



VR4 EMPATHY

Report on the power of VR to stimulate students' empathy skills and motivation to learn

Research phase of the project – literature review, quantitative and qualitative research



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Abbreviations

DIH	Digital Innovation Hub
KPI	Key Performance Indicator
VR	Virtual Reality
WP	Work Package
AR	Augmented reality
ADHD	Attention deficit hyperactivity disorder
UL	University of Ljubljana

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Chapter 1

Introduction



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1. INTRODUCTION

1.1. Background

In recent years, the rapid advancement of technology has significantly reshaped various aspects of society, including education. Among these technological innovations, Virtual Reality (VR) has emerged as a powerful tool with the potential to revolutionize traditional learning environments. Unlike conventional educational methods, which often rely on passive forms of knowledge transfer, VR offers an immersive and interactive experience that can engage students in ways previously unimaginable. By simulating real-world scenarios and allowing students to interact with virtual environments, VR can enhance the learning process, making abstract concepts more tangible and fostering deeper understanding. As such, the world continues to evolve, so too must our educational practices. The project [VR4EMPATHY](#) represents a forward-thinking approach to education, one that embraces the possibilities offered by new technologies while remaining focused on the development of essential human skills like empathy.

The project VR4EMPATHY is rooted in the belief that empathy—both cognitive and emotional—is a crucial skill for personal development, social interaction, and lifelong learning. With the increasing importance of social-emotional learning in education, the project aims to explore how VR can be leveraged to develop these skills among adolescents. By immersing students in carefully designed virtual scenarios, we can encourage them to step into others' shoes, thereby enhancing their ability to understand and share the feelings of others. This, in turn, can lead to greater motivation to learn, as students find themselves more connected to the content and its relevance to the world around them.

The project is structured around several key objectives, each contributing to the overarching goal of integrating VR as an educational tool to enhance empathy and learning outcomes.

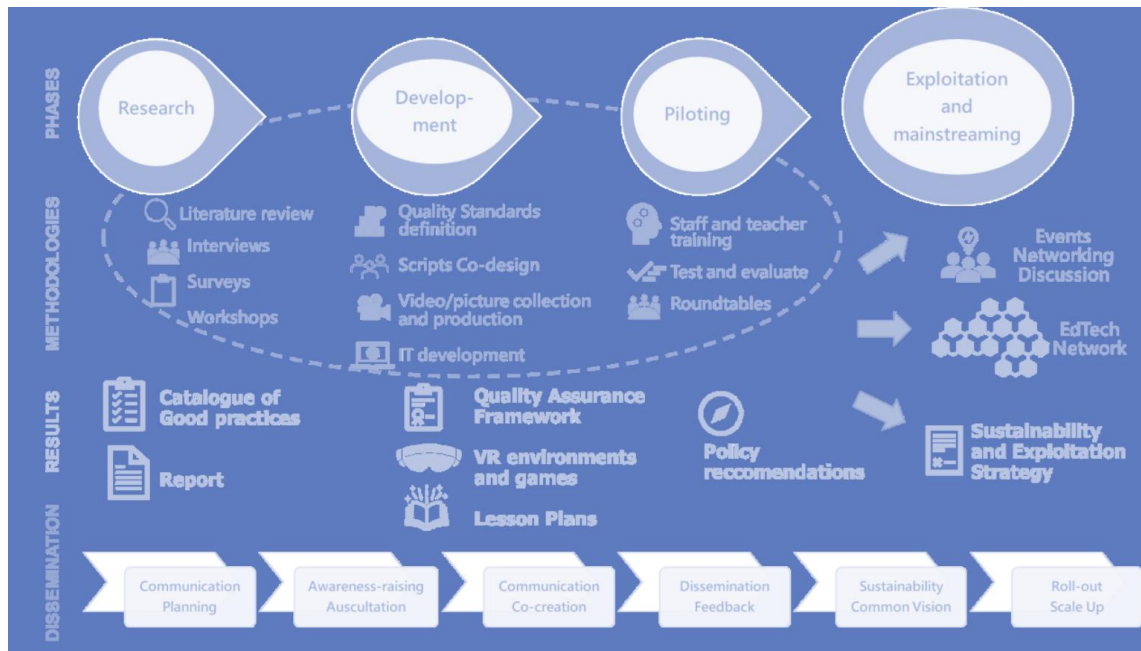


Figure 1: The project structure

The second work package (WP2) is a critical research phase of the project, focused on exploring how VR can enhance empathy and motivate students to learn. It was organized into five tasks: a literature review on VR in education, international benchmarking of VR resources, surveys on teachers' and students' needs, design thinking workshops, and the development of a final report.

This report details the process, implementation, and outcomes of WP2. It also serves as a roadmap for the future steps necessary to continue the project's momentum. As we move forward, the insights gained from this phase will be instrumental in shaping the development and application of VR in educational contexts, ensuring that the tools we create are not only effective but also aligned with the broader goals of empathy development and lifelong learning.

1.2. Executive Summary

Purpose and Aims

The VR4Empathy project aims to investigate how Virtual Reality (VR) can enhance students' empathy skills and motivation to learn. The core objective is to use VR as a tool for fostering both cognitive and emotional empathy among adolescents, thereby enriching their learning experiences and outcomes. By immersing students in virtual scenarios, the project seeks to help them step into others' perspectives, promoting

deeper emotional connections and engagement with educational content. The second work package (WP2) of the project focuses on exploring these possibilities through research, surveys, workshops, and the development of educational resources.

Methodology

The research phase of the project, WP2, was divided into five key tasks:

1. **Literature Review (T2.1):** A comprehensive review of existing research on VR as a learning tool was conducted, which included over 173 scientific articles. This task was essential in identifying best practices and critical needs for integrating VR into educational contexts.
2. **International Benchmarking (T2.2):** Comparative analysis of VR-based educational resources across different countries.
3. **Surveys (T2.3):** Surveys were conducted to assess the needs and expectations of teachers and students concerning VR, focusing on its potential to foster empathy and enhance learning in three countries: Greece, Portugal and Slovenia.
4. **Design Thinking Workshops (T2.4):** Workshops were held in Greece, Portugal, and Slovenia with students and teachers to develop insights into how VR could be effectively integrated into classrooms to promote empathy.
5. **Report Elaboration (T2.5):** Findings from all tasks were compiled into a comprehensive report detailing the process, implementation, and outcomes of WP2.

Key Findings

- **Empathy Development:** VR has significant potential in enhancing both cognitive and emotional empathy. Students who engaged in immersive VR experiences showed increased understanding and emotional connection to the subject matter.
- **Motivation to Learn:** Immersive VR environments positively impacted students' motivation and engagement, offering a more interactive and engaging learning experience compared to traditional methods.
- **Teacher and Student Feedback:** Surveys and workshops highlighted the need for support and training for teachers in using VR tools. Both groups expressed enthusiasm for VR, but also noted challenges related to accessibility and technical difficulties.

- **Inclusivity and Accessibility:** The literature review emphasized the need for VR resources to be designed with inclusivity in mind, particularly for students with disabilities, to ensure equal access to these innovative educational tools.
- **Best Practices and Competencies:** The project identified key competencies required by educators to effectively integrate VR into their teaching, as well as necessary technical and pedagogical standards for developing VR-based educational resources.

Conclusion

WP2 has laid a strong foundation for integrating VR into education, particularly for fostering empathy and improving motivation among students. The research insights gained from this phase will guide future development of VR-based educational tools, ensuring they are inclusive, effective, and aligned with broader educational goals. The project also highlights the importance of preparing educators with the necessary skills to successfully implement VR in classrooms.

1.2. Overview of the research phase (WP2)

In our project, within the second work package (WP2), the objective was to explore the power of VR to stimulate students' empathy skills and motivation to learn. In alignment with this objective, WP2 has been segmented into five consecutive tasks:

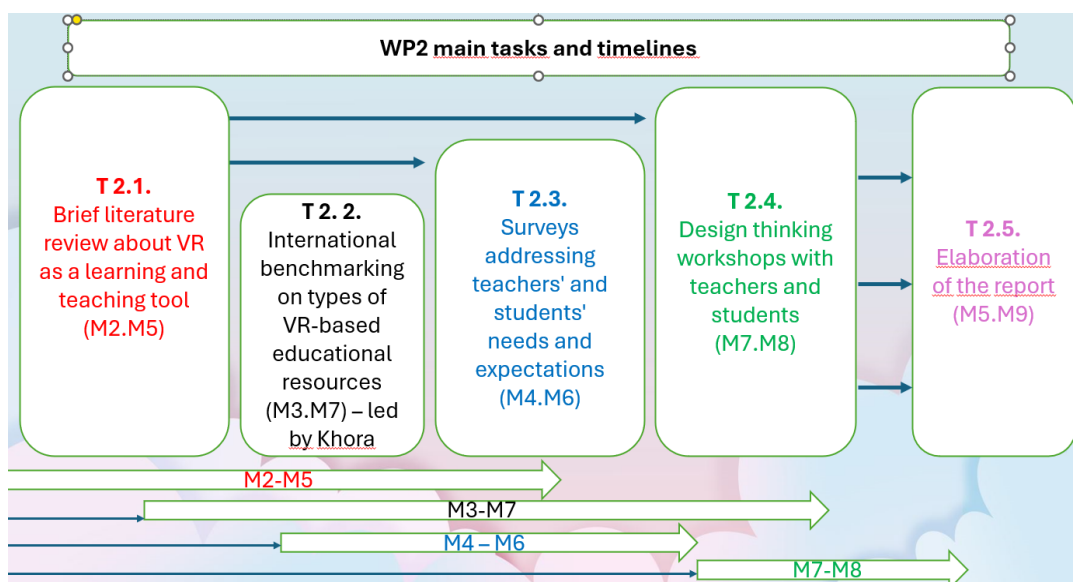


Figure 2: WP2 main tasks and timelines

Additionally, this phase sought to determine the most critical needs and expectations of educators and students regarding the use of VR-based educational resources. The findings enabled the consortium to identify the necessary competencies for teachers to effectively integrate these resources into their classrooms and pinpoint the most appropriate features and technical aspects for developing VR-based educational tools in formal education. These insights formed the basis for establishing a quality framework for the development and utilization of VR-based educational resources.

WP2 played a pivotal role in achieving the project's goals, namely: raising awareness of the importance, need, and benefits of a more empathetic society; understanding the role and impact of empathy on self-development and lifelong learning; and exploring the current and future applications of VR in educational contexts, particularly for advancing individuals' soft skills.

During the research phase, we employed both primary and secondary research methods, incorporating a participatory component to enhance the partners' understanding of the project's key topics. These topics included the use of VR as a learning and teaching tool, the needs and expectations of teachers and students regarding VR, and the essential features of a quality assurance framework. The methodologies used in this phase included a literature review, surveys, and design-thinking workshops with teachers and students. The main outcomes of this phase were the *Catalogue of Good Practices for the use of VR-based resources in school education* (D2.1) and the *Report on the Power of VR to Stimulate Students' Empathy Skills and Motivation to Learn* (D2.2).

In this report, we will detail the process, implementation, and results for each of the tasks.

As the literature review was the inaugural task, the team from the University of Ljubljana (UL) preliminary commenced work in December 2023, by defining the main research areas for the literature review following the application form, building the foundations to start the research in January 2024. As part of the literature review, we examined the latest trends in the scientific literature on the use of VR in education, as well as the development of cognitive and emotional empathy in adolescents. Our desk research encompassed numerous categories, the details of which will be provided in a subsequent report. The timeframe for this task was from January to April 2023, which was a relatively short period. However, in collaboration with our partners, we were able to review over 170 scientific articles and incorporate them into our findings.

At the same time, Khora proceed with the international benchmarking on types of VR-based educational resources, done combining interviews with experts with the promotion of a workshop with teachers. As for the workshop with teachers, it was promoted online with partners and teachers from Portugal, Slovenia and Greece in

February. The objective was to discuss learning outcomes for empathy generation within specific subjects (e.g. history, geography and social sciences). The workshop encouraged teachers to consider what they would like students to learn, change, understand or relate to. From these tasks resulted the *Catalogue of Good Practices for the use of VR-based resources in school education*. This is the first result of the project (deliverable 2.1), is available in English and it aims to inspire and guide educational organisations and EdTech providers in developing and integrating VR in education

At the February meeting, we started the task of developing questionnaires for teachers and students. These questionnaires were designed to gather information on digital technology usage, opinions on VR in education, empathy (both cognitive and emotional), and demographic data. The questionnaire for opinions on VR was created in collaboration with Khora. Partners reviewed and finalized both questionnaires, and they were translated into the national languages by March.

The necessary documents for ethical approval of the research were submitted, and approval was granted. Surveys were then distributed to schools in Slovenia, Greece, and Portugal with the support of ministry partners. The survey period concluded with 127 teacher responses (20 from Portugal, 50 from Slovenia, and 57 from Greece) and 239 student responses (82 from Portugal, 48 from Slovenia, and 109 from Greece), exceeding the required numbers. Data analysis was completed by July, and the results were shared with partners.

In preparation for the design thinking workshops, it was agreed that the workshops would be conducted in a select number of schools, involving both teachers and students. Despite challenges with timing, all three countries—Slovenia, Greece, and Portugal—successfully conducted three workshops in distinct schools.

A total of 129 students and 36 teachers participated in the nine workshops. Slovenia had 38 students and 15 teachers, Greece had 36 students and 9 teachers, and Portugal had 55 students and 12 teachers. During the workshops, attendance lists were collected, and photos were taken to document the process. The data from the workshops was analyzed and shared with partners in mid-July.

By the end of August, the final report, which focused on the potential of VR to enhance students' empathy skills and motivation to learn, was completed and presented to all partners.

The success of WP2 can be attributed to the efforts of the VR4Empathy team, which enabled the consortium to complete a comprehensive literature review, benchmarking, surveys and design thinking workshops in a relatively short timeframe of approximately



six months. The VR4Empathy team from Portugal, Greece, Denmark and Slovenia demonstrated excellent teamwork. All partners fulfilled their responsibilities in a timely and satisfactory manner, as agreed upon during meetings or via email conversation. All queries or concerns regarding project completion were promptly addressed, ensuring a smooth and uninterrupted workflow. We extend our gratitude to all partners for their dedication and commitment. We look forward to continuing our collaboration in the upcoming work packages.

The conclusions and key takeaways are presented in the fifth chapter of this document.

Following this introduction, we provided a detailed chronological account of the task implementation, followed by a more in-depth content report for each completed task, and concluded with a summary and recommendations for the subsequent work packages.





Chapter 2

Theoretical background – literature
review



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2. THEORETICAL BACKGROUND – LITERATURE REVIEW

2.1. Methodology for literature review

The purpose of the first research task (task 2.1 - literature review) was to present a systematic overview of the findings of recent scientific studies that have examined the power of VR to stimulate students' empathy skills and motivation to learn. Based on the analysis, we want to present the role of VR in stimulating students' empathy skills and motivation to learn, and the development of emotional and cognitive empathy during adolescence, including people with different abilities in VR-based education.

To gain insight into the role of VR in stimulating students' empathy skills and motivation to learn and all other categories we conducted a systematic literature review. This approach involves identifying, summarizing, and synthesizing available research in the field. It entails comparing the results of qualitative and quantitative studies using a qualitative framework (Snyder 2019). By identifying, critically assessing, and integrating findings from key qualitative studies on a specific research topic, this method provides an impartial and systematic overview of the field, offering valuable insights (Cooper 2003). Developing a comprehensive analysis protocol and utilizing pertinent studies that meet predefined inclusion and exclusion criteria are necessary steps in this method (Ressing, Blettner, and Klug 2009). According to this we specified categories and subcategories with the inclusion and exclusion criteria (table 1). The outcome was a thorough and systematic review of a broad range of published quantitative and qualitative research studies within a specific (sub)category. Integrating the findings and perspectives from these diverse studies allows us to address research questions in ways that no single study could (Snyder 2019).

2.2. Procedure for literature review

According to the application form, the team defined five main areas and fourteen subcategories (table 1). The fifth area was researched and analysed along the international benchmarking on types of VR-based educational resources (task 2.2) and the main results can be found in the *Catalogue of Good Practices for the use of VR-based resources in school education*. This is the first result of the project (deliverable 2.1 available here [Link](#)).

Main research area		Sub-categories
1.	the use, role, and impact of VR (immersive and non-immersive) in formal education in general	1. VR in general in education
		2. motivation to learn
		3. impact VR on the brain
		4. ethical concerns
		5. risk factors of VR use, safety protocols
2.	the use, role, and impact of VR for the development of soft skills and awareness raising on social, civil, and historical facts	6. VR on emotional empathy,
		7. VR on cognitive empathy
		8. VR on awareness raising - different EU values-based fields of education
3.	the role and impact of Empathy on self-development	<i>definition of empathy</i>
		9. adolescent neurocognitive development
		10. adolescent emotional development
		11. adolescent empathy development
4.	including people with different abilities in VR based education - equal access and inclusion	12. importance of empathy skills
		13. visual and hearing impairments
5.	identification of existing video materials for VR-based education: T2.2. Benchmarking - Deliverable D2.1.	14. other impairments
		existing video materials
		script ideas for filming

Table 1: Main research areas and subcategories

For each subcategory, the team defined a research question and allocated a partner responsible for deepening the analyses, as it can be presented in Table 2.

N. of the main area	Subcategories of the research area	N. of the sub-category	Research questions:	Partner responsible for the research
1.	VR in general in education	1.	What is the use, role, and impact of VR (immersive and non-immersive) in formal education in general?	UoP

	motivation to learn	2.	What is the use, the role, the impact of VR (immersive and non-immersive) in/on motivation to learn?	UoP
	impact VR on the brain	3.	What is the roll and the impact of VR (immersive and non-immersive) on the adolescent brain?	UL
	ethical concerns	4.	What are the ethical concerns in the use of VR in formal education and how to adress and mitigate them?	UL
	risk factors of VR use, safety protocols	5.	What are risk factors and safety protocols in the use, the role, the impact of VR (immersive and non-immersive) in formal education?	Inova+
2.	VR on emotional empathy,	6.	What is the influence of the use, role, and impact of VR on the development of emotional empathy in adolescence?	UL
	VR on cognitive empathy	7.	What is the influence of the use, role, and impact of VR on the development of cognitive empathy in adolescence?	UL
	VR on awareness raising - different EU values-based fields of education	8.	What is the influence of the use, role, and impact of VR on awareness raising on social, civil, and historical facts?	UoP
3.	definition of empathy			UL
	adolescent neurocognitive development	9.	Which aspects of neurocognitive development can be linked to the promotion of adolescent empathic competence?	UL
	adolescent emotional development	10.	What is the role and impact of empathy on adolescent emotional development?	UL
	adolescent empathy development	11.	What is the role of empathy in adolescents and the characteristics of its development?	UL
	importance of empathy skills	12.	How and why are empathy skills important in formal education?	UL
4.	visual and hearing impairments	13.	How to include people with visual and hearing impairments?	Inova+
	other impairments	14.	What impairments are not suitable to be included?	(Inova+)
5.	existing video materials	15.	What kind of video materials exist; descriptions for identifying video materials	Khora
	script ideas for filming			Khora

Table 2 Subcategories, research questions and responsible partner

For the purpose of the study we preliminary prepared the Excel document with inclusion and exclusion criteria, recommended keywords and web search for each category and subcategory.

The scientific articles of qualitative and quantitative studies were searched on online bases of articles: Scopus, PubMed, Google Scholar, PsycINFO, JSTOR, ProQuest, ERIC, EBSCOhost, ScienceDirect, IEEExplore (tech), Taylor & Francis Online, Whiley Online Library, SpringerLink.

The period from January 2013 to the present time, 2024, was selected for the collection of articles. For the subcategories: VR in formal education in general, VR and motivation to learn, and VR – impact on the brain, we chose a shorter period, starting from January 2017.

Other inclusion criteria were: language = English or other languages; peer-reviewed articles, participants=adolescents; year of article=2013/2017 and up; empirical research (case study, metanalysis, qualitative and quantitative studies).

Keywords for the search were defined for each subcategory separately.

The instruction for the partners was to find ten to twenty most relevant articles for each subcategory.

2.3. Literature review results

The literature review synthesizes existing research on several key topics: the use of immersive and non-immersive VR in formal educational settings, the significance of empathy as a crucial skill for personal development, and the effects of VR-based educational resources on emotional and cognitive empathy. Given that the goal of our project is to foster cognitive empathy in adolescents through VR-based education, a considerable portion of the reviewed literature is focused on the development of both emotional and cognitive empathy in adolescents. The results of the literature review thus begin with the importance of empathy in adolescent development, the specific developmental tasks during adolescence, and the impact of VR on adolescents and empathy development. Additionally, the review places special emphasis on the importance of equal access and inclusion for individuals with diverse abilities, including those with visual or hearing impairments and mental disabilities. Furthermore, it addresses the associated risks and ethical issues related to VR use in education, ensuring a comprehensive understanding of the potential challenges and considerations involved.

2.3.1. The role and impact of Empathy on self-development

Empathy as a Key Skill for Self-Development

Empathy is usually understood as the ability to understand another's emotions (Carey et al, 2017). Understanding and resonating with others' emotions, empathy plays a vital role in fostering successful social exchanges. Research indicates that empathy not only enhances comprehension but also serves as a catalyst for promoting acts of kindness and cooperation (Herrera et al, 2018).

In the psychological sciences, there is a distinction between two primary types of empathy—cognitive empathy and emotional empathy (Carey et al, 2017). Cognitive empathy refers to the capacity to empathize by understanding and acknowledging that people hold diverse beliefs and have undergone distinct life experiences. Affective empathy, distinct from cognitive empathy, involves experiencing a mutual emotional reaction with another person in response to an emotional trigger (Trudeau, 2023).

Understanding Cognitive Empathy in Adolescents: Neurodevelopmental Insights and Challenges

Cognitive empathy, defined as the ability to understand the intentions and experiences of others, is intricately linked to the development of cognitive abilities, which intensify during adolescence. This developmental phase enables individuals to behave in more socially appropriate ways and to recognize emotions more deeply, resulting in more complex forms of empathy compared to earlier ages.

Empathy itself is composed of two distinct components: an evolutionarily and developmentally older emotional component and a younger cognitive component. Yu and Chou (2018) describe a neurobiological model of the dual pathway of empathy, distinguishing between the so-called lower, less complex pathway, which characterizes emotional empathy, and the higher, more complex pathway, which describes cognitive empathy. These two pathways differ in speed, complexity, and level of awareness. Emotional empathy is understood as an emotional response to another's emotional state, with evidence from behavioral studies showing that even infants respond to the emotions of others. This is often explained by the role of mirror neurons, which are foundational for understanding an individual's empathic emotional connection to their environment.

On the other hand, cognitive empathy—the ability to understand other people's subjective mental states, perspectives, and intentions—is more complex and requires advanced cognitive functioning. It presupposes the development of cognitive abilities such as inhibition and executive functions, which do not fully emerge until after the first year of life (Onishi & Baillargeon, 2005). Adolescence is a period marked by significant

development in executive functions, which are the basis of metacognitive skills. As these capacities evolve, adolescents gain an increased ability to understand complex situations and plan actions more effectively (Ciccia, Meulenbroek, & Turkstra, 2009). Cognitive empathy is closely related to theory of mind and mentalization, with some scholars even treating these terms as synonymous.

Reflecting on the cognitive capacities of adolescents in the context of empathy, it becomes clear that these abilities are not merely peripheral but central to the formation of a more complex empathic response. Rieffe and Camodeca (2016) emphasize that a full empathic reaction requires an adolescent not only to possess the cognitive capacity to understand another's perspective but also to be motivated to focus on the well-being of others. Awareness of emotions and their significance for human functioning is crucial for this process.

Research into cognitive empathy also reveals intriguing differences in how adolescents recognize emotions, particularly in relation to the valence of those emotions. Mazza et al. (2014) conducted a study comparing the cognitive and emotional aspects of empathy between adolescents with autism spectrum disorder (ASD) and those in the general population. They found no differences between the two groups in recognizing emotions with positive valence on scales measuring emotional empathy. However, a deficit was identified in autistic adolescents in recognizing emotions with negative valence. When measuring cognitive empathy, autistic adolescents performed worse in recognizing both positive and negative emotions. These results align with findings of poorer social competence in individuals with ASD, where the ability to unpack negative emotions in others is key to adaptive social behavior.

Similarly, Rieffe and Camodeca (2016) found in their study of 182 adolescents aged 11-16 years that higher levels of empathy are characteristic of those adolescents who place importance on identifying emotions—both their own and those of others. This underscores the importance of cognitive capacities in the recognition and response to emotional cues, further highlighting the challenges and nuances in the development of cognitive empathy during adolescence.

Social-moral development and cognitive empathy

Khanjani et al. (2015) in their study compared cognitive empathy, emotional empathy, and social functioning of individuals in different age groups. They demonstrated a rise in both aspects of empathy among adults compared to adolescents and a decline in cognitive empathy and social functioning among the elderly.

That empathy-based prosocial behaviour is associated with higher empathy development is supported by Rieffe and Camodeca's (2016) research, where they also highlight the important but under-researched role of empathic distress. Young people confronted with peer violence take different positions in the social group (becoming the bully, being a bystander or coming to the aid of the victim). As expected, higher empathy is characteristic of individuals who resist violence. Young bystanders have a higher level of empathic distress compared to others, which the authors attribute to their lower ability to focus on events outside themselves (they are more focused on their own experience), but suggest that their inactivity is not related to a possible lower sense of social justice, but rather to the feeling of helplessness they experience when they do not know how to react. Bullies are characterised by lower cognitive as well as emotional empathy. In their study, Robinsons et al. (2007) compared young offenders with their peers during their sentence and, predictably, found evidence of lower levels of empathy. They highlighted the significant influence of the educational environment (family abuse, socio-economic status, quality of attachment, etc.) on youth offending, linked lower levels of empathy, and poorer emotional and socio-moral development to an unprivileged and abusive environment. The propensity to engage in prosocial behaviour changes during adolescence, as confirmed by Van der Graaf and colleagues (2018) in their longitudinal study, pointing to important gender differences. For boys, a typical increase in prosocial behaviour occurs between the ages of 14 and 17 and declines slightly thereafter, whereas for girls, an increase is observed up to the age of 16 and a slight decline after this age. Empathic concern was consistently associated with higher prosocial behaviour at all ages. The school environment (may) also play an important role in the development of empathy and prosocial behaviour (Barr and Higgins-D'Alessandro 2007).

Decety and Cowell (2014) highlight the complexity of the term empathy, and question how meaningful it is to combine "Emotional sharing (or affective arousal), empathic concern, and perspective taking" with the overarching notion of empathy, especially in the context of studying moral behaviour. Each of these concepts represents a distinct theoretical starting point, and in this respect the authors express concern that combining the concepts leads to over-generalisation and loss of meaning.

The role of empathy in adolescents

Empathy serves several crucial functions during adolescence, including:

1. *Connecting with Others:* Empathy fosters understanding and connection with peer groups and family members, which is essential for building and navigating relationships (Miklikowska et al., 2022; Rieffe & Camodeca, 2016).

2. *Conflict Resolution*: Empathy is a valuable tool in conflict resolution, allowing individuals to understand others' perspectives and emotions, thereby facilitating effective communication and negotiation (Van Lissa et al., 2014).
3. *Promoting Prosocial Behavior*: Adolescents with well-developed empathy are more likely to engage in acts of kindness and altruism, contributing to a positive and supportive community (Weisz et al., 2022).
4. *Enhancing Emotional Regulation*: Empathy helps adolescents recognize and understand their own emotions and those of others, leading to improved emotional regulation and coping mechanisms (Price & Macdonald, 2019; Sagura et al., 2020).
5. *Improving Communication*: Empathy allows adolescents to attune to the emotions underlying verbal and nonverbal cues, facilitating more accurate and compassionate communication (Allemand et al., 2015).

2.3.2. Developmental Characteristics of Empathy in Adolescents

Empathy in Adolescence: Cognitive and Affective Growth Through a Complex Developmental Phase

The development of empathy during adolescence is a complex and multifaceted process involving emotional, cognitive, and behavioural components. During adolescence, the development of empathy undergoes significant changes and plays a crucial role in shaping social interactions and prosocial behaviour. Research suggests that empathy tends to increase from childhood to adolescence (Allemand et al., 2015) and further into adulthood (Kim et al., 2020). Sex differences in the maturation of neural networks and emotional responses emerge early and influence the development of empathy (Decety & Svetlova, 2012).

Adolescence, characterised by emotional and regulatory processes (Gross, 2015), becomes a focal point for the study of empathic development. Early adolescence is considered a critical period for empathic growth (van Lissa et al., 2014), and the development of emotion regulation during this phase influences empathic responses (Cole & Jacobs, 2018). While some propose a linear increase in empathy from early to late adolescence, others suggest a peak in mid to late adolescence, followed by a slight down-regulation (Bailen et al., 2019). However, the literature presents different perspectives on changes in empathy during adolescence, with limited attention compared to earlier

life stages. There is evidence of more intense negative emotions and reduced positive emotions in adolescents compared to adults (Kim, 2020).

The pathway of empathy development from early adolescence to adulthood remains incompletely described, with research gaps in understanding the contribution of empathy to emotion processing skills and the role of environmental influences (Silke, 2018). There are internal (biological, cognitive) and external (social and environmental) factors that shape empathy during adolescence.

Research by Decety and Svetlova (2012) examined gender differences in the maturation of neural networks and emotional responses during adolescence, revealing early influences on empathic tendencies. Research (Gaspar & Esteves, 2022; Van Hoorn et al., 2016) suggests subtle sex differences in the development of cognitive (and emotional) empathy. While both boys and girls generally experience growth in empathetic skills, girls often show slightly earlier and more advanced development of cognitive empathy during adolescence. In girls, cognitive empathy begins to increase from the age of 13. Affective empathy remains relatively high and stable throughout adolescence. In boys, cognitive empathy starts to increase from the age of 15. There is a temporary decline in affective empathy between the ages of 13 and 16, but this recovers in the late teens. The decline in affective empathy in young teenage boys may be partly related to an increase in testosterone levels at the same time. This rise in testosterone levels is associated with a desire for dominance and power over others, and it is not hard to see that these interests will often conflict with the ability to show compassion and understanding towards others. So while they may be beginning to develop cognitive empathy skills and theoretically be able to put themselves in someone else's shoes, they may find it difficult to act on this, especially in group situations. These findings highlight the dynamic and gendered nature of empathy development during adolescence and shed light on the nuanced timeline of cognitive and affective empathy maturation (Van der Graaff et al., 2014).

Adolescence is characterised by significant neurobiological changes, particularly in the prefrontal cortex. This brain region, associated with higher-order cognitive functions including perspective-taking and understanding the mental states of others, matures during adolescence and contributes to the development of cognitive empathy (Blakemore, 2008). Adolescents experience cognitive advances such as improved abstract thinking and metacognition. These developments enhance their ability to understand and consider multiple perspectives, a crucial component of cognitive empathy (Dumontheil, 2014).

Influences on Empathy Development

Several factors influence the development of empathy during adolescence, including:

1. *Biological and Cognitive Changes*: The maturation of the prefrontal cortex and other brain regions contributes to the development of cognitive empathy (Blakemore, 2008; Dumontheil, 2014).
2. *Social Experiences and Learning*: Adolescents' increasingly sophisticated social interactions provide opportunities to observe and learn about the thoughts and perspectives of others (Dvash & Shamay-Tsoory, 2014).
3. *Peer Relationships*: Interactions with peers play a crucial role in developing cognitive empathy, as adolescents navigate social dynamics and learn perspective-taking skills (Van Hoorn et al., 2016).
4. *Family Environment*: Parental modeling, communication, and support significantly influence the development of cognitive empathy (Decety & Michalska, 2010; Van Heel et al., 2020).
5. *Educational Practices*: School environments and educational programs that promote perspective-taking and understanding others' feelings can enhance adolescents' cognitive empathy skills (Jolliffe & Farrington, 2006).
6. *Media Exposure*: Exposure to diverse perspectives, emotional nuances, and complex characters in media can positively contribute to the development of cognitive empathy (Konrath et al., 2011).
7. *Cultural and Societal Influences*: Cultural contexts shape the emphasis placed on understanding others' perspectives, contributing to individual differences in cognitive empathy (Quesque, 2022).

2.3.3. The Importance of Empathic Skills in Education

Enhancing Academic Success and Well-being

Empathy has an impact on learning both cognitively and affectively (Bostic, 2014). Empathy skills are crucial in formal education with adolescents, as they enhance engagement, motivation, and moral development (Ghasemian, 2017). They also play a significant role in creating positive interactions, supportive classroom climates, and student-centered practices, particularly in culturally diverse settings (Martinson, 2023). Furthermore, empathic accuracy is associated with better peer relations and adjustment in adolescents (He, 2023). Therefore, empathy skills are important in formal education

with adolescents as they contribute to their social and emotional development, as well as their academic success.

The development of empathy in adolescents is crucial for their communication skills, behaviour, and personal growth (Maystrenko, 2016). Empathy and social responsibility are particularly important in the face of academic pressure and societal challenges (Vadeyar, 2015). The role of parents and teachers in fostering empathy is significant, as they serve as role models for adolescents (Dewi, 2020). Empathy is also linked to social competence, with emotional perspective-taking being a key factor (Hirn, 2018). Therefore, the empathy skills of adolescents are important in formal education as they contribute to their personal and social development, and can be nurtured through effective parenting and teaching.

A range of studies have highlighted the importance of empathy skills in adolescents' formal education. Boele (2019) found a positive correlation between empathy and relationship quality. Empathy, recognized as a vital life skill, particularly for adolescents, plays a multifaceted role in enhancing their engagement, motivation, moral development, and pro-social behaviour, and is important in formal education. Moreover, empirical evidence indicates a significant correlation between life skills training and the enhancement of empathetic understanding and performance among adolescents. Through programs like life skills training implemented in schools, not only can caring communities be fostered, but communication and interpersonal skills can also be enriched, self-awareness can be heightened, and adolescents can be empowered to develop empathy for others, thereby contributing to their holistic development and societal well-being (Ghasemian, 2017). Additionally, the cognitive and emotional empathy of adolescents have a notable impact on psychological well-being through their expression of altruistic behaviour. These findings underscore the significance of empathy not only in aiding others but also in facilitating one's own psychological adaptation and well-being. They suggest that efforts aimed at understanding and empathizing with others are meaningful for enhancing the happiness of ordinary adolescents, especially within educational environments characterized by intense competition and diminished happiness (Yoo and Han, 2024). Furthermore, emotional intelligence stands as a pivotal element influencing the social and mental well-being of students. It aids in the regulation and management of their emotions, facilitating a better understanding of their surroundings and enabling sound decision-making amidst daily classroom stressors. This highlights the necessity for continuous and progressive development of emotional intelligence through educational institutions (Molero et al., 2020). Moreover, the emotions that learners experience in technology-rich learning settings play a crucial role in their cognitive and affective learning advancements (Lajoie et al., 2019).

For example, the use of drama in education has the power to evoke emotions and stimulate thoughts within the school classroom. The study (Mardas and Magos, 2020) sought to explore the impact of Educational Drama on the empathy of middle adolescents, indicating that drama can facilitate participants' comprehension of social situations and the distinction between cognitive and emotional empathy. Additionally, Mardas and Magos (2020), uncovered that middle adolescents already possess a well-developed capacity for cognitive empathy.

The Importance of Empathic Skills for Peer Relationships in School

Empathy holds pivotal significance in fostering favourable peer engagements throughout the phases of childhood and adolescence (Wu, 2023)

Empathizing with peers not only impacts the dynamics within the classroom team but also significantly influences the learning journey of every individual student. The findings indicated that cognitive empathy correlated with affective empathy, which, in turn, was associated with higher levels of study engagement and lower levels of cynicism and feelings of inadequacy. (Tikkanen et al., 2022)

Furthermore, the results revealed that assessing both one's own emotions and those of others, as well as engaging in more defending behaviours, were linked to both affective and cognitive empathy. Conversely, facets of emotion awareness associated with internalizing symptoms were connected to empathic distress, indicating maladaptive emotion appraisal. Additionally, outsider behaviour correlated with empathic distress, highlighting a self-centered perspective. On the other hand, increased instances of bullying were inversely related to cognitive empathy. Overall, these findings underscore the significance of emotion awareness in fostering adaptive empathic responses, while suggesting that emotion dysregulation may lead to distress when witnessing others' negative emotions, independent of social roles (Rieffe, Carolien & Camodeca, 2016).

Adolescents who possess greater empathic accuracy, and have cultivated empathy tend to encounter fewer adjustment issues, highlighting the significance of this skill in peer interactions and overall adaptation (He, 2023) can achieve quicker understanding in communication, leading to a more harmonious adaptation to society (Novic, 2014).

The Role of Teachers in Fostering Empathy

It is important to stress, that empathy is a crucial skill for educators to facilitate the creation of a positive learning environment with students, as it is defined in standards frameworks worldwide. This complex skill encompasses elements of experience, sharing, mind perception, and mentalization (Swan and Riley, 2015).

Research suggests that teachers play a crucial role in fostering cognitive empathy skills in adolescents. Vandenbroucke (2018) emphasizes the importance of teacher-student interactions in promoting executive functions, which are closely linked to empathy. Chan (2021) highlight the effectiveness of mindfulness and experiential learning programs, respectively, in enhancing empathy and other socioemotional competencies.

In the classroom, empathy can support deep learning and engagement (Wynn et al., 2023).

These findings collectively suggest that teachers can foster cognitive empathy skills in adolescents through positive interactions, mindfulness practices, experiential learning, and social and emotional learning programs.

Empathy plays a multifaceted role in enhancing engagement, motivation, moral development, and pro-social behaviour among students, contributing to the creation of positive classroom environments and student-centered practices. Furthermore, the influence of empathy extends beyond the classroom, shaping peer relationships, adjustment, and overall well-being among adolescents. Studies have highlighted the importance of empathy skills not only for educators but also for students' socioemotional development and academic success. Teachers, in particular, play a crucial role in fostering cognitive empathy skills through positive interactions, mindfulness practices, experiential learning, and social and emotional learning programs. Cultivating empathy in education is essential for creating supportive learning environments and promoting holistic student development.

2.3.4. Adolescent Neurocognitive Growth and the Role of VR in Shaping Empathy

Neurocognitive development in adolescence and VR

Virtual reality (VR) has been coined as the "ultimate empathy machine" due to its capacity to enable individuals to immerse themselves in experiences from the perspective of another person. This interest in VR as a tool for fostering empathy has resulted in a rise in the creation of Immersive Virtual Environments (IVEs) specifically aimed at enhancing empathy. Conventional tasks involving taking on different perspectives have been widely utilized in research and have proven to be effective in heightening the empathy individuals feel towards particular social targets (Herrera et al, 2018).

Neurocognitive development is a complex process, with executive functions, verbal memory, and visuospatial performance showing ongoing development (Korkman et al., 2013). Neurocognitive development in adolescence refers to the maturation and

refinement of cognitive functions, including attention, memory, executive functions, and decision-making abilities, that occur during the teenage years. This period is characterized by significant changes in the structure and functioning of the brain, particularly in regions associated with higher-order thinking and emotional regulation, such as the prefrontal cortex and limbic system (Blakemore & Choudhury, 2006). Understanding the specific vulnerabilities associated with these conditions can help identify potential intervention targets and optimal developmental epochs for intervention.

Model learning in adolescence

Adolescent learning is a complex process influenced by various factors. Researchers (Eckstein et al., 2022; Master et al., 2020) explore the cognitive aspects of adolescent learning, with the former suggesting that adolescents are uniquely adapted to uncertain environments and the latter demonstrating the role of reinforcement learning and working memory in learning during this period. These studies collectively underscore the multifaceted nature of adolescent learning, encompassing cognitive, social, and emotional dimensions.

Adolescents demonstrate unique advantages in learning, particularly in uncertain and probabilistic environments (Eckstein et al., 2022; Xia et al., 2021). This is attributed to their optimal processing of negative outcomes and mental models, as well as their ability to navigate volatile and uncertain environments (Eckstein et al., 2022). Furthermore, their learning performance is influenced by an increase in learning rate and a decrease in exploratory choices, with salivary testosterone levels positively related to learning rates in mid-adolescence (Xia et al., 2021). These findings collectively suggest that adolescence is a critical period for the development of learning and decision-making processes.

Task learning in adolescence

Research on task learning in adolescence has revealed several key findings. Knoll (Knoll et al., 2016) highlighted the importance of late adolescence for cognitive training, with greater improvement in certain skills during this period. Prater (Prater et al., 1991) demonstrated that self-monitoring of on-task behaviour can be effective for adolescents with learning disabilities. Finally, Andersson and Bergman (2011) found that task persistence in young adolescence is a significant predictor of educational and occupational attainment in middle adulthood. These studies collectively underscore the importance of task values, cognitive training, self-monitoring, and task persistence in adolescent learning and development. Gender differences also play a role, with girls outperforming boys in information processing efficiency (Dekker et al., 2013).

Perception in adolescence

Adolescents' perception of themselves and their environment is influenced by various factors. Alipieva (2020) highlights the role of academic success in shaping adolescents' self-esteem and future plans. Guerrero (2017) emphasizes the importance of interpersonal relationships, particularly with family and peers, in the construction of personal identity. Zhedunova (2021) discusses the challenges adolescents face in fully comprehending texts, suggesting the need for the development of decentration skills. Ogwo (2013) explores the differences in perception of parent-adolescent relationships between younger and older adolescents, with younger adolescents generally having a more positive view. These studies collectively underscore the complex interplay of academic, social, and cognitive factors in shaping adolescents' perceptions.

Memory in adolescence

Adolescence is a critical period for memory development, with specific factors influencing memory function. Overgeneral autobiographical memory and rumination are vulnerability factors for depressive symptoms in adolescence, particularly in girls (Hamlat et al., 2015). Reese and Robertson (2019) highlighted the role of maternal reminiscing in shaping the age of adolescents' earliest memories, with elaborative reminiscing leading to earlier recall. Altgassen (Altgassen et al., 2014) identified theory of mind and executive control processes, particularly switching, as predictors of prospective memory performance in adolescents. Lastly, chronic stress during adolescence can have both positive and negative effects on learning and memory in adulthood, with enhanced reversal learning but increased vulnerability in working memory (Chaby et al., 2015). These studies collectively underscore the complex interplay of biological, cognitive, and environmental factors in shaping memory function during adolescence.

High-level cognition in adolescence

Adolescence is a critical period for the development of high-level cognitive functions, including cognitive control, social cognition, and problem-solving skills (Dumontheil, 2016; Greiff et al., 2015). These skills are influenced by factors such as working memory and fluid reasoning, which are strong predictors of complex problem solving (Greiff et al., 2015). The refinement and sophistication of social cognitive processes also occur during this period, with adolescents becoming increasingly aware of their social worlds and developing skills to navigate them. However, the ability of adolescents to adjust their cognitive effort according to the value of the outcome may be constrained by the ongoing maturation of corticostriatal connectivity (Insel et al., 2017).

Motivation in adolescence

Adolescent motivation is a complex and multifaceted construct, influenced by various factors such as self-efficacy, sociocultural contexts, and peer norms in shaping academic motivation (Pajares, 2007). Further research highlights the impact of heightened reward sensitivity on risk-taking, learning, and cognitive control in adolescents (van Duijvenvoorde et al., 2016) and emphasizes the role of self-perception and the need for autonomy, competence, and relatedness in shaping adolescents' achievement motivation (Rani & Reddy, 2019). Naik (2021) further explores the influence of gender, type of management, and locality on achievement motivation, finding that males and urban students tend to have higher achievement motivation. These studies collectively underscore the need for a comprehensive understanding of adolescent motivation, taking into account individual, social, and environmental factors.

The Role of Virtual Reality in Adolescent Neurocognitive Development and Empathy Enhancement

Neurocognitive development in adolescence encompasses the refinement of cognitive functions such as attention, memory, and decision-making abilities, influenced by ongoing changes in brain structure and functioning.

Recent advancements in virtual reality (VR) technology have opened up new possibilities for research in cognitive neuroscience, particularly in the study of adolescence. VR has been found to be a useful tool in creating controlled environments for studying brain processes (Rey & Alcañiz, 2011). However, the implementation of VR in cognitive neuroscience requires careful consideration of the technology's potential adverse effects (Kourtesis et al., 2019). To address this, researchers provide guidelines for the development of VR software, emphasizing the importance of user experience and the mitigation of adverse symptoms (Kourtesis et al., 2020). Furthermore, the use of new generation VR head-mounted displays, particularly those with ergonomic interactions, has been found to significantly reduce adverse symptoms and dropouts in neuroscientific studies (Kourtesis et al., 2020). These findings underscore the potential of VR in cognitive neuroscience, particularly in the assessment and treatment of adolescent psychiatric disorders.

Recent studies have explored the potential of VR to enhance empathy in adolescents, as when combined with machine learning, adolescents can effectively discriminate between different dimensions of empathy (Vargas et al., 2022) and VR experiences can lead to greater engagement and empathy, particularly when the content is emotionally evocative (Schutte & Stilinović, 2017). However, further research cautioned that while VR can increase emotional empathy, it may not necessarily improve cognitive empathy

(Martingano et al., 2021). Barbot and Kaufman (2020) added to this by suggesting that the effectiveness of VR in enhancing empathy may be influenced by the user's experience, particularly the sense of body ownership and agency within the virtual environment. These findings collectively suggest that while VR has the potential to enhance empathy in adolescents, the design and content of the VR experience are crucial factors to consider.

Recent research indicates that adolescents exhibit proficiency in uncertain learning environments and show enhancements in task learning and memory function. Investigations into VR have highlighted its potential to bolster empathy among adolescents.

Exploring the Impact of Virtual Reality on Empathy: Insights from Recent Research

Virtual reality (VR) is known to be an effective intervention for promoting empathy. A prior meta-analysis by Martingano et al. (2021) found that VR use promoted emotional empathy but not cognitive empathy, meaning that it may promote feelings of compassion but not perspective-taking. Based on this, we can conclude that emotional empathy requires different mechanisms than cognitive empathy. It seems that emotional empathy can be evoked automatically, whereas cognitive empathy requires more effort, such as using one's imagination to create the experiences of others. Based on these findings, we are interested in what the effect of VR is on cognitive empathy in adolescents. To find the answer, we did a literature review based on 12 recent articles.

In a scoping review conducted by Tay et al. (2023) wanted to evaluate the effectiveness of VR interventions in improving knowledge, attitudes, empathy, and stigma regarding people with mental illness. They found that absolutely all studies (N = 7) that examined the improvement of empathy in relation to people with mental illness demonstrated the effectiveness of VR interventions.

Somewhat different conclusions were reached by Walewijns et al. (2023), who studied the extent to which different types of videos are associated with empathy and the intention to donate among young people at the transition to adulthood (18-25 years). Participants were exposed to three different conditions, namely classic video, 360° video and VR. The results of the study showed that participants scored significantly higher on empathy in the VR condition compared to the classic video condition, while the difference with the 360° video was significant. Also, participants exposed to VR had the highest donation intention. At the same time, it should be noted that in this case it was only an intention and not an actual donation.

Emotional empathy is one of the components of intercultural sensitivity. A study by Li et al. (2022) investigates the use of virtual reality (VR) exposure to improve intercultural

sensitivity. The results showed that the cross-cultural sensitivity of the VR group was significantly increased in both within-subject and between-subject comparisons. They also showed that there were no significant differences in cross-cultural sensitivity between the VR group and the video group immediately after exposure, but the VR group maintained the improvement better at three weeks after exposure. The final finding of the study, however, is that sense of presence and emotional empathy were good predictors of change in intercultural sensitivity of the VR group.

The effectiveness of virtual reality (VR) in eliciting empathy lies in the fact that VR offers the possibility for people to take on the perspective of other persons. A study by Bacca-Acosta et al. (2023) sought to identify predictors of empathy in VR experiences. The model explained 44.8% of the variance in emotional empathy as a result of the positive influence of compassion (medium effect size) and attitude towards migrants (small effect size) and 36.8% of the variance in cognitive empathy as a result of the positive influence of engagement, attitude towards migrants, compassion and depth (small effect size for all). The authors explain that the less well-explained cognitive empathy may be the result of the participants being passive users of VR and not being embodied in the migrants, making perspective-taking more difficult.

A study by Martingano et al. (2022) studied the effect of VR, namely 360° videos, on emotional and cognitive empathy. The researchers sought to create strict experimental conditions, which is a major advantage of this study. The results showed that both experimental conditions statistically significantly increased the emotional empathy of adults compared to the control groups. In contrast, the results suggest that VR does not have a unique benefit for increasing cognitive empathy, even when participants were instructed to take perspective. At the same time, the researchers also studied how prosocial behavior in the form of donating actually manifests itself in the participants. The results showed an interesting finding that none of the conditions significantly increased the likelihood of giving.

VR has been identified as one of the most promising resources for developing empathy towards stigmatized groups, as it allows individuals to experience a situation close to reality from another person's perspective. A quasi-experimental study by Marques et al. (2022) studied the effect of a VR simulation while performing a cognitive task on empathy and attitudes towards people with a diagnosis of schizophrenia compared to watching a 2D video. They wanted to find out how the VR experience can reduce the stigma towards people diagnosed with schizophrenia. The average age of the participants was 21.8 years. Both interventions achieved higher levels of empathy and improved attitudes toward people diagnosed with schizophrenia, but a statistically significant effect on empathy occurred only in the control group, while attitudes toward people diagnosed with

schizophrenia increased statistically significantly in both the control and experimental groups. Regarding cognitive empathy, there was a statistical difference between before and after the test only in the control group. The results suggest that not only VR but also 2D videos can be effective strategies for increasing empathy and improving attitudes towards people with schizophrenia.

Traditional perspective-taking can pose a more difficult cognitive task for individuals, so Wang et al. (2022) used VR to try to facilitate tasking for participants. VR offers a tangible experience, so perspective-taking requires less cognitive effort. The hypothesis that they proposed that students would have more positive attitudes towards the homeless after being exposed to VR from a first-person perspective, compared to their initial attitudes towards the target group, was thus confirmed, leading to the conclusions that VR can promote perspective-taking.

Trudeau et al. (2023) used cinematic virtual reality (CVR) to examine the effects of VR on the empathic responses of adolescents (12-13 years). While the experimental group was exposed to the CVR, the control group watched the same footage in the form of a 2D movie. The results showed that adolescents who watched the CVR film experienced a statistically significant increase in cognitive empathy (medium effect size), while participants who watched the 2D film did not. Also, the effect of increasing cognitive empathy appeared only in male adolescents, but not in females. For emotional empathy, both film formats had a significant effect, with an increase in emotional empathy, with Cohen's *d* indicating a small effect size for 2D film and a medium effect size for CVR. Here, too, a large effect occurred only in males, while there was no significant effect in females. The results suggest that men have a stronger emotional response when experiencing VR.

The study compared affective and cognitive mediators underlying the effect of virtual reality perspective-taking (VRPT) on immigrant outgroup prejudice (Chen & Ibasco, 2023). Participants (adults between 19 and 33 years old) were divided into two conditions: VR with people who often receive stereotypical treatment (out-group), and VR with people who usually do not receive stereotypical treatment in this environment (in-group). It was found that VRPT in the out-group condition, compared to VRPT in the in-group, contributes to improving attitudes and reducing negative stereotypes towards the out-group of immigrants. Perspective taking can trigger the emotional experience of experiencing another's problems as if they were one's own. In the models, empathy had a significant mediating effect, while situational attributions did not reach a significant effect.

2.3.5. The Use of VR-Based Resources in Formal Education

The use of VR for empathy training can be particularly beneficial in educational settings, where many students lack social-emotional skills and become disengaged as they progress through school (Bertrand et al, 2018). Immersion within VR gives users the sensation of being transported to alternate spaces through computer-generated environments that replicate visual, auditory, and other sensory experiences akin to real-life situations. Utilizing VR within educational settings opens doors to providing learners with experiences that might otherwise be too hazardous or outside the realm of possibility. (Trudeau, 2023).

Integration of VR and AR Technologies in Educational Settings

Most research fortifies that the utilization of VR and AR technologies produces a huge impact when incorporated into educational settings. Hence, when combined, the implication of the immersive experience dramatically enhances the learning experience, and the source of the history and Social Science academic discipline proves as a case. Moreover, students' virtual field trips with VR applications are an example of clearly illustrated historical contexts. The students get a chance to learn more, which ultimately boosts their morale and interest while aiding them to understand much more complex facts in-depth.

Efficacy in Enhancing Learning Outcomes

VR and Augmented Reality (AR) technologies have demonstrated a significant potential to improve learning outcomes by making complex concepts more tangible and engaging. Research conducted in multiple educational settings have found that such technologies promote a higher level of understanding, particularly for material requiring conceptualization based on images or interaction. For example, immersion in the scientific or historical environment makes abstract concepts more real and hence easier to remember and to understand (Remolar, Rebollo, & Fernández-Moyano, 2021). This effect is rooted in the nature of the immersion, as VR and AR grant students an opportunity to take part in the events and processes occurring before their eyes, as opposed to reading about them theoretically (Zulfiqar et al., 2023).

Enhancing Student Motivation and Engagement

The novelty and interactivity of VR and AR technologies have a substantial impact on student motivation. Studies consistently show that the immersive nature of VR captures students' attention and significantly increases their motivation to learn. This heightened

engagement stems from the technologies' ability to present learning in a novel, interactive manner, which contrasts with traditional educational methods (Holstein, McLaren, & Alevan, 2018; Sun, Ye, Yu, & Chiu, 2023). When students encounter new and innovative approaches, their involvement and enthusiasm naturally increase, fostering a positive attitude toward learning and enhancing perseverance (Fowler, 2015).

The analysis of empirical studies consistently highlights the high influence of VR and AR on student motivation. A majority of the studies reviewed emphasize that the immersive quality of VR not only grabs students' attention but also significantly boosts their enthusiasm for learning (Remolar, Rebollo, & Fernández-Moyano, 2021; Serrano-Ausejo & Mårell-Olsson, 2023). This increased engagement is particularly evident when students are exposed to materially new and innovative approaches, which enhance their involvement and positively affect their attitudes toward education (Zulfiqar et al., 2023; Sun et al., 2023).

Pedagogical Integration and Skills Development

Integrating VR and AR into education requires careful consideration of their compatibility with existing curricular objectives, teaching strategies, and methodologies. These technologies should complement, not replace, traditional tools, enhancing the learning experience without disrupting established educational practices (Fowler, 2015). VR and AR also offer unique opportunities for experiential learning, critical for developing skills such as critical thinking, problem-solving, and other complementary abilities. Simulated environments enable students to practice and hone skills that may not be feasible in real-world settings, providing a transformative educational experience (Babu, Krishna, Unnikrishnan, & Bhavani, 2018).

Accessibility and Inclusivity

Despite their potential, VR and AR technologies also present challenges related to accessibility and inclusivity, particularly for students with disabilities (Graeske & Sjöberg, 2021). You can find more on this topic in a later subsection (2.3.6.). It is essential to develop VR and AR experiences that accommodate various learning styles and make these resources universally available. Accessible design practices are crucial to ensure that all learners, regardless of their abilities, can benefit from these advanced educational tools (Almufarreh & Arshad, 2023). Addressing the digital divide and ensuring that VR

and AR tools are inclusive and accessible will be critical in realizing their full educational potential (Serrano-Ausejo & Mårell-Olsson, 2023).

Fostering Interactive and Immersive Learning Environments

VR's immersive quality is central to its ability to foster interactive learning environments. Studies indicate that this immersion increases students' interest and understanding, particularly in subjects that benefit from realistic simulations (Fransson, Holmberg, & Westelius, 2020). By recreating real-world scenarios and providing tangible conditions for learning, VR helps students grasp complex topics more effectively, leading to improved academic performance and a higher quality of education (Huang, 2022; Remolar, Rebollo, & Fernández-Moyano, 2021).

Implications for Instructional Design and Future Educational Practices

The integration of VR and AR technologies into educational practices requires thoughtful instructional design. The development of VR-integrated curricula and the adoption of new teaching methodologies can optimize learning experiences and outcomes (Collins, Regenbrecht, & Lanalotz, 2018). As educational technologies evolve, ongoing research and innovation will be essential to maximize the benefits of VR and AR. Educators must consider the readiness and planning required for successful integration, ensuring that these technologies enhance, rather than disrupt, traditional educational practices (Alam & Mohanty, 2023).

Conclusion

The use of VR and AR in education represents a promising path for improving teaching and learning, particularly in disciplines such as History and Social Sciences (Remolar et al., 2021). The empirical evidence reviewed underscores the transformative potential of these technologies in creating immersive, engaging, and efficient learning environments (Rueda, Godínes, & Rudman, 2018). However, the successful implementation of VR and AR in education depends on addressing challenges related to pedagogical integration, accessibility, and inclusivity (Sun, Ye, Yu, & Chiu, 2023). As educational practices continue to evolve, VR and AR offer valuable tools for creating more interactive, effective, and equitable learning conditions, enriching the educational landscape for all students.

2.3.6. Including People with Different Abilities in VR-based Education

Despite the bright prospects for education, VR and AR technologies also include a range of accessibility and inclusivity problems, notably for people with disabilities. The most critical point is the importance of accessible design practices to enable VR and AR in education to be beneficial for multiple categories of learners (Chițu et al., 2023). In light of a significant digital gap, it is crucial to use the principles of developing VR and AR experiences and tools that consider various learning styles and make these resources universally available (Fernandes et al., 2023).

According to UNICEF, at least 93 million children with disabilities “are one of the most marginalized and excluded groups in society and they suffer from discrimination with regard to access to education.” It is not easy to provide the right education for children with disabilities, as they face specific barriers, and have access to limited social and economic opportunities (Jones et al., 2014).

In the literature review, we dedicated a specific subcategory to examining the latest literature on inclusive digital education to ensure equality for all students. We divided it into two parts: Equal Access to Education for Children with Visual or Hearing Impairments and Equal Access to Education for Children with Autism, ADHD, and Other Mental Disabilities. Both types of impairments involve different aspects that require attention to ensure inclusiveness for all students (Quintero et al., 2019).

Equal Access to Education for Children with Visual or Hearing Impairments

Literature reviews have shown that the use of accessible digital technologies contributes to the inclusiveness of the teaching-learning process for people who have hearing impairments. Digital technologies promote the expansion of the reading, writing, and drawing skills of these individuals. In addition, they contribute to their autonomy and social inclusion (Fernandes et al., 2023).

In the reviewed studies, the use of VR technologies in education for individuals with hearing impairments was examined, revealing both advantages and disadvantages. The main advantages reported include improvements in the learning process and increased

interest in activities. For instance, a significant increase in sign language learning when using an AR mobile application compared to traditional methods (Fernandes et al., 2023). Similarly, enhanced academic performance in Architecture and Construction Sciences courses with the integration of VR was noted (Lorenzo et al., 2016). However, some disadvantages were also reported, with discomfort when using head-mounted displays being the most cited. Other challenges included initial difficulty in understanding VR images, software handling issues, and the requirement for sophisticated devices. Despite these challenges, the use of VR technologies holds promise in enhancing education for individuals with hearing impairments, offering opportunities for improved learning experiences and engagement (Jones et al., 2014).

The importance and usefulness of VR-based education for children with visual impairments are highlighted through various studies examining its application in this context. In the analysed research, VR was found to be particularly beneficial in Sign Language Literacy. Additionally, VR was utilized in Mathematics, Science, Human Anatomy, and Architecture, albeit to a lesser extent (Chițu et al., 2023).

A notable advantage of VR-based education for children with visual impairments is its ability to provide immersive learning experiences. Marker-based solutions were commonly employed, offering accessible options such as printed markers like images, text, or QR codes. These solutions are easier for teachers to implement, especially in regions with limited resources (Lorenzo et al., 2016).

An exemplary case of VR's effectiveness in Sign Language teaching was demonstrated by Atanan et al. (2017), where a Sign Language classroom equipped with smartphones and QR code markers facilitated learning. The VR app displayed relevant information when markers were scanned, enhancing understanding of various topics. The systematic review also highlighted the benefits of VR in educational activities for children with visual impairments, including improvements in writing, reading, communication, social relations, and personal motivation (Jones et al., 2014).

Another successful application of VR involved creating books with AR markers, benefiting both Sign Language and Mathematics education. Some articles have described the creation of AR books with image markers to facilitate basic mathematical skills acquisition among children with visual impairments. Their research demonstrated that

utilizing VR books and smartphone apps effectively supported children with visual impairments in achieving basic math skills (Chițu et al., 2023).

In conclusion, VR-based education offers significant potential for children with visual impairments by providing immersive and accessible learning experiences across various subjects, including Sign Language and Mathematics. By leveraging VR technology, educators can enhance the educational outcomes and overall learning experiences of children with visual impairments (Jones et al., 2014).

Equal Access to Education for Children with Autism, ADHD, and Other Mental Disabilities

The importance and usefulness of VR-based education for children with mental disabilities, such as Autism and Attention deficit hyperactivity disorder (ADHD), are underscored by several key factors highlighted in the provided texts (Bradley & Newbutt, 2018).

Firstly, traditional methods and learning tools may not always effectively cater to the needs of children with disabilities. VR offers a novel approach that can facilitate the learning process by providing immersive experiences tailored to the unique requirements of these children (Ip et al., 2018). Specialists emphasize the importance of adapting educational methods to better align with the realities of children with disabilities, acknowledging their distinct perspectives and learning styles (Didehbani et al., 2016).

Moreover, VR can offer invaluable benefits in education for children with intellectual disabilities who may struggle with real-world interactions. By providing immersive experiences and user interaction within virtual environments, VR enables these children to engage with abstract concepts and scenarios that may be challenging to replicate in real life due to various constraints (Ip et al., 2018). For instance, children with autism can benefit from the authenticity and realism offered by VR, enhancing their learning and perception processes and enabling the acquisition of real-world skills. Video modeling through VR can also enhance the involvement of children with different intellectual and developmental disabilities, offering a controlled environment for learning and skill development (Lorenzo et al., 2016).

The proposed applications of VR span various fields, including mathematics, geography, biology, hygiene, and adaptation to daily life situations. These applications leverage VR's ability to provide visual aids, simulate real-world phenomena, and create immersive learning experiences tailored to the specific needs of children with disabilities (Chițu et al., 2023). From exploring geometric figures in space to understanding the water cycle in nature, VR offers a versatile platform for engaging and educating children with disabilities across different subjects (Didehbani et al., 2016).

However, it's essential to consider the unique needs and challenges of children with specific disabilities when implementing VR technology. Concerns such as epilepsy, claustrophobia, photosensitivity, and coordination issues must be addressed to ensure the safety and suitability of VR experiences for these children (Bradley & Newbutt, 2018). While VR may not be suitable for all children with disabilities, experts agree that it can serve as a valuable complementary tool in the teaching process, offering concrete and intuitive learning experiences tailored to their individual needs (Ip et al., 2018).

In conclusion, VR-based education holds significant promise for children with mental disabilities, offering immersive, engaging, and tailored learning experiences that can enhance their educational outcomes and overall well-being. By leveraging the unique capabilities of VR technology, educators can provide inclusive and effective learning environments that cater to the diverse needs of children with disabilities (Lorenzo et al., 2016).

2.3.7. Quality assurance

Exploring the Benefits and Risks of Virtual Reality for Cognitive and Emotional Development in Adolescents

The adoption of Virtual Reality (VR) in formal education heralds a transformative era in teaching and learning, providing immersive environments that can significantly enhance student engagement and understanding. However, as VR gains traction in educational settings, it also brings forth a range of ethical concerns that require careful consideration and management.

Adolescence as the period of rapid brain growth and integration is especially vulnerable to quality of learning experiences from emotional and cognitive points of view. The

integration of the adolescent brain is visible in the development of cognitive empathy, the ability to consciously understand emotions and behaviour. Winters (2021) defines empathy as the capacity to understand and share others' emotions that can occur through cognitive and affective components which are different conceptually, behaviourally, and in the brain.

For neurotypical adolescents, however, the most frequently raised issue is the negative impact of excessive use of VR for gaming purposes and the various unpleasant effects of VR goggles, such as nausea, dizziness and, for younger children, the difficulty in separating real memories from memories acquired through virtual experiences. It is these effects that require the most care in planning the production of materials for the pedagogical use of VR technology, as well as the timing and clearly defined placement of the use of VR goggles within the curriculum.

On the other hand, studies have shown that the virtual environment can produce different cortical activation patterns when considering inter-hemispheric analysis. This highlights a greater potential for activation in the right hemisphere, which is the part of the brain involved in emotional empathy (de Olivera et al., 2018). The integration of the adolescent brain is evident in the development of cognitive empathy, which is the ability to consciously understand emotions and behaviour (Winters et al., 2021). Cognitive empathy is associated with the default mode and frontoparietal networks, whereas affective empathy is associated with regions of the salience network. It is worth noting that cognitive empathy matures slower than affective empathy (Winters et al., 2021). The association of cognitive empathy within default mode network connectivity is independent of affective empathy or empathy in general. It seems that evocative stimuli in VR can automatically elicit emotional empathy, while cognitive empathy may require more effortful engagement, such as using one's imagination to construct others' experiences (Martingano et al., 2021). Numerous surveys provide evidence of positive learning outcomes resulting from the use of digital media, where users can consume and actively create content (Checa and Bustillo, 2020). Therefore, the mechanisms underlying cognitive empathy, particularly in adolescents, require active and profound engagement and should be combined with some form of live interactive work.

The effects of VR glasses also depend on the technical characteristics of the material used. It is worth noting that videos featuring real nature, natural sounds, and scenes from nature have a greater impact on increasing empathy and well-being (Owens, 2023). There are also studies that show that simpler film materials are sufficient to increase emotional empathy. However, caution should be exercised regarding the emotional weight of these clips. It is crucial to reflect on the emotional impact of VR on the hypersensitive minds of adolescents (Kyer, 2020) and create materials that do not induce a dissociative response. In relation to these effects, it is important to consider the impact on vision, including problems with blurred vision, particularly in adolescents with pre-existing eye conditions, as well as the weight of VR glasses, especially when combined with head movements. Fernandez et al. (2018) found that young people's eyes and brains absorb significantly higher levels of local radiation than those of adults. Age-specific simulations indicate the need for more refined methods for regulatory compliance testing. Kyer's study found that VRM (moving background) causes more cybersickness than VRF (fixed background). According to Paulus et al. (2019), there is a complex relationship between screen media activity, including VR, and physical well-being, fluid and crystallized intelligence, and emotional and cognitive empathy.

Navigating Ethical Issues, Risks, and Mitigation Strategies for Safe Implementation of Virtual Reality in Education

Numerous studies have examined the impact and risks of virtual reality (VR) on the development of children and adolescents across educational, domestic, and healthcare contexts. The findings from these diverse settings have led to the development of guidelines and safety protocols tailored for educators. This review highlights the potential ethical issues and risks associated with VR use in education and suggests strategies for mitigating these concerns.

The key ethical challenges, risks and mitigation strategies identified in the literature for the use of VR technology include the following:

1. Mental and Physical Health Risks

Cybersickness: VR can induce psychological effects such as depersonalization or derealization disorders, where users might feel detached from their bodies or reality,

potentially leading to prolonged disorientation (Spiegel, 2018). Extended VR exposure can also cause "cybersickness," which includes symptoms like nausea, dizziness, and disorientation (Kenwright, 2018). Cybersickness is characterized by symptoms such as nausea, disorientation, and eye strain, which can occur during or after using VR. These symptoms are commonly linked to extended and frequent use of headsets, large screens, or curved screen systems. Such usage can also negatively impact posture, potentially leading to musculoskeletal problems over time. Additionally, the presence of physical objects or obstacles in the learning environment can result in accidents or injuries during VR activities, which must be carefully managed.

Mitigations: Implement regular health monitoring and psychological assessments to identify any adverse effects from VR use early. Provide clear guidelines on the safe durations and conditions for VR usage to minimize health risks (Spiegel, 2018). Additionally, to minimize cybersickness symptoms among 15-18-year-old students, several adjustments can be made to the VR technology, including device customization, implementing proprioceptive vibrations, adjusting rotational blurring effects, and modifying the depth of field to match the user's gaze.

2. Privacy and Data Security

The immersive nature of VR allows for the collection of vast amounts of personal data, including biometric and behavioral data, raising significant privacy concerns and potential misuse of this data (Kenwright, 2018). VR systems could be used for surveillance or other invasive activities without the user's explicit consent (Cotton, 2021).

Mitigations: Develop and enforce strict data protection policies that comply with data privacy laws. Ensure transparency in data collection, use, and sharing. Provide users with controls over their data and require explicit consent for data processing (Kenwright, 2018).

3. Equity and Access

The high cost and technical requirements of VR technology might exacerbate existing inequalities in access to educational and technological resources, potentially limiting access to affluent students and schools (Cotton, 2021). There is also a risk that VR

technology could deepen the digital divide, affecting less affluent users (Madary & Metzinger, 2016).

Mitigations: Promote policies that ensure equitable access to VR technology in educational settings. Provide funding or subsidies for VR technologies in underprivileged schools to prevent the widening of the digital divide (Cotton, 2021).

4. Impact on Social Skills

Over-reliance on VR for social interactions could impede the development of real-world social skills and emotional intelligence, reducing face-to-face interactions and affecting users' ability to engage in physical social environments (Madary & Metzinger, 2016).

Mitigations: Integrate VR with traditional educational methods that promote face-to-face interactions. Design VR experiences that include collaborative and social interaction components to enhance social skills (Madary & Metzinger, 2016).

5. Content Regulation

There is a need for strict regulations regarding VR content, especially to prevent exposure to violent or inappropriate material that could negatively influence users' behaviors and attitudes. Ensuring that VR content is appropriate and does not perpetuate stereotypes, misleading information, or discrimination is crucial.

Mitigations: Establish a regulatory body to oversee VR content, ensuring it meets educational and ethical standards. Implement content rating systems to guide users and educators in selecting age-appropriate and non-harmful material.

6. Addiction and Neglect

VR can be highly engaging and addictive, leading to potential neglect of other academic responsibilities and even social relationships. Excessive use of immersive technologies has been reported to lead to severe personal neglect, including health and well-being (Cotton, 2021).

Mitigations: Educate users about the risks of excessive VR usage. Implement usage tracking and alerts to warn users when excessive usage is detected. Encourage regular breaks and balanced engagement with non-VR activities (Cotton, 2021).

7. Manipulation and Consent

The potential for VR to influence users' beliefs, emotions, and behaviors without their explicit consent or even awareness raises ethical concerns about manipulation. The immersive and interactive nature of VR could be exploited to influence user behavior or *decisions in subtle yet impactful ways* (Cotton, 2021).

Mitigations: Ensure that all VR applications require explicit user consent before exposure to potentially manipulative content. Educate users about the potential for manipulation and how to recognize and report unethical practices (Cotton, 2021).

8. Distinction Between Real and Virtual

VR blurs the lines between reality and virtual experiences, which could have profound implications for users' perception of reality and their actions within both realms. The ethical implications of actions taken within immersive virtual environments and their potential impacts on real-world behavior need careful consideration (Spiegel, 2018).

Mitigations: Promote educational programs that help users understand the differences between virtual and real-world interactions and consequences. Develop VR experiences that clearly distinguish between virtual scenarios and real-life applications to avoid confusion (Spiegel, 2018).

Mitigation Strategies for Safe VR Use in Education

1. Recommended Session Lengths

Limiting VR sessions to short, frequent intervals can prevent overwhelm and fatigue, thereby improving information retention and minimizing discomfort. This approach also allows teachers to provide immediate feedback and address any concerns, enhancing the overall learning experience.

2. Breaks and Rest Periods

Incorporating regular breaks during VR learning sessions is essential to prevent physical discomfort and reduce the risk of long-term adverse effects. Students should be encouraged to stretch, rest their eyes, and relax their muscles at appropriate intervals to maintain focus and engagement throughout the learning program. These breaks also give teachers an opportunity to monitor students' progress, address any concerns, and make necessary adjustments to the learning content or approach.

3. Educating Students

Educating students about the risks of VR and the associated safety measures empowers them to use the technology responsibly. During breaks, teachers can introduce techniques such as stretching exercises and eye relaxation to alleviate symptoms of cybersickness. Providing ergonomic guidelines for maintaining proper posture during VR sessions is also beneficial.

In addition to these guidelines for students, it is crucial to:

- a) Establish emergency protocols for VR sessions, including clear response plans.
- b) Ensure teachers are fully prepared to supervise VR sessions, and equipped with the necessary tools, resources, and competencies to promote safe and effective use of VR in education.

Mitigation Strategies Related to Teacher Supervision

1. Preparation

Equipping supervisors with the necessary tools and expertise is critical for ensuring the ethical and safe use of VR in education. This preparation enables teachers to guide students effectively and ensure adherence to safety protocols, ultimately optimizing the outcomes of VR learning sessions.

2. Pre-Session Checks

Before starting a VR session, teachers should prepare students by:

- a) Communicating the objectives of the session to ensure a clear understanding of the virtual activities.
- b) Teaching students navigation skills for virtual environments.
- c) Educating students about the risks of VR and the strategies to mitigate them.
- d) Conducting health assessments to identify any pre-existing conditions that could be worsened by VR use.

3. Ensuring a Safe Learning Environment

To reduce the risks associated with VR sessions, it is essential to provide clear instructions and maintain an obstacle-free learning space. Creating a conducive learning environment, with adequate lighting, proper ventilation, and clear signage, further reduces the potential for physical risks.

4. Supervising VR Learning Sessions

During VR sessions, teachers should prioritize clear communication, foster a supportive atmosphere, and conduct debriefings to address any emotional concerns. This involves closely monitoring students' experiences, promptly addressing any difficulties, and assisting students in transitioning back to the real world after the session.

2.4. Existing Video Materials: Virtual Reality Experiences in Education

Introduction

The educational landscape is rapidly evolving with the integration of Virtual Reality (VR) technologies. This review explores the current state of VR in education, focusing on the functionalities and immersive experiences that enhance learning among secondary school students. The study emphasizes the growing relevance of VR as a supplementary tool in education, offering insights into how VR can foster empathy, improve learning outcomes, and provide personalized educational experiences.

Method

The analysis was conducted through comprehensive desk research, including the review of technology media, scientific articles, and VR content distribution platforms such as Google, Steam, and YouTube. The primary focus was on 3DOF (Degrees of Freedom) educational VR resources, with a secondary focus on 6DOF VR games and resources that offer technical

functionalities like interactivity and collaboration. The research targeted educational content suitable for secondary school students, excluding vocational training or adult education.

Current State of VR in Education

VR is transforming education by offering immersive learning experiences that enhance engagement and understanding. The global VR education market is projected to reach \$22 billion by 2025, driven by increasing investments and the demand for interactive learning tools. Studies indicate that VR significantly improves focus, emotional connection to content, and confidence in applying new skills, making it a valuable complement to traditional teaching methods.

Availability of VR Applications and Experiences

The VR market is rapidly expanding, with platforms like YouTube VR, ClassVR, and Engage providing thousands of educational resources. These platforms cover a wide range of subjects, offering immersive experiences that enhance students' understanding of complex concepts. The increasing availability of VR tools and content highlights the potential for integrating VR into mainstream education.



VR for Empathy Generation and Improved Learning Outcomes

The review identified key VR functionalities that enhance learning outcomes and foster empathy:

1. **Perspective Shifting:** VR enables students to experience different viewpoints, deepening their understanding of historical contexts, social issues, and cultural differences.
2. **First-Hand POV:** Immersive VR experiences allow students to navigate spaces as if they were physically present, enhancing spatial understanding and empathy.
3. **Experiential Simulations:** VR provides hands-on learning in controlled environments, allowing students to explore dangerous or complex scenarios safely.
4. **Emotional Storytelling:** VR's ability to tell emotionally resonant stories fosters empathy by connecting students with the lived experiences of others.
5. **Virtual Field Trips:** VR enables students to visit remote locations, broadening their understanding of diverse cultures and ecosystems.
6. **Collaborative Environments:** Multi-user VR platforms support group learning and collaboration, enhancing communication skills.
7. **Feedback and Assessment:** VR applications offer immediate feedback, helping students learn from their mistakes in a risk-free environment.
8. **Emotional Engagement through Sensory Immersion:** VR's sensory engagement creates memorable and impactful learning experiences.
9. **Personalized Learning Paths:** VR offers customized learning experiences tailored to individual students' needs and interests.

10. **Visualization of Complex Concepts:** VR makes abstract concepts tangible, aiding comprehension and retention.

Concluding Remarks

VR presents significant opportunities for enhancing education, particularly in fostering empathy and improving learning outcomes. As the technology continues to evolve, it is essential to view VR as a complementary tool that enriches traditional teaching methods. By integrating VR functionalities into educational content, educators can create more interactive, personalized, and effective learning experiences. The future of education lies in the thoughtful combination of digital tools and traditional pedagogical approaches, ensuring that students are equipped to navigate an increasingly complex world.

2.5. Conclusion

Empathy, encompassing both cognitive and emotional aspects, is essential for self-development, fostering successful social interactions, kindness, cooperation, and personal growth. Cognitive empathy, which involves understanding others' perspectives, is more complex and develops later than emotional empathy, which entails sharing others' emotional responses. Adolescence is a critical period for developing cognitive empathy, closely linked to executive functions and metacognitive skills. This development is crucial for prosocial behavior, moral development, and managing social roles, such as being a bystander, victim, or bully.

Empathy also plays a vital role in adolescents' social and personal growth, enhancing communication, conflict resolution, emotional regulation, and overall social competence. The development of empathy during adolescence is influenced by neurobiological changes, particularly in the prefrontal cortex, and is marked by gender differences, with girls generally developing cognitive empathy earlier than boys. Various factors, including biological, social, and environmental influences, contribute to the complex development of empathy during this period.

In educational settings, empathy is linked to academic success, well-being, and positive peer relationships. Teachers play a significant role in fostering empathy through positive interactions, mindfulness practices, and experiential learning programs. Additionally, empathy, as a component of emotional intelligence, helps students manage academic pressures and societal challenges, highlighting the need for its continuous development in educational contexts.



Virtual Reality (VR) has emerged as a powerful tool for enhancing empathy, especially emotional empathy, by allowing users to immerse themselves in others' perspectives. However, while VR is effective in evoking emotional empathy, it shows limited success in fostering cognitive empathy, which requires more effortful perspective-taking. VR's effectiveness in increasing empathy varies by gender and is most impactful when designed to promote deep emotional connections. Despite its potential, VR also presents significant ethical challenges. These challenges include physical discomfort, privacy concerns, and the potential for VR experiences to impact social skills negatively. It is imperative that these risks are carefully managed in educational settings to ensure that VR is used safely and effectively.

The integration of VR and Augmented Reality (AR) into formal education holds great promise for enhancing learning outcomes, motivation, and engagement by making complex concepts more tangible and interactive. However, this integration also introduces complex ethical challenges that require thoughtful and proactive strategies. These technologies must be implemented with careful consideration of accessibility and inclusivity, particularly for students with disabilities, to ensure that all learners benefit. The successful integration of VR and AR requires not only proper instructional design but also ongoing research and innovation. Ethical considerations must be at the forefront, as the literature highlights the need to address these issues to harness VR's potential responsibly.

As D. Siegel (2020) points out, an adolescent's brain development is shaped by the activities they spend the most time on, whether that's screen time, playing an instrument, or engaging in social activities. This understanding underscores the need to design learning tools, including VR, that cater to the specific developmental needs of adolescents, promoting integrated and flexible brain structures.

Ultimately, the use of VR in education should aim to create enriching learning experiences while upholding high ethical standards, ensuring that VR technology serves as a tool for educational enhancement rather than a source of inequity or harm. Educators have the potential to create more interactive, efficient, and equitable learning environments by thoughtfully integrating VR and AR into the curriculum. This balanced approach will be crucial for the sustainable and ethical development of VR technologies in educational settings, leading to a future where digital solutions are an inherent part of teaching and learning, while also safeguarding the well-being and development of all students.

A person wearing a VR headset is shown in profile, holding a digital wireframe model of a classical building. The background is a museum with various statues and architectural details. The scene is overlaid with a pattern of blue squares of varying sizes.

Chapter 3

Quantitative and qualitative research



Co-funded by
the European Union

3. QUANTITATIVE RESEARCH - SURVEYS TO MAP TEACHERS AND STUDENTS' NEEDS AND EXPECTATIONS

3.1. Introduction

To review the state of the art on the use of VR technology in schools and its impact on empathy in students and teachers, a quantitative study titled "VR4Empathy: Using Virtual Reality for Inclusive and Action-Oriented Empathy in Schools" was conducted across various secondary schools in Slovenia, Greece, and Portugal. Prior to initiating the survey, approval was obtained from the Ethics Committee at the University of Ljubljana, Faculty of Theology.

3.2. Methodology

3.2.1. The objectives of the quantitative study

The purpose of the survey, which will be carried out among teachers and students, is to gather information on:

- the availability of digital technologies in their school, their experience of using VR technologies in the educational process,
- their motivation to use VR technology in the school process,
- the opportunities they see in using VR technology for learning/teaching,
- any concerns (practical and ethical) about the use of VR technology in schools,
- their level of empathy (questionnaires: AMES adolescent measure of empathy and sympathy (2015) and Basic empathy scale in adults (2013)).

In line with the above project objectives, the results from the quantitative and qualitative research will provide insights into teachers' and students' preferences, needs, motivations and potential concerns about the use of VR technology in schools. The information obtained will have a decisive impact on:

- the design of learning resources based on VR technology (to be aligned with the needs, desires and abilities of the target group to actually use VR in practice),
- the development of appropriate guidance and documentation for the use of VR technology,
- the preparation of appropriate pilot training courses for teachers to provide them with the necessary knowledge to use VR.

3.2.2. Measuring instruments

Based on an extensive literature review (in the areas of digital technology use in education (Southgate 2020; Choi, Dailey-Hebert and Estes 2016), empathy in adolescents (Altavilla, Manna and Lipoma 2021; Ratka 2018), the role of VR technology in the development of cognitive and affective empathy (McCall et al. 2018; Schutte and Stilinović 2017), ethical and practical challenges of VR (Rueda and Lara 2020; Kenwright 2018)), and consultation with project partners, we have developed two questionnaires (one for teachers and one for students), which include four sections in addition to an introduction, key definitions, and a GDPR consensus.

The two questionnaires are structured as follows:

- Introduction (explaining the context of the survey and the basic aims and objectives of the VR4Empathy project, as well as the structure of the questionnaire).
- Definitions (definitions of key terms are provided, as a common understanding of these terms is crucial to ensure that all respondents understand the questions in the same way: "virtual reality", "empathy" and the 5 types of empathy).
- GDPR (in order to proceed with the survey, participants must confirm that they agree that their data is used in accordance with the relevant law - GDPR (Regulation (EU) 2016/679).
- Part 1: Questions on the use of digital technologies (SELFIE questionnaire - "Self-reflection on Effective Learning by Fostering the use of Innovative Educational technologies"). The first part of the questionnaire contains four groups of statements, for which respondents choose an answer between 1 and 5 according to how strongly they agree with the statement. This part of the questionnaire is designed to elicit information on which digital tools they use in the teaching/learning process, their experience of using digital technologies and their attitudes towards or opinions on the use of digital technologies in school.
- Part 2: Questions on the use of VR in school (questions were developed in consultation with the project partner Khoros - a Danish company that develops VR applications for educational purposes). This part includes questions on how familiar the respondents are with VR technology and whether they have any concerns about using it in school. In addition, it includes ten statements about attitudes towards VR technology, for which participants give their opinion on how strongly they agree with them on a scale from 1 to 5 (example statement: "I find VR technology suitable for all school subjects").

- Part 3: Questions on respondents' empathy (questions are taken from the evaluated questionnaires: AMES Adolescent Measure of Empathy and Sympathy (Vossen, Helen G. M., Piotrowski, Jessica T., & Valkenburg, Patti M. 2015) and BES Basic Empathy Scale in Adults (Carré, A., Stefaniak, N., D'Ambrosio, F., Bensalah, L., & Besche-Richard, C. 2013) - both licensed for use without the authors' consent). Respondents answer about how often (1 = never, 5 = always) they know how their fellow human beings feel, and how often they feel like their fellow human beings themselves. This part of the questionnaire aims to evaluate the level of affective and cognitive empathy of the respondents.
- Part 4: Demographic questions. These include age, gender, the environment in which they live (city, village, island, etc.), how often they use digital technology for specific purposes (school, extracurricular, learning, entertainment), what kind of technology they have access to at home, what kind of software they use and what kind of video games they play. We will also check with teachers which subject they teach and how long they have been in the teaching profession.

The teacher and pupil questionnaires differ only on some questions directly related to the role of the teacher/pupil. For teachers, we are interested in whether they expect to experience technical difficulties in implementing VR technologies in their teaching and what kind of help they would need and want to get to overcome them, and for students, we are interested in whether they feel that the use of VR technologies would have an impact on their motivation to learn and on their grades in specific subjects. In some cases, demographic and empathy questions are also tailored to whether a teacher or a student completes the questionnaire.

3.2.3. Participants

The 127 teachers who took part in the survey came from three different countries, with the largest number coming from Greece (42%), followed by Slovenian teachers (36%) and Portuguese teachers (20%). Given the population studied, it is not surprising that more women (71%) were included in the survey. Most of the teachers had more than 15 years of experience.

Students aged 14 to 18 also took part in the survey. A total of 239 pupils answered the questionnaire - 45% from Greece, 34% from Portugal and 19% from Slovenia. Of these, 53% were girls, 41% were boys and 5% indicated their gender identity as other. More than half of them live in urban areas.

3.3. Results of quantitative study

3.3.1. Results from SELFI - teachers

The vast majority of teachers in Greece, Slovenia and Portugal who took part in the survey (N = 127) have digital devices available for teaching (72%) and technical support in case of problems with their use (66%). Only 9% of teachers answered that VR glasses are available for their students. It is very encouraging that 75% of teachers feel that their school offers them opportunities to participate in professional development programmes on teaching with digital devices. More than half of those who had attended training on the use of digital technology (mainly in the form of webinars) found the training useful. As many as 69% of teachers feel that the school management encourages them to share their experiences of using digital technologies with other teachers in the school.

Like students, teachers expressed that they mainly use digital platforms and interactive whiteboards. They find online classrooms (81%) and interactive whiteboards (69%) particularly useful. 77% of teachers use digital technology for school-related communication. They mainly use e-mail, online classrooms, eAssistant and MS Teams.

When they use digital technology, they use it mainly to make students more engaged in lessons (81%) and to encourage student participation (80%).

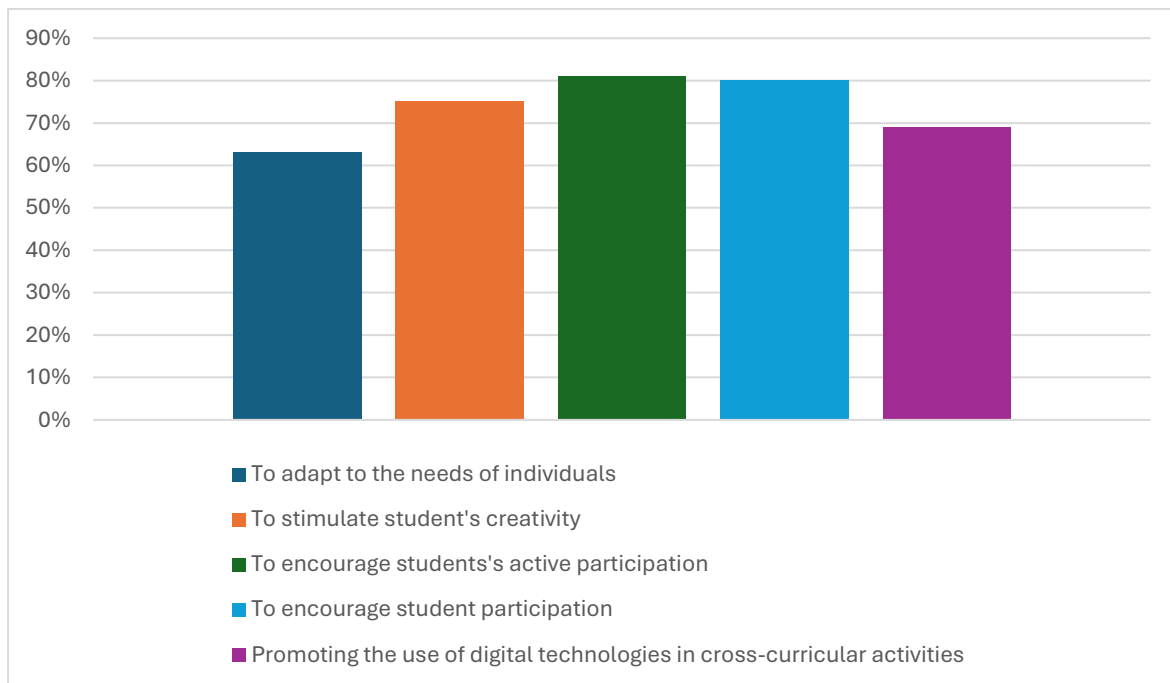


Figure 3. Reasons for using digital technology – all

The most frequently cited purpose for using digital technology is to get quick feedback from students (67%).

37% of teachers were already familiar with the SELFIE questionnaire (and 50% of teachers over 50).

There is no significant difference between teachers of different genders. There is also no significant variation between teachers of different ages.

3.3.2. Results from VR questionnaire - teachers

Teachers overwhelmingly do not use VR. The largest number, 55%, say they are not familiar with VR technology and are not familiar with it. 19% say they have tried VR but do not use it, while 19% have heard of it but do not use it.

The majority of teachers (68%) have no concerns about the use of VR. Those who do have concerns said that the use of VR alienates people, that excessive use of the technology distances people from the real world and prevents contact with their fellow human beings, and that, on the other hand, the actions one does in the virtual world can be carried over into one's real life, to the detriment of others. At the same time, this reduces critical thinking. Teachers express concern that the use of VR would put a strain on students on a psychological level, with isolation also being mentioned. Teachers with experience of VR warn of the possibility of disadvantages and possible impairment of hearing and vision. They also find the financing of such equipment problematic.

Teachers feel that the use of VR can help them to convey the material. Most of them tend to assess the material delivered using VR technology in the same way as other material. 37% agree and 21% disagree with the statement that VR is only a tool to help better understanding of the material. 35% of these are undecided. The majority of teachers would be willing to use VR in the classroom if given the right support, 74% are willing to receive training. More than half could not agree on the statement that using VR requires more time. Teachers found it difficult to decide on how to assess the material learned through VR. However, they are slightly more inclined to use formative rather than summative assessment.

56% of teachers find it difficult to integrate VR technology into the curriculum, while 37% neither agree nor disagree with the statement. The most common reasons are poor knowledge of the technology and lack of time to invest in preparation, with the risk that it too will soon be outdated. Teachers also mention that they cannot imagine using VR in the classroom. If VR were to be used in schools, curricula would have to be updated, as

this would lead to a radical change in the delivery of the content. On the other hand, it is interesting to note that 31% of teachers are looking forward to updating curriculum preparation, while 53% are undecided. Teachers who are looking forward are motivated by new challenges and the acquisition of new knowledge and believe that this will help them to motivate their pupils and make them more engaged.

Only 11% of teachers do not think that VR is appropriate for their subjects. The majority of teachers (65%) cannot say whether there are more advantages than disadvantages to using VR.

Teachers see the challenges of teaching VR as too many students in the classroom, the use of equipment, the reduction of social contact and the already high workload. On the other hand, some teachers are in favour of modernising education to keep up with the times and also see the challenge in teachers being able to keep up to date with developments in technology and to be able to use it more quickly.

3.3.3. Results from BES-A questionnaire (cognitive and emotional empathy) - teachers

Teachers (N = 103) scored slightly higher on cognitive empathy (M = 3.78) compared to emotional empathy (M = 3.28) on the Basic Empathy Scale in Adults (BES-A) (Carré et al., 2013), a questionnaire that measures emotional empathy (11 items) and cognitive empathy (8 items). The mean scores for each scale were presented by dividing the total score by the number of items.

Differences in the level of cognitive and emotional empathy are also evident by gender. Men (N=29; M=3.34) scored higher on emotional empathy than women (N=73; M=3.25). On cognitive empathy, women (M=4.04) scored higher than men (M=3.10). Cognitive and emotional empathy scores are similar for men, while results show a greater difference for women, where cognitive empathy scores higher than emotional empathy (Table 2/Figure 6).

	COGNITIVE EMPATHY	EMOTIONAL EMPATHY
MALE	3.10	3.34
FEMALE	4.04	3.25
ALL TEACHERS	3.78	3.28

Table 3: Mean values of cognitive and emotional empathy by gender for teachers

The results show an interesting phenomenon of higher levels of emotional empathy in male teachers, as typically in different studies men score lower on both emotional and cognitive empathy compared to women. This may be because men entering the teaching profession have higher levels of emotional empathy than the general male population.

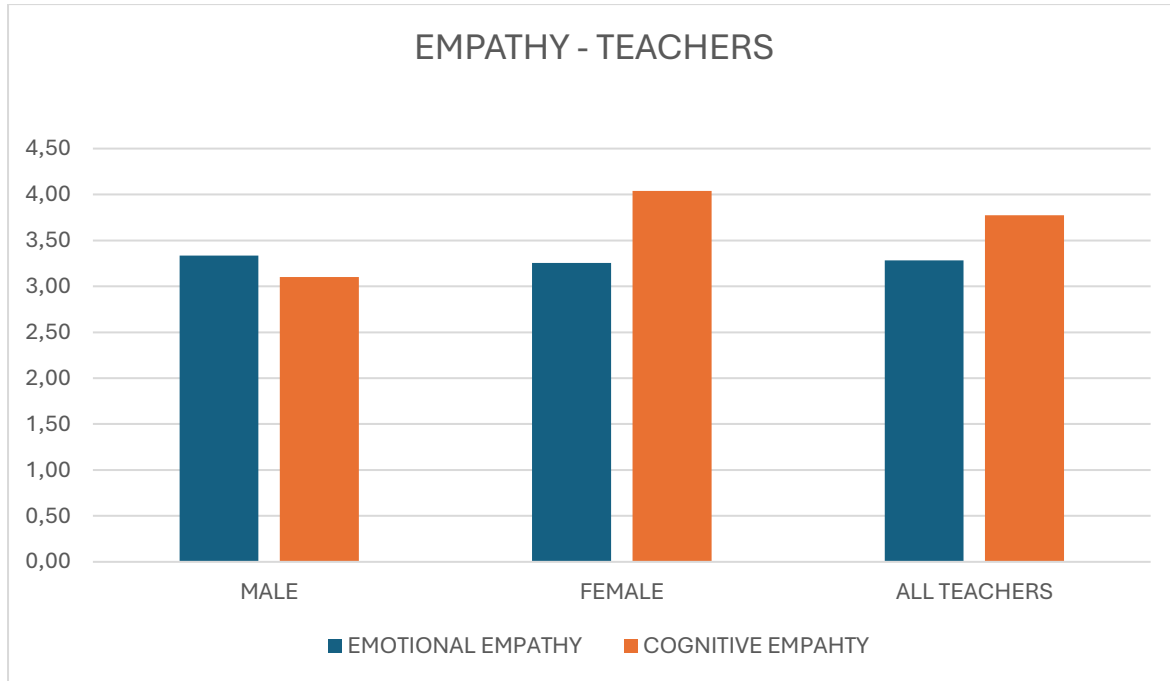


Figure 4: Mean values of teachers' cognitive and emotional empathy by gender in the full sample

We also tested whether there is a statistically significant difference between cognitive and emotional empathy by gender among teachers. Differences were determined using the Mann-Whitney U-test, as the data are not normally distributed. The results show that gender differences in cognitive ($p = .000$) and emotional empathy ($p = .027$) are statistically significant for teachers. Female teachers score statistically significantly higher on cognitive empathy compared to male teachers. For emotional empathy, male teachers score statistically significantly higher than female teachers.

3.3.4. Results from SELFI - students

A sample of students from Greece, Slovenia and Portugal ($N = 239$) showed that 68% of students have access to the internet at school.

81% of pupils answered that they use digital platforms at school. Of these, online classrooms, Teams, Moodle and Kahoot were particularly frequently highlighted.

Interactive whiteboards (48%) and 3D printers (23%) are the second most frequently used digital technologies. Pupils find digital platforms (75%) and interactive whiteboards (63%) particularly useful, while other digital technologies are used less (e.g. digital library 44% and 3D printers 32%).

Interestingly, only 13% of students answered that they have VR technology at school, and in the second question on which digital technologies they find particularly useful for learning, 24% answered VR glasses. Given that 48% of pupils responded that they had tried VR glasses when asked how familiar they were with VR technology, it seems encouraging that exactly half of the pupils who have tried VR glasses think that this technology would be beneficial for learning.

As regards motivation to use digital technologies, it is notable that 73% of students find lessons more interesting when digital technologies are used and 60% think they are more motivated and learn more when digital technologies are used. For boys (N = 96), for example, the difference between the two figures is even slightly higher, which may indicate that increasing the interestingness of a lesson does not necessarily increase motivation to learn.

	Lessons are more interesting when we use digital technology	When we use digital technology, I am more motivated and learn more
MALE	80%	61%
FEMALE	70%	57%
ALL STUDENTS	73%	57%

Table 4: Differences of perspective on the impact of the use of digital technologies in students' participation, motivation and learning by gender

In almost all cases of positive evaluation of digital technologies, the figures for men are slightly higher than for women, but the differences are not very large.

There are no significant differences in the responses of pupils of different ages.

3.3.5. Results from VR questionnaire – students

The survey data shows that the majority of participants are familiar with VR technology, but only 9% use it on a regular basis. A fifth of the participants have never been exposed to VR technology. Among those who answered that they use VR technology, 14 were male,

6 were female and 3 identified as other. Of these, 75% live in cities and more than half play video games, 43% on a daily basis and 17% on a weekly basis.

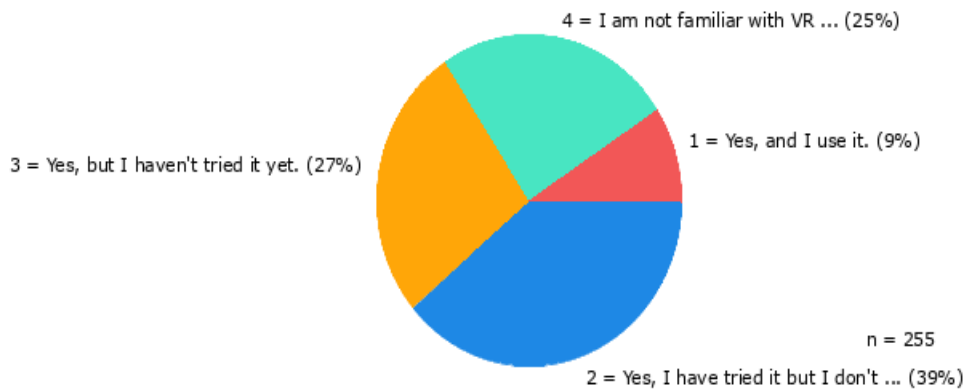


Figure 5: Students' knowledge of VR

The majority of respondents (83%) do not think that there are any circumstances in which the use of VR at school could be problematic. Among the problematic circumstances, students highlighted the possibility of misuse, the use of VR in case of neurological and psychosocial disorders, in case of simulation of serious historical events and accidents. Students consider that the use of VR in schools can reduce concentration and that it cannot be used in all subjects.

47% of the pupils surveyed agree with the use of VR in schools. Furthermore, 18% disagree and 24% say they neither agree nor disagree. As many as 11% consider that the latter is not valid for them.

Among students, 18% do not think that the use of VR in schools would contribute to a better understanding of school material. The majority (32%) answered that they neither agree nor disagree, while 19% strongly agree and 28% agree. The rest (3%) consider that the latter is not valid for them. Similarly, students also expressed their opinion on the usefulness of digital VR tools and their help in better understanding complex subjects. Just over half agree that the use of VR in the classroom would help to improve understanding of complex subjects.

A fifth of students neither agree nor disagree with the statement that the use of VR is appropriate for all subjects. Furthermore, 36% agree and 18% disagree. Pupils think that VR glasses are appropriate for mathematics, physics, history, geography, technical subjects, chemistry, biology and language learning. Few think that VR can also be used in

sports education. It can also be noted that some respondents were of the opinion that the latter would depend on the material that would be delivered through VR.

Just over half of the respondents (55%) would be willing to use VR as a complementary tool in their education. 23% are not sure whether they would use VR in the classroom, while 13% of the students surveyed disagree with the use of VR in the classroom. When asked which types of content they found most interesting, the most frequently cited were content of a technical nature, content that responds to their needs and content that covers specific subjects. Physics and history were mentioned most frequently.

The majority of respondents felt that using VR would not have a negative impact on their grades. 42% are sure and 42% are undecided. Only 8% of respondents think that using VR would have a negative impact on their grades because it reduces work efficiency and attention.

Students do not find the use of VR too difficult. Only 7% of the students surveyed think so, and in most cases, they did not explain their answer. Among those who gave reasons, one mentioned that using VR makes him feel nauseous and dizzy.

Some pupils felt that they would not need any help to use VR. Others felt that support should be provided by teachers and staff who know how to use VR and that the instructions provided would be useful. Quite a few students also mentioned that they would need financial support if they were to use VR at school.

3.3.6. Results from AMES questionnaire (cognitive and emotional empathy) - students

Students (N =244) scored higher on cognitive empathy (M=10.2) compared to emotional empathy (M=4.8) on the Adolescent Measure of Empathy and Sympathy (AMES) questionnaire (Vossen, Piotrowski & Valkenburg, 2015), which differentiates between emotional and cognitive empathy. A maximum of 20 items could be scored on each scale.

Differences in the level of cognitive and emotional empathy are also evident by gender. On average, boys (N=100) scored lower on cognitive empathy (M=10.5) than girls (N=130) (M=12.7). Similarly, boys (M=3.3) scored lower than girls (M=9.0) on emotional empathy (Table 10).

	COGNITIVE EMPATHY	EMOTIONAL EMPATHY
MALE	10.5	3.3
FEMALE	12.7	9.0
ALL STUDENTS	10.2	4.8

Table 5: Mean cognitive and emotional empathy scores by gender for students

The results show that, overall, students' cognitive empathy skills are better compared to emotional empathy, where the scores are quite low. This means that students are relatively proficient in understanding another person's perspective or emotional state at an intellectual level, while their ability to actually share and experience another person's emotions is relatively low. On cognitive empathy, girls score higher on average than boys, but the level of cognitive empathy is still relatively equal or comparable. There are greater differences in emotional empathy, where boys score significantly lower than girls. These aspects represent relevant starting points for interventions to promote empathy in adolescents and also represent different starting points to consider when addressing adolescent empathy (e.g. girls are more likely to draw on emotional empathy than boys when learning about a topic and situation, while cognitive empathy capacity will be relatively similar in both genders).

3.3.7. Conclusions

The survey shows that teachers and students predominantly use digital devices at school, while VR equipment is not yet in use. The majority of teachers are in favour of using VR, while students are less in favour of this type of learning, but do not question it either. Both consider it important that VR is appropriately integrated into the curriculum and mention a wide range of subjects in which VR could be used. The most frequently mentioned subjects are physics, history and biology. It is important that both teachers and students are aware of the potential negative consequences of using VR.

The results of the quantitative study also showed that female students are more empathetic than male students. For teachers, the pattern is slightly different, which is also due to the nature of the profession, as men, who have a higher level of empathy, are more likely to choose the teaching profession.

Here are presented key conclusions and recommendations from the analysis of research data:



For Students

- **Familiarity vs. Usage:** While most students are familiar with VR, regular usage is low, with a significant demographic skew favoring male and urban students.
- **Perceptions of VR in Education:** Students have mixed views on the effectiveness of VR in education, with concerns about its misuse and impact on concentration, though many recognize its potential for complex subjects.
- **Support Needs:** There is a clear demand for support from knowledgeable teachers and financial assistance to facilitate VR use in schools.

Recommendations

- **Targeted Implementation:** Introduce VR in subjects where it can most enhance learning, such as history, physics, and empathy-related activities, aligning with the goals of VR4Empathy to deepen cognitive empathy.
- **Teacher Training:** Invest in professional development for teachers to ensure they can effectively support students in using VR, particularly in ways that foster empathy.
- **Addressing Concerns:** Develop guidelines to mitigate concerns about VR misuse and its potential impact on concentration, ensuring it is used effectively to engage students without distraction.



For Teachers

Conclusions

- **Limited Familiarity and Use:** A majority of teachers are not familiar with VR, and those who are, use it infrequently, reflecting a gap in adoption.
- **Mixed Attitudes:** Teachers express concerns about VR's psychological, social, and practical implications, though many are open to using it with proper support.
- **Empathy Development:** Teachers exhibit higher cognitive empathy, with significant gender differences, highlighting the importance of tailored approaches in empathy development.

Recommendations

- **Professional Development:** Provide targeted training that not only covers the technical use of VR but also its potential to develop empathy in students, aligning with VR4Empathy's objectives.
- **Curriculum Integration:** Collaborate with curriculum developers to integrate VR in a way that supports both cognitive and emotional empathy, addressing the unique challenges identified by teachers.
- **Supportive Environment:** Foster a supportive environment where teachers can share best practices and concerns regarding VR, ensuring its thoughtful and effective integration into classrooms.

4. QUALITATIVE RESEARCH – DESIGN THINKING WORKSHOPS

4.1. Introduction

Design Thinking Workshops followed the online surveys in terms of content and timing. The purpose of the workshops was "to deepen some of the surveyed aspects, but with a clear focus on the motivation to use/learn through VR-based educational resources."

The team placed great emphasis on the choice of an appropriate research approach in the design of the workshops, as we wanted to use the language of the young participants and give them a space where they could really express their views and their thinking. We were aware that it is crucial to establish a safe and respectful environment in which students feel safe enough to look realistically and critically at their schooling experience and to allow themselves to think about possible improvements. The researchers felt that it was important to use ways of working that are not familiar in the school space, to further provide a separation from the school system (and especially a separation from grading by which students are often highly stressed) and to encourage creativity in young people (ensuring participants that there are no right answers, it is their opinion that is important to the research).

The consortium decided to run the workshops for students and teachers at the same time in order to allow the possibility of exchanging experiences between the two groups of participants. Working together has enabled relationship building and a better understanding of the contexts that influence learning processes, which are sometimes

beyond the control of either students or teachers. The final feedback showed that working together was a good approach.

4.2. Methodology

4.2.1. The objectives of the qualitative study

The primary objectives of the qualitative study are as follows:

Explore Motivation for VR-Based Learning

To gain a deeper understanding of the factors that motivate students to use and learn through VR-based educational resources, building on insights gathered from previous surveys.

- **Identify Strategies to Improve Lesson Tracking**

To collect and analyze ideas and strategies from teachers and students that could improve how lessons are tracked, to enhance student engagement and learning outcomes.

- **Examine the Most Inspiring Lesson**

To identify what constitutes the most inspiring lesson from both the teachers' and students' perspectives, with a focus on understanding the key elements that make a lesson engaging and effective.

- **Assess the Role of VR in Lessons**

To explore how both teachers and students perceive and mention VR technology concerning its potential integration into lessons, and how it could influence the teaching and learning experience.

- **The key message from the research participants: students and teachers**

- **The researchers' key message for the project**

Establish the critical factors to consider when designing educational programs and materials, focusing on aligning them with the needs and preferences of both students and teachers.

4.2.2. Research protocol

The research protocol was prepared by UL and distributed to partners. In order to gain a deeper understanding of the design thinking workshops, we will include a short version of the research protocol.

The following research protocol outlines the structured approach undertaken during our workshop aimed at exploring the perspectives and experiences of students and teachers regarding educational methodologies and tools. The workshop is designed to foster an open and collaborative environment where participants feel comfortable sharing their insights without judgment or evaluation. The activities are structured to encourage engagement, creativity, and reflective thinking, ultimately contributing to a comprehensive understanding of the participants' viewpoints.

1. Introduction *Estimated Time: 15-20 minutes*

1.1. Opening Remarks

- Begin by introducing the research team and clarifying the purpose of the workshop. Emphasize that the aim is to gather insights into participants' views and experiences, rather than to evaluate their thinking or performance.
- Express gratitude to both students and teachers for their participation, reassuring them that the focus of the session is purely on understanding their experiences and perspectives.

1.2. Participant Introductions

Activity: Use story cubes as an interactive icebreaker.

Instructions: Invite participants to sit in a circle. Each participant selects an image from the story cubes and uses it to introduce themselves by incorporating it into a story. The story should build meaningfully on the previous participant's contribution, ensuring the narrative remains cohesive.

Example: "Once upon a time, there was a girl named Anna who hid a crocodile in her castle. The crocodile's name was Peter, and he loved to nibble on bells..."

1.3. Establishing Group Norms

Purpose: Establish a safe and supportive environment conducive to creative thinking and open sharing.

Instructions: Suggest basic ground rules, writing them on coloured sheets to display prominently.

Potential rules include:

- **Confidentiality:** What is shared in the workshop remains within the group.
- **Voluntary Sharing:** Participants share only what they feel comfortable with.

- **Equal Value of Opinions:** Every opinion is important and welcomed.

Encourage participants to contribute their own rules to foster a collaborative atmosphere.

Contact Information: Provide participants with contact details for any post-workshop queries or reflections.

2. IF TIME IS LIMITED (for 90-minute workshops), THE FOLLOWING SEGMENT MAY BE OMITTED *Estimated Time: 15 minutes:*

2.1. Exploring Learning Dynamics

- **Objective:** Assess students' perceptions of their learning during lessons and explore underlying reasons.
- **Method:** Utilize a simplified H-method on a large sheet of paper, dividing it into four segments with a large "H" shape.
 - **Center Segment:** Write the primary question and include a rating scale from 0 to 10.
 - **Left Segment:** Reflect on reasons for not rating 10.
 - **Right Segment:** Reflect on reasons for not rating 0.
 - **Bottom Segment:** Gather suggestions and ideas for improvement.

- Questions:

- For students: "How much do I learn during class?" (Rate 0-10)
- For teachers: "How much influence do I, as a teacher, have on students' motivation and engagement in class?"

3. Visualization and Creation

3.1. Visualization Exercise *Estimated Time: 10 minutes*

- **Objective:** Encourage participants to reflect on a typical school day from their perspective or from their student years.
- **Instructions:** Invite participants to find a comfortable space, relax, and, if they wish, close their eyes or focus on a quiet point in the room. The facilitator narrates a visualization exercise designed to evoke memories and feelings related to engaging and impactful lessons.
- The exercise should describe a typical school morning, leading up to an unexpectedly engaging lesson that leaves the participant wishing it could continue beyond the ringing of the school bell.
- After the visualization, invite participants to open their eyes and reflect on their experience.

3.2. Reflection with Visual Aids *Estimated Time: 10 minutes*

- **Materials:** Dixit/OH-cards spread out on the floor.
- **Instructions:** Invite participants to choose a card that best represents their experience during the visualized lesson. Ask them to describe their experience briefly.

3.3. Group Work: *Estimated Time: 20 minutes*

Students: Imagine being a jury in a competition to select the most inspiring lesson. Develop evaluation criteria and a rating scale to judge lessons. Discuss what makes a lesson inspiring versus unengaging.

Teachers: Reflect on a lesson where students were fully engaged. Consider what made the lesson effective, what the teacher did, and what resources or strategies were used. Imagine teaching without limitations.

- **Materials:** Posters, pens, creative supplies. *Estimated Time: 10-20 minutes*

3.4. Group Reporting *Estimated Time: 15 minutes*

- **Objective:** Share and discuss the key findings from each group.
- **Instructions:** Each group has 3 minutes to present their key points.
- **Follow-up Discussion:** If VR is not mentioned, prompt participants to consider the impact of VR in education. Pose questions such as: "Imagine if you had VR glasses that allowed you to experience exactly what you are learning. What are your thoughts on this idea?" Record responses for further analysis.

4. Conclusion *Estimated Time: 5 minutes*

4.1. Objective: Encourage participants to reflect on their learnings and experiences from the workshop.

4.2. Instructions: Ask participants to consider what they found interesting, what they learned, and what surprised them.

4.3. Closing Activity: Offer participants a sweet treat from a basket as a token of appreciation, inviting them to exchange their reflections for a treat.

This structured and interactive workshop protocol aimed to elicit deep and meaningful insights into the experiences and perspectives of students and teachers regarding effective teaching practices and the potential integration of advanced technologies like VR in education. Through a combination of creative exercises, reflective discussions, and

collaborative activities, the workshop facilitated a comprehensive exploration of factors that contributed to engaging and impactful learning experiences.

4.3. Participants

The workshops were carried out in three countries, Slovenia, Greece and Portugal. According to the participation indicators foreseen in the call for proposals, where it was foreseen that each country would carry out 3 workshops involving 10 students and 3 teachers each, the criteria were met, as we included in the research:

- Slovenia: 38 students, 15 teachers
- Greece: 36 students, 9 teachers
- Portugal: 55 students, 12 teachers

There were 129 students and 36 teachers in 9 design thinking workshops.

4.4. Results of qualitative research

The results will be presented by research area for each country. For each research area, we will provide a summary of the main conclusions and key findings for all nine schools.

4.4.1. Identify Strategies to Improve Lesson Tracking

Slovenia

- ❖ 1st School | Urban Secondary School

Reflecting on opportunities for improvement, teachers stressed the importance of teachers being able to listen to young people and making an effort to understand them. They also think it is important for students to understand that learning has a purpose, what the teacher can clearly support by being able to show them why knowledge is important and where they will be able to imply it. They also stressed the importance of creativity when working with young people, whether it be by changing the learning environment, enriching the lesson by inviting guests, sharing experiences or coming up with alternative approaches (e.g. a mikado competition).

Reflecting on possible improvements, students self-critically noted that they could remove some distractions themselves (especially not using phones during class or refraining from playing games), and also mentioned the importance of a regular and good night's sleep. They also stressed the desire for more order in terms of the school timetable (starting classes at the same times, not too early, etc.). In terms of expectations regarding

the way lessons are delivered, they particularly wanted them to be dynamic and not all delivered using the same method.

➤ 2nd School | Urban Secondary School

In the context of our research, we have identified several factors related to improving lesson tracking, as highlighted by the participating teachers. Teachers have highlighted four areas where they themselves feel they can contribute most to improving lesson tracking, and in each of these areas they feel there is room for improvement. They stressed the importance of taking care of their own well-being, the importance of coming to class rested, in a good mood, as this gives off better energy and makes them better motivators for their students. They consider it important to continuously explore new possibilities and alternative approaches to teaching and to be open to training. They also stressed the importance of individual approaches to students, as individual and personalised work could help them to be more intrinsically motivated (because they would have better insight and understanding of why a certain subject is important to them). They also see opportunities in cross-curricular integration.

Students feel that teachers should involve them more in lessons. They see a possible solution in dividing classes into smaller units (smaller classes), especially to make sure that students with different backgrounds learn together. Many students have critically pointed out that the material is often too easy and that they get bored or do not use the time wisely. Younger students in particular pointed out that they are aware of how distracting phones are when they are studying. However, they have difficulty concentrating and would like to have longer breaks and shorter lessons. However, they also pointed out that they would like to see stricter rules in the classroom.

○ 3rd School | Rural Secondary School

Teachers feel that they could do a lot to improve students' motivation by showing enthusiasm for the subject and preparing well for lessons. They believe that innovative choices of methods can help. Above all, they stressed the importance of a good interpersonal relationship (that it is important to be positive towards students, to be approachable and fair, to talk to students, to be able to praise and encourage them, to reward them appropriately and to motivate them to do extra work).

Students want teachers to be respectful (to give them extra explanations when they ask for them) and to make better use of the time between lessons (less reinforcement, because otherwise they don't work through the material). Some pointed out that they would like computers to be allowed during lessons so that they could take notes on the computer. They would like to see more cross-curricular links and a pleasant atmosphere in the classroom.

Greece

❖ 1st School | Urban Upper Secondary School

As part of the research, we have recorded several factors related to a set of ideas to improve lesson tracking. The teachers highlighted the modernization of educational materials, including the curriculum and textbooks. They emphasized the importance of interdisciplinarity, for example integrating subjects with the fine arts. Furthermore, they suggested interactive teaching methods using various media, such as experiments. The teachers also advocated for experiential learning, connecting school knowledge with real life contexts. Lastly, they called for a change in the evaluation methods for students, moving away from a focus on grades.

In the context of our research, we have also recorded several suggestions from the students to improve lesson tracking. These suggestions include the rationalization of the curriculum and alignment with the available time, modernization of educational materials (curriculum and books), and suitable classrooms for the size of the relevant classes. Students also proposed utilization of technology, and dedicated labs and special rooms for each subject. They emphasized the importance of making lessons more engaging with activities both inside and outside the classroom, and personalized career guidance for each student.

➤ 2nd School | Semi Urban Upper Secondary School

In the context of our research, we have identified several factors related to improving lesson tracking, as highlighted by the participating teachers. These include the modernization of educational materials, the need for changes in teaching methods, and the connection of school knowledge with real-life applications. Additionally, opening the school to the community and linking it to real-life conditions were emphasized. Flexibility in authority and leadership, along with a social environment that recognizes the value of knowledge and learning, were also considered important.

The Students in the same school highlighted several factors to improve lesson tracking. They suggested reducing the curriculum content and making lessons more engaging through outdoor activities and innovative methods. They emphasized the importance of utilizing technology and focusing more on practical knowledge rather than theoretical. Additionally, students expressed the need for open dialogue and exchange of ideas between students and teachers in a democratic atmosphere that encourages freedom of expression. They also proposed starting classes later, either after 9:00 AM or even after 11:00 AM.

○ 3rd School | Semi Urban Lower Secondary School

We have identified several factors highlighted by the teachers in this school so as to improve lesson tracking. These factors include the implementation of interactive whiteboards, ongoing teacher training, and the reduction of non-teaching responsibilities. Additionally, the staff suggested the hiring of secretarial support for the school, better salaries, and reducing the number of students per class.

We have recorded several suggestions from the students to improve their learning experience. They emphasized the utilization of technology, including the use of interactive whiteboards. They also suggested starting classes later than the current schedule and reducing the number of teaching hours. Students also proposed the elimination of the absence limit and expressed a desire for lessons to be fun and engaging, capturing their interest. Additionally, they recommended allowing students to park their vehicles at school and permitting the use of mobile phones. Lastly, they highlighted the importance of regularly assessing teachers' teaching and pedagogical skills to ensure they can effectively manage large classes without causing disruptions.

Portugal

❖ 1st School | Semi Urban Secondary School

Teachers mentioned the lack of educational materials, especially digital ones, and the importance of connecting and articulating teaching-learning with the world of work. Students considered it important to reduce the workload, make teaching more interactive and less theoretical, and enhance autonomy and creativity. They emphasized the importance of dialogue and listening to others, considering their specificities. They also highlighted the importance of using technologies.

➤ 2nd School | Urban Secondary School

Teachers did not specifically identify driving factors, only mentioning the importance of knowledge consistency and problematization. Students considered it important to reduce the workload, have fewer theoretical classes, outdoor activities and field trips, use technology, and connect school knowledge with real life. They also highlighted the importance of dialogue and interaction between teachers and students and the value of knowledge for future preparation. They also considered project work important.

○ 3rd School | Semi Urban Secondary School

Teachers only mentioned the importance of connecting and articulating teaching-learning with the world of work and the need for systematic student monitoring. Students considered it important to reduce the workload, have fewer theoretical classes and outdoor activities, use technology, and connect school knowledge with real life. They also highlighted the importance of dialogue and interaction between teachers and students

and the value of knowledge for future preparation. They also considered project work important, as well as moments of social interaction between students and teachers, like shared snacks.

Combined data and main conclusions from all nine schools with conclusions and key takeaways:

1. Importance of a Dynamic and Student-Centered Learning Environment

- **Teachers' Perspective:** Teachers consistently emphasized the need for a supportive and engaging learning environment across all nine schools. They highlighted the importance of modernizing educational materials, integrating interdisciplinary approaches, and connecting classroom learning with real-world applications. Teachers also stressed the significance of interactive teaching methods, such as the use of technology, simulations, and experiential learning. Additionally, they called for smaller class sizes, better-equipped classrooms, and ongoing professional development to enhance their teaching practices.
- **Students' Perspective:** Students from all schools shared a strong desire for lessons that are more engaging and interactive. They emphasized the need for reducing theoretical content in favor of practical, real-life applications of knowledge. Students also expressed a preference for varied teaching methods, including the use of technology, outdoor activities, and project-based learning. They highlighted the importance of a classroom environment where they feel heard and respected, with ample opportunities for dialogue and interaction with teachers.

2. Flexibility and Adaptability in Teaching and Learning

- **Teachers' Perspective:** Teachers recognized the importance of flexibility in teaching, including adapting lesson plans to better meet the needs of students. They suggested the introduction of flexible schedules, such as starting classes later in the day, to accommodate students' natural rhythms and improve their focus and engagement. Teachers also pointed out the need for reducing non-teaching responsibilities and increasing support staff to allow them to focus more on teaching.
- **Students' Perspective:** Students echoed the need for flexibility, particularly in terms of scheduling and workload. They suggested starting classes later in the morning, reducing the overall teaching hours, and allowing more breaks to improve concentration. Students also called for a reduction in the curriculum content, focusing more on depth rather than breadth of knowledge. Additionally,

they requested more opportunities for independent learning and autonomy in their educational journey.

3. Strong Teacher-Student Relationships and Communication

- **Teachers' Perspective:** Teachers across the schools highlighted the importance of building strong, positive relationships with their students. They believe that being approachable, empathetic, and enthusiastic about teaching can significantly enhance student motivation and engagement. Teachers also emphasized the need for regular, open communication with students to better understand their needs and tailor their teaching methods accordingly.
- **Students' Perspective:** Students placed a high value on the quality of their relationships with teachers. They appreciated teachers who are respectful, open to dialogue, and genuinely interested in their students' well-being and academic success. Students also expressed a desire for more collaborative learning experiences, where they can work closely with their teachers and peers to co-create knowledge and explore topics of interest.

4. Integration of Technology and Real-World Applications

- **Teachers' Perspective:** Teachers recognized the potential of technology to enhance the learning experience, particularly through the use of digital platforms, interactive whiteboards, and VR. They also stressed the importance of connecting classroom learning with real-world contexts, such as integrating career guidance and practical applications of knowledge into the curriculum.
- **Students' Perspective:** Students were enthusiastic about the use of technology in the classroom, noting that it makes lessons more engaging and relevant to their lives. They also emphasized the importance of linking academic content to real-world scenarios, which they believe makes learning more meaningful and prepares them better for the future. Students expressed a strong interest in project-based learning and other hands-on activities that allow them to apply their knowledge in practical ways.

Main Conclusions

- **Need for Modernization and Flexibility**

Both teachers and students agree on the need for modernizing educational materials and adopting more flexible approaches to teaching and learning. This includes integrating technology, offering more hands-on learning opportunities, and adjusting schedules to better align with students' needs.

- **Emphasis on Relationships and Communication**

The importance of strong, positive teacher-student relationships was a common theme across all schools. Both groups emphasized the value of open communication, mutual respect, and collaboration in creating a supportive learning environment.

- **Connecting Learning to Real Life**

There is a shared desire to make learning more relevant to students' lives by connecting academic content with real-world applications. This approach not only enhances engagement but also helps students see the value of their education in preparing them for future challenges.

- **Challenges and Opportunities for Improvement**

- While there are several challenges, such as large class sizes, heavy workloads, and the need for more personalized attention, both teachers and students see these as opportunities for improvement. By embracing innovative teaching methods, fostering strong relationships, and integrating technology effectively, schools can create more dynamic, engaging, and effective learning environments.



Key Takeaways:

- **Dynamic and Engaging Learning**

Teachers: Emphasized the need for modernized materials, interactive methods, and real-world connections in lessons.

Students: Prefer practical, varied lessons that are engaging and incorporate technology.

- **Flexibility in Education**

Teachers: Support flexible schedules and reduced non-teaching tasks to better meet student needs.

Students: Want later start times, reduced workload, and more independent learning opportunities.

- **Strong Relationships and Communication**

Teachers: Highlight the importance of building positive, supportive relationships with students.

Students: Value respectful, open communication and collaborative learning with teachers.

- **Integration of Technology**

Teachers: See the potential in using technology like VR to enhance learning, especially with real-world applications.

Students: Enthusiastic about technology but emphasize it should complement real-life learning and be used effectively.

4.4.2. The most inspiring lesson

Slovenia

❖ 1st School | Urban Secondary School

Teachers stressed the importance of a supportive and safe learning environment, free from incorrect answers and wrong questions. The objectives of the lesson should be clear, not too many, but at the same time the teacher should be open to questions and encouragement from the students. They consider it important that students have concrete experiences and learn in different, dynamic ways (such as app-based activities, simulations, role-playing, fieldwork, social games, experiments, etc.) Above all, it is important that students work well with each other and with the teacher to design the lesson together.

Students pointed out that the most important thing for a good lesson are the relationships that create a pleasant atmosphere in the classroom (that the teacher does not get angry with students, does not single them out if they do not want to, but at the same time allows opportunities for those who do want to voice their opinions, that the teacher is sympathetic to students but at the same time knows how to establish authority).

They consider that a good lesson is one where different, dynamic methods are used, as these help to make the explanation dynamic and interesting, but at the same time they want it to be clear at the end of the lesson which information is important and it is important that they know and understand it. They feel that the lessons take too long (they cannot concentrate for so long), and they would like to see lessons without assessments. They care about what their teachers think and would like them to give their opinion and their view on particular (current) issues more often.

Their answers also indicate how important it is that their biological needs are taken care of and how important dialogue with the teacher is for them (e.g. they accept prohibitions but would like to understand why they are not allowed to do something).

➤ 2nd School | Urban Secondary School

We have identified several factors highlighted by the teachers regarding the most inspiring lesson. Teachers consider the ideal lesson to be defined by interesting learning content and good classroom dynamics. For the latter in particular, they believe it is important to keep classes small so that lessons can be as personalised as possible.

However, factors that teachers do not have much control over, such as the weather, how tired students are, what time of the day the lesson is (after snack, students are more tired than before), also have an impact on an inspiring lesson.

The students confirmed some of factors mentioned by teachers and expressed some additional factors regarding the most inspiring lesson. The students stressed the importance of a good relationship between students and teachers (that they try to establish a genuine contact with students, are respectful and open). The teacher's presence and the quality of their knowledge is important (what is their attitude towards the subject they teach, how much energy does they bring to the class, how interested they are in teaching, etc.). Students get a very good idea of when/which teachers are really good at the subject they teach and which teachers love their profession. Students also attached great importance to the activities that teachers encourage them to do (project work, independent research - any move away from traditional ex cathedra teaching and encouragement to independent research and integration is warmly welcomed by students).

- 3rd School | Rural Secondary School

Teachers felt that the ideal lesson would be longer than the current one, to allow more time and opportunities for more interactive tasks. They would also like to have more freedom in the choice of material and the way the material is explained. We would like to see better equipped facilities, the possibility of classrooms in nature. They feel that invited guests, experts, would add value to the lessons.

Like the teachers, the students also expressed a desire for lessons in nature. They would like to see more discussion with their teachers, more opportunities for debate and discussion, more varied lessons (group work, use of technology, distance learning...) They would like to see humour and relaxation, and strict adherence to the announced assessment.

Greece

- ❖ 1st School | Urban Upper Secondary School

We have identified several factors highlighted by the teachers regarding the most inspiring lesson. These factors include maintaining a calm and positive classroom atmosphere with a pleasant, friendly, and good psychological disposition, along with passion from the teacher and the coordination and motivation of all students. Additionally, the use of differentiated instruction and experiential learning, incorporating playful learning, utilizing new technologies, interactivity, and virtual reality, were also emphasized. Teachers also stressed the importance of connecting school knowledge with

real life contexts, addressing the daily interests and needs of students for their development.

The students have similarly identified factors regarding the most inspiring lesson. These factors include having lively and engaging lessons that motivate interest and cooperation among all students. Students, as their teachers did, emphasized the importance of connecting the lessons with their needs and future prospects. They also valued a calm classroom atmosphere, free from noise, where the teacher fosters a good, friendly, and humorous environment, allowing for free dialogue and expression of opinions. Objectivity in grading, tolerance of student differences, and adequate resources were also considered crucial. Utilizing digital technologies, such as videos and interactive whiteboards, was seen as beneficial. Students suggested excluding teachers who are unpleasant, overly strict, indifferent to student needs, and disorganized. Lastly, they stressed avoiding monotonous lectures focused solely on completing the curriculum without engaging students meaningfully.

➤ 2nd School | Semi Urban Upper Secondary School

We have identified several factors highlighted by the teachers regarding the most inspiring lesson. These factors include creating a classroom environment that does not resemble a traditional classroom, instead taking place outdoors in nature, with balls, colors, and sofas instead of desks. The participating teachers emphasized experiential learning, incorporating play and the use of new technologies. Additionally, they suggested using the project method and interdisciplinary approaches, as well as ensuring homogeneity in the students' proficiency levels.

The students on the other hand expressed some additional factors regarding the most inspiring lesson. These factors include stimulating student interest and demonstrating patience and care by the teacher, without discrimination or offensive language. Emotional connection and familiarity between teachers and students were also deemed important. Students, similarly to teachers, emphasized the value of a calm classroom atmosphere that fosters dialogue and exchange of ideas with a good sense of humor, free from conflicts and offensive remarks. The use of digital technologies (such as videos and interactive whiteboards), exercises resembling games, and clear explanations focused on practical application rather than unnecessary information were also considered crucial.

○ 3rd School | Semi Urban Lower Secondary School

In the context of our research, we have recorded several factors highlighted by the teachers regarding the most inspiring lesson. These factors include maintaining a calm and friendly classroom environment where all students are engaged and their individual differences are accepted. The teachers emphasized the importance of differentiated

instruction and student-centered pedagogy. They also highlighted the benefits of experiential and collaborative learning. Additionally, having each teacher in their own classroom equipped with the necessary tools and ensuring that students are not assigned an excessive workload were considered crucial elements.

On the other hand, the students highlighted multiple factors regarding the most inspiring lesson. These factors include good communication between teachers and students, and the utilization of digital technologies such as videos and interactive whiteboards. The students also emphasized the importance of group teaching and the assignment of tasks that are easy to understand for everyone. They highlighted the need for lively and engaging lessons that capture the interest and participation of all students, and a calm and enjoyable classroom atmosphere. Additionally, they preferred lessons based on dialogue rather than teachers' monologues, with clear explanations of the material.

Portugal

❖ 1st School | Semi-urban Secondary School

Teachers emphasized the importance of knowing each student individually and encouraging students to think "outside the box," that is, innovatively and creatively. They considered it necessary to change the curriculum and learning goals to benefit the students' voice and a new school. Students considered it important to enhance autonomy and creativity and plan dynamic activities that are motivating. They pointed out the importance of changing the schedules as they felt overloaded, and that the classroom was the place where paths guiding their future were built. They also mentioned the importance of connecting teaching to the real world and emphasized that teachers could motivate and lead students to realize their potential.

➤ 2nd School | Urban Secondary School

Teachers highlighted the importance of classes that enhance reasoning and problematization, leading students to have new ideas. They also considered it important for students to obtain consistent knowledge that does not crumble in the face of difficulties and facilitates informed choices. Students emphasized the importance of a calm and relaxed environment where the focus is on knowledge. They considered it important that there is no atmosphere marked by the fear of participating or triggered by the teacher's or other student's judgment. They conceived teaching as the light that leads them to dream of the future, solve problems, and think creatively and innovatively. They mentioned it would be important to have more interaction and support between teachers and students, as well as conducting educational activities in spaces other than the classroom, as these provide greater freedom of thought.

- 3rd School | Semi-urban Secondary School

Teachers only mentioned the importance of connecting and articulating teaching-learning with the world of work and the need for systematic student monitoring. Students considered it important to reduce the workload, have fewer theoretical classes, and outdoor activities, use technology, and connect school knowledge with real life. They also highlighted the importance of dialogue and interaction between teachers and students and the value of knowledge for future preparation. They also considered project work important, as well as moments of social interaction between students and teachers, like shared snacks.

The most inspiring lesson: combined data from all nine schools with conclusions and key takeaways

Across nine schools from various regions, both teachers and students shared their perspectives on what makes a lesson truly inspiring. The common themes identified from these discussions highlight the importance of a supportive and dynamic learning environment, the need for engaging and innovative teaching methods, and the value of strong relationships between teachers and students.

1. Supportive and Safe Learning Environment

Teachers' Perspective

Teachers from multiple schools emphasized the importance of creating a supportive and safe classroom environment. They believe that a good lesson is one where students feel free to ask questions without the fear of being judged for incorrect answers. Clear objectives should guide the lesson, but the flexibility to encourage student participation and questions is key. Additionally, teachers noted that a calm and positive atmosphere, enriched by a good psychological disposition and passion from the teacher, fosters a productive learning space.

Students' Perspective

Students echoed the teachers' emphasis on the classroom atmosphere. They highlighted that the most inspiring lessons occur when teachers are approachable, empathetic, and able to establish a respectful and authoritative presence. They value a classroom where they can express their opinions freely, without fear of judgment or harsh criticism. Moreover, students appreciate when teachers make an effort to connect lessons to their personal lives and future aspirations.

2. Engaging and Dynamic Teaching Methods

Teachers' Perspective

Teachers across the schools stressed the importance of using varied and dynamic teaching methods. They advocate for incorporating experiential learning, such as simulations, role-playing, fieldwork, and interactive technologies like videos and virtual reality. These methods not only make lessons more engaging but also help students connect theoretical knowledge with real-life applications. In some schools, teachers also mentioned the benefits of interdisciplinary approaches and integrating lessons with arts and other subjects.

Students' Perspective

Students expressed a strong preference for lessons that go beyond traditional lectures. They appreciate project-based learning, independent research, and other activities that encourage active participation and critical thinking. Students also noted that lessons should be lively and varied, incorporating group work, technology, and outdoor activities. They believe that these approaches make learning more interesting and help them better understand and retain the material.

3. Strong Teacher-Student Relationships

Teachers' Perspective

Teachers recognize the importance of building strong, positive relationships with their students. They believe that showing enthusiasm for the subject, being approachable, and engaging in meaningful dialogue with students are essential components of an inspiring lesson. Teachers also stressed the importance of understanding each student individually, which helps in tailoring lessons to meet their needs and motivates them to learn.

Students' Perspective

Students place a high value on the relationship they have with their teachers. They appreciate when teachers take the time to understand them, listen to their concerns, and provide support when needed. Students also value teachers who are passionate about their subjects and who convey that passion in their teaching. A good relationship with the teacher makes students more likely to participate in class and be motivated to learn.

4. Real-World Connections and Autonomy

Teachers' Perspective

Teachers across different schools emphasized the need to connect classroom learning with the real world. They believe that lessons should be relevant to students' lives and future careers. Teachers also highlighted the importance of fostering autonomy and creativity in students by encouraging them to think outside the box and explore new ideas.

Students' Perspective

Students similarly stressed the importance of making connections between what they learn in school and real-world applications. They appreciate when teachers help them see the relevance of their studies to their future goals. Students also expressed a desire for more autonomy in their learning, including having a say in what and how they learn.

Main Conclusions

The data from all nine schools reveal a shared vision of what constitutes an inspiring lesson. Both teachers and students agree on the importance of a supportive and dynamic learning environment, engaging and varied teaching methods, strong relationships between teachers and students, and the relevance of lessons to real-life contexts. These factors collectively contribute to a more effective and inspiring educational experience. To enhance lesson delivery, educators should focus on creating a positive classroom atmosphere, employing innovative teaching methods, fostering strong relationships, and connecting learning to the real world while promoting student autonomy.



Key Takeaways

- **Supportive and Safe Learning Environment**

Both teachers and students value a classroom atmosphere that is safe, and positive, and allows open communication without fear of judgment.

- **Engaging and Dynamic Teaching Methods**

There is a strong preference for varied teaching methods that include experiential learning, technology integration, and active participation, making lessons more engaging and relevant.

- **Strong Teacher-Student Relationships**

Positive and supportive relationships between teachers and students are seen as crucial for motivation and effective learning.

- **Real-World Connections and Autonomy**

Both teachers and students emphasize the importance of connecting lessons to real-world applications and allowing students more autonomy in their learning process.

4.4.3. Assess the Role of VR in Lessons

Slovenia

- ❖ **1st School | Urban Secondary School**

The concept of Virtual Reality was mentioned by the researcher ("If you think of VR, could it fulfil any of the criteria of the most inspiring lesson that you have mentioned?"). It was not spontaneously identified as a factor by either the teachers or the students.

However, once mentioned by the researcher, teachers expressed concern regarding their work overload and lack of time. They assured that they are open to innovations, but that not all of them necessarily have sufficient technical knowledge to develop (and sometimes use) approaches that require additional skills in computing (use of technology).

The participating students thought that it would be interesting to have VR glasses and be able to imagine more easily what the teacher is explaining, and when they listed the content areas/topics where they thought they would benefit most from this type of demonstration, they highlighted e.g. history (The Story of Minotaurus), geography (Amazon Rainforest), etc. However, they pointed out that they would find, for example, insights into current wars (e.g. the war in Syria) too scary.

- **2nd School | Urban Secondary School**

The topic of Virtual Reality was introduced by the researcher. Neither the teachers nor the students mentioned Virtual Reality on their own.

Compared to students, teachers were more open to using VR in the classroom. They stressed, in particular, the importance of having content prepared in advance, otherwise it represents too much energy and time investment for the teacher for one single lesson. It is important that the aim of such demonstrations is clear - to encourage students to be active (e.g. demonstrations of mathematical functions, foreign language lecturing).

Students unanimously reacted negatively to the mention of VR. They see the use of VR as unnecessary, wasteful and do not see any particular benefits that could not be obtained in simpler ways. They pointed out that VR gets boring, that they feel it does not offer anything that other approaches do not already offer. It is important to point out that two students have explored VR in depth in the past school year and pointed out that it could be useful in situations where additional visualisation would make sense (e.g. biology, history, technical lessons - the inside of machines, etc.). However, there was strong agreement that if VR were to be introduced into the classroom, it was important that this type of instruction represented a very small percentage (1-2 hours per year at most), and concerns were raised that it might otherwise impair students' knowledge.

- **3rd School | Rural Secondary School**

It was the researcher who introduced the mention of Virtual Reality, as neither the teachers nor the students brought it up themselves.

Students thought that using VR would be interesting and could help with understanding certain material (e.g. how certain processes work in nature, e.g. photosynthesis, physics in everyday life, historical events, the use of mathematical functions in nature).

Teachers accepted the potential idea of using VR on the condition that it forms a short part of the lesson (for introductory motivation or for reinforcement), as they consider it important that students do not use screens during the lesson. They see the opportunity mainly in illustrating more abstract material (e.g. in subjects such as physics) or to support the concrete application of material (e.g. languages - used in everyday practice).

Greece

- ❖ **1st School | Urban Upper Secondary School**

The concept of Virtual Reality was mentioned by the researcher. It was not spontaneously identified as a factor by either the teachers or the students.

However, once mentioned by the researcher, several factors regarding the potential use of Virtual Reality (VR) in education were highlighted by the teachers. They suggested that VR could facilitate student dialogue with historical figures, making knowledge more accessible and friendly through visual engagement. It was noted that VR could increase

students' concentration and attention. Additionally, incorporating VR in schools could integrate tools that are currently considered extracurricular, such as video games. VR was also seen as particularly useful for vocational school subjects. However, teachers emphasized that VR should be used as a supplementary tool rather than as the primary method of teaching.

The participating students had also generated numerous views once the notion of VR was put forward by the researcher. They believe that it would make lessons more experiential, which is especially beneficial for subjects that many find boring and uninteresting, such as History or Physics. Virtual Reality would make lessons more interactive. However, students emphasized that it cannot replace the teacher but can effectively complement the school textbook. Additionally, it would provide the opportunity to oversee artistic works and cultural monuments, enhancing the overall learning experience.

➤ **2nd School | Semi Urban Upper Secondary School**

The topic of Virtual Reality was introduced by the researcher. Neither the teachers nor the students mentioned Virtual Reality on their own.

Once mentioned by the researcher, there were several factors highlighted by the teachers regarding the use of virtual reality in everyday teaching. Some teachers expressed concerns that virtual reality could limit students' imagination and considered it to be negative and potentially dangerous. However, others noted that it could help students understand difficult concepts by providing virtual experiences of places such as museums or outer space, where physical presence is not possible.

Similarly, the students expressed a lot of views regarding the use of Virtual Reality in lessons. Specifically, the students mentioned that while Virtual Reality could be a helpful tool, traditional books are still necessary. They expressed that although Virtual Reality would be interesting, they are concerned it might limit their imagination.

○ **3rd School | Semi Urban Lower Secondary School**

It was the researcher who introduced the mention of Virtual Reality, as neither the teachers nor the students brought it up themselves.

The teachers expressed a quite diverse range of positive ideas regarding virtual reality. They noted that virtual reality increases student interest by allowing them to visit distant places and experience different cultures, lifestyles, and mindsets. It also provides opportunities for experiential learning of historical events, such as the American and French Revolutions, World War I, and the ancient Olympic Games.

On the other hand, students believe that lessons, particularly History and Biology, would become more comprehensible through the use of virtual reality. They expressed excitement about the possibility of virtually travelling to different places, such as Australia, Japan, the depths of the oceans, and outer space. They also mentioned the potential to visit historical events, like the Trojan War, the Battle of Thermopylae, Socrates drinking hemlock, and the Chernobyl disaster, as well as exploring the future. Additionally, students noted the opportunity to meet influential figures like Escobar and Tony Montana.

Portugal

❖ 1st School | Semi-urban Secondary School

The concept of Virtual Reality did not spontaneously arise in the teachers' and students' discourse and was introduced by the activity facilitators.

After mentioning it, the teachers were experienced, and one of them owned VR glasses. They considered it to have potential and pointed out the importance of using it with rules, giving the example of artificial intelligence. However, it was the students who gave more importance to the use of VR, considering it motivating and facilitating learning as it would promote understanding. On the other hand, they emphasized its importance for knowledge construction, although not replacing teachers. They particularly pointed out themes related to History, focusing on the 18th to 20th centuries, sustainability, Art History, museum visits, the solar system, DNA, and the human body. Both students and teachers indicated it would be important to complement VR use with other digital tools that test knowledge construction, such as a Quiz. Students, like teachers, mentioned the importance of responsible use of the equipment and the establishment of usage and hygiene rules. They also indicated that its use should be done in rooms that ensure safety.

➤ 2nd School | Urban Secondary School

The concept of Virtual Reality did not spontaneously arise in the teachers' and students' discourse and was introduced by the activity facilitators.

Teachers considered new technologies important but did not specifically focus on Virtual Reality. However, following the debate, they considered its use might be interesting. Students found its use interesting but not in all classes and subjects. They highlighted its use in Biology and Geology, Mathematics, Physics-Chemistry, and Portuguese on themes such as: studying species, biological and geological phenomena, visualizing molecules and chemical reactions, and viewing plays. Students, as well as teachers, mentioned the importance of responsible use of the equipment and the establishment of usage rules. They also indicated that its use should be done in rooms that ensure safety.

- **3rd School | Semi Urban Secondary School**

The concept of Virtual Reality did not spontaneously arise in the teachers' and students' discourse and was introduced by the activity facilitators.

Teachers considered it relevant. An example of its usefulness for inclusive education students in spatial orientation within the school space and the surrounding community was given. It was also highlighted that it allows working on essential skills, not just curriculum content. Students found it very useful in Informatics to see the inside of computers, visit a Data Center, and present projects. They also highlighted its use in accident simulation, referring to Camões and the Cantigas de Amigo. They also mentioned its importance in History as it would allow them to travel through time, in Foreign Languages allowing the learning and/or improvement of various languages, and in Physics-Chemistry. They considered its use important but not systematically, and that it is important to distinguish reality from fiction. They believe it is important to establish rules for its use and ensure the existence of safe spaces.

Assess the role of VR in lessons - combined data from all nine schools with main conclusions and key takeaways:

Across nine schools, the topic of Virtual Reality (VR) was introduced by researchers rather than spontaneously mentioned by teachers or students. The responses varied widely, indicating both potential benefits and concerns regarding its integration into educational settings.

1. Teacher' Perspectives



Across the schools, teachers generally did not spontaneously mention VR as a tool for enhancing lessons. However, once introduced by researchers, they expressed a mix of openness and caution towards its use.

- **Potential Benefits**

Teachers recognized the potential of VR to make lessons more engaging, especially in subjects like history, geography, and science. They noted that VR could help illustrate complex or abstract concepts, provide experiential learning opportunities, and increase student motivation by making lessons more interactive. For instance, VR could enable virtual field trips, historical reenactments, and simulations of scientific phenomena, which could make the material more accessible and engaging for students.

- **Concerns**

Despite acknowledging these benefits, teachers also expressed concerns about the practicality and appropriateness of VR in the classroom. They pointed out the need for extensive preparation, technical knowledge, and the potential for VR to be a distraction rather than an aid if not used judiciously. Some teachers were particularly worried about the time and effort required to integrate VR effectively into their lessons, as well as the risk of it limiting students' imagination if overused. There was also concern about the potential negative effects of too much screen time on students.

- **Implementation**

Many teachers suggested that VR should be used sparingly, perhaps as a supplementary tool rather than a primary teaching method. They emphasized that its use should be well-regulated, with clear objectives and rules to ensure that it enhances rather than detracts from the learning experience. Safety and responsible usage were also highlighted as key considerations, particularly in terms of ensuring that VR sessions are conducted in appropriate settings.

2. Student Perspectives



Students' reactions to the idea of using VR in lessons were mixed, with opinions ranging from enthusiastic to sceptical.

- **Enthusiasm for Innovation**

Some students were excited about the possibility of using VR to make lessons more immersive and engaging. They saw value in VR's ability to bring abstract or distant concepts to life, such as exploring historical events, understanding scientific processes, or visiting different parts of the world virtually. Subjects like history, biology, and geography were frequently mentioned as areas where VR could be particularly beneficial.

- **Skepticism and Concerns**

However, other students were less enthusiastic, expressing concerns that VR might be unnecessary or even counterproductive. Some felt that traditional teaching methods were sufficient and that VR could become boring or distracting if overused. There were also concerns about the potential for VR to limit creativity and imagination, with some students preferring hands-on, real-world experiences over virtual ones.

- **Specific Preferences**

Students suggested that if VR were to be used, it should be done selectively and in a way that complements traditional teaching methods. They emphasized the importance of keeping VR sessions short and focused, and many mentioned the need for clear rules and guidelines to ensure that VR is used responsibly and effectively. Some students also pointed out the potential for VR to be unsettling or overwhelming, particularly in simulations of intense or frightening content.

Main Conclusions

The data from all nine schools reveal that while there is significant potential for VR to enhance learning, its implementation in the classroom needs to be approached with caution. Both teachers and students see value in the immersive and interactive qualities of VR, particularly for certain subjects and topics. However, there are concerns about the time, effort, and expertise required to use VR effectively, as well as the potential for negative impacts if it is not carefully managed.



Key Takeaways

- **Selective Integration**

VR should be used as a supplementary tool, integrated selectively into the curriculum where it can provide clear benefits, such as in visualizing complex concepts or creating immersive experiences that are not possible through traditional methods.

- **Clear Objectives and Guidelines**

The use of VR should be guided by clear educational objectives and accompanied by rules that ensure its responsible use. Teachers need support and training to effectively integrate VR into their lessons.

- **Balancing Innovation with Tradition**

While VR can offer new and exciting ways to engage students, it should not replace traditional teaching methods but rather complement them. The goal should be to enhance, not overwhelm, the learning experience.

- **Student and Teacher Involvement**

Both students and teachers should be involved in discussions about how and when to use VR in the classroom, ensuring that its implementation meets the needs and preferences of all parties involved.

4.4.4. The key message from students and teachers involved in the research

Slovenia

Students in all schools expressed their gratitude for the open conversation with their teachers, saying that it was valuable to hear their opinions. In all schools, good relationships with teachers were the most important aspect of their aspirations and expectations. They would have liked more communication, they would have liked to have been asked for their opinion more often.

Teachers were very impressed with how enjoyable the workshop was and stressed that communication is important and that they should ask students for their opinions more often. They would like to have (at least a few) motivated students in each class.

Greece

Students highlighted several suggestions to enhance lesson tracking, including rationalizing the curriculum to align with the available time, modernizing educational materials, and ensuring that classrooms are appropriately sized for the groups. They emphasized the importance of utilizing technology and establishing dedicated labs and special rooms for each subject. Engaging lessons that involve activities both inside and outside the classroom, along with personalized career guidance, were also considered crucial. For the most inspiring lessons, students valued lively and engaging content that connects with their needs and future prospects, a calm and friendly classroom atmosphere, objectivity in grading, and adequate resources. The use of digital technologies like videos and interactive whiteboards was seen as beneficial. Additionally, students suggested avoiding monotonous lectures and emphasized the importance of meaningful engagement. Regarding Virtual Reality (VR), students believe it would make lessons more experiential and interactive, particularly for subjects like History and Physics. They noted that while VR cannot replace teachers, it can effectively complement textbooks and provide opportunities to explore artistic works and cultural monuments, enhancing the overall learning experience.

Teachers emphasized several key factors across various schools to improve lesson tracking and enhance the learning experience. Teachers highlighted the importance of modernizing educational materials, including curriculum and textbooks, and integrating interdisciplinary approaches that connect subjects with fine arts and real-life applications. They advocated for interactive teaching methods, experiential learning, and the use of various media, such as experiments and digital technologies. Teachers also stressed the need for ongoing professional development, reducing non-teaching responsibilities, and providing adequate resources and support staff, such as secretaries. Furthermore, they called for changes in evaluation methods for both teachers and students, aiming to shift the focus away from grades. A consistent theme was the importance of maintaining a calm, friendly, and engaging classroom environment where differentiated instruction and student-centered pedagogy are prioritized. Reducing class sizes and ensuring teachers have their own well-equipped classrooms were also seen as crucial for fostering a productive learning atmosphere.

Portugal

Students emphasized some aspects they consider factors that contribute to creating an ideal class. In this sense, they focused on the importance of teacher support, guidance, and the development of their maximum capabilities. A recurring theme was the importance of creating a positive and constructive social climate in the classroom, allowing each student to feel calm and safe to maximize their creative potential. They also highlighted the importance of diversified classes with a more practical component and outdoor activities. They mentioned that VR would be a learning strategy that allows access to more interactive content and experiences, making classes more motivating and meeting their interests.

Teachers emphasized the importance of creating responsible citizens with critical thinking and decision-making skills, providing diverse learning strategies (such as practical/laboratory classes, exploring digital platforms), and knowledge connected to the real world that allows meaningful learning and greater student engagement.



The key message from the research participants: students and teachers - combined data from all nine schools with key takeaways and conclusions

- **Strong Teacher-Student Relationships**

Both students and teachers across all schools emphasized the importance of good relationships. Students valued open communication and wished to be asked for their opinions more often, while teachers acknowledged the need for regular communication with students to enhance motivation and engagement.

- **Engaging and Dynamic Learning Environment**

Students highlighted the need for lively and engaging lessons that connect with their personal needs and future goals. They prefer diverse teaching methods, including practical activities, outdoor experiences, and the use of digital tools like VR, which they believe can make learning more interactive and experiential.

- **Modernization and Utilization of Technology**

Both students and teachers pointed out the importance of modernizing educational materials and incorporating technology, such as interactive whiteboards and VR. Students believe that VR can complement traditional teaching methods, particularly in subjects like History and Physics, by providing immersive and interactive experiences.

- **Curriculum and Classroom Management**

Students suggested aligning the curriculum with available time and modernizing educational resources. They also emphasized the need for appropriately sized classrooms and specialized labs. Teachers, on the other hand, called for a reduction in non-teaching responsibilities, smaller class sizes, and well-equipped classrooms to create a more effective learning environment.

- **Real-World Connections and Student Autonomy**

Both students and teachers agreed on the need to connect classroom learning with real-world applications. Teachers stressed the importance of fostering critical thinking and decision-making skills, while students expressed a desire for more autonomy in their learning and the opportunity to engage in practical, real-life applications of their knowledge.

Main Conclusions

- **Mutual Respect and Communication**

There is a strong mutual desire for better communication between students and teachers. Both groups recognize the importance of understanding each other's perspectives to create a more engaging and supportive learning environment.

- **Innovative Teaching Methods**

The integration of technology and experiential learning methods, such as VR, is seen as a valuable tool to enhance engagement and make lessons more interactive. However, there is also a recognition that technology should complement, not replace, traditional teaching methods.

- **Focus on Practical and Real-World Learning**

There is a clear consensus on the need to modernize the curriculum and focus more on practical, real-world applications of knowledge. Both students and teachers believe that this approach will make learning more meaningful and better prepare students for the future.

- **Importance of a Positive Classroom Environment**

Creating a positive, calm, and friendly classroom atmosphere is crucial for fostering student engagement and motivation. This environment, combined with varied and dynamic teaching methods, is seen as key to delivering inspiring and effective lessons.

4.4.5. The researchers' key message for the project

Slovenia

Although the schools we surveyed are geographically dispersed, the key message from students and teachers was very similar and can be summarised in a few points:

1) *Attitude plays a key role.* An emotionally regulated teacher who is able to establish a respectful relationship with students and has a positive attitude towards the material and his/her work motivates students. Students want to talk, they want to be challenged, they want to explore and be creative. Students want to know how their teachers feel about current global challenges.

2) *Opening up space and bringing creativity.* Students expressed indirectly (e.g. it is difficult to concentrate) or directly (e.g. we wish we could have chewing gum) that it is sometimes difficult to stay focused in lessons. Therefore, the use of different techniques was encouraged (most frequently, the desire for discussions, small group work, the desire to go out in nature was mentioned, VR was never mentioned spontaneously).

3) Restraint towards the use of VR. Although both teachers and students were challenged to let their dreams go, no one spontaneously mentioned the use of VR. In the school with the highest proportion of subjects related to computing and technology, students had the most reservations about using VR.

The openness to using VR is conditioned by the fact that

- (a) it represents a smaller proportion of the lesson and is very rarely used,
- (b) it is used in cases where a good visual representation is important but difficult to access in everyday life with the naked eye,
- (c) the preparation for the lesson is done in advance (no extra work for the teacher).

In light of what we have heard, the researchers believe that in our ethical stance, we are compelled to seriously consider the reluctance to use and (at times) resistance to the use of VR, and to use it exclusively in a way that fosters and supports respectful and inclusive communication between teachers and students, in other words, that VR serves (also) as a means of building a quality relationship in the classroom.

Greece

1) Modernization and Interactivity: Update educational materials and integrate digital tools like interactive whiteboards and VR to make lessons engaging and relevant. Use interdisciplinary approaches and connect lessons to real-life applications.

2. Support and Professional Development for Teachers: Provide ongoing training and equip classrooms with necessary resources and promote differentiated, student-centered instruction.

3. Positive and Inclusive Classroom Environment: Foster a calm, friendly, and inclusive atmosphere. Reduce class sizes for individualized attention and use holistic evaluation methods beyond traditional grading.

Portugal

The design of school programs and the preparation of teaching materials are dynamic processes that require constant reflection, updating, and improvement to ensure quality education for all students, especially through the following aspects:

- (a) Promoting equity and inclusion,
- (b) Involvement of various educational agents,

(c) Promoting the professional development of teachers, especially through continuous training and the promotion of the exchange of experiences and good practices to develop innovative and creative solutions,

(d) Promoting curriculum articulation, enhancing the integration of different areas of knowledge, and connecting with the Real World.



The researchers' key message for the project- combined data from all nine schools with key takeaways and conclusions:

- **Teacher Attitude and Student Engagement**

The attitude of teachers plays a crucial role in motivating students. An emotionally regulated, respectful, and positive teacher can inspire students to be more engaged, creative, and open to discussions. Students value knowing their teachers' perspectives on current global issues and want to be challenged and encouraged to explore.

- **Need for Creativity and Variety in Lessons**

Students expressed the need for more creative and varied teaching methods to maintain focus during lessons. They suggested incorporating discussions, small group work, and outdoor activities to keep them engaged. Interestingly, VR was not spontaneously mentioned as a desired tool, indicating a preference for more traditional, interactive methods.

- **Caution Towards the Use of VR**

Both teachers and students showed restraint and some resistance towards the use of VR in lessons. While they acknowledged that VR could be beneficial in certain situations, such as providing visual representations that are difficult to access otherwise, they emphasized that it should be used sparingly and not replace traditional teaching methods. Preparation for VR lessons should be minimal for teachers, and its use should enhance, rather than detract from, the learning experience.

- **Ethical Considerations for VR Use**

The researchers highlighted the need to respect the cautious approach towards VR expressed by participants. VR should be used in a way that supports inclusive and respectful communication in the classroom and contributes positively to the teacher-student relationship.

- **Modernization and Interactivity**

There is a strong call for updating educational materials and integrating digital tools like interactive whiteboards and VR to make lessons more engaging and relevant. Interdisciplinary approaches and real-life applications of lessons are also seen as crucial for effective learning.

- **Support and Professional Development for Teachers**

Ongoing training and professional development are essential for teachers to adapt to modern teaching methods and technologies. Providing necessary resources and promoting differentiated, student-centered instruction are key to improving lesson delivery.

- **Positive and Inclusive Classroom Environment**

A calm, friendly, and inclusive classroom atmosphere is vital for fostering effective learning. Reducing class sizes and using holistic evaluation methods that go beyond traditional grading can help create a more personalized and supportive learning environment.

Conclusions

- **Reluctance to VR**

Despite its potential, there is a clear reluctance among both teachers and students to fully embrace VR in the classroom. This suggests that while VR can be a useful tool, its implementation must be carefully considered and balanced with more traditional, proven teaching methods.

- **Focus on Human Connection**

The importance of strong relationships and communication between teachers and students cannot be overstated. Educational programs should prioritize these connections, ensuring that any technological tools, including VR, are used to enhance rather than replace human interaction.

- **Ongoing Modernization and Training**

Continuous updates to educational materials and methods, along with ongoing professional development for teachers, are necessary to keep education relevant and engaging for students. This includes incorporating new technologies in a way that complements and enhances traditional teaching practices.

- **Equity and Inclusion**

Educational programs must remain focused on promoting equity and inclusion, ensuring that all students have access to quality education that is tailored to their individual needs and connected to the real world.

Chapter 5 ⁴

Main conclusions and findings



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5. CONCLUSIONS AND TAKEAWAYS FOR FUTURE WORK

This chapter presents the main conclusions and findings of the project's initial research, grouped into three strands. The first strand comprises the conclusions drawn from the literature review. The second strand encompasses the conclusions derived from the quantitative research, specifically, the survey conducted with teachers and students. The third strand outlines the conclusions derived from the qualitative research, namely the design thinking workshops.

For each strand, the recommended future steps for the implementation of the work packages of the VR4Empathy project are highlighted.

5.1. Conclusions from literature review

- **Effectiveness of VR in Enhancing Empathy and Learning Motivation**
The use of Virtual Reality (VR) has been shown to significantly enhance students' empathy skills, particularly emotional empathy, by immersing them in diverse perspectives. This heightened emotional connection is critical for fostering a deeper understanding of social and emotional issues among adolescents. VR also appears to positively influence students' motivation to learn by providing engaging, immersive experiences that make abstract concepts more tangible and relatable.
- **Challenges in Developing Cognitive Empathy**
While VR is effective at promoting emotional empathy, it has shown limited success in fostering cognitive empathy, which requires more complex, effortful perspective-taking. Future work packages should explore ways to design VR experiences that better support the development of cognitive empathy, possibly by integrating more interactive and reflective elements that encourage users to engage deeply with others' perspectives.
- **Inclusion and Accessibility in VR-Based Education**
Ensuring that VR resources are inclusive and accessible to all students, including those with disabilities, is crucial. The project has identified both the potential benefits and challenges of using VR for students with visual, hearing, and cognitive impairments. Future efforts should focus on developing accessible VR tools and resources that can accommodate various learning needs, ensuring that no student is left behind.

- **Ethical Considerations and Safety Protocols**

The integration of VR into educational settings introduces ethical challenges, such as managing the risks of cybersickness, ensuring data privacy, and preventing over-reliance on virtual interactions at the expense of real-world social skills. Establishing comprehensive safety protocols and ethical guidelines is essential as the project progresses to mitigate these risks and ensure the responsible use of VR in education.

- **Role of Teachers in Enhancing Empathy through VR**

Teachers play a critical role in facilitating the effective use of VR in the classroom. Their ability to guide students through VR experiences, provide contextual understanding, and foster empathy through reflective discussions is vital. Future work packages should include teacher training and support to ensure they are equipped to maximize the educational benefits of VR while addressing any challenges that arise.

- **Long-Term Impact and Sustainability**

To ensure the long-term impact of the VR4Empathy project, it is important to focus on creating sustainable practices that can be adopted across educational settings. This includes developing a robust quality assurance framework for VR resources, engaging stakeholders in continuous feedback and improvement processes, and advocating for policy changes that support the integration of VR into mainstream education.

Future Steps for supporting the Implementation of Upcoming Work Packages

- **Development of Advanced VR Modules**

Future work packages should focus on creating more sophisticated VR modules that specifically target the development of cognitive empathy. This could involve scenarios that require users to actively engage in problem-solving, decision-making, and perspective-taking exercises.

- **Inclusive Design and Implementation**

Continue refining VR tools to ensure they are inclusive, particularly for students with disabilities. Collaborating with experts in special education and accessibility will be key to developing tools that are universally beneficial.

- **Ethical Framework and Guidelines**

Establish and disseminate comprehensive ethical guidelines for the use of VR in education, including protocols for managing health risks, ensuring data privacy, and balancing virtual and real-world interactions.

- **Teacher Training Programs**

Implement teacher training programs that focus on integrating VR into their pedagogical practices effectively. These programs should cover both technical skills and strategies for using VR to enhance empathy and other socio-emotional skills.

- **Monitoring and Evaluation**

Develop a monitoring and evaluation framework to assess the ongoing impact of VR interventions on students' empathy, learning motivation, and overall educational outcomes. This will help in making informed adjustments to the project as it progresses.

These conclusions and recommendations are intended to align with the broader goals of the VR4Empathy project and support the successful implementation of the upcoming work packages.

5.2. Conclusions from the surveys (quantitative research)

Conclusions For Students

- **Familiarity vs. Usage:** While most students are familiar with VR, regular usage is low, with a significant demographic skew favoring male and urban students.
- **Perceptions of VR in Education:** Students have mixed views on the effectiveness of VR in education, with concerns about its misuse and impact on concentration, though many recognize its potential for complex subjects.
- **Support Needs:** There is a clear demand for support from knowledgeable teachers and financial assistance to facilitate VR use in schools.

Recommendations -students

- **Targeted Implementation:** Introduce VR in subjects where it can most enhance learning, such as history, physics, and empathy-related activities, aligning with the goals of VR4Empathy to deepen cognitive empathy.
- **Teacher Training:** Invest in professional development for teachers to ensure they can effectively support students in using VR, particularly in ways that foster empathy.

- **Addressing Concerns:** Develop guidelines to mitigate concerns about VR misuse and its potential impact on concentration, ensuring it is used effectively to engage students without distraction.
- **Development of Cognitive Empathy:** Special emphasis should be placed on developing VR resources and supporting materials aimed at deepening cognitive empathy. This includes creating modules and content that encourage complex thinking and a deep understanding of diverse perspectives.

Conclusions for teachers

- **Limited Familiarity and Use:** A majority of teachers are not familiar with VR, and those who are, use it infrequently, reflecting a gap in adoption.
- **Mixed Attitudes:** Teachers express concerns about VR's psychological, social, and practical implications, though many are open to using it with proper support.
- **Empathy Development:** Teachers exhibit higher cognitive empathy, with significant gender differences, highlighting the importance of tailored approaches in empathy development.

Recommendations - teachers

- **Professional Development:** Provide targeted training that not only covers the technical use of VR but also its potential to develop empathy in students, aligning with VR4Empathy's objectives.
- **Curriculum Integration:** Collaborate with curriculum developers to integrate VR in a way that supports both cognitive and emotional empathy, addressing the unique challenges identified by teachers.
- **Supportive Environment:** Foster a supportive environment where teachers can share best practices and concerns regarding VR, ensuring its thoughtful and effective integration into classrooms.

Future steps for supporting the Implementation of Upcoming Work Packages

- **Pilot Programs:** Launch pilot programs to test VR-based empathy development activities in a controlled setting, gathering data to refine approaches before broader implementation.
- **Stakeholder Engagement:** Engage teachers, students, and parents early in the process to address concerns and build a supportive community around the VR4Empathy project.

- **Monitoring and Evaluation:** Establish clear metrics to monitor the impact of VR on empathy development and academic performance, ensuring continuous improvement and alignment with project goals.
- **Risk Management and Uncertainties:** Incorporate strategies for managing risks, including data security, preventing overuse of VR, and ensuring a balance between virtual and real-world social interactions. This will ensure the responsible and ethical use of VR in education.
- **Quality Assurance Framework for VR Resources:** Establish a quality assurance framework for VR resources to ensure their effectiveness and alignment with the educational goals of the project. This framework should include regular review and adaptation of resources based on monitoring results and feedback.

5.3. Conclusions from the design thinking workshops (qualitative research)

Shared Vision of Inspiring Lessons

Teachers and students across nine schools emphasized the importance of a supportive and dynamic learning environment, where effective lessons are characterized by diverse and engaging teaching methods, strong teacher-student relationships, and connections to the real world.

Recommendation: Future work packages should focus on creating and maintaining these environments by promoting innovative yet balanced teaching approaches that enhance, rather than overwhelm, the learning experience.

Role of Virtual Reality (VR)

Although VR was not initially mentioned, it was recognized as a potentially valuable tool for enhancing the appeal of lessons, especially for illustrating complex concepts and providing experiential learning opportunities.

Recommendation: VR should be integrated selectively and purposefully into the curriculum, with clear educational objectives and guidelines to ensure it complements traditional teaching methods.

Future Steps: The integration of VR should be aligned with the broader goals of the VR4Empathy project by utilizing VR to foster cognitive empathy and create immersive learning experiences. Future work packages should include the development of specialized VR modules and supporting materials aimed at promoting cognitive empathy

among students. These modules should incorporate interactive and reflective elements that encourage students to deepen their understanding and embrace different perspectives.

Focus on Relationships and Communication

Strong teacher-student relationships and open communication were repeatedly emphasized as crucial for creating a positive learning environment.

Recommendation: Educational strategies should prioritize these relationships, ensuring that any technological tools, including VR, enhance communication and interaction.

Future Steps: Work packages should include teacher training that emphasizes the role of VR in supporting rather than diminishing these critical human connections.

Innovative Yet Balanced Teaching Methods

There is a clear preference for innovative, experiential teaching methods that are balanced with traditional approaches. Both teachers and students expressed caution about the potential overuse of VR.

Recommendation: Continuous professional development should be provided for teachers, equipping them with the skills to effectively integrate VR and other modern technologies while maintaining the strengths of traditional teaching methods.

Future Steps: Mechanisms for feedback within upcoming work packages should be developed to continually assess and refine the balance between innovation and tradition in teaching practices. It is also important to develop strategies for managing risks associated with VR use, such as the risks of overuse, ensuring data security, and balancing virtual and real-world interactions. Work packages should also include protocols to ensure these safety measures are in place.

Modernization of Educational Materials

The need for continuous updating of educational resources to reflect modern teaching practices and technologies, with a focus on real-world applications, is recognized.

Recommendation: The curriculum should be modernized and aligned with real-world contexts, ensuring that interdisciplinary approaches are incorporated where possible.

Future Steps: Future work packages should include a review and update of educational materials, ensuring that they support the project's objectives of fostering empathy and inclusivity through relevant, real-world content. A quality framework for VR resources should be established to ensure their alignment with the educational goals of the

VR4Empathy project. This includes regular review, monitoring, and adaptation of resources based on feedback from teachers and students.

Ethical and Inclusive Use of VR

The cautious approach towards VR expressed by participants highlights the need for its responsible and ethical use, ensuring it contributes positively to the classroom environment and teacher-student relationships.

Recommendation: VR should be used in a way that supports inclusive and respectful communication, aligned with the ethical considerations of the VR4Empathy project.

Future Steps: Guidelines and training for the ethical use of VR should be implemented within work packages, with a focus on promoting equity and inclusion in educational settings.

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