The Use of Virtual Reality in Preventive Education

Zuzana Fojtíková[1*], Zuzana Plešková[1], Lenka Brumarová[1]

[1] Faculty of Safety Engineering, VŠB – Technical University of Ostrava, Czech Republic
zuzanafojtikova@outlook.com

Abstract. Contemporary preventive education faces the need to implement modern technologies capable of effectively engaging the current generation of adolescents. The aim of this paper is to present the potential uses of virtual reality as an innovative educational and preventive tool for young people aged 11–15. The article includes theoretical foundations based on an analysis of the current state of preventive programmes in the Czech Republic, findings from developmental psychology and the principles of experiential learning. At the heart of the paper is the presentation of a proposal for methodological guidelines for the 'Safe School' virtual simulation. This simulation faithfully models the school environment and its most common risks, which enables pupils to encounter these risks in a safe environment. The implementation and application of the proposed solution will take place with the support of the Centre for Simulation Technologies, the Faculty of Safety Engineering, VŠB – Technical University of Ostrava.

Keywords: Virtual reality, Preventive education, Adolescents, Immersive simulation, Experiential learning.

1 Introduction

Ensuring safety and protecting lives, health and property are among the priorities of every developed society. Although the Czech Republic has a robust integrated emergency response system, the individual preparedness of every citizen remains a key element. It is precisely here that preventive educational activities take on greater significance; their mission is to foster responsible attitudes and equip the population with the correct habits necessary for dealing with risks or effectively managing emergencies. However, the effectiveness of this education depends directly on the ability to adapt teaching methods to the needs and perceptions of modern society, particularly those of children and young people. The current generation is growing up in a technology-saturated environment, which fundamentally influences the way in which they receive and process information. Traditional forms of teaching topics relating to preventive education – based predominantly on one-way instruction, static lectures or the passive reception of information – appear inadequate in this context. Furthermore, children and adolescents exhibit specific psychological characteristics, such as a sense of invulnerability or what is known as a 'personal myth' – that is, the belief that negative events only affect others. These factors create a barrier between the information being conveyed

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and its genuine internalisation, which in turn results in a limited ability to apply this knowledge in everyday life. [1]

In this context, immersive technologies – and virtual reality in particular – represent a promising technological tool that enables a targeted response to the long-term limitations of the traditional approach to preventive educational activities. The use of these technologies brings specific added value in the form of experiential learning, which combines the participant's emotional engagement with their active decision-making, thereby leading to the deep-rooted adoption of correct procedures and patterns of behaviour. [1]

The aim of this article is to present the potential use of virtual reality as an innovative educational tool for preventive educational activities aimed at young people aged 11–15. The intention is not merely to provide a theoretical description of the possibilities, but to present a proposal for methodological guidelines for the 'Safe School' virtual simulation, which models a real school environment and its most common risks, thereby enabling adolescents to experience these risks in a safe environment. [1]

The primary and, in systemic terms, most widespread setting for the implementation of preventive educational activities is the school environment, particularly primary schools. Topics of preventive education are incorporated into the Framework Educational Programmes and implemented through lessons, themed days, evacuation drills or collaboration with the integrated emergency services. In the school environment, the primary responsibility for implementing preventive educational activities lies with teaching staff, who integrate topics relating to the protection of people against both everyday risks and emergencies into their lessons. [1]

However, specialist studies highlight the fact that the current teaching approach is perceived by many schools as inadequate. Teaching is often focused predominantly on theoretical information, whilst practical training and the development of decision-making remain limited. From the perspective of those implementing the Civil Protection Programme, a significant finding is that 75 per cent of primary schools recognise the need to innovate teaching practices and regard current teaching methods as rather conservative. Respondents agree that traditional forms of instruction do not provide pupils with sufficient scope for active engagement and, consequently, for developing an awareness of risks. Despite the available methodological support, school practice is coming up against the rapidly declining appeal of traditional teaching formats for the current generation of pupils. [2]

This imbalance creates scope for seeking innovative solutions, and virtual reality presents itself as a highly suitable alternative in this regard. Most schools express a willingness and interest in incorporating modern technological elements into their teaching, which would enable the visual representation of risks and the modelling of situations that pupils may encounter in real life. Furthermore, immersive virtual reality simulations allow for safe, controlled and repeatable practice of scenarios, thereby significantly increasing the appeal of teaching for today's young people. [1, 2]

2 Theoretical and Methodological Foundation

Planning preventive educational activities requires a firm grounding in developmental psychology. Age-appropriate content does not merely mean simplifying the language, but above all involves a different choice of objectives, methods and forms of feedback. Each stage of development brings not only specific cognitive tools for perceiving reality, but also 'blind spots' that limit a realistic assessment of risks. Teaching approaches must therefore correspond to the pupils' current level of thinking, motivation and social relationships, with their individual pace of development being the decisive factor, rather than their chronological age alone. [1]

2.1 Characteristics of the Target Group (Adolescents aged 11–15)

The period between the ages of eleven and fifteen, corresponding to attendance at lower secondary school, represents a critical phase in terms of education in the field of safety and preventive educational activities. At this age, there is a transformation in adolescents' relationship with their own bodies, with authority figures and with their peer group, with the dominant feature being the search for their own identity and emancipation from family ties. Whilst adolescents do acquire the capacity for hypothetical-deductive reasoning, this process also brings with it new risks linked to emotional instability, impulsivity and a willingness to take risks. One of the psychological phenomena that directly influences risky behaviour is the so-called 'personal myth'. This refers to an adolescent's inner conviction of their own uniqueness, exceptionality and, above all, invulnerability. Although an adolescent is able to logically identify a danger or risk, they subconsciously believe that it applies to others, not to themselves. Traditional methods of preventive educational work primarily appeal to the reflective, cognitively controlling system, which, however, in adolescents is structurally less developed and is easily overridden in situations of emotional arousal or social pressure. It follows that knowledge of correct behaviour does not guarantee its application in real-life situations. A gap persists between what adolescents know and how they actually behave. [3]

2.2 Principles of Experiential Education in a Virtual Environment

Overcoming the gap described above requires an educational method that deliberately utilises emotional experience as the primary tool for learning. Experiential education provides a methodological framework that enables the transformation of passively received information into actively acquired competences. [4] In a VR environment, this approach is enhanced by a high degree of immersion, which allows for the simulation of encounters with risks that pose no real threat to health, but which elicit an authentic emotional response. The cornerstone for understanding the mechanism by which VR influences the development of healthy habits is Kolb's learning cycle, which links concrete experience, reflective observation, abstract conceptualisation and active experimentation. [5] The effectiveness of this approach in a virtual environment is further explained by the Cognitive Affective Model of Immersive Learning (CAMIL). Immersion helps adolescents to truly 'experience' the risk and commit it to memory. [6]

3 Proposal for the 'Safe School' Virtual Simulation

At the heart of this paper is a proposal for methodological guidelines and a didactic concept for a virtual simulation specifically targeted at lower secondary school pupils. The proposal is based on the integration of three key pillars: the CAMIL model, the psychological characteristics of adolescents, and an analysis of risk perception. The aim of the simulation is to enhance situational awareness, provide an immersive experience without real risk, and verify knowledge in practice. [1]

The proposed simulation is divided into three logically sequential scenarios that replicate a pupil's typical day. Each of these scenarios lasts approximately 4 to 8 minutes. This time limit is crucial for staying within the recommended cognitive load and preventing fatigue arising from the virtual environment. [1]

A key innovative feature of the architecture is the transformation of static points of internal guidelines – such as school rules, evacuation plans or fire alarm procedures – into dynamic situations. For each risk, a so-called 'Methodological Risk Card' is created, which serves as a basis for developers and defines both the visual presentation and the educational objective of the phenomenon in question. In this way, the simulation bridges the gap between formal knowledge of internal standards and their practical application in real life. [1]

3.1 Risk Modelling

When selecting and defining specific risks, account was taken of current technological capabilities, with priority given to those risks that can be clearly depicted visually. To avoid overwhelming the pupil, the number of risks in a single scenario is limited to 6 to 8 key situations, which are incorporated into the environment at logical intervals.

Scenario 1: The journey to school. This introductory scenario serves to orient the user in the environment and takes place in a city park and at a pedestrian crossing in front of the school. Here, the pupil encounters traffic hazards, such as a car failing to stop at a red light or a cyclist riding fast on the pavement; technical and environmental hazards, such as an open drain, a severed power cable or a broken tree; and social hazards, including an aggressive dog off the lead, a discarded syringe, or a stranger luring children into a car. [1]

Scenario 2: Inside the school building. This covers corridors, cloakrooms, classrooms, toilets and the canteen. Attention is focused on security and operational risks, such as a suspicious person attempting to gain unauthorised entry to the building, an abandoned black rucksack as a potential trap, the discovery of a gun or knife in a locker (Fig. 1), a blocked emergency exit or an unlocked cleaning cupboard containing chemicals. The scenario also covers social threats, such as conflict and fights between pupils involving unethical filming on mobile phones, a pupil sitting in an open window, or smoking in the toilets. [1]

Scenario 3: School grounds and playground. The final section tests the pupil's vigilance in the less formal, open space of the school courtyard and playground. The aim is to identify biological risks – a dead animal near the rubbish bins, excrement in the sand, a wasps' nest; technical faults – an open electrical distribution box, broken glass; and

social risks in the form of vandalism and breaches of the smoking ban on the premises. [1]

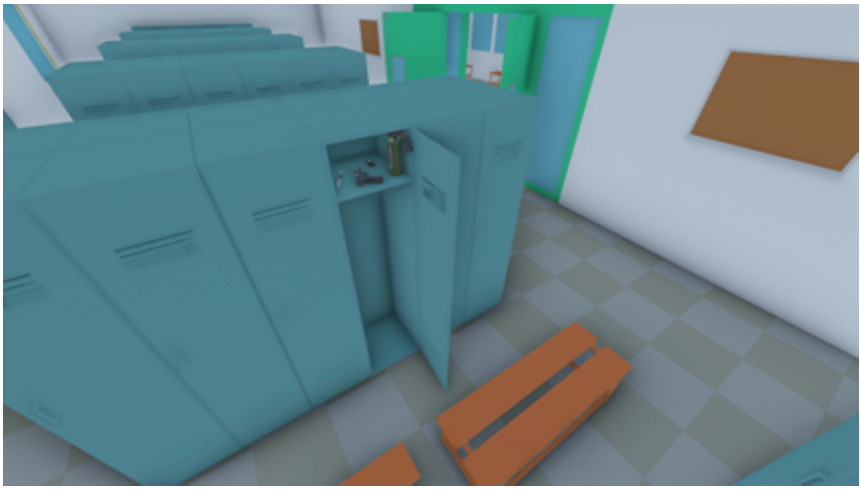


Fig. 1. Visualisation of One of the Risks [1]

3.2 Methodological Guidelines for Teachers or Facilitators

A fundamental prerequisite for the success of the proposed solution is the recognition that virtual reality is not a panacea and does not in itself guarantee better skill acquisition unless it is guided by pedagogical principles. The reflection and debriefing phase, which follows immediately after the simulation ends, is therefore crucial.

Within the simulation, the method of implicit observation followed by retrospective evaluation is employed. Whilst navigating the risk environment, the pupil actively observes and does not simply click through. This maintains a high level of immersion and compels the learner to constantly and naturally scan their surroundings and store these perceptions in their short-term memory. The simulation therefore does not primarily train mechanical perception, but builds the fundamental competence of 'seeing and perceiving' before a danger escalates. [1]

Each scenario is followed by a structured assessment module designed to eliminate random guessing. The questions are presented in pairs. First comes an identification question (e.g. whether the pupil noticed a suspicious rucksack) and this is followed by a verification question checking the exact location or a question focusing on the description of the negative impact of the risk in question. Only a correct answer to both questions is considered a successful identification. [1]

This mechanism makes full use of Kolb's learning cycle. [5] After a specific experience in VR, a phase follows in which the teacher discusses the test results with the pupil. The pupil receives immediate feedback straight after the experience, when the emotional imprint is at its strongest. Despite its realism, the simulation remains a safe

environment for experimentation, where mistakes have no real-world health consequences but do have significant educational implications. It is precisely this safe environment for making mistakes and the subsequent group reflection that are critically important for building self-confidence in adolescents. [1]

4 Discussion and Limitations of Using Virtual Reality in Practice

The use of virtual reality in preventive educational activities brings a number of demonstrable pedagogical benefits. A key benefit is the high level of motivation among pupils to learn and their active engagement in the educational process. Virtual reality explicitly creates a safe environment for making mistakes. If a pupil overlooks a risk or makes a wrong decision in a simulation, this failure has no real-world consequences, but it does have an immediate educational impact and provides feedback that is more effective than any verbal instruction. For adolescents, the very opportunity to experiment and learn from their own mistakes within a safe framework is a key prerequisite for building healthy self-confidence.

Despite these advantages, the widespread integration of immersive technologies into everyday school practice faces certain limitations. Among the main obstacles are the financial costs associated with purchasing the necessary hardware and maintaining the systems. Another significant factor is teachers' technological literacy, which is essential not only for operating the equipment but, above all, for the proper methodological delivery of simulation lessons and the subsequent debriefing. From the perspective of user comfort, one must also not overlook the health risk of cybersickness, which may limit some individuals' ability to become fully immersed in the virtual environment. For these reasons too, it is strategic to use an XVR simulation environment controlled via a standard monitor as a preliminary step or alternative.

Overcoming the aforementioned technological and developmental barriers requires close collaboration with experts. The implementation and application of the proposed 'Safe School' simulation solution is therefore being carried out with the support of the Centre for Simulation Technologies, Faculty of Safety Engineering, VŠB – Technical University of Ostrava. This centre provides the necessary technological know-how to translate theoretical didactic concepts into a practically usable simulation model.

5 Conclusion

This article has addressed the issue of modernising preventive educational activities through the use of immersive technologies, with a focus on the specific target group of adolescents aged 11–15. It can be confirmed that virtual reality has a fully justified place in this area of education. Unlike traditional forms of teaching, which often come up against the barrier of what is known as the 'personal myth' and a sense of invulnerability amongst young people, VR enables pupils to be confronted with risk in a safe environment, thereby effectively building the right safety habits.

The main contribution of this paper was the presentation of a proposal for the 'Safe School' virtual simulation, which comprehensively simulates a real school environment and its most common risks. The innovative aspect of this concept lies in its shift away from the mechanical identification of threats towards training in situational awareness. The use of the implicit observation method, followed by structured reflection, encourages pupils to actively process their perceptions and transforms an emotional experience into a lasting skill. In a broader context, the integration of immersive technologies into preventive educational activities represents an essential step, moving away from mere passive information provision towards an authentic experience and the building of a truly resilient society.

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