to further investigate the feasibility of VR and to evaluate its ability to elicit affective and cognitive empathy. Thus the key difference between the first and second VR scenarios was the inclusion of an empathy condition in the second session.

For the second workshop, four HMD headsets were available, allowing four participants to test simultaneously. Participants were chosen one at a time and assigned to one of the four HMD VR headsets. The researchers explained that participants would be undergoing a test in the VR environment and emphasized that they could ask if they needed any help. Again, the participants were told by the researchers that they should press the green button to start the VR. During the second workshop, participants also remained seated throughout the VR experience. After the VR session, a qualitative interview was conducted to assess the feasibility of VR, and an adapted Child Sickness Questionnaire (CSSQ) was administered verbally. Additionally, participants were required to complete a questionnaire following the qualitative interview.

VR Scenario 2. In the second workshop, the VR experience started again with a brief familiarization phase and the participants had to push a green button to start. After pressing the green button the virtual teacher started explaining the testing and emotion rating process. Participants were also informed that the NPC student "Charlie" would take the test after them. One difference from the first VR scenario regarding Charlie was that this time the NPC was either female or male depending on the gender of the participant. Following this introduction, participants rated their emotions (*baseline emotions*), followed by a brief relaxation phase. Once the relaxation period concluded, children once again assessed their emotions (*pre-test emotions*) and they had a task rehearsal before the actual test started, to familiarize themselves with the process. During the test the virtual teacher gave statements like, "Try to be faster", to induce an emotional response. After completing the test, the children rated their emotions again (*post-test emotions*), followed by another relaxation period and an emotion rating (*post-relaxation emotions*). Next, it was Charlie's turn to undertake the test, which was designed so that participants could observe the NPC making numerous mistakes, through visual and auditory signals. During Charlie's task, the teacher also made remarks like, "Try to be faster". After the NPC's performance, participants were asked to evaluate how they thought Charlie felt during the task (*cognitive empathy*) and to express their feelings after watching Charlie's experience (*affective empathy*). This evaluation was conducted in the same manner as the earlier VR emotion ratings. The VR session ended with a final relaxation period followed by an emotion rating (*end emotions*).

Emotion Rating

The emotion ratings always appeard on the desk of the participants, as seen in Figure 3.

Figure 3

VR Student's desk with task

Participants had the opportunity to select one of the following six emotions in the VR emotion rating: happy, proud, sad, angry, anxious and neutral, all displayed as emojis accompanied by the names of the emotions, as shown in Figure 4. Above the emojis, the following question was presented: "How are you feeling now?". The participants selected the emotion by clicking on an emoji with their index finger in the VR.

Figure 4

Own Emotion rating task in VR

Note. The question: "Wie fühlst DU dich jetzt?" means "How are you feeling now?". The following emotions are shown underneath the question: happy, proud, sad, angry, scared and neutral.

After clicking on an emotion, a second question appeared, such as “How proud are you?”, as shown in Figure 5. This was intended to allow the participants to indicate the level of their emotion. However, the level of emotion is not further addressed, as it is not included in the analysis of this study.

Figure 5

Own Emotion rating task in VR

Note. The question: “Wie STOLZ fühlst DU dich jetzt?“ means “How proud are you?”. The following options are shown underneath the question: a little, quite, very, extremely.

Empathy rating

To assess cognitive empathy the following question was displayed after the participants watched the NPC Charlie take the test: “How does Charlie feel now?”, as shown in Figure 6. Participants had to select one of the following six emotions: happy, proud, sad, angry, anxious and neutral. They selected the emotion by clicking on an emoji.

Figure 6

Emotion Rating of Charlie

Note. The question: "Wie fühlt sich CHARLIE jetzt?" means "How does Charlie feel now?". The following emotions are shown underneath the question: happy, proud, sad, angry, scared and neutral.

Next, after watching Charlie take the test, to assess affective empathy, the participants rated their own emotions after watching Charlie take the test in the same way as the emotion ratings before, as seen in Figure 5.

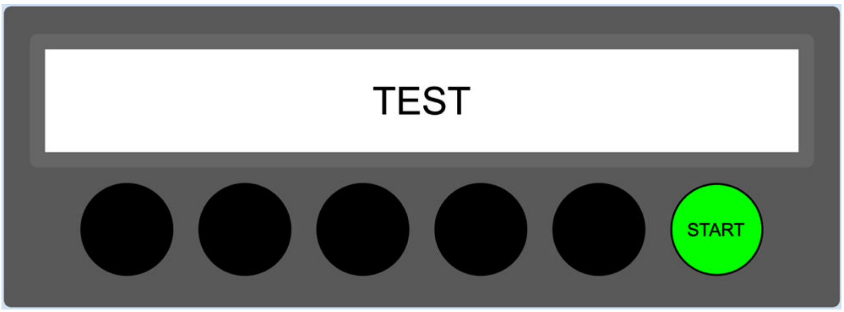
VR Task

The task in the VR was based on the Tier Social Stress Test for Children (TSST-C; Buske-Kirschbaum et al., 1997) and inspired by the Trail Making Test (TMT; Müller, 2021). The TSST is a method used to induce psychological stress through the creation of a social-evaluative threat und uncontrollability (Zimmer et al., 2019; Dickerson & Kemeny, 2004). The TSST-C is specifically used for underage participants, as it incorporates age-appropriate tasks and environments (Spengler et al., 2020). This VR test is based on the TSST-C, as it involves a test performance in front of an audience (represented by NPCs like Charlie and the teacher) and the presence of social comparison (represented by the NPC student Charlie), which are both elements that induce social evaluative threat (Dickerson & Kemeny, 2004). Additionally, the time limit introduces a factor of uncontrollability, all within an age-appropriate setting (VR classroom) (Dickerson & Kemeny, 2004). The arithmetic test of the TSST was replaced in this study with a task inspired by the TMT (Müller, 2021). The TMT (Müller, 2021) is a neuropsychological assessment tool used to evaluate attention disorders and executive dysfunctions, with a wide variety of applications (Müller, 2021). The TMT was selected due to its simplicity and its effectiveness in assessing cognitive functions (Müller, 2021). However in this study, an adapted version of the TMT was implemented, where the objective was to find and press the numbers in the correct order (1-2-3-4-5) within a time limit.

In the VR the test appeard on the desk of the participants and to start the participants had to push the green button (see Figure 7).

Figure 7

VR Test

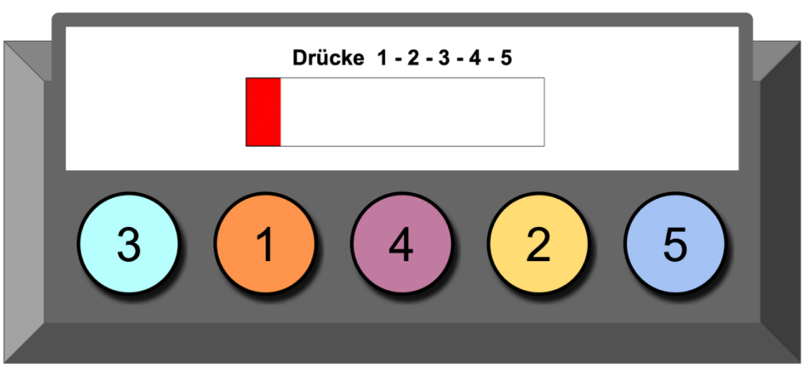


Note. VR task before starting the test.

The task was for participants to press the five numbers in the correct order as quickly as possible within a set time, which was shown on a bar above the buttons, as seen in figure 8.

Figure 8

VR Test

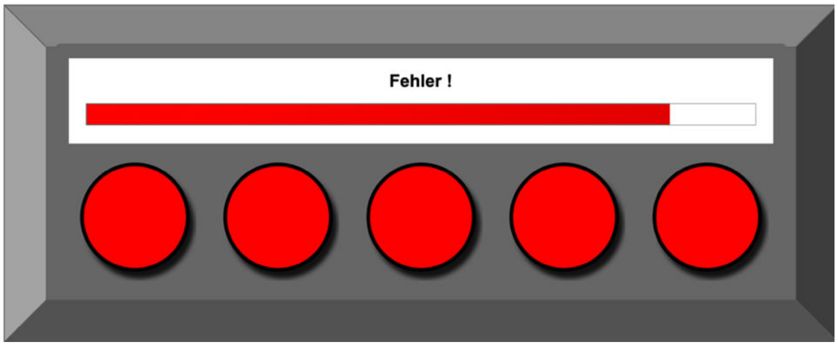


Note. “Drücke” means “Push”.

After completing a task, the numbers would change positions, and the next round would start. If a participant pressed the wrong number or ran out of time, a sound would play, and the display would show an error, as seen in Figure 9. They would then have to start over.

Figure 9

Error shown during the VR Test

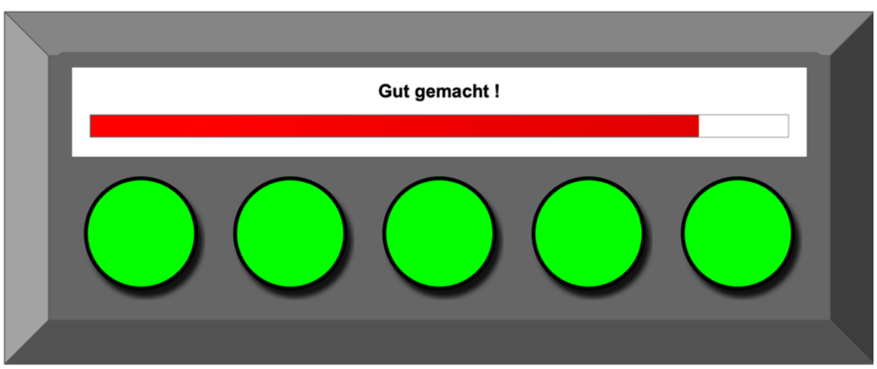


Note. "Fehler!" means "Mistake!".

If the participants completed the task correctly, a success sound would play, and the circles would turn green, as shown in Figure 10. Then, the next round would begin.

Figure 10

Success shown during the VR Test



Note. "Gut gemacht!" means "Well done!".

Measures

The present study includes a combination of quantitative and qualitative data, as seen in Table 1. Measures for quantitative data collection include VR data and the data from the questionnaires GEQ (Ijsselsteijn et al., 2008) and CSSQ (Hoeft et al., 2003), which will be described in detail in the following section. Furthermore, the VR data includes the emotion ratings of the participants in the VR and the success and failure rates of the VR test. The questions listed in Table 1 were utilized for the qualitative data collection.

Table 1

Quantitative and Qualitative Measures

Variables	Quantitative Measures	Qualitative Measures
Sense of Presence		Did the Classroom feel real? Do you feel like you were really in that classroom? Did you get distracted by the noises here in the room? Did it feel real when the teacher talked to you?
Immersion	GEQ	
Flow	GEQ	
Emotions	GEQ, VR-Data	How do you feel now? How do you feel about the test? How did you feel during/after the test? How did you feel in VR?
Simulator Sickness	CSSQ	Do you feel any pain anywhere? Do you feel dizzy?
VR-Ratings		How did you like the VR experience? How was it for you to answer the questions about your feelings in VR? How did you like the classroom? Were you able to press the buttons well? What do you think of the teacher/ Charlie? Was it easy to understand what you had to do during the test? How was the VR for you? Can you tell me what happened?
VR- Task	GEQ	
Empathy	VR-Data	Cognitive empathy: how do you think Charlie felt during the test? Affective empathy: how did you feel when you watched Charlie take the test?

Note. GEQ = Game Experience Questionnaire; CSSQ = Child Simulator Sickness Questionnaire.

Game Experience Questionnaire (GEQ)

The GEQ (Ijsselsteijn et al., 2008) is a self-report measure, which aims to assess the experience of playing digital games (Nacke, 2009). An adapted version of the GEQ (Ijsselsteijn et al., 2008) was administered to the participants of this study to measure the feasibility of VR. The GEQ (Ijsselsteijn et al., 2008) consists of seven subscales, namely immersion, flow, tension, competence, negative affect, positive affect, and challenge. Each subscale is measured with 5 items, except for immersion, which is measured with 6 items. In total the scale consists of 42 items, whereby the German version of the scale was used and translated into child-friendly language by the research team. Furthermore the items were adapted to assess the VR experience. Participants were asked to rate these statements on a five point scale from not at all (0) to extremely (4). The subscales are computed as the average of its items.

Child Simulator Sickness Questionnaire (CSSQ)

The CSSQ (Hoeft et al., 2003) is an adaptation of the Simulator Sickness Questionnaire (Kennedy et al., 1993) and is a method for measuring simulator sickness symptoms in children. The CSSQ consists of seven questions that target one of the following three simulator sickness categories: nausea, oculomotor, and disorientation (Hoeft et al., 2003). In this study, the CSSQ questionnaire was shortened and summed up from 7 to 3 following questions: “Do you feel sick”, “Do you have pain anywhere?” and “Are you feeling dizzy?”. Therefore, in the present study, the CSSQ is operationalized to focus on three simulator sickness symptoms: “sickness”, “pain”, and “dizziness”, and the data are reported descriptively. Participants were asked to answer each question with one of three possible choices: no (0), a little (1) and a lot (2).

Variables

The following variables will be evaluated to determine the feasibility of using VR with primary school children, as well as its application for empathy assessment: sense of presence, immersion, flow, emotions, simulator sickness, VR ratings, VR task ratings and empathy.

Sense of presence. Sense of presence was assessed through the following qualitative questions: “Did the classroom feel real?”, “Do you feel like you were really in that classroom?”, “Did you get distracted by the noises here in the room?”, “Did it feel real when the teacher talked to you?”. These questions were inspired by the Igroup Presence Questionnaire (IPQ; Schubert et al., 2001), which is a measure used to assess the sense of presence experienced in VR (Melo et al., 2023). The IPQ questionnaire consists of 14 items that measure four factors: presence, spatial presence, involvement, and experienced realism (Melo et al., 2023). The qualitative questions in the present study were designed to align with these four factors. The spatial presence subscale refers to users’ sense of being physically present in the VR environment, which relates to the question “Do you feel like you were really in that classroom?”. This question directly assesses the participant’s spatial presence by asking about their subjective experience of reality within the VR classroom. Involvement measures the attention devoted to the VR, reflected in the question “Did you get distracted by the noises here in the room?”. This question explores how focused the participants were in the VR environment versus external distractions. Experienced realism assesses the subjective experience of realism in VR, which connects to the question “Did it feel real when the teacher talked to you?”. This question aims to evaluate the authenticity of interactions in the VR.

Immersion. To measure immersion the subscale immersion (α = .78) from the GEQ (Ijsselsteijn et al., 2008) was used. An example of an item is “I was interested in what was happening in the VR”.

Flow. Flow was measured using the subscale flow from the GEQ (Ijsselsteijn et al., 2008). An example of an item measuring flow is “I forgot everything around me when I had the VR glasses on”, with a cronbachs α of .80.

Emotions. Three methods were used to assess the participants’ emotions regarding the VR experience: the GEQ (Ijsselsteijn et al., 2008), VR data specifically the data from the emotion ratings during the VR experience, and data from the qualitative interview conducted after the VR.

The GEQ (Ijsselsteijn et al., 2008) was used to measure positive affect (α = .81, e.g., ”I felt happy”), which contains all positive emotional reactions such as joy, fun, pleasure and happiness, that are central to the digital game experience. Moreover, also the subscale negative affect (α = .70, e.g., “I found it tiresome”) of the GEQ (Ijsselsteijn et al., 2008) was used to measure negative emotional reactions that do not reach the level of hostile and aggressive affect.

Regarding the VR data, the focus of this study was on the pre-test emotions and post-test emotions.

Four qualtitative questions were asked in the interview after the participants’ VR experience: “How do you feel now?”, “How do you feel about the test?”, “How did you feel during/after the test?” and “How did you feel in VR?”.

Simulator Sickness. In the present study simulator sickness is comprised of the symptoms: sickness, pain and dizziness and is inspired by the CSSQ (Hoeft et al., 2003).

Additionally, pain und dizziness were assessed using the qualitative questions: “Do you feel any pain anywhere?” and “Do you feel dizzy?”.

VR Ratings. To assess how the participants rate their overall VR experience and specifically aspects like the VR classroom, the NPCs, the clarity of the task process, and the emotion ratings, the following qualitative questions were asked: “How did you like the VR experience?”, “How was the VR for you?”, “Can you tell me what happened?”, “How was it for you to answer the questions about your feelings in VR?”, “How did you like the classroom?”, “Were you able to press the buttons well?”, “What do you think of the teacher/ Charlie?” and “Was it easy to understand what you had to do during the test?”.

VR Task. Two subscales, challenge (α = .70) and tension (α = .74), from the GEQ (Ijsselsteijn et al., 2008) were used to assess how realistic the VR test felt. Since the VR test was based on the TSST (Buske-Kirschbaum et al., 1997) and aimed to induce psychological stress, these two GEQ subscales were utilized to determine whether the VR test and experience were realistic enough to effectively create a sense of challenge and tension. The subscale challenge (e.g., “I felt time pressure during the test”) describes how stimulated the participant felt during the VR test and how much effort they invested. Furthermore, the subscale tension (e.g., “I felt tense”) is described as a feeling of uncertainty that arises during the VR test when the participant is unsure whether they will be able to successfully complete the given task.

Additionally, the success and failure rates of the VR task were used to evaluate the difficulty of the VR test.

Empathy. The assessment of empathy was conducted through qualitative questions alongside data collected from the VR experience. Two qualitative questions were posed to the participants after their VR experience: “How do you think Charlie felt during the test?” to assess cognitive empathy and “How did you feel when you watched Charlie take the test?” to measure affective empathy. Both qualitative questions were inspired by the empathy measures used in Bray et al. (2021).

Regarding the VR data, the emotion ratings from the question “How does Charlie feel now?” were used to assess cognitive empathy, and the question “How do you feel after watching Charlie take the test?” was used to measure affective empathy.

Quantitative Analysis

In the present study the statistical analysis were conducted using the software *SPSS* (IBM, Version 29). First, descriptive statistics of emotions (VR-Data), empathy (VR-Data), pain, sickness and dizziness (CSSQ) and the subscales of GEQ were examined.

Furthermore, the correlation between cognitive and affective empathy was assessed using Cramér's V, because both variables are on a nominal scale and categorical.

Qualitative Analysis

The data was collected during the workshops using paper questionnaires, in which all the responses provided by the children were documented. Afterwards, the data was digitalised and electronic documents were analyzed by using the qualitative analysis software MAXQDA24 with the 2022.8 version, which was released September 12th, 2023. Imported data took the form of word chunks and short sentences. A mix of inductive and deductive thematic analysis (TA) based on Braun and Clarke (2006) was conducted. TA is a method for analyzing qualitative research data presented in text format. Braun and Clarke (2006) describe it as a method "for identifying, analysing, and reporting patterns (themes) within data".

The benefits of TA include its flexibility, as there are no defined rules for when a theme should be created. Instead, it is up to the researcher to determine which themes are necessary (Braun & Clarke, 2006). TA is carried out in six phases, which may be repeated until various themes are fully developed: (1) Data familiarization, (2) Generating initial codes, (3) Theme development, (4) Reviewing themes, (5) Defining and naming themes and (6) Reporting (Braun & Clarke, 2006). These six phases for data analysis were also utilized in this study. Data was indexted using a line-by-line coding in an inductive, data-driven approach. Some data points (sentences, chunks) are linked to multiple themes simultaneously, since the information may relate to more than one theme.

The final framework included the themes: (a) *Sense of Presence*, (b) *Empathy*, and (c) *Simulator Sickness*, which were a-priori defined based on literature, and (d) *Emotions* and (e) *VR-ratings*, which were generated from the data.

Results

Quantitative Results

Descriptives

The following section presents the frequencies of emotions, affective and cognitive empathy, as well as the success and failure rates of the VR task, and instances of pain, sickness, and dizziness. In this study, VR data includes only the 33 participants from the second workshop.

Before taking the VR task (pre-test emotions) 42.4% (n = 14) of the participants reported being "happy", while 12.1% (n = 4) indicated feeling "angry" and "anxious". Fifteen and two tenths ($n = 5$) expressed feeling "proud", and 3% ($n = 1$) reported being "sad". Additionally, 15.2 % ($n = 5$) of the participants indicated feeling "neutral". After participating in the task (post-test emotions) 36.4 % ($n = 12$) of the participants reported feeling "happy", 15.2% ($n = 5$) indicated feeling "angry", and 3% ($n = 1$) "anxious". Twenty-four and two tenths ($n = 8$) reported feeling proud and 15.2% ($n = 5$) indicated being "neutral". None of the participants reported feeling "sad". In Table 2 the frequencies of the pre- and post-test emotion ratings along with the specific emotions are presented.

Table 2

Frequencies of Pre-test and Post-test Emotion

	Happy		Proud		Sad		Angry		Anxious		Neutral		Sum
	n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	
Pre-test Emotions	14	42.4	5	15.2	1	3	4	12.1	4	12.1	5	15.2	33
Post-test Emotions	12	36.4	8	24.2			5	15.2	1	3	5	15.2	31

The average trials score was 12.03 ($SD = 2.08$) with a minimum score of 8 and a maximum score of 17. Referring to the successes of the VR task, the participants average score was 9.21 ($SD = 2.50$) with scores ranged from 2 to 13. The average score regarding the failures was 2.82 ($SD = 2.78$) with a minimum of 0 and a maximum of 15. The ratio of failures to trials had an average score of 22.41 ($SD = 18.25$) with scores ranged from 0 to 88,24. In Table 3 the sample sizes, means, standard deviations, minimum and maximum scores of each component are presented for descriptive statistical purposes.

Table 3

Descriptive Statistics of Trials, Failures and Successes

Variable	*M*	*SD*	Min	Max
Trials	12.03	2.08	8	17
Success	9.21	2.50	2	13
Failures	2.82	2.78	0	15
Ratio_Failures	22.41	18.25	0	88.24

Note. n = 33.

In terms of cognitive empathy, 3.1% (n = 1) of the participants reported that they believed the NPC felt "happy", while 34.4% (n = 11) thought the NPC felt "sad". Additionally, 31.3% (n = 10) of the participants indicated that they thought the NPC was feeling "proud", while 21.9% (n = 7) reported the NPC being "angry". Three point one percent (n = 1) expressed thinking the NPC was anxious and 6.3% (n = 2) reported the NPC feeling "neutral". All frequencies of the emotions related to cognitive empathy are presented in Table 4.

Table 4

Frequencies of Cognitive Empathy

	n	%
Happy	1	3.1%
Proud	10	31.3%
Sad	11	34.4 %
Angry	7	21.9%
Anxious	1	3.1%
Neutral	2	6.3%

Regarding affective empathy, 48.1% (n = 13) participants reported feeling "happy" while watching the NPC take the test, whereas 3.7% (n = 1) indicated being "sad". Furthermore, 22.2% (n = 6) expressed feeling proud during the NPCs' test and 14.8% (n = 4) reported feeling "angry". Three and seven tenths (n = 1) indicated feeling "anxious" while watching the NPC and 7.4% (n

= 2) indicated being neutral. Table 5 presents the frequencies of all emotions related to affective empathy.

Table 5

Frequencies of Affective Empathy

	n	%
Happy	13	48.1%
Proud	6	22.2%
Sad	1	3.7%
Angry	4	14.8%
Anxious	1	3.7%
Neutral	2	7.4%

Regarding feeling sick after the VR experience 90.9% (*n* = 30) of the participants reported "no", while 6.1% (*n* = 2) indicated feeling "a little" sick and 3% (*n* = 1) expressed feeling "a lot" sick. The frequencies of sickness experienced following the VR session are presented in Table 6.

Table 6

Frequencies of Sickness

	n	%
no	30	90.9%
A little	2	6.1%
A lot	1	3%

In terms of feeling pain after the VR session 87.9% (*n* = 29) of the participants reported "no", while 6.1% (*n* = 2) indicated feeling "a little" pain and 6.1% (*n* = 2) expressed having "a lot" of pain. Table 7 presents the frequencies of the experienced pain after the the VR session.

Table 7

Frequencies of Pain

	n	%
no	29	87.9%
A little	2	6.1%
A lot	2	6.1%

Regarding feeling dizzy after the VR experience 87.9% (*n* = 29) of the participants reported "no", while 12.1% (*n* = 4) indicated feeling "a little" dizzy. None of the participants expressed feeling "a lot" dizzy. The frequencies of dizziness experienced following the VR session are presented in Table 8.

Table 8

Frequencies of Dizziness

	n	%
no	29	87.9%
A little	4	12.1%

The Game Experience Questionnaire (GEQ; Ijsselsteijn et al., 2008) was administered to the participants as a measure of immersion, flow, tension and challenge, positive and negative affect. The average score of immersion was 3.10 (*SD* = .89) with a minimum score of 0 and a maximum score of 4. Flow had an average score of 2.95 (*SD* = .86) with scores ranging from 1 to 4. The average score regarding tenstion was 1.30 (*SD* = .99) with a minimum score of 0 and a maximum score of 3. The subsale challenge had an average score of 1.43 (*SD* = 1.01) with scores ranging from 0 to 4. Positive affect had an average score of 3.23 (*SD* = .97) with a minimum score of 0 and a maximum score of 4, whereas the average score of negative affect was 1.05 (*SD* = .97) with scores ranging from 0 to 4. In Table 9 the sample sizes, means, standard deviations, as well as the minimum and maximum of the subscales of the GEQ are presented.

Table 9

Descriptive Statistics of GEQ

Variable	*n*	*M*	*SD*	Min	Max
Immersion	30	3.10	.89	0	4
Flow	30	2.95	.86	1	4
Tension	29	1.30	.99	0	3
Challenge	29	1.43	1.01	0	4
Positive Affect	29	3.23	.97	0	4
Negative Affect	28	1.05	1.05	0	4

Note. GEQ = Game Experience Questionnaire.

Inferential Statistical Analysis

The relationship between cognitive empathy and affective empathy was assessed using the Fisher's exact test (Fisher, 1922). The data fulfill the requirements for this test, as they are categorial, the variables are independent and, measured on a nominal scale. As shown in Table 10, there was not a statistically significant association between cognitive empathy and affective empathy ($p = .883$).

Table 10

Fisher's Exact Test

	Value	*p*
Fisher's exact test	19.22	.883

Note. $p < .05$, two-tailed.

Qualitative Findings

This chapter will present the most relevant themes and codes that emerged from the thematic analysis. The themes and codes from the first and second workshops vary due to the different qualitative questions posed in each session and the distinct VR scenarios. Therefore, the resulting themes from each workshop will be presented separately. Additionally, the percentages provided were calculated based on the sample size of each specific workshop.

Sense of Presence

Regarding the first workshop the theme *sense of presence* consisted of the following four codes, which were derived from literature: *presence*, *spatial presence*, *involvement* and *experienced realism*. The code *presence* refers to whether participants perceived the classroom as real. Forty-five percent of the children did perceive the classroom as real with remarks like, “yes especially the window”. In contrast 40% stated that the classroom did not look real with statements like: “no because the characters did not look realistic”. When asked about feeling physically present in the classroom (code: *spatial presence*) 40% agreed with responses like, “Yes I wanted to touch things but I couldn’t” and 15% disagreed with remarks like, “not really”. Regarding the code *involvement* 85% of the participants stated not being distracted during their VR experience, while 5% indicated being distracted, for example: “When someone talked from outside the VR, it was difficult to listen”. The code *experienced realism* refers to whether the interaction with the NPC (VR teacher) was perceived as real from the participants. Twenty percent of the participants felt that the interaction was realistic, with comments such as, “It felt normal.” In contrast, 35 % expressed that the interaction did not feel real, with statements like: “like a robots voice”, “was too quiet, like you were in a cartoon” and “It was strange because she didn't move her mouth, yet her voice was still heard. The teacher was tall and looked intimidating”.

In the second workshop 6% of participants stated feeling a *sense of presence* when talking about their VR experience, with remarks like, “it felt like it was real” and “as if it was real”.

Empathy

The theme of *empathy* consisted of the two codes *cognitive empathy* and *affective empathy* that were derived from existing literature (Bray et al., 2021). *Cognitive empathy* was mentioned by 93% of the participants, while *affective empathy* was reported by 33%. Participants expressed *cognitive empathy* by describing how they thought the NPC (Charlie) felt during the VR test, with remarks like: “Charlie was angry because of many mistakes”, “ashamed because he did not get as many right as me”, “When she was finished, she was proud”, “Charlie felt a bit anxious, nervous and had trouble pushing quickly“ and “sad because he didn't get so much right”. On the other hand *affective empathy* was expressed by participants’ descriptions of their own feelings while observing the NPC (Charlie) take the test. Examples for *affective empathy* are: “I was angry because she always got it wrong”, “I was uncomfortable because she made many mistakes” and “Cheerful, but also anxious because she made mistakes”.

Simulator Sickness

The theme of s*imulator sickness* was conducted in the first workshop and included the codes: *discomfort* and *dizziness* and was inspired by existing literature (CSSQ; Hoeft et al., 2003). Participants reported *discomfort* (20%) when asked about any pain, with remarks like: "VR glasses pressed against my head", "the VR glasses were too tight", "the VR glasses were too heavy" and "VR glasses were sliding down". *Dizziness* was mentioned by 2% of the participants, with statements like: "shortly after I took off my VR glasses".

Emotions

The theme of *emotions* was mentioned in both workshops. In the first workshop, the participants expressed different emotions mostly associated with the following codes: *test-emotion*, *VR-Teacher* and *VR-Experience*. The *test-emotion* refers to to the feelings participants reported experiencing during and after the VR task, including emotions such as "happy", which was indicated by 27% of the participants. An example is "happy because it was fun". When asked about the VR teacher 27% of the participants stated "scary" (e.g., "Teacher was tall and looked scary") and 9% were anxious. Regarding the participants' perceptions of the *VR experience* 9% mentioned that they were bored (e.g., "it was short, easy and boring"). In contrast, 64% expressed being "cheerful" about participating in the VR experience, with remarks like, "cheerful that I took part in the VR".

In the second workshop, the theme of *emotions* was associated with the codes *test emotion* and *VR Experience*. Unlike the first workshop, the code *test emotion* in this context refers to both the emotions participants felt while completing the VR task themselves and how they perceived the emotions of the NPC and their own emotions while observing the NPC during the test. The reported emotions were as follows: "sad" (50%), "angry" (40%), "proud" (33%), "anxious" (17%), "nervous" (10%), "relieved" (7%), and "excited" (3%). Some examples are "I feel proud because I did everything right", "relieved that I was finished" and "I was angry because the VR-glasses had no battery during the test". The emotion stated at 30% and linked to the overall VR experience the most was "happy".

VR-Ratings

The theme of *VR-Ratings* from the first worshop included the following codes: *easy*, *fun*, *cool*, *funny*, *exciting*, *difficult*, *weird*, *confusing* and *stressful*. *Easy* was mentioned from 53% of the participants regarding their experience with the VR test and the emotion rating process (e.g., "easy because I knew how to do it"). Regarding the overall VR experience and the VR test, 33% of the participants stated that it was *fun* (e.g., "it was fun, I want to do it again"), 33% described it as *cool*, 27% said it was *funny* and 13% mentioned *exciting* (e.g., "it was exciting because of the VR glasses", "very exciting because I have never experienced something like that"). *Difficult* was mentioned by 40% of the participants in relation to difficulties in pressing the buttons in VR, with remarks like "a little bit difficult because I had to press with my fingertips". In addition, for 7% of the participants pressing the buttons was *stressful*. Furthermore, 33% of the participants called the overall VR experience "weird" with statements like "it was weird because a stranger was sitting next to me" and "because a woman was sitting next to me and she wasn't moving". Additionally, regarding the VR experience 27% of the participants mentioned *confusing* (e.g., "ghost hands were confusing").

The second workshop had the *VR ratings*: *fun*, *cool*, *funny*, *not stressful*, *weird*, *unpleasant* and *annoying*. Regarding the overall VR experience 33% stated that it was *fun*, 33% described it as *cool* and 25% called it *funny*. *Not stressful* was mentioned by 8% of the participants with remarks like, "not stressful because I didn't make any mistakes". The word *weird* was stated by 57% of the participants, for example: "it was weird because you could only see your hands and pressing the buttons didn't work". The VR test was described as *unpleasant* by 14% of the participants. Regarding the NPC (VR teacher) 14% described her as *annoying* with remarks like, "The teacher was a little bit annoying".

Discussion

The aim of this study was to explore the feasibility of VR as an assessment tool for evaluating affective and cognitive empathy in primary school children. For this purpose, a study with a combination of qualitative and quantitative methods was conducted. The feasibility was assessed through various factors, including levels of sense of presence, immersion, flow, emotional responses, experiences of simulator sickness, ratings of the VR experience, performance in VR tasks, and it's effectiveness in eliciting empathy.

In literature, sense of presence and immersion are commonly defined as a person's acceptance of a virtual environment (Hirt et al., 2020). As noted in the quantitative result section, both immersion (M= 3.10) and flow (M= 2.95) were relatively high, which aligns with existing research indicating that children experience a strong sense of presence in VR (Cadet et al., 2022). This suggests that the children accepted the virtual environment and perceived it as real. However, the qualitative findings regarding presence in VR were mixed. Notably, 40% of the participants reported that the classroom setting did not appear real. Additionally, only 20% of participants felt that their interactions with the NPCs were realistic, which indicates challenges in achieving full immersion, particularly concerning the realism of the NPC characters and their interactions. Comments of the children regarding the robotic voice of the VR teacher and the lack of movement of the NPC student reinforce the need for more lifelike VR characters. In contrast, 45% of the children perceived the classroom as real and 85% reported not being distracted during the VR experience, implying strong involvement, which suggests that, a portion of participants found the VR experience to be immersive. One possible explanation for these mixed results is that the participants felt immersed during the VR experience, but during the qualitative interviews, as they reflected on it, it led them to recognize that the experience did not fully replicate real-life situations.

Considering the VR ratings of the children, the present study highlights the positive and negative aspects of the designed VR environment and VR scenarios. The VR scenarios from both workshops were rated as *cool*, *fun* and *funny*. In particular, the first workshop was further characterized as *exciting* and *easy*, suggesting that the VR environment effectively engaged users and fostered enjoyment and participation. However, there were also negative aspects reported. Notably, 40% of the participants pointed out difficulties in pressing the buttons in the VR, which indicates usability issues, particularly regarding the control and interaction within the VR environment. Furthermore, the VR experience was reported as *weird* by 33% of the participants in the first workshop and by 57% in the second workshop, due to the discomfort caused by the presence of the NPCs. In addition, 27% of the participants found the VR experience to be *confusing* in the first workshop. These findings indicate that while the VR was able to create a sense of presence and was meant to represent a usual classroom setting, it still led to a partly confusing or “weird” experience for the children.

Furthermore, the VR experience was described as *not stressful* by 8% of the participants, as they did not make many mistakes in the VR test. This is contrary to the originally intended purpose of the VR task, which was designed to induce stress in the children, based on the TSST. Considering the success and failure rates of the VR test, it shows that the children had higher success rates ($M = 9.21$) and fewer failures ($M = 2.82$) during the task. This aligns with the results from the GEQ, which indicated that the levels of tension ($M = 1.30$) and challenge ($M =$

1.43) during the VR experience were relatively low. Additionally, these findings correspond with the low levels of negative affect (*M* = 1.05) and high levels of positive affect (*M* = 3.23) reported by the children in regard to the VR experience.

Research has demonstrated that VR tasks can elicit a variety of emotions, a finding that is consistent with the results of this study (Somarathna et al., 2023). The most frequently reported emotion in relation to the VR test was "happy". In the qualitative findings, 27% of participants in the first workshop and 30% in the second workshop expressed feeling happy. This was also reflected in the quantitative results, with 42.4% reporting happiness as a pre-test emotion and 36.4% as a post-test emotion. The second most frequently reported emotion was "proud", with 33% of children in the second workshop mentioning this in the qualitative interviews. Additionally, 15.2% reported feeling proud before the VR test, while 24.2% expressed this feeling afterward. One participant remarked, "I feel proud because I did everything right", which again hints at the VR-test being relatively easy. Another reason for the frequent reports of pride could be that the children in the second workshop observed the NPC making many more mistakes than they did, which were 18 mistakes and comparing themselves to the NPC made them feel proud. These findings suggest that the VR task did not effectively induce stress or present significant challenges for the majority of the children.

Further insights from this study highlight the emotional experiences of participants during the VR interactions, particularly concerning the VR teacher and the overall experience. In the first workshop, 27% of children described the VR teacher as "scary", and 9% reported feeling anxious, which may be attributed to factors such as the teacher's height and demeanor. In the second workshop, qualitative interviews revealed that 17% of children reported anxiety, while 12.1% expressed this feeling immediately before the VR test and 3% afterward. Furthermore, 40% of participants indicated feeling angry in the qualitative interview, with 12.1% reporting anger just before the test and 15.2% reporting it immediately after. During the VR experience, the emotion "sad" was the least reported, with only 3% of the children expressing sadness before the VR test, and none reporting it afterward. In contrast, the qualitative findings revealed that 50% of participants mentioned feeling "sad", primarily concerning their perceptions of the NPC's feelings and their own emotions while observing the NPC. This aspect reflects the concept of empathy, which will be discussed further in the subsequent sections of this study. The findings of the present study are consistent with existing research, which demonstrates that VR technology is able to elicit a variety of emotions in children (Bailey & Bailenson, 2017; Somarathna et al., 2023).

VR has the potential to function as an "empathy machine", as it enables users to adopt the perspectives of others, thereby eliciting empathy (Barreda-Angeles et al., 2021; Tan et al., 2022). Furthermore, research indicates that participants can deeply relate with another person's emotions or situation by being in the same space or near that person, such as being in the same VR classroom alongside a NPC student (Shin, 2017). In the present study cognitive empathy was indicated by the children's perceptions of Charlie's feelings during the VR test. In the qualitative interviews, 93% of participants demonstrated *cognitive empathy* by articulating the emotions they believed Charlie experienced, which included anger, sadness, anxiety, and nervousness. These emotions were primarily justified by the observation that Charlie made many mistakes, as illustrated by comments such as, "Charlie was angry because he made many mistakes". These qualitative findings align with the emotion ratings of Charlie's feelings in the VR, as sadness (34.4%) and anger (21.9%) were also the most frequently reported emotions. Interestingly, the emotion "proud" was reported by 31.3% of the participants in this context during the VR experience, possibly due to egocentricity bias, which is the tendency to project one's own current emotions onto others (Silani et al., 2013; Hayashi & Nishikawa, 2019). Children who felt proud of their own success during the VR task might have assumed that Charlie also felt proud, overlooking the fact that the NPC made many mistakes.

In contrast, *affective empathy*, as indicated by the children articulating their own emotions while observing the NPC during the VR test, was reported by only 33% of participants in the qualitative interviews. *Affective empathy* was often expressed through feelings of discomfort, anger, and anxiety when watching Charlie make mistakes. Statements such as "I was uncomfortable because she made many mistakes" highlight a more self-focused emotional response, suggesting that participants felt empathy primarily in relation to their perceptions of Charlie's errors. In line with these qualitative findings, the emotion of anger was also reported during the VR emotion assessment after the NPC completed the VR task by 12.1% of the participants. In contrast, the emotions "happy" (48.1%) and "proud" (22.2%) were the most frequently reported feelings during the VR experience. In this case, egocentricity bias could again be a possible reason for the high rates of happiness and pride. Another explanation could be that the children compared themselves to the NPC Charlie, and because they performed better, they did not feel affective empathy.

An additional reason for the differences in the reported emotions regarding empathy during the VR experience and in the subsequent qualitative interviews could be that while immersed in the VR, participants were likely less aware of Charlie's struggles, experiencing joy or excitement regarding their own performance. However, upon reflecting on the experience afterward, some children reported feelings of sadness and discomfort regarding Charlie's failures, demonstrating a shift in the emotional understanding.

The findings from this study also provide valuable insights into the relationship between cognitive and affective empathy among children in a VR setting. Fisher's exact test was used to determine if there was a significant association between cognitive and affective empathy. The analysis revealed no statistically significant association between cognitive and affective empathy ($p = .883$). Therefore the hypothesis, which assumed a positive correlation between cognitive and affective empathy, could not be confirmed on the basis of this data. The absence of this significant correlation suggests that the two types of empathy may function independently, challenging previous research that observed a significant correlation between the two dimensions and suggested that individuals who better comprehend others' emotions are also more likely to experience shared feelings (Knafo et al., 2019; Boele et al., 2018).

Previous research has reported common sideffects of VR HMD usage in children, particularly simulator sickness, which includes symptoms such as nausea, discomfort, sickness, disorientation and oculomotor issues (Araiza-Alba et al., 2022; Kaimara et al., 2021; Hoeft et al., 2003). In the first workshop, 2% of the children reported experiencing dizziness, while 20% mentioned discomfort. In line with existing research, discomfort was frequently attributed to the weight of the VR glasses, with participants stating remarks like, "the VR glasses were too heavy" (Araiza-Alba et al., 2022). In the second workshop, the majority of children reported experiencing no sickness (90.9%), no pain (87.9%), and no dizziness (87.9%). Only 6.1% of participants reported experiencing "a lot" of pain, while 3% indicated feeling "a lot" sick. No participants described their dizziness as "a lot", rather, 12.1% reported that they felt "a little" dizzy. These results suggest that, although some children may initially experience some symptoms of simulator sickness, primarily due to the weight of the VR, the majority did not have issues with the VR experience.

Limitations and Future Implications

The present study has several limitations. First of all, the sample size was relatively small, with a total of 53 participants, of whom only 33 participants provided VR data from the second workshop. This small sample size may have contributed the results not matching the hypothesis and reduces the generalizability of the findings. Future research should consider a larger sample and include children from different schools and classrooms to enhance the validity and applicability of the findings.

To enhance the sense of presence within the VR environment and create a more realistic classroom setting that fosters empathy, several improvements could be made. Currently, the NPC teacher and student display only neutral facial expressions. By adding a variety of facial expressions, more realistic interactions can be achieved and this may elicit greater empathy, such as showing Charlie with a sad or anxious expression during or after his/her task. Additionally, the NPC's mouth should move in synchronization with the spoken dialogue, as the participants have remarked, to enhance the realism of the interaction. According to Reid et al. (2013), one limitation of VR scenarios is their simplicity because VR test situations mostly involve only two-person interactions, while these kind of real-life social interactions are typically more complex and dynamic, often involving multiple individuals. Therefore to make the VR interactions more realistic, additional NPC characters could be included, or the NPC Charlie could be programmed to engage in the conversation with the participant.

One limitation of the VR task is that it did not induce stress as originally intended. Although this task is modeled after the TSST-C and incorporates elements of uncontrollability, performance in front of an audience, and the presence of social comparison, study results indicate that it did not effectively generate stress, challenge, or tension among participants (Zimmer et al., 2019; Dickerson & Kemeny, 2004). Because the task itself was too easy for the participants, one suggestion could be to replace the current task with an arithmetic test, as the original TSST-C does, to make it more challenging (Buske-Kirschbaum et al., 1997).

Participants' comments regarding the difficulty in pressing the buttons in the VR highlight an area for improvement in the design of the user interface to enhance user satisfaction and not distort the results.

Another limitation is that the present study relies on self reports, like GEQ, CSSQ, the emotion-ratings in the VR and the qualitative interviews. Thus, it is questionable to what extent the methods of this study can accurately assess the conducted variables, as a drawback of self-report measures is the tendency toward responses that reflect social desirability, as the children may answer in ways they think will be viewed favorably.

Considering the emotion ratings in the VR, children may have chosen an emotion not based on what they were feeling but on how much they liked the appearance of the emojis.

There were some limitations concerning the qualitative questions. Firstly, the first workshop had too many prepared questions, and overall, the questions differed between the first and second workshops. It would be beneficial to ask fewer questions, similar to the approach taken in the second workshop, and to use the same questions across both workshops in order to get more comparable data. Secondly, some qualitative questions are closed-ended, prompting yes or no answers from participants (e.g.,"Do you feel like you were really in that classroom?"). This limitation restricts the depth of insights that can be gathered, as it can prevent participants from fully expressing their thoughts and feelings. Additionally, the qualitative questions regarding sense of presence, as well as the questions used for assessing simulator sickness, are suggestive, as they imply certain feelings or experiences (e.g., "Did it feel real when the teacher talked to you?" or "Do you feel any pain anywhere?").

Regarding the assessment of simulator sickness, future research should present the full version of the CSSQ (7 items) to accurately assess simulator sickness experiences. This comprehensive approach would provide more insights into the symptoms and occurance of simulator sickness among participants.

Future research could implement more diverse methodologies, including physiological measurements (e.g., heart rate variability) to complement self-reported data. For instance, Barreda-Angeles et al. (2001) utilized psychophysiological measures, including heart rate and electrodermal activity, to assess arousal and negative experiences in relation to empathy in VR bullying situations. Additionally, adding different empathy-related VR scenarios, such as a bullying situation, might yield valuable data on how specific emotional cues and interactions influence empathy in children.

Conclusion

This thesis study aimed to investigate the feasibity of VR technology as an assessment tool for evaluating affective and cognitive empathy in primary school children. It was hypothesized that there would be a positive correlation between affective and cognitive empathy. However, the quantitative findings did not support this hypothesis, as the results did not reveal a significant correlation between the two dimensions of empathy. Neverthless, the findings indicated that VR was capable of eliciting both affective and cognitive empathy, with cognitive empathy being demonstrated more frequently than affective empathy.

In terms of feasibility, the study demonstrated a high level of acceptance of the VR experience among participants, as demonstrated by increased feelings of presence, immersion, and flow during the experience. Connecting the experienced high levels of immersion to empathy, previous studies indicate that immersion in VR has the potential to enhance empathy (Shin, 2017). This heightened empathy can elevate an individual's overall empathetic ability and improve their perception of the realism of the virtual environment (Shin, 2017). Nonetheless, aspects of realism could be improved, particularly in the dialogues and movements of the NPCs. According to Somarathna et al. (2023), VR serves as an active method for eliciting emotions. In this study, children expressed more positive affect than negative affect, with happiness and pride being the predominant reported feelings, which connects with the high success rates and low failure rates observed during the VR tasks. In addition, the VR task induced low levels of challenge and tension. Regarding simulator sickness, most of the children did not experience pain, sickness, or dizziness. Overall, the VR experience was perceived as fun and exciting, indicating high levels of enjoyment.

In conclusion, the findings of this thesis indicate that VR technology is a feasible tool for assessing emotional states and empathy in primary school children. By understanding how children engage in virtual environments and addressing the emotions experienced during VR interactions, researchers, therapists, and educators can more effectively utilize this technology as a tool for learning and empathy development in children.

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Appendix

Abstract (EN)

In recent years, the use of virtual reality (VR) technology has emerged as a promising tool for psychological research in emotional and social development, particularly in understanding empathy. The purpose of this thesis is to investigate the feasibility of VR technology as an assessment tool for evaluating cognitive and affective empathy in primary school children. A combination of qualitative and quantitative methodologies was used to explore several key factors of feasibility and to evaluate the influence of immersive VR experiences on children's empathy. The results indicated that, while there was no significant correlation between affective and cognitive empathy, the VR environment was able to elicit empathetic responses, with participants reporting higher levels of cognitive empathy. The high levels of sense of presence, immersion, and flow, as well as low adverse effects reported by the participants, indicate the acceptance of VR among children. However, improvements in the realism of non-player characters (NPCs), the interactions in the VR, and the VR task are suggested. Overall, these findings add to the existing literature on the potential of VR as a research tool for children and highlight its effectiveness in enhancing empathy.

Keywords: Virtual reality (VR), cognitive empathy, affective empathy

Abstract (DE)

In den letzten Jahren hat sich der Einsatz von Virtual Reality (VR) als vielversprechendes Instrument für die psychologische Forschung im Bereich der emotionalen und sozialen Entwicklung erwiesen, insbesondere für das Verständnis von Empathie. Ziel dieser Masterarbeit ist es, die Anwendbarkeit der VR-Technologie als Instrument für die Erfassung der kognitiven und affektiven Empathie bei Grundschulkindern zu untersuchen. Um dies zu erreichen, wurde eine Kombination aus qualitativen und quantitativen Methoden eingesetzt, um wichtige Aspekte der Anwendbarkeit von VR-Technologie zu erforschen und den Einfluss von immersiven VR-Erlebnissen auf die Empathie der Kinder zu ermitteln. Die Ergebnisse zeigten, dass es zwar keine signifikante Korrelation zwischen affektiver und kognitiver Empathie gab, die VR-Umgebung jedoch in der Lage war, empathische Reaktionen hervorzurufen, wobei die Versuchspersonen ein höheres Maß an kognitiver Empathie berichteten. Die hohen Werte des Gefühls von Präsenz, Immersion und Flow sowie die geringen negativen Auswirkungen, die von den Teilnehmenden berichtet wurden, deuten auf die Akzeptanz von VR bei Kindern hin. Es werden jedoch Verbesserungen in der Realitätsnähe von Nicht-Spieler-Charakteren (NPCs), den Interaktionen im VR sowie der VR-Aufgabe vorgeschlagen. Insgesamt erweitern diese Ergebnisse das bestehende Wissen über das Potenzial von VR als Forschungswerkzeug bei Kindern und betonen dessen Wirksamkeit in der Förderung von Empathie.

Schlüsselbegriffe: Virtual reality (VR), kognitive Empathie, affektive Empathie

Themes & Codes

Theme	**Code**	**Semantic description**
Sense of Presence	Presence	„yes especially the window“ “no because the characters did not look realistic”
	Spatial Presence	“Yes I wanted to touch things but I couldn’t” “not really”
	Involvment	“When someone talked from outside the VR, it was difficult to listen”
	Experienced Realism	“It was strange because she didn't move her mouth, yet her voice was still heard. The teacher was tall and looked intimidating” “It felt normal.” “like a robots voice” “was too quiet, like you were in a cartoon”
Empathy	Cognitive Empathy	“Charlie was angry because of many mistakes” “ashamed because he did not get as many right as me” “When she was finished, she was proud” “Charlie felt a bit anxious, nervous and had trouble pushing quickly“

		sad because he didn't get so much right”
	Affective Empathy	“I was angry because she always got it wrong” “I was uncomfortable because she made many mistakes” “Cheerful, but also anxious because she made mistakes”
Simulator Sickness	Discomfort	“VR glasses pressed against my head” “the VR glasses were to tight” “the VR glasses were too heavy” “VR glasses were sliding down”
	Dizziness	“shortly after I took off my VR glasses”
Emotions	Test-Emotion	“happy because it was fun” “I feel proud because I did everything right” “relieved that I was finished” “I was angry because the VR-glasses had no battery during the test”
	VR-Teacher	”Teacher was tall and looked scary”
	VR-Experience	“it was short, easy and boring”
VR-Ratings	Easy	“easy because I knew how to do it”

	Fun	“it was fun, I want to do it again”
	Cool	„it was cool“
	Funny	„funny“
	Exciting	“it was exciting because of the VR glasses” “very exciting because I have never experienced something like that”
	Difficult	„a little bit difficult because I had to press with my fingertips”
	Weird	“it was weird because a stranger was sitting next to me” “because a woman was sitting next to me and she wasn’t moving” “it was weird because you could only see your hands and pressing the buttons didn’t work”
	Confusing	“ghost hands were confusing”
	Stressful	„pressing the buttons was stressful” “not stressful because I didn’t make any mistakes”
	Annoying	“The teacher was a little bit annoying”
	Unpleasant	„it was unpleasant“

Adapted Game Experience Questionnaire (GEQ)

German Items	English Items
Ich fand es spannend, was im VR passiert ist.	I thought it was exciting what happened in VR.
Mir hat es gefallen, wie es im Klassenzimmer im VR ausgesehen hat.	I liked how the classroom looked in the VR experience.
Ich hatte das Gefühl im Klassenzimmer Sachen entdecken zu können.	I felt like I could explore things in the classroom.
Ich war sehr beeindruckt, als ich die VR-Brille aufgesetzt habe.	I was very impressed when I put on the VR glasses.
Ich fand, dass es viel zu sehen gab in dem VR-Klassenzimmer.	There was a lot to see in the VR classroom.
Ich war sehr vertieft.	I felt completely absorbed.
Ich habe alles um mich herum vergessen, als ich die VR-Brille aufhatte.	I forgot everything around me, when I had the VR glasses on.
Ich habe keine Ahnung, wie lang ich im VR-Klassenzimmer war.	I have no idea how long I was in the VR classroom.
Ich habe mich sehr auf die Aufgaben im VR konzentriert.	I was deeply concentrated on the tasks in the VR.
Ich habe mich gefühlt, als wäre ich wirklich in dem VR-Klassenzimmer.	I felt like i was really present in the VR classroom.
Ich war total in die Aufgabe vertieft.	I was totally absorbed in the task.
Ich konnte die Aufgaben gut schaffen.	I managed the tasks well.
Ich fühlte mich sicher.	I felt strong.
Ich war gut.	I was good at it.
Ich habe mich wie der der Gewinner/Gewinnerin gefühlt.	I felt like the winner.
Ich habe die Aufgaben richtig gelöst.	I have solved the tasks correctly.

Ich habe gewusst, was ich tue und mich deshalb schlau gefühlt.	I knew what I was doing and therefore felt clever.
Ich war angespannt.	I felt tense.
Ich habe mich unruhig gefühlt.	I felt restless.
Ich habe mich ärgerlich gefühlt.	I felt annoyed
Ich war schnell wütend.	I quickly got angry.
Ich war genervt.	I was irritated.
Ich fühlte mich, als hätte ich ganz schön viel zu tun, fast wie bei einer schwierigen Hausaufgabe.	I felt like I had quite a lot to do, almost like a difficult homework assignment.
Ich hatte das Gefühl, etwas zu lernen	I felt that i was learning
Ich fand es schwierig	I thought it was hard
Ich habe mich begeistert/aufgeregt gefühlt.	I felt enthusiastic/excited.
Ich hatte das Gefühl, es ist schwierig, aber ich kann es schaffen.	I felt like it was difficult but manageable.
Ich musste mich bei den Aufgaben sehr anstrengen.	I had to put a lot of effort into the tasks.
Ich hatte das Gefühl, dass ich nicht genug Zeit für die Aufgabe hatte.	I felt like i did not have enough time during the tasks.
Ich fühlte mich zufrieden	I felt content.
Ich konnte über die Dinge im VR lachen.	I could laugh about the things in the VR.
Ich habe mich glücklich gefühlt.	I felt happy.
Ich habe mich gut gefühlt	I felt good.
Ich hatte Spaß	I had fun.
Ich fand, es hat Spaß gemacht	I thought it was fun.
Ich habe während dem VR an andere Dinge gedacht	I thought about other things during the VR.
Das VR hat mich müde gemacht.	I found the VR experience tiresome.
Ich habe mich gelangweilt	I felt bored.
Ich war abgelenkt	I was distracted.

Ich war vom VR gelangweilt	I was bored by the VR.
Ich hatte schlechte Laune danach.	It gave me a bad mood

Adapted Child Simulator Sickness Questionnaire (CSSQ)

German Items	English Items
Ist dir übel?	Do you feel sick?
Hast du irgendwo schmerzen?	Do you have pain anywhere?
Ist dir schwindelig?	Are you feeling dizzy?