The Emerging Role of New Technologies in Vocational Education

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ABSTRACT

The paper presents some essential tools in the field of 3D modelling for vocational education. The purpose of vocational training is to adequately prepare students for the needs of the industry. Over the last decade, the appearance of low-cost virtual reality (VR) technology has enabled it to be deployed across a broad range of educational institutions. VR as a system allows intuitive human-computer interaction and offers great benefits in many application areas important for educational process. In this paper, two VR studies in educational field were compared.

Keywords: 3D modelling, virtual reality, vocational studies, education.

INTRODUCTION

Ever since the first industrial revolution impacted a world on a big scale, science and technology are rapidly evolving year after year. With the introduction of the steam engine, new business ideas and opportunities are created. By its evolution, improvements in speed, productivity and transport speeds were significantly improved. The steam engine allowed and brought many advantages. Big factories were opened, new transportation means were presented. The creation of the steam engine shows the result of many years of research and technology development. When the scale of the possibilities brought by that innovation was understood, people started to realise the importance of science. With the continuous work and improvements in technology and science, the world was introduced with many new solutions, inventions and things that made such a drastic and significant impact on it. Today it is almost impossible to even think about not travelling by buses, ships, planes, electric cars, etc. It is practically impossible to imagine humans lives without computers, playing consoles, mobile phones, TVs. All of those things are the result of technology evolution, research and innovation. Some of the tools that are at the basis of teaching in the field of 3D modelling for
vocational education are *Virtual reality (VR), Augmented reality (AR), 3D modelling and 3D printing* (Radolovic, 2019).

**EDUCATION LEVEL AS A VARIABLE IN PROCESS**

The application of different technological devices in the educational process accelerates the teaching process and makes it more exciting and more acceptable. The knowledge that students need to have at the end of schooling is rapidly changing.

**3D MODELING**

The 3D modelling process has become more and more used in broad industry range to improve and to speed up the planning as well as the working process. Virtual models of various products, machines and facilities can help to increase efficiency while reducing costs like the ones that occur when having defect parts and components. Building a 3d product component before starting to manufacture it can help with the estimation of material costs and manufacturing process. If the product is part of an assembly we can see how will that component interact with other components of the assembly in a virtual space, and make changes if needed before the component is even made. All the virtual 3d components are made in programs that are called Computer Aided Design (CAD). There are several different CAD programs, some of them require a licence that must be purchased in order to be able to use the program, but there are also some free CAD programs or the ones that offer free licence for educational use or for small businesses that are just getting started. One of the free CAD programs that are recently starting to be used more and more is the FUSION 360 from the company Autodesk. It is a user-friendly easy to use and cloud-based program that offers the user an interactive and multifunctional all in one service. CAD programs are most commonly used to better visualize the end product, to increase its functionality and to make assembly and work drawings of the components to be used in the workshop. In cooperation with CAM (eng. Computer Aided Manufacture) software it can be used to create the manufacturing process for the part to be made and then creating a G-code that is compatible with the CNC machine. CAD models can also be used to create analysis of the model under different loads (statically, dynamical, vibrating…), and to test and see how the product will behave under different temperature (thermal analysis). This type of virtual 3D model analysis is called Finite Element Method (FEM). Today we have one major field that is expanding at high speed every day, and it’s the field of 3D printing. Combined with 3D modeling it goes hand to hand as 3D printing represents the fastest way to get from a virtual 3D model to a functional prototype at your desk. Virtual 3D models can be used in a very versatile way, and are therefore compelling to be used if not even necessary in the education. Specially important application can be for students in technical fields of study to be able to adapt to the high demands of today’s market and industrial requirements.

Industrial design has become crucial to the products innovation and value-added process in current highly competitive marketplace. To provide designers nature and natural means to express their ideas freely and overcome the technical gap in the iterative design process, virtual and augmented reality technologies are employed to supplement the traditional Computer Aided Design – Rapid Prototyping (CAD-RP) iterative design process (*Yang Ran & Zhenbiao Wang, 2011*).

**VIRTUAL REALITY**

Virtual reality or popularly called just VR, is becoming a field of intense interest in the modern days. Today VR is used for different things, from presentation and marketing up to making video games that allow the players to experience the feeling like they are part of the game they ar
VR helps us better envisage a specific product or a particular area. The recent appearance of low cost virtual reality (VR) technologies – like the Oculus Rift, the HTC Vive and the Sony PlayStation VR – and Mixed Reality Interfaces (MRITF) – like the Hololens – is attracting the attention of users and researchers suggesting it may be the next most massive stepping stone in technological innovation (Pietro Cipresso et al. 2018). Today we have two fields that can at first seem as very similar, but in reality they are different. One is virtual reality or VR as we mentioned before, and the other is augmented reality or AR. The big difference is that augmented reality allows us to visualise a virtual component in the real world that surrounds us, while the virtual reality enables us to create a fictional virtual world that doesn't have to be similar to the real one. For example with virtual reality we can stay at our office desk while simultaneously virtually visit the factory in London. That's why this is so tempting for usage in educational purposes. With the help of virtual reality students can visit the factories, production lines from all around the Globe while being at their Universities. They can inspect the motors, turbines and all the different machines up close and see how they work instead of just reading about them in the books. Virtual reality is a tempting tool to be used for better visualisation and better understanding, and needless to say it is fun to use. Although working to create a virtual reality program requires a little programming experience, the usage of it results does not. Today, there are few different programs that allows the creation of the virtual reality, and like the CAD programs, some require a paid licence while others give free educational licences like for example Unity.

Virtual reality aids many types of industries such as construction companies, automobile industry, military designers, research and education developers and hospitals. It has been most helpful in improving the design and reducing prototype costs, which lowers manufacturing costs (D.C. Sherrard & M. Narayanan).

Some experimental virtual reality usage in education has already been made and it was found that students become self-motivated learners and mentors for their peers (Rex Kozak & Robert Berggren, 2013).

**THE RADOLOVIĆ AND ALLCOAT & VON MUHLENEN RESULTS COMPARATION**

This paper is focused on our previous work Radolović et al. (2019), and the work of Allcoat & Von Mühlenen (2018) results comparison. In mentioned previous study, (Radolović et al., 2019,) 58 students were interviewed with different previous educational background.

A survey was based on the following questions:

1. Do you think that the design and implementation of 3D print models should be introduced into regular teaching at a vocational training?
2. How satisfied are you with the quality of the virtual model?
3. Do you think that the implementation of 3D models would contribute to a significant improvement of vocational training?
4. How informed are you about the application of new technologies in educational activities in the process industry?
5. Do you think that the implementation of 3D models would contribute to a significant improvement in the quality of teaching?

Students were given access to the virtual model and got explanations for use. A link to the virtual model on which education was provided was attached. After that, they followed instructions to get hands-on through the 3D model preview software. The survey was bilingual in Croatian and English to cover as many different students as possible. Poll questions were closed type. The answers offered the option of choosing between answers yes/no or they are given on a five-degree Likert-type scale (gradually from 1 - I am not at all, 5 - I am extremely/fully) Radolović et al. (2019).
Answers on the questions:

1.) 96.4% of respondents believed that the design and implementation of 3D models should be introduced into regular teaching at the vocational training. 3.6% of respondents believed that they should not be introduced.

2.) 59.6% of respondents are very or very satisfied with the quality of the virtual model, 29.8% are not sure, neither satisfied nor dissatisfied, while 3.5% of respondents stated that they are not satisfied.

3.) 94.7% of respondents considered that the 3D model application would contribute to a significant improvement in vocational training, while 5.3% of the respondents believe that the application of the 3D model would not contribute to a significant improvement in vocational training.

4.) Most respondents (43.9%) replied that they are medium introduced, 24.6% are fully introduced while 29.8% of respondents are not introduced at all.

5.) 93% of students considered that the application of 3D models contributed to a significant improvement in teaching. Only 7% of them think that applying 3D models would not bring significant improvement in teaching.

In their investigation, Allcoat and Von Mühlenen (2018) explored recent advances in virtual reality (VR) technology for potential learning and education applications. They assigned 99 participants to one of three learning conditions: traditional (textbook style), VR and video (a passive control). The learning materials used the same text and 3D model for all conditions. Each participant was given a knowledge test before and after learning. Participants in the traditional and VR conditions had improved overall performance (i.e. learning, including knowledge acquisition and understanding) compared to those in the video condition. Participants in the VR condition also showed better performance for ‘remembering’ than those in the traditional and video conditions.

The 17 focused questions were marked as correct or incorrect and used in the calculation of an overall percentage correct, separately for each participant. Allcoat and Von Mühlenen (2018) marked the average knowledge and confidence scores ratings in the pretest and the post-test, together with the difference scores, as an indicator for learning.

Table 1. The VR models learning impact in Radolović et al. and Allcoat and Von Mühlenen study

| The application of VR models contributed to a significant improvement in teaching. | What was the difference in approving the knowledge scores in pre and post-test in using virtual model |
|---|---|
| Radolović et al. | Allcoat & Von Muhlenen |
| Not at all | 7,0% | 28,1% Pretest |
| Fully introduced | 93,0% | 56,5% Post-test |
| Difference | 86,0% | 28,4% Difference |
Table 1. shows VR models learning impact in Radolović and Allcoat and Von Mühlenen study. VR models impact was, in both cases, tested by enabling students to learn from VR model. In Radolović et al. (2019) study 93% of students who learned by using VR model considered that the application of 3D models contributed to a significant improvement in teaching, in sense of a better remembering and understanding the presented material, while Allcoat and Von Mühlenen study (2018) showed the 28.4% difference in approving the knowledge scores in pre and post-test, as shown in fig 1.

CONCLUSIONS

In order to follow the high industrial and marketing demands, students and future engineers need to embrace the new technologies that are today implemented in modern factories. These technologies serve not only to prepare them for the future market and workplaces but also as a tool for better and faster learning as it helps students to better visualize new content. Young engineers and students seem to adapt the changes of the modern industry as shown by the results of both Radolović as well as the Allcoat & Von Muhlenen studies. Both studies showed students considered that the application of 3D models, as well as VR, contributed to a significant improvement in teaching in a way of a better remembering and understanding the presented material. Knowledge scores and confidence ratings are improved in VR learning vs traditional ones. Remembering and understanding increased more in VR learning, and in using 3D model, then in using textbook as a dominant learning tool. With these results we can suggest the implementation of 3D modelling and VR technologies as an addition to classic lecture in form of laboratory practice exercises.

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REFERENCES

Allcoat, D. & Von Muhlenen, A. (2018). Learning in virtual reality: Effects on performance, emotion and engagement. *Research in Learning Technology*, 26

Cipresso, P., Giglioli, I. A. C., Raya, M. A., & Riva, G. (2018). The past, present, and future of virtual and augmented reality research: A network and cluster analysis of the literature. *Frontiers in Psychology*, 9, Article ID 2086.

D.C. Sherrard & M. Narayanan, The aid of virtual reality in the industry, Proceedings of WESCON '94, 27-29 Sept, 1994. doi: 10.1109/WESCON.1994.403569

Kharb, P. (2013) ‘The learning styles and the preferred teaching–learning strategies of first year medical students’, *Journal of Clinical and Diagnostic Research*, 7, 6, pp. 1089–1092. doi: 10.7860/JCDR/2013/5809.3090.

Mazuryk T., Gervautz M. (1999). *Virtual Reality: History, Applications, Technology and Future*, Institute of Computer Graphics, Vienna University of Technology

Milić, M., Maričić, S. & Radolovic, D. (2017). Implementation of additive technologies in elementary education. *International Conference of Modern Technologies in Manufacturing, Cluj-Napoca*

Pietro Cipresso, Irene Alice Chicchi Giglioli, Mariano Alcañiz Raya & Giuseppe Riva, The Past, Present, and Future of Virtual and Augmented Reality Research: A Network and Cluster Analysis of the Literature, 11.06.2018. doi: 10.3389/fpsyg.2018.02086

Radolović, D. (2019). *3D Modelling and Robotic Arm Control*. Unpublished Bachelor Thesis, University of Juraj Dobrila, Croatia.

Rex Kozak & Robert Berggren (2013), Virtual Reality Educational Pathfinders (VREP), Published in: 2013 3rd Interdisciplinary Engineering Design Education Conference, doi:10.1109/IEDEC.2013.6526752

Yang Ran & Zhenbiao Wang, Virtual and Augmented Reality Applications in Industrial Design, 2011 3rd International Conference on Machine Learning and Computing (ICMLC 2011)