

PROJECT-ORIENTED LEARNING THROUGH VIRTUAL AND AUGMENTED REALITY (VR/AR) AND 3D EDUCATIONAL EXPERIENCE USING THE ZSPACE® INSPIRE LAPTOP IN A LESSON UNIT WITH ENVIRONMENTAL CONTENT

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Abstract: This article examines the application of project-oriented learning, utilizing virtual and augmented reality (VR/AR) and 3D technologies, through the use of the zSpace® Inspire laptop in the educational process with ecological content. The primary goal is to explore innovative teaching methods that engage students and enhance the understanding of ecological concepts through interactive and 3D experiences. The zSpace® Inspire laptop provides a unique opportunity to create realistic 3D simulations that students can view and manipulate in real time. This technology supports project-oriented learning by allowing students to actively participate in the process of exploring and solving ecology-related problems. The present article includes a partial analysis of the curricula for: Foreign Language (English) to achieve level A2 (general education) for students in grades VIII, IX, and X, Biology and Health Education (X grade), Chemistry and Environmental Protection (X grade), Foreign Language for the Profession (XI and XII grades) for all specialties within the professional direction code 522 Electrical Engineering and Energy, and Homeroom (VIII grade – XII grade), unified by ecological themes. A survey was conducted among teachers to determine their readiness to integrate the zSpace® Inspire laptop into their teaching activities. The survey focuses on various aspects such as familiarity with VR/AR technologies, possibilities for their use in the educational process, challenges, and advantages associated with the implementation of new technologies in the classroom. The results of the survey show that teachers are interested and willing to use VR/AR and 3D technologies in teaching. However, some express concerns about technical challenges and the need for additional training to effectively use these technologies. Despite these challenges, the potential of the zSpace® Inspire laptop to transform ecological education is significant and can lead to a better understanding and engagement of students with the studied topics. The conclusions identify and highlight some advantages and disadvantages of the zSpace® Inspire laptop. Additionally, recommendations for future research and practical applications are provided to support the integration of these technologies. This study contributes to the growing body of literature on the use of immersive technologies in education. The findings underscore the importance of professional development for teachers. As technology evolves, continuous evaluation of its educational impact is necessary. Furthermore, collaboration between educators and technology developers is essential to address the emerging needs and challenges.

Keywords: Project-oriented learning, virtual and augmented reality (VR/AR), 3D educational experience, zSpace® Inspire laptop, environmental content, educational innovations

1. INTRODUCTION

In the era of rapidly developing technologies, education strives to integrate them into the learning process with the aim of modernization. Virtual and augmented reality (VR/AR) offer opportunities for creating interactive and engaging learning experiences. This article examines the application of the zSpace® Inspire laptop in project-based learning with environmental content and assesses, through a survey, teachers' attitudes and readiness to use this technology in their pedagogical practice. The potential benefits and challenges of integrating VR/AR and 3D technologies in education are analyzed.

2. VIRTUAL AND AUGMENTED REALITY (VR/AR), 3D LEARNING EXPERIENCE

According to A. Aljumaiah & Y. Kotb „With the development of augmented reality (AR) and virtual environments, there are opportunities to enhance learning through experience in schools and classrooms, and users can be allowed to engage with a 3D virtual environment by simulating a lot of senses as it brings elements of the virtual world into the real world, thus enhancing the things we see, hear, and feel“ (2021, p.1).

In the context of virtual reality, it is appropriate to briefly define terms and commonly accepted abbreviations and compare their main characteristics. VR (Virtual Reality) = Computer-generated environment with 3D images and

usually with sound. It can be delivered through large screens, in special rooms (Cave Automatic Virtual Environment, abbreviated as CAVE), or through VR goggles (<https://wirtschaftslexikon.gabler.de/definition/virtuelle-realitaet-54243>). In virtual reality, the user is unaware and does not understand the surrounding environment and objects within it; they cannot interact simultaneously with the real and virtual worlds in real-time, and there is no immediate connection or collaboration between objects from the real and virtual models of the projection scenes. AR (Augmented Reality) = Computer-assisted perception or presentation that adds virtual objects to the real world. With the help of integrated cameras in mobile devices, additional objects or information can be overlaid onto the current image of the real world (<https://wirtschaftslexikon.gabler.de/definition/augmented-reality-53628>). In augmented reality, the user is aware of and understands the surrounding environment and objects within it; they can interact simultaneously with both the real and virtual worlds in real-time, and there is immediate connection or collaboration between objects from the real and virtual models of the projection scenes. According to D. Kirova & S. Aliev, "The use of VR/AR resources is one of the effective ways to achieve a new type of behavior, creating conditions for lasting knowledge and competencies" (2018, p. 49). In this context Petrov and Atanasova said that „teacher is provided with various features to improve students' learning experience and assist them in learning and discovery“ (2020, p. 7).

3D experience is a term that describes the perception of three-dimensional visual objects and environments through computer technologies. In 3D experience, users see objects and scenes with realistic depth and perspective, creating the illusion of physical presence in virtual or augmented reality. This experience may include visual effects, interactivity, sound effects, and immersion. Visual effects are three-dimensional images that appear realistic and have depth, created through stereoscopic technologies. Interactivity is the ability for users to interact with three-dimensional objects and environments through gestures, controllers, or other interfaces. Sound effects are achieved through surround sound, complementing the visual experience and adding a sense of reality. Immersion involves immersing the user in a 3D environment, which can be entirely virtual (VR) or mixed with the real world (AR).

3. FUNCTIONAL CAPABILITIES AND TECHNICAL SPECIFICATIONS OF THE ZSPACE® INSPIRE LAPTOP

The zSpace® Inspire laptop offers an innovative, personalized experience that removes the barrier between the user and the content by combining components of augmented reality (AR) and virtual reality (VR) into one system (<https://interactivebg.com/>, 2024). The zSpace® Inspire laptop is a stereoscopic 3D device that provides virtual and augmented reality (VR/AR) in the educational environment. Using innovative technology developed by Acer and SpatialLabs™, the laptop projects a stereoscopic 3D image with a holographic effect, eliminating the need for 3D glasses. zSpace® Inspire combines various technologies, including eye tracking, stereoscopic 3D display, real-time digital image rendering, and artificial intelligence. The portable computer zSpace® Inspire is equipped with tracking sensors embedded in the display, which monitor the movement and position of the user's head interacting with the laptop. This process is called "tracking." The stylus (electronic pen) connected to the laptop allows users to "extract" objects from the screen, making them appear as if they are real, enabling users to inspect them and interact with them. The Stylus Sensor Module (SSM) tracks the position of both the zSpace® Inspire laptop and the stylus to create highly realistic 3D interactions. Depth perception is achieved through stereoscopic 3D projection technology, creating 3D objects (holograms). The tracking sensor system allows the position and orientation of objects to be updated in real-time, depending on the user's head position, enabling a 360-degree view of the objects. Another specific feature of the zSpace® Inspire laptop is „Touch Sensation“, which provides realism in movements and interactions, using familiar user gestures and interactions.

The technical specifications of the zSpace® Inspire laptop position it as one of the top contenders in the realm of modern technologies. It operates on the Windows 11 Pro 64-bit operating system, allowing compatibility with a wide range of educational applications. Powered by an Intel® Core™ i5-11400H 11th generation processor, it delivers high performance and energy efficiency, crucial for smooth operation of VR/AR applications. With 16GB DDR4 SDRAM RAM, multitasking is seamless, enabling smooth execution of complex tasks. The 15.6" display features an HD display with Ultra HD 3840 x 2160 resolution in 2D mode and 1920 x 2160 in 3D mode, ensuring exceptional image quality, vital for visualizing educational materials. Another advantage of the zSpace® Inspire laptop is the NVIDIA® GeForce RTX™ 3060 with 6 GB GDDR6 VRAM, offering powerful graphics performance suitable for VR/AR applications and 3D simulations. Data storage is facilitated by a 512 GB SSD, providing fast data access and sufficient space for storing educational materials and software. The presence of multiple ports (USB 3.2, USB Type C, HDMI, 1000mb Ethernet, and SD Card reader) facilitates its connectivity with various devices and peripherals (zspace.com, 2024).

As drawbacks of the zSpace® Inspire laptop, several specifications could be mentioned. Despite having 16GB DDR4 RAM, which is sufficient for most applications, some more demanding VR/AR applications may require

more memory for optimal device performance. The webcam, which has a resolution of 1280 x 720, is lower compared to modern standards, which could be a drawback for video conferencing and online learning. Although the SpatialLabs™ technology is innovative, the resolution of the eye-tracking cameras is relatively low (1280 x 480), which may limit accuracy and effectiveness in some applications.

For the purposes, tasks, and needs of modern education, more than 20 software applications have been developed for the zSpace® Inspire laptop, targeting the STEM educational environment and professional training.

4. PROJECT-ORIENTED LEARNING

Project-oriented learning is a method of organizing educational activities through project implementation. According to St. Chakarova, „In project-oriented learning, the pedagogical goals are more focused on shaping behavioral patterns and attitudes towards independent learning, goal setting, planning and implementing one's own ideas, and forming personal qualities and attitudes, towards communicative, civic, digital, and other competencies“ (2022, p. 107). This method is oriented towards activities and goals that can be both in and out of school and usually have social, civic, or personal orientations.

The main characteristics of project-oriented learning include a high level of autonomy and freedom for students in goal setting and their work, the possibility of establishing interdisciplinary connections, and encouraging initiative. The role of the teacher is supportive, with students planning activities and generating ideas independently. This approach allows for more „mistakes“ and encountering more difficulties in the work process, which provide opportunities for acquiring knowledge and experience.

5. LESSON PLAN FOR INTEGRATED LEARNING ON A TOPIC RELATED TO THE EFFECTS OF CLIMATE CHANGE

The topic is covered in 8th, 9th, 10th, 11th, and 12th grades, across several subjects. Its introduction begins in the lower secondary stage and continues to develop in the subsequent upper secondary stage of Bulgarian education. The specific pedagogical approach to the lesson is presented through the lens of the curricula for Foreign Language - English, as a first foreign language without intensive or extended study in the first stage of secondary education - 9th grade, Biology and Health Education - 10th grade, Chemistry and Environmental Conservation - 10th grade, Class Leader Hour - 9th grade, and it extends to the second stage of secondary education, in the curriculum of the Foreign Language for Professional Purposes (English) (11th and 12th grades), in vocational high schools specializing in electrical engineering and power engineering. In the English language curriculum for achieving level A2 (general education preparation), designed for students in 8th, 9th, and 10th grades with a curriculum plan without intensive or extended study of the English language, starting in 8th grade to achieve A2 level by the end of 10th grade according to the Common European Framework of Reference for Languages, in thematic area V, „Nature and Ecology“, the following topics are covered: „Seasons, Weather, Climate“, „Geographical Objects“, „Plants and Animals“, „Pets“, „Environmental Conservation“ (<https://www.mon.bg/obshto-obrazovanie/uchebni-planove-i-programi-2/uchebni-planove-i-programi-po-klasove/uchebni-programi-po-chuzhd-ezik>).

In the second stage of secondary education, in the curriculum for the subject Foreign Language for Professional Purposes (English), for all specialties within the professions in vocational direction code 522 Electrical Engineering and Power Engineering, in Section V „Electrical Engineering/Energy“, the following topics are covered: „Basic Terms and Concepts in Electrical Engineering/Energy“, „Basic Terms and Concepts for Electric Power and Energy Systems“, „Basic Productions and their Application“, building upon the acquired knowledge, skills, and competencies from the thematic area „Nature and Ecology“ from the first stage of secondary education.

Description: Effects of Climate Change (A623), scope: Upper secondary stage of secondary education, lesson duration: one class period (40 minutes). Key terms: Climate Change, Smog (Ground-level Ozone), Coral Bleaching, Global Warming, Ocean Acidification, Paris Agreement, Renewable Energy, Flood, Drought, Hurricane, Tsunami, Storm, Heatwave, Breeze, Sustainable Development, Harmful Emissions, Atmosphere, Climate, Greenhouse Effect, Carbon, 3R - Reduce, Reuse, Recycle.

In the curriculum for 10th grade, general education preparation in „Biology and Health Education“, the topic „Biosphere“ is covered with two subtopics: „Population, Biocenosis, Ecosystem“ and „Ecological Factors“. In the subject „Chemistry and Environmental Conservation“, in the curriculum for 10th grade, general education preparation, the topic „Environmental Conservation“ is intended to be explored with two subtopics: „Pollutants of Air, Water, and Soil“ and „Human Activity and Environmental Conservation“ (<https://www.mon.bg/obshto-obrazovanie/uchebni-planove-i-programi-2/uchebni-planove-i-programi-po-klasove/uchebni-programi-za-x-klas>).

Climate change is defined as a long-term alteration in the Earth's temperature and meteorological patterns currently experienced. Through project-oriented learning, which incorporates the mentioned subjects and the described zSpace laptop technology, students are expected to learn about the impacts of climate change (from sea level rise to

ocean pH change, extreme weather events, etc.). The learning process raises questions such as: What is the difference between climate change and global warming? How does the increase in greenhouse emissions affect the ocean and its inhabitants? What does the Paris Agreement, signed by global leaders in 2015, represent? How does climate change affect the spread of diseases? The main objectives in project-oriented learning on this topic include understanding complex models such as the greenhouse effect and climate change, offering solutions to reduce the pace of climate change through renewable energy sources, visualizing the impact of human activity on the environment and on people themselves.

To help students better understand what climate change entails and its potential effects, zSpace provides a short film (3 minutes) created by National Geographic: (https://www.youtube.com/watch?v=G4H1N_yXBIA). It serves as an introduction to the issue for students and sets the stage for subsequent tasks and activities. The teacher assigns the students the task of watching the video and listing at least two possible effects of climate change mentioned in the video material. From a methodological perspective, this task focuses on the issue and generates possible aspects of climate change. Through graphical data representation, students track climate change. The long-term change in global climate models is caused by the gradual increase in Earth's average surface temperature, known as global warming. This leads to more extreme and unpredictable weather conditions, with alternating periods of extremely cold and extremely hot weather, atypical for different regions.

Another activity from project-oriented learning and the provided zSpace educational materials involves instant capturing and manipulation of images (object tagging) related to information about very low and very high levels of particulate emissions. If the Earth becomes too hot, environmental factors will change, impacting ecosystems, and people are likely to face health issues, especially if they are not accustomed to the increased atmospheric temperatures. The seriousness of these facts is reflected in the Paris Agreement of 2015.

In zSpace activities, there is an illustration of an iceberg model, accompanied by a task to remove the glaciers and add (draw) a line above the original water line of the model. After completing the task, students need to take a picture of the final result and determine the change in the water level in the World Ocean.

In parallel to aquatic ecosystems, students observe changes in terrestrial ecosystems. Loss of biodiversity, compositionally poor ecosystems, which will lead to unstable and unsustainable ecosystems. These changes are again due to climate change, to specific meteorological conditions where populations will decrease drastically. Through the zSpace® Inspire laptop, students have access to a simulator of biodiversity loss. They have the ability to remove animals and plants from the simulated virtual ecosystem scene using the laptop stylus. If there is not enough prey to sustain predators due to unstable and extreme climatic conditions, populations will decline.

The increase in CO₂ levels, as a result of the changing climate, leads to a change in the pH of ocean water. This, in turn, affects biodiversity, ecosystem composition, and coral reefs.

Through project-oriented learning, students reach the conclusion that climate change leads to serious consequences for all living organisms on the planet. The environment for both aquatic and terrestrial inhabitants is disrupted and altered. Natural disasters such as hurricanes and floods become more frequent, along with prolonged droughts and frequent wildfires.

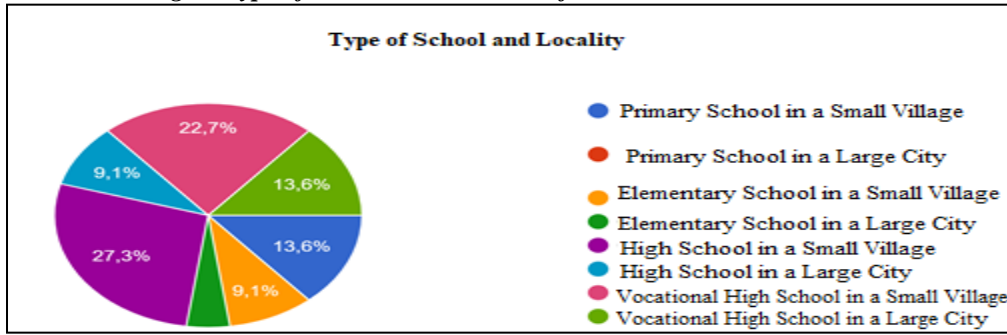
Other aspects of the issue addressed in the topic „Climate Change“ include the spread of infectious diseases and their correlation with rising air temperatures, as well as the pursuit of alternative environmentally friendly energy sources. The zSpace® Inspire laptop provides electronic content for students to work with on these aspects, describing suitable activities.

To assist the teacher, the zSpace® Inspire laptop comes with an integrated educational platform. It includes sample lesson plans with identification codes. The materials are in English and include all additional didactic resources such as videos, worksheets, surveys, etc. This facilitates the learning process and provides opportunities for developing key competencies, teamwork, small group work, and supportive learning. Both language and digital competencies of the students are enhanced.

6. RESULTS AND SURVEY ANALYSIS

The analysis of the first part of the survey shows that the largest percentage of surveyed teachers are between 36 and 45 years old (63.6%). Additionally, 90.9% of the teachers participating in the survey have up to 5 years of teaching experience. These data suggest that the teaching profession is likely not the first career they have pursued. Regarding the type and location of the educational institution where the teaching specialists work, the results are presented in Figure 1.

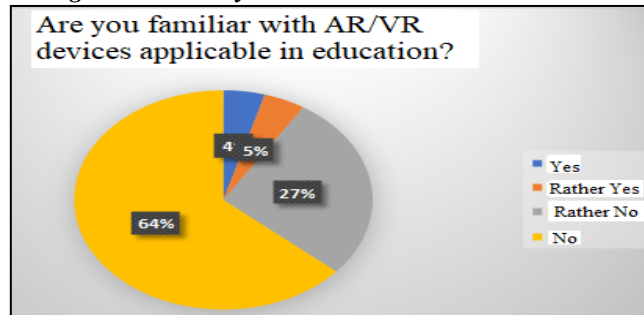
Fig. 1. Type of School and Location of the Educational Institution



Source: The authors

Regarding the stage of the educational system in which the surveyed teachers work, it was found that 54.5% of them work in the high school stage, 31.8% in the middle school stage, and 13.6% in the primary school stage. For the first two questions in the second part of the survey, relating to the understanding of abbreviations for virtual and augmented reality and their definitions, the collected data show that 54.5% of the surveyed teachers are not familiar with these terms, 27.3% answered "Rather No," and only one teacher provided a complete and accurate definition of these technologies. The results of the response to the question "Are you familiar with AR/VR devices applicable in education?" are presented in Figure 2.

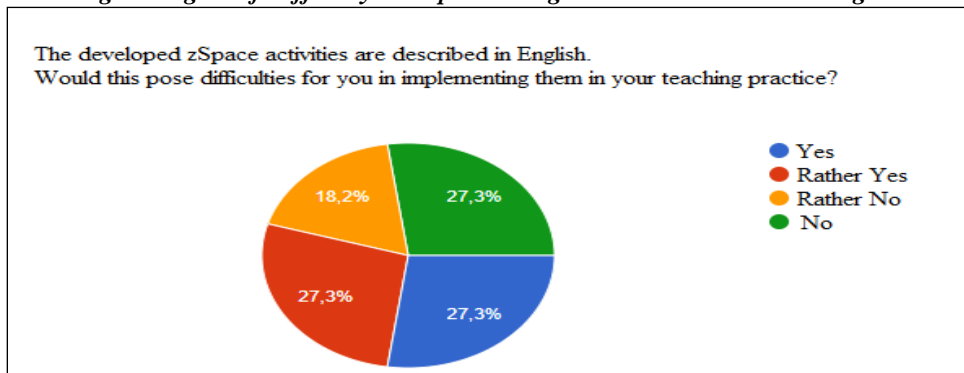
Fig. 2. Familiarity with Educational AR/VR Devices



Source: The authors

Although 90% of the surveyed teachers indicated that they are not familiar with the operating principle of the zSpace® Inspire laptop and have not worked with augmented and virtual reality devices, approximately 91% of them stated that they would use AR/VR devices in their direct work if given the opportunity. The results of the responses to the question of whether the zSpace activities, developed and described in English, would pose difficulties for teachers in applying them in a lesson are presented in Figure 3.

Fig. 3. Degree of Difficulty in Implementing Activities Described in English



Source: The authors

6. CONCLUSIONS AND SUMMARY

After conducting a technological review and describing the capabilities of virtual and augmented reality technologies and devices, 3D learning experiences, and the zSpace® Inspire laptop, and considering the data from the conducted survey, the following conclusions can be drawn:

- Teachers are willing to use virtual and augmented reality, 3D learning experience devices, and the zSpace® Inspire laptop in their teaching activities.
- Teachers encounter difficulties in understanding the developed zSpace activities, as they are in a foreign language.
- If the developed activities integrated into the zSpace platform were in Bulgarian, it would facilitate their application in educational practice.
- Teachers need additional training in a foreign language, working with augmented and virtual reality devices, 3D learning experience devices, and the zSpace® Inspire laptop.

In conclusion, we can summarize that the analyzed technologies and devices facilitate better understanding of the educational content, better visualization of the studied processes and phenomena, and contribute to the enhancement of digital competencies for teachers and students. The environmental issues developed in zSpace are aligned with the high school curricula and are applicable in the educational environment in the Republic of Bulgaria.

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