Unlocking new horizons with Virtual Reality and Digital Learning to facilitate career transitions in IT and science

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Abstract: *The fields of information technology and communication (IT&C) and science are in a state of constant evolution and expansion, creating a need for a labor force that is both highly skilled and adaptable. This paper explores the potential of utilizing virtual reality (VR) technologies in conjunction with intelligent communication as a primary tool for training individuals pursuing a career transition. The combination of these two methodologies creates an integrated environment that can be utilized for the purpose of smart education. Virtual reality simulations provide an effective means of integrating individuals into realistic scenarios that closely resemble the environments and tasks typically encountered by professionals in the fields of IT&C. Such integration allows for the combination of knowledge and provides a chance for experiential learning. This form of learning provides an accessible and flexible environment, allowing each individual to progress at their own pace and convenient times, thereby eliminating space and time constraints. This paper presents an effective method to facilitate career changes, with a focus on the benefits of distance learning. It discusses the advantages of VR from a cost perspective for companies and for students with disabilities, irrespective of their economic status. The immersive nature of VR technology enables learners to engage in hands-on practice without the risk of real-world consequences, thereby fostering confidence and competence in tackling complex technical challenges.*

Keywords: Virtual Reality, Distance Learning, Career Development, Continuing Education, Educational Technology.

1. Introduction

The world is in constant change, and the fields of information technology and communication (IT&C) and science represent the most dynamic but also the most sought-after fields. With the rapid technological evolution, the demand for specialists in these fields is continuously increasing. For those who want a career change and turn to IT or science, there may be obstacles. Acquiring new skills and knowledge is necessary, and the learning process can be long and difficult (Wang et al., 2022).

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An innovative solution for overcoming obstacles is offered by virtual reality (VR). The virtual experience can radically change the known way of learning, offering an interactive and immersive experience that can substantially accelerate the learning process. VR has become a popular technology for both gaming and learning (Wu et al., 2020).

Vocational retraining and job change are becoming common nowadays, even more necessary to meet market demands in today's economy, which is characterized by rapid changes and continuous technological developments. While many sectors are experiencing an overproduction of professionals, in many other sectors there is an acute shortage of skilled labor. A proactive approach to vocational retraining can help solve labor market problems and stimulate economic growth and innovation in important areas (Carruth, 2017).

It will examine how this technology can help reduce barriers to entry and improve the process of building the skills needed for new careers. The purpose of the paper is to provide a detailed analysis of how VR can offer new perspectives to those who wish to change their career direction and reorient themselves towards fields such as IT or science, emphasizing the essential role of technology in facilitating successful professional transformation in the digital age by accumulating new information and experiences with its help (Xie et al., 2021).

2. Literature review

In an article by Nelson and Ahn, they discuss the growing need to teach engineering students at Iowa State University professional development skills. These skills are critical to their academic and professional success. In their research, the authors explore the use of VR to teach four professional development skills to students: leadership, teamwork, communication, and ethics. The authors note that the inclusion of physical accessories makes the system more accessible, improves interaction, and lowers costs. Thus, we understand an increased desire for professional development, present since the student years (Nelson & Ahn, 2018).

Research by Zawadzki et al. (2020) gives the findings of a study on how well staff training for manufacturing jobs is impacted by VR. The work was done in the Smart Factory Laboratory, a model of a smart factory that works according to the concept of Industry 4.0. Currently, employee training within companies is quite often done with the help of VR. The solution proposed in the paper is helpful for employee training (Zawadzki et al., 2020). Carruth shows that affordable home VR technology is making immersive education more accessible. Previously, high costs and technical limits hindered VR's use in education. VR provides hands-on training in safe environments, offering access to expensive equipment and inaccessible locations. Though its effectiveness in learning is still debated, the study concludes that VR is a practical and useful educational tool (Carruth, 2017). The specialized literature on education, particularly with virtual reality, includes various publications by numerous authors. Using the "Dimensions.ai" platform for the search, the results were analyzed with VOSViewer, producing a graph of author networks. The dataset included 10.565 authors, but only those with at least three papers and two citations were deemed relevant. This resulted in 470 selected authors.

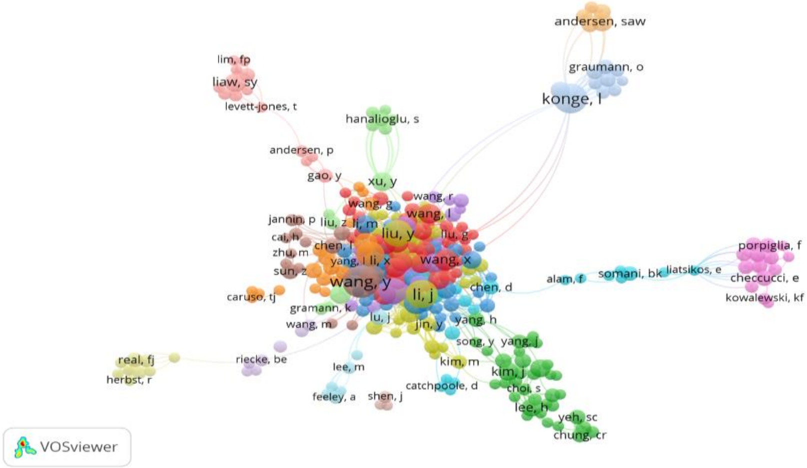

Figure 1. A graphic map of authors for the search term "virtual reality and learning"

3. Methodology

The main purpose of this research is the development of a gamified system that is used by people who want a professional reconversion and who want a career oriented towards the medical field or the IT industry. The objectives that this system proposes are the following: interactive scenarios, open-source technology, user performance, safe training, and increased retention level.

The development of interactive scenarios that facilitate the learning and assimilation process involves creating dynamic and engaging environments where learners can actively participate in their own education. These scenarios are designed to encourage exploration, experimentation, and critical thinking, providing learners with opportunities to apply theoretical knowledge in practical situations (Bratosin et al., 2021). The app was developed using the open-source version of Unity, which offers numerous advantages in terms of accessibility, flexibility, and innovation. By using open-source platforms such as Unity, OpenVR, and OpenXR, we can gain access to many resources, community support, and collaborations. These latest technologies empower us to customize and extend VR experiences according to our specific needs (Novotny, Gudmundsson & Harris, 2020). Evaluating the performance of people or employees who want professional reconversion through a VR-based system offers a comprehensive and immersive approach to empower their skills, capabilities, and readiness for a new career path (Wu et al., 2020). Virtual reality is a technology that has the advantage of designing any training, which can be risky or high-risk, into one that is risk-free. People who do specialized training in certain work areas can be exposed to many dangers. Using VR, they can protect themselves from these risks and dangers in a very safe space that allows them to complete training for the work area at the same time. Trainings made with the help of VR are much more interactive and engaging, which leads to a deeper assimilation of knowledge. People who do training with the help of VR are much more focused on the tasks they have to do and much more motivated to learn what they apply. Thus, the senses are greatly simulated, and they are allowed to participate actively (Xie et al., 2021).

An application built with the help of VR is presented that proposes different training scenarios. These are intended for people who want a professional reconversion into three areas of work: the medical field, the chemistry field, and the IT field. These are two very vast areas of work, for which a certain amount of knowledge is needed to carry out the tasks at the workplace. Thus, an application is needed that simulates real training very well (Ivascu et al., 2022).

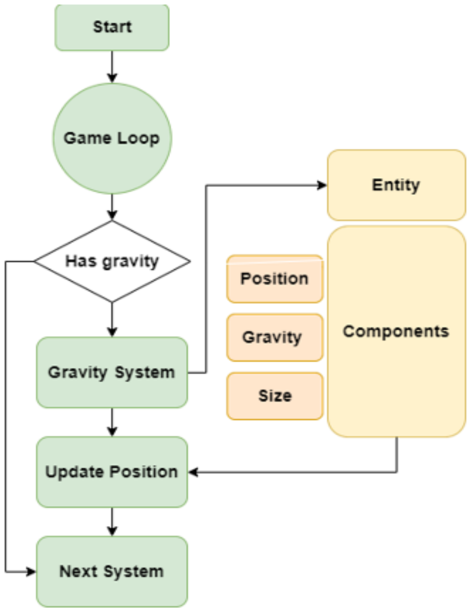

Figure 2. Gravity System Flowchart

Figure 2 shows the gravity system flowchart in a game engine diagram. The entity is defined by an object for the purpose of the entire game. In the case of our application, which is oriented towards the user and the graphic part with which he has contact, the entity can be defined as objects that are included in the game. To create real-life scenarios, the application was implemented in a "first-person controller" manner. There are two ways in which gamified scenarios can be made, namely: "first-person controller", a way in which the player realizes the scenario through their own eyes; and "third-person controller", in which the player is a third person in the game and sees the scenario from behind. In order to create scenarios as close as possible to reality and to make information retention more efficient, we implemented the application in "first-person controller" mode. Scripts aim to create user behavior within the game: creating animations, managing the connection between the game interface and the functionalities themselves (Jinga et al., 2024). The objects found in the scene are unique and have a unique ID assigned to each of them. Component is another element that we find in the ECS type architecture. It aims to give the entity, which is a unique object, the property of being private and also assigns it a label. In addition, another functionality of the component is to store data related to the entity. For example, in our application, any entity placed in the scene is defined by a color, texture, or size. If it is an object, it has defined movement, which has attributes such as position, gravity, and speed. These properties are kept inside the component, which stores all the data belonging to an object. The system is the most important part of the ECS architecture (Zawadzki et al., 2020). A game can be defined as a virtual physical system, inside which there are interactions between the elements found in that game. The system has the role of interrogating the entities in the game in order to extract data, which is necessary to make various calculations (Voinea & Moldoveanu, 2018). It can be used in performance tests for real-life scenarios, but using virtual reality to be later analyzed by the system (Han et al., 2023).

The engine we used to implement this application is Unity. Unity is a powerful and versatile game development platform that has gained widespread popularity for creating VR experiences. Leveraging the Unity engine for VR learning applications offers numerous advantages due to its robust features and extensive support for various VR devices. One of the key strengths of Unity is its cross-platform compatibility, allowing developers to create VR experiences that can run on a wide range of devices, including Oculus Rift, HTC Vive, PlayStation VR, and mobile VR platforms like Google Cardboard and Oculus Quest. This versatility ensures accessibility for learners across different hardware setups, enhancing the reach and effectiveness of VR learning initiatives (Carruth, 2017). Unity also offers a rich ecosystem of assets, plugins, and libraries that facilitate the integration of advanced features into VR applications. Developers can access a wide range of premade assets for building realistic environments, dynamic interactions, and engaging gameplay mechanics, accelerating the development cycle and enabling the creation of high-quality VR learning experiences. Moreover, Unity's support for advanced graphics rendering techniques, such as real-time lighting and shades, allows developers to create visually stunning VR environments that enhance immersion and engagement. By leveraging Unity's capabilities, VR learning applications can provide lifelike simulations of real-world scenarios, enabling learners to practice and master skills in a safe and controlled environment (Custură-Crăciun et al., 2015).

Unreal Engine is a powerful tool for developing immersive VR learning experiences, particularly for career shifts in IT and science. It is highly regarded for its stunning graphics and robust development capabilities, which create visually rich and engaging environments that closely replicate real-world scenarios (Novotny, Gudmundsson & Harris, 2020). Its advanced rendering features enhance immersion, aiding in the understanding of complex IT and scientific concepts. Additionally, Unreal Engine's Blueprint visual scripting system allows educators to design interactive VR experiences without extensive coding, focusing on content creation (Popescu, Ileana & Bold, 2024). Unity is often favored over Unreal Engine for certain projects due to its user-friendly interface and accessibility, making it suitable for developers of all skill levels. Its intuitive design, along with the Visual Scripting tool, allows users to create interactive experiences without needing extensive coding knowledge, simplifying the development process. Unity also boasts excellent cross-platform compatibility, supporting various devices and platforms like PCs, consoles, mobile devices, and VR headsets, which helps developers reach a wider audience. Additionally, Unity's Asset Store offers a vast array of assets, plugins, and tools that can speed up development and enhance project quality (Mohd et al., 2023).

The diagram in Fig. 3 illustrates the Entity-Component-System (ECS) architecture. The three entities A, B, C have components such as "Render", "LocalToWorld", "Rotation" and "Translation". The system (L2W = T * R) combines "Translation" and "Rotation" to update "LocalToWorld". The system interacts with components to manage data and update the state of entities in the game or simulation (Unity Technologies, 2023).

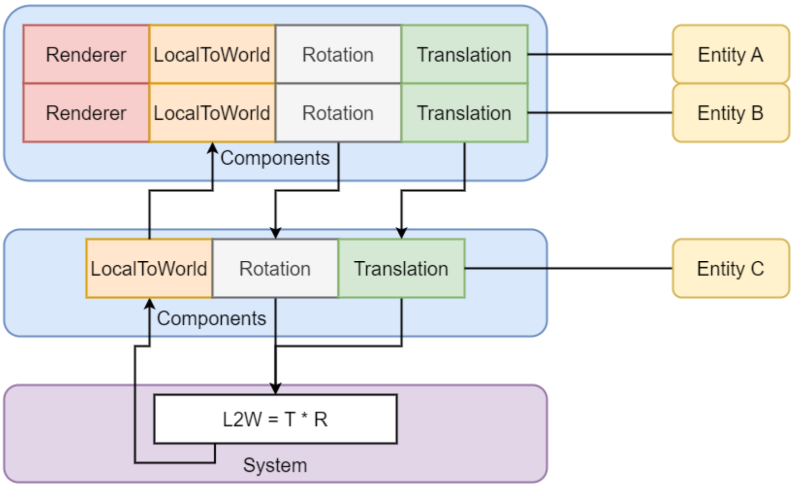

Figure 3. Entity-Component-System (ECS) architecture (Unity Technologies, 2023)

4. Results

The new element brought is application modularity for predefined scenarios, so that the application brings a plus in the ease of use even by teachers who do not have advanced knowledge in the field of IT in the niche of VR.

By integrating VR into student classes and more specifically in labs, institutions can significantly cut down on costs related to physical materials, equipment, and space while still providing high-quality education and training. Reducing costs in IT, chemistry, and medical labs using VR can be achieved in several ways. For IT labs, the application is using Virtual Hardware (VR simulates servers, networks, and other IT infrastructure instead of expensive physical hardware); offers Remote Access (enabling participation in virtual labs to reduce the need for physical space and maintenance costs); and uses various Training Programs (developing VR-based training programs to reduce the need for physical training materials and travel expenses). For chemistry labs, we can mention Virtual Experiments (conduct experiments virtually to save on costs); Reusable Resources (using VR simulations that can be reused multiple times); Reduced Waste (perform experiments virtually to minimize waste and disposal costs). For medical laboratories, VR technology is used for training purposes, thereby reducing the reliance on costly physical specimens and physical models (Zawadzki et al., 2020).

Virtual reality makes education more accessible and engaging for all students. The cost-saving benefits of VR for students, including those from economically disadvantaged backgrounds, can be summarized as follows:

- Reduced expensive field trip costs (transport, admission fees, other expenses);
- Access to high-quality learning experiences (realistic 3D models and complex abstract concepts, e.g., molecular structures, astronomy);
- All students have the same training experience regardless of their economic status and even their disability level (the controls can be modified).

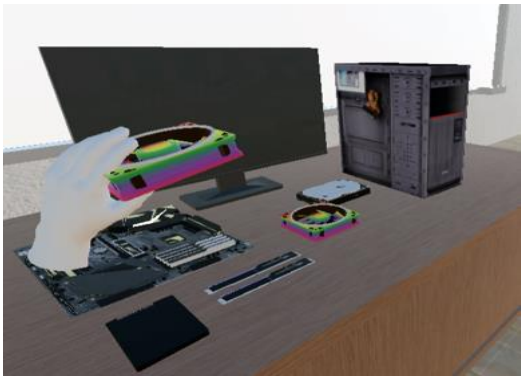

Figure 4. Scenario for computer assembly

As part of this research, we have implemented an application in VR to help people who want a professional reconversion. As shown in the following figures, the users of the application can train, with the help of the application, in three areas of work, namely: IT, the medical field, and chemistry. In Figure 4, the user trains in the IT area (Pirker et al., 2020). The purpose of this scenario is to know the components of a computer and how to assemble them into a unit. The user must place all these components in the unit and then turn on the computer.

Another scenario that the user will go through is illustrated in Figure 5. This represents the training he has to re-profile himself in the medical field (Ileana, 2024). Users are invited to discover essential information for their field of work in the medical field, together with a specialized medical staff (Sfat & Marian, 2022).

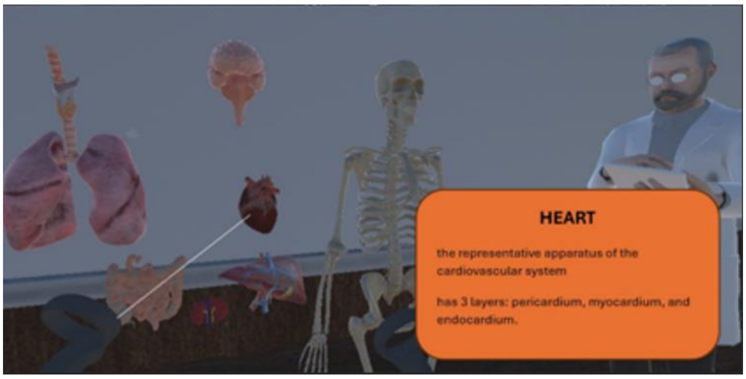

Figure 5. Scenario for medical field training

Figure 6 shows another scenario in which users are invited to perform a chemical experiment. In this scenario, users have contact with chemical elements, recognize the elements from the periodic table of elements, and have contact with chemistry-specific equipment. A third scenario, which exists in the application, is related to training in the field of chemistry for people who want to re-profile themselves in this work area. They are advised to put on gloves and protective glasses for greater safety during the experiment (Nelson & Ahn, 2018). In addition to the scenarios outlined above, our VR application offers a comprehensive training experience tailored to individuals seeking professional reconversion. Beyond the IT, medical, and chemistry fields, users can explore a diverse range of career paths and skill sets to better equip themselves for their desired transition.

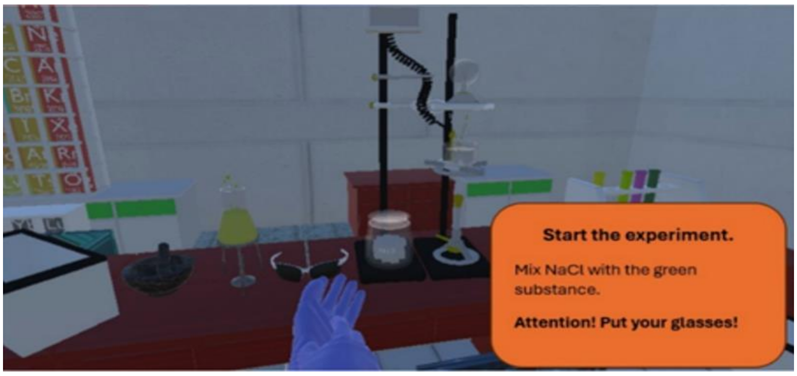

Figure 6. Scenario for chemistry training

VR is much more practical to use in real-world fields, especially when working with physical concepts, compared to subjects involving abstract concepts. VR with headsets is better for learning than traditional methods, especially for science students. It helps with skills and knowledge, and the effects last (Newman et al., 2022). Figure 7 presents the most important features of the VR app that were implemented. We focused our efforts on detailed graphics and multiple VR experiences. In Figure 8, are presented the features that were appreciated by the users.

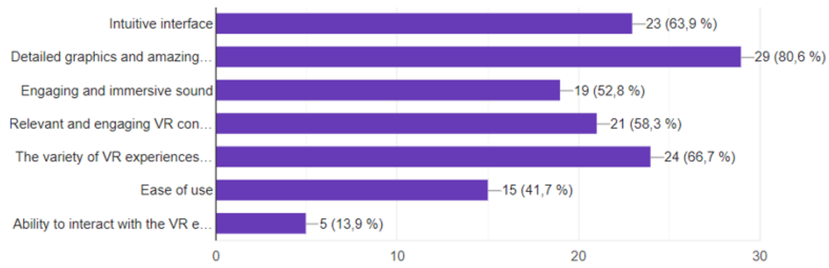

Figure 7. Planned important features of the VR app

After the app was implemented, the users' focus group considered the most important features were the immersion feeling and, at equal level, the feeling of relaxation and fun combined with work and the object interaction.

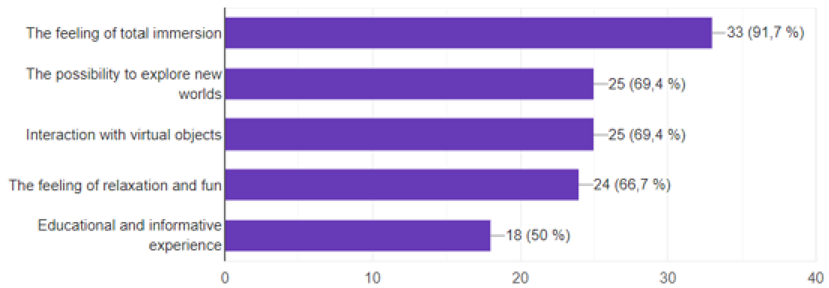

Figure 8. Implemented favorite features of the VR app

The users' feedback was appreciative (Fig. 9), in 72.2% the working experience was fluent, and only in 27.8% of cases did they experience minor performance issues (e.g., lagging).

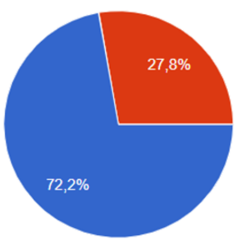

Figure 9. VR app stability and smooth running

To identify gaps and opportunities, research was conducted in which existing studies, technologies, and educational methodologies were analyzed. The objective was to gain insight into the current landscape of VR and digital learning in the context of career transitions.

Consequently, we developed VR-based learning modules tailored to the fields of IT and science education. The modules are designed to provide learners with immersive, hands-on experiences that mimic real-world scenarios, thereby facilitating a deeper understanding of complex concepts.

To substantiate this approach, we analyseed case studies, such as the aforementioned real-world applications, which demonstrated the efficacy of VR and digital learning in enhancing educational outcomes and facilitating career transitions. To evaluate the impact of VR and digital learning tools on learners, we conducted a feedback and evaluation process. This was done to refine the approach and ensure that the learning modules met the needs of diverse learners. The feedback was gathered from participants to inform future iterations of the modules.

5. Conclusions

In conclusion, addressing the digital divide through distance learning not only facilitates career transitions in IT and science but also unlocks new horizons for the future of the workforce, ensuring equitable access to the resources needed to tackle upcoming challenges and opportunities.

The article discusses the creation and utilization of a gamified system via VR, which can be advantageous for individuals seeking to broaden their knowledge, acquire new skills, or transition into different careers.

The project is focusing on smart education used as a platform to address students' digital inequalities, whether economic or with medical disabilities. The software-based platform empowers digital education and assures a low-cost inclusion system for all students. This is achieved through the implementation of an inclusive educational platform, supplemented by low-cost remote virtual labs and smart communication tools, providing practical education in biology, chemistry, and IT systems. This approach offers an alternative to traditional hands-on labs, catering to students with restricted access.

The interface emulates an interactive system that encourages users to complete various tasks in fields such as IT, medicine, and chemistry. The acquisition of knowledge through practical application can enhance information retention and facilitate access to specific tasks in desired fields.

The application is designed to be customizable based on the user's level of difficulty and work area, providing a tailored experience. The objective of implementing this system is to ensure equal opportunities for all individuals who wish to broaden their career prospects. The customizable nature of the application allows for adjustments in difficulty levels and focus areas, ensuring a personalized learning experience tailored to individual preferences and goals. This approach aims to provide equal opportunities for all users, irrespective of their background or prior expertise, to explore and excel in their desired fields.

Furthermore, integrating exercise into the learning process can improve information retention and cognitive function, resulting in effective and enjoyable learning. As technology advances, gamified VR systems are being used for education and career development. They have the potential to reshape how we acquire and apply knowledge in the digital age. Ultimately, the implementation of such systems underscores a commitment to empowering individuals on their journey towards personal and professional growth.

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