DIGITAL REALITY-TECHNOLOGY FOR SUSTAINABLE SKILLS DEVELOPMENT IN VOCATIONAL EDUCATION AND TRAINING

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Abstract: The skills and competences needed by the industry are constantly changing. This applies to already existing as well as newly created professions. Naturally, the teaching and learning scenario changes in the same rhythm, requiring new innovative pedagogical approaches that will raise the level, quality and attractiveness of Vocational, Education and Training (VET). The use of Digital Reality (DR) technologies such as Virtual Reality (VR), Augmented Reality (AR), Mixed Reality (MX) and Extended Reality(XR), will allow students and trainees to complete a real task with simulated tools or in a simulated environment mirroring reality. This approach will positively influence the development of VET so that it can provide answers to the rhythm of labour market demands. This way VET teachers and trainers competencies will be strengthened, while being encouraged to incorporate DR tools into their teaching processes. For this to be possible, it is necessary the development of a good pedagogical approach and methodology for the use of DR tools in VET, which does not currently exist, with the possibility of international transferability in all areas of vocational education. This paper will present the pedagogical and methodological approach that is being developed within the Erasmus + project, 2020-1-HR01-KA226-VET-094650, entitled: "Digital reality - the basis of skills training" (DRinVET). The development of the DRinVET project is based on many years of experience in the industry field working with DR technologies partner organisations, from the development of the environment devices to pedagogical and methodological guidelines related to educational processes in welding.

1   INTRODUCTION

COVID-19 has had a global impact on our world order, impacting multiple sectors, being one Education. Vocational education, especially practical training and assessment have been negatively impacted, due to the fact that all classes have been moved to the internet. Many teachers and trainers had to adapt the way they were providing training and assessment to be delivered through online platforms. According to an OECD report, more than 60% of them have not learned to work in a digital environment. On the other hand, in vocational education, the problem is even more pronounced and relates to skills - the practical part of education. While online theoretical classes have been implemented at a certain pace, many students have been left without the opportunity to do the practical part in industry, training centres and schools due to COVID-19 and anti-pandemic measures. As a result, in Denmark alone, e.g., close to 20,000 students were prevented from taking practical exams. Both of these problems suggest that quick solutions need to be found to lessen the problem, primarily through accessible solutions for distance learning. In this sense, the Erasmus+ partnership project Digital reality – the basis of skills training or DRinVET for short, was launched.

The project involves 7 partners from 6 European countries with different profiles and set of competences in the field of Digital Reality (DR), such as Association for the Promotion of Vocational Education, Secondary Vocational School and University as experienced users of the DR tool, companies that produce simulators based on DR technologies and a virtual reality development agency. The project partners see the solution in DR tools that allow students to complete a real task in a simulated environment mirroring reality, which ultimately contributes to solving the problem of practical training and assessment. In order to do this, a good pedagogy and methodology for the use of DR tools is being developed, as well as tools that will raise teachers' and trainers' competences and enable teaching processes to lead safely towards learning outcomes needed for the labour market. The objectives of the project can be summarized as follow: promotion of DR tools as a solution for distance learning with the possibility of application in theoretical and practical teaching and training, applicable to a variety of social crisis circumstances. Therefore, the goal is to develop tools and procedures to raise teachers' and trainers' competencies to work in the DR environment, promoting learning through technology. In that sense, partners are developing the following 6 Intellectual Outputs (IOs) during the project implementation:

1) Basics of digital reality - A handbook for teachers and trainers on how to use different virtual reality simulators for professional occupation in VET;

2) VET library of DR - A database of digital content creators / developers;

3) HOW TO ... - Best practice examples from VET digital classrooms across Europe (platform for knowledge exchange);

4) Pedagogical guidelines for learning and teaching using DR technologies;

5) Technical manual: Minimum conditions for education, training and testing in educational processes in virtual environment;

6) Guideline for Online assessment: Tools and procedures to perform harmonized online assessment of learning gained through virtual environment.

As there are currently no solutions such as the ones offered by this project, but an emergent need for their implementation, the partners decided to apply a "step by step" methodology through each phase of the project, as in step by step to the solution. All IOs will be developed according to this methodology, both internally and externally. The project results are intended primarily for secondary vocational teachers, their students, high(er) VET education, adult education institutions with vocational characteristics, theirs trainers and trainees, and public authorities both at national and international levels. However, it is important to emphasize that the pedagogical guidelines being developed are generic for DR, as a way to ensure transferability. Therefore, their use will not be limited to vocational education.

2 EXPECTED RESULTS
2.1 Basics of digital reality

Basics of digital reality is a manual being developed for teachers, It will provide answers on how to use various virtual reality simulators for professional occupation in vocational education and training and the development of training materials for the Instrucor 2.0. Define the different types of digital reality environments (XR, VR, AR, MR, among others) and its possible impacts in VET education. The handbook will provide recommendations and good examples to educators on how to choose virtual technologies that can be most effectively integrated into their own education system. Summarize and compare the advantages and disadvantages (possible limitations) of different XR environments and tools to help and support to choose the right training tool for the own needs. Summarize and standardize the use of different simulators in VET. Present what kind of VET areas can adressed efficiently thanks to use of XR technologies and how can they help in everyday vocational training and adult education. Formulate methods for what kind of pedagogical tools the educator can most effectively use to develop the skills of his/her students, thus exploiting the benefits of XR technologies. Onboarding of the instructor: toolkit for training of the trainer to enable him/her to become the Instructor 2.0. First of all the instructor has to be integrated into the VR solution. More than XR, it is a learning tool. Pedagogy of the content: XR content has to be designed in order to become the VR solution as a real learning tool. The use of XR for industrial training is clearly essential and should be part of the new training revolution that is coming up, boosted by the COVID-19 crisis.).

2.2 VET library of DR

The sudden appearance of the novel coronavirus in the early months of 2020 caught the world by surprise in all segments of everyday life - the education being one of them. Educators around the globe suddenly found themselves in an unknown and unchartered territory, most of them completely unprepared for what was to come and what was expected of them.

Over night they were supposed to become experts in all matters digital. Mastering using digital skills is only one side of the coin. The other, which is much more time consuming, is choosing from the vast offering presenting itself on the internet. Hundreds and hundreds of hours have gone into the research and many more are to come if we are to believe the experts who say that the virus is not going anywhere any time soon. The teaching has moved online and will remain there for an unknown while and digital reality in all its forms has become the teacher's best friend. Not only because of the COVID-19, but also because the world and the learners have changed. Using technology in teaching/learning is becoming/has become a standard, depending on where one lives. This is precisely why the educational world needs an intellectual output of this kind - a database of digital content creators / developers (teachers/trainers/specialists) across Europe who can contribute to the development of digital training in the VET field through e.g. elaboration of theoretical lessons materials, practical exercises, real life situations that can be simulated using AR/VR/MR/XR technologies, etc. The possibilities are endless. Such a database of people/institutions from all European countries, who have either theoretical knowledge about the topic, or who can develop content, would be highly beneficial to everyone involved in VET - be it on a secondary or high(er) level or even in the adult education. In other words, the target group(s) of this output are all the VET educators and providers across Europe (maybe even further). This intellectual output would not only prove itself very practical but would also save time because all the information one requires would be in one place - the only thing left to do would be to start the search across the categories - innovative, practical and fast at the same time. There is not an educator in the world who would not appreciate this. Although primary users of this output would be the educators, they are not the only ones who would profit from it - their learners would benefit, too. So, it is more than obvious that the expected impact and the transferability potential in this case are huge. Moreover, there is also a potential for cooperation between the industry and the education using the results from the database as we know that in the VET

field the synergy between these two stakeholders is very important - one cannot exist without the other. They complement each other and in working together, they yield the best possible results.

2.3 HOW TO

HOW TO.... resultsis focused on presentation of best practices in digital teaching and learning using virtual classrooms. This results contribution to the use of digital platforms during the COVID-19 pandemic will target a wide range of digital tools dedicated to teaching, learning and assessing students in vocational schools. A strong emphasis will be placed on dedicated platforms such as examples of good practice through the use of the Google Classroom or Microsoft Teams platform, but also on dedicated open source, be spoke, or on-theshelf learning management systems. In addition, this intellectual product will integrate into the set of good practices by providing teachers, instructors and students with applications dedicated to learning developed in previous ERASMUS projects such as FUTUREWELD (FutureWeld app and WELD app), MICROBOND (MicroBond app) or current as ar fi DIGIWELD (DIGIWELD off-line course, DIGIWELD study cases for welding simulators and DIGIWELD learning management system), InteractivWeld, WeldChance, WELDONE.

The project partners will summarize the most used e-learning platforms in their countries and among Europe in order to link them and to provide digital tools for teachers and students.

COVID-19 crisis raised an important issue of educational systems. According to OECD (2020) report related to the impact on education systems, the COVID-19 crisis has exposed the many inadequacies and inequities in our education systems – from access to the broadband and computers needed for online education, and the supportive environments needed to focus on learning, up to the misalignment between resources and needs. Previous reports of OECD also outlined that less than 40% of educators felt ready to use digital technologies in teaching with wide differences across the EU. Moreover, although there are simulators that use technologies based on augmented reality or virtual reality, they can only be accessed by students inside the laboratories of the vocational school. No European country has been prepared for the transition from traditional face-to-face learning to online or blended learning, much less in the case of practical activities absolutely necessary for qualification in special trades such as welding. Therefore, the need to present the best practices in the activity of teaching / theoretical and practical learning is absolutely necessary for the improvement of the educational process in vocational schools that have not used digital tools so far. On the other hand the digital skills of teachers and students are very important for the succes of uptaking of virtual learning envirnoment in education process. According to JRC Technical Report of EU (2020) related to the impact of COVID-19 on education, the need for profesional development in the are of ICT skills for teaching is also higher in schools with high concetration of disadvantaged students.

The target groups are: teachers/trainers and students.

Teachers/Trainers: will benefit from concise information on how to use the widely used digital tools, good practices applied in 2020 as a result of the translation of the educational system from the teaching / learning / face-to-face assessment environment to the digital / virtual environment.

Students: will be able to access online courses using their own phone/laptop/tablet.

This result is innovative taking into consideration that the project partners will develop teaching notes for teachers/traines in order to give them harmonized digital competences focused on online learning management system, and virtual classrooms as well as simulators using augmented or virtual reality. The outputs/results will support and comply with the Digital Education Plan outlined by European Commission to make education and training systems to fit for the digital age. The best practices developed in this result will meet the needs for digitally competent and confident teachers and education and training staff as well as providing examples with high-quality learning content, user-friendly tools and secure platforms with respect privacy and ethical standards. These results are expected to have a major impact on the teaching / learning process. The expected impact is to increase the digital skills development to VET learners and apprentices as well as to offer professional opportunities for teachers, trainers and other educational staff.

The transferability potential is high. Taking into consideration that the outputs will be focused on digital content, the best practices elaborated in this intellectual outputs can be easy transferred to other teaching/learning processes in various technical domains. The teacher from VET schools will be encouraged and assisted in their efforts to adopt project results.

2.4 Pedagogical guidelines

The purpose of this component is to define and describe the pedagogical guidelines for employing DRs within teaching and learning. The special focus is on VET in education, but the guidelines are generic across DR to ensure transferability.

There are 4 main reasons for implementing DRs in learning and education, especially within VET, based on necessity and benefits:

1. The COVID-19 effect:

COVID-19 shut down most learning institutions, but most, despite initial challenges, managed to maintain a good portion of their educational offerings and deliver teaching and testing via online media platforms. But, VET educations suffered and are still suffering tremendously, due to the fact that theoretical classes were maintained, but 1) apprenticeships and internships were cancelled 2) practical exercises were made impossible and 3) VET students were

prevented from taking their practical exams, thereby not being able to graduate. Various unions have advocated strongly for future-proofing VET educations, for instance via DR tools.

DR tools such as physical models that simulate the actual tool's behavior, computer-based training models and Virtual and Augmented Reality versions of training environments, haveshown enormous potential addressing the above problem, as it relates to the educational context. These tools enable the learners to perform the actual task either with a simulated tool, or in a simulated environment mirroring reality. In this way students can still practice their practical skills and even take exams. Some studies find no discrepancy between the skills practiced in a virtual versus a real environment. In a January 2020 report by PwC* which compared traditional training with training in VR, the top 5 findings were, 1) learners in VR courses could be trained up to 4 times faster, 2) Learners are more confident in applying what they've learned in VR, 3) learners are more emotionally connected with the materials, 4) VR learners are more focused and, 5) VR learning can more cost-effective (less transport, less material usage, etc), is more accessible (no construction site is needed for instance).

2. In short: DR technologies show a valid tendency to increase learner outcome This has been documented by, among others, Copenhagen University lecturer and researcher in VR and educational psychology, Guido Makransky, in several studies. It has, however, been found to be equally important to establish a structure and process around DR inclusion. In some studies, VR/DR, when used alone, had no further effect than simply watching a video or movie. However, if combined with pre-teaching, VR/DR were shown to have a better effect than all other technologies. This stresses the importance of establishing proper pedagogical guidelines.

3. There's a significant increase in online learning platforms (Udemy, Coursera, etc)

Several reports outline a significant increase in the desire for distance learning and the number of independent platforms (Coursera, Udemy, SmartLearning, etc) and established educational institutions that formally offer the possibility.

4. The social inclusion component.

As also stressed in the report "..on academic further and distance education as part of the European lifelong learning strategy": "..poor access to educational opportunities can reduce people's competitiveness in the labour market and cause difficulties in their private life or even lead to permanent inertia, exclusion from society and, as we have seen in recent years, violent radicalisation, especially among the young, who are the most vulnerable in circumstances of risk."

Availability of distance education, perhaps especially in VET education can help alleviate this problem, but in order to do this properly, a good pedagogy and methodology for use of the DR tools, which does not currently exist, must be developed, which also has international transferability.

In summary, results are not merely achieved by introducing digital tools in education, as shown in many different studies. The various tools must be integrated correctly in the pedagogical and educational models in order to reap the benefits. In turn, it is expected that distance education can and will become more inclusive and that VET educations in general will be more solidly future proofed, for disturbances such as COVID-19. These guidelines will be provided will be ensured via continued research and synthesis of state-of-the art methodologies in combination with project findings.

*It must be stated that The PwC report does not address VET students, but soft skills.

2.5 Technical manual

The result is the development of a technical manual describing the minimum necessary conditions for education, training and testing in educational processes in virtual environment.

For its performance, all technical issues related to technologies applied to education will be taken into account: learning management system, virtual and augmented reality tools, multimedia and other educational applications with a view to improving teaching-learning processes.

The real need to improve the quality of online vocational education and training (VET), establishing the minimum requirements at a technical level to carry out the training experience successfully.

The target group is represented by teachers and students. Teachers will have a greater knowledge of the educational resources, tools and applications that they can use in their courses to improve the teaching-learning processes. Students will be able to know, access and use a variety of motivating educational resources using a digital environment closer to their needs, taking into account that they live in a digital world. The inclusion of innovative tools to learn, teach, evaluate, test, and monitor student learning in virtual environments. With the creation of this technical manual, it is expected to take a step forward in improving the quality of these processes.

By creating this handbook, the quality of the teaching and learning process in virtual environments will increase.

Virtual training should not be a pdf repository where students practice e-reading but rather an opportunity to connect a variety of resources and tools to generate meaningful, motivating and successful teaching-learning experiences. The technical manual will be digitized.

2.6 Guideline for Online assessment

This result consists on the development of a guideline and online tools for quality assurance when performing assessment of digital/virtual learning outcomes.The guideline will describe the procedures and conditions in which the online assessment shall be conducted and also consider best-practices in the development of assessment tools, which will

be in the form of case study projects, multiple choice questions and short essays. The external review of the assessments will be organized to ensure that the standards of the assessments are consistent with the guideline and aligned with a harmonized implementation (meaning following the same quality criteria). The expected impact for this result is as follows:

▪   The Guideline will support teachers and trainers in the development of online assessment;

▪   The assessment template can be used as reference for several qualifications andcourses in order to facilitate their uptake by National VET and HE Systems;

▪   Quality Assurance when delivering online assessment.

Transferability potential:

▪   The Guideline can be used as reference for a range of online trainings;

▪   The use of an online template for the assessments will allow wider implementation across all partners;

▪   Online assessment materials can be transferred into a printed format if required.

3   CONCLUSION

COVID-19 has had a global impact on education, especially since all classes have been moved to the internet. According to an OECD report, more than 60% of students and trainees have not learned to work in a digital environment. And while online theoretical classes have been implemented at a certain pace, many of them have been left without the opportunity to do the practical part in industry, training centres and schools due to the pandemic and anti-pandemic measures.

As the DRinVET project partnership sees the solution in DR, this project will develop tools to help teachers and trainers, who have found it difficult to adapt to this new digital environment, overcome their difficulties, especially in terms of conducting and assessing practical training. In this way, students and trainees will experience the compleation of a task using simulated tools that reflect reality.

The DRinVET project will have an immediate and long-term impact on target groups and vocational education as a whole - from the local, national to international levels. The project can be considered a basis, because it will deliver tools that will provide all target groups with easier access to DR technologies; the foundations for further personal development of teachers, trainers students and trainees; and the development of the educational organizations and institutions in which they operate and learn. Teachers, trainers, students and trainees will learn how to learn with technology. This will allow them to dive into DR as experienced users and participate equally in the education and technology race mentioned in the saying at the beginning of this summary.

4   REFERENCES

[1] Southgate E. (2020). Virtual Reality in Curriculum and Pedagogy. Evidence from Secondary Classrooms. *Routledge*

[2] Information Resources Management Association (2019). Virtual Reality in Education: Breakthroughs in Research and Practice.. *IGI Global; 1st edition*

[3] Chan M. (2020). Digital Reality: The Body and Digital Technologies. *Bloomsbury Academic; 1st edition*

[4] Tom Dieck M.C., Jung T.H., Louerio S.M.C. (2021). Augmented Reality and Virtual Reality: New Trends in Immersive Technology. *Springer; 1st ed.*