

# Immersive Virtual Reality (VR) in Geography Lessons in Schools – A Case Study from North Rhine-Westphalia, Germany

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## Abstract:

The ongoing urbanization and digitization of society bring new challenges and opportunities for urban development and planning. In this context, the concept of the "Smart City" has been gaining increasing significance for years. For geography education, this topic not only provides an opportunity to address current developments but also helps students gain a deeper understanding of the interactions between humans, space, and technology. The areas of Smart Mobility, Smart Retail, Smart Living, and Smart Environment offer practical examples that enable students to critically examine urban development processes and actively participate in shaping them.

Urban mobility faces significant challenges. Increasing traffic, air pollution, and limited space demand innovative solutions. This is where the concept of Smart Mobility with new mobility solutions for densely populated cities comes into play. Exemplary solutions include the use of intelligent transportation systems, such as autonomous vehicles, transport drones, ride-sharing platforms, efficient public transport (Weißmann et al. 2023) and the introduction of mobility hubs, which integrate various transportation modes like bicycles, buses, and e-scooters at central locations. In geography lessons, the topic of urban mobility offers the opportunity to analyze the functioning of mobility systems and examine their impact on the quality of life in cities. Students could, for instance, study how traffic flow in a densely built urban neighborhood changes with the implementation of specific traffic solutions.

Digitization is transforming the retail landscape. Smart Retail represents online and offline commerce, integrating technological innovations like AI assistants and smart inventory systems into physical stores. Shopping malls are evolving into multifunctional spaces, offering experiences and fostering social interaction beyond traditional shopping. In geography classes, this shift can illustrate the changing use of urban spaces. Students could analyze how consumer behavior has evolved within their communities and assess the future role of shopping centers in urban environments. Additionally, they might explore how existing buildings can be repurposed to meet future needs.

Another key aspect of Smart Cities is Smart Living, which combines intelligent housing solutions with sustainable lifestyles. Smart City residential areas often use sensors to optimize energy consumption, water usage, and waste management. These technologies empower residents to create more sustainable living environments. They also offer new opportunities for participation: residents can actively contribute to the planning and design of their neighborhoods through digital platforms that promote collective decision-making. In geography classes, students could design their own housing concepts and discuss their ecological and social impacts. Additionally, economic constraints (adhering to an approved budget) should be considered in planning exercises. This may help to create an awareness of sustainable urban development.

In geography lessons, where, as previously described, digitalization is taught through the subject of Smart Cities, it is also appropriate to use digital teaching media for content delivery. Cartographic media are inherently linked to geography. Therefore, it makes sense to incorporate modern approaches such as 3D visualization to develop contemporary spatial teaching materials. This offers significant potential for immersive virtual reality (VR).

One major advantage of VR is its ability to make complex spatial concepts tangible. Students can immerse themselves in virtual city models and experience, for instance, how autonomous vehicles improve traffic flow. This immersive experience could foster a deeper understanding and facilitate learning through interaction. Moreover, VR enables the

simulation of future scenarios. Students can test different developments in smart technologies and analyze their impacts on urban structure and sustainability, such as in virtual shopping malls or residential blocks. This could enhance their ability to make informed decisions about future urban developments.

Virtual environments promote collaboration, allowing students to work on projects, explore diverse perspectives, engage with modern (geo)data, and build problem-solving skills. At the same time, VR supports spatial thinking by visualizing complex spatial connections, such as the relationship between mobility and urban planning. Finally, the immersive nature of VR can boost students' motivation and engagement. They become more actively involved in the learning process and experience the consequences of their decisions firsthand, potentially increasing their interest in topics like urban development and sustainability.

Overall, VR provides a practical, interactive approach that brings geography lessons to life and prepares learners for the challenges of urban transformations. A current research project in North Rhine-Westphalia, Germany, builds on this concept. Since 2021, the Ministry of Schools and Education of the State of North Rhine-Westphalia (MSB NRW) has been funding the development and evaluation of VR applications for geography lessons. In addition to the cartographic development of the application by the Geomatics Research Group at the Department of Geography at Ruhr University Bochum (RUB), didactics researchers from the University of Cologne, as well as teachers, are involved in the development and evaluation of the VR applications. Currently, about 3,000 VR headsets are being prepared at media centers in the state of NRW for use in schools and for lending purposes.

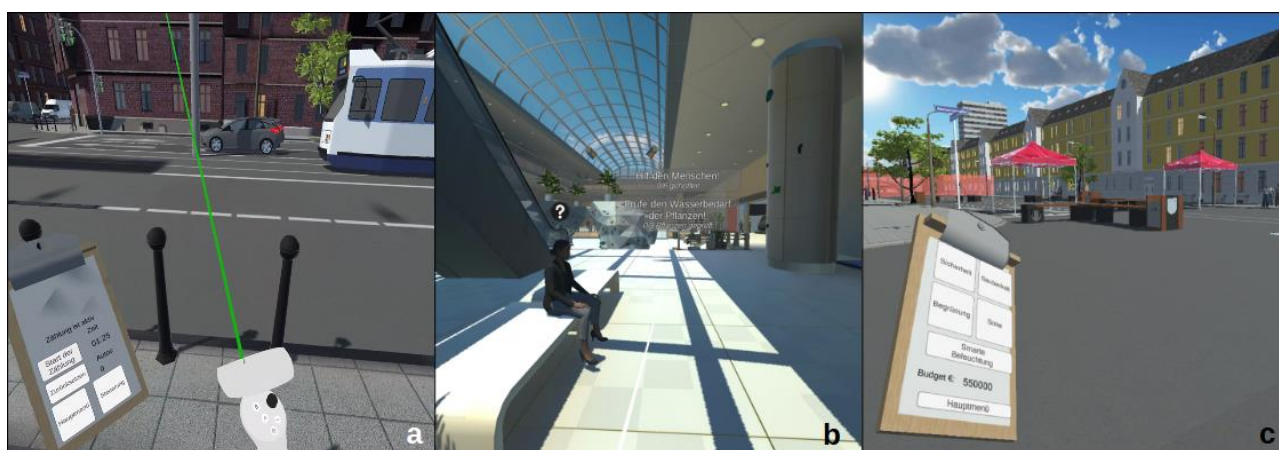


Figure 1: (a) Smart Mobility, (b) Smart Retail, (c) Smart Living

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## References

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