DEVELOPMENT OF VOCATIONAL LEARNING SCENARIOS WITH APPLICATION OF DIGITALISED RESOURCES IN THE INITIAL VET LESSONS

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Abstract

The paper presents teaching scenarios for application of the digitalised tools in developing of vocational and technical skills in the field of metalworking and engineering in a VET centre from Lithuania. These scenarios have been developed in the framework of the Erasmus+ strategic partnership project IDC-VET aiming to develop a series of resources for professional development for teachers and trainers in VET for planning and delivering professional development for effective digital and innovative education and pedagogies.

Keywords:

Vocational education and training, digitalised tools for vocational learning, development of vocational knowledge and skills

Introduction. Erasmus+ project IDC-VET

Digitalization and 4th industrial revolution has made profound changes in the skills needs and the ways these skills are provided in the vocational education and training (VET) processes (Spöttl and Windelband 2021). Technological and organizational changes of the work processes require VET providers to prepare for the different possible change scenarios having specific implications for the skills needs (Lee and Pfeiffer 2019). Digitalization also impacts the change of vocational qualifications and the processes of their design and provision (Spöttl and Tūtlys 2021).Digitalization and the 4th industrial revolution open new opportunities for the development of the provision of training through provision of new channels of communication, technological platforms for the transfer of the knowledge and skills, space for the design and elaboration of the innovative training and learning methods (Spöttl and Windelband 2019; Spöttl and Tūtlys 2020).

This paper discusses development of the educational scenarios for vocational education and training (VET) aiming to help VET teachers to apply digitalization technologies in dealing with the different didactic and organisational issues of training provision. Presented scenarios have been developed by the VET teachers from the Alytus VET centre (Lithuania) together with experts from the Academy of Education at Vytautas Magnus University in the framework of the Erasmus+ project IDC-VET. This project seeks to develop a series of resources for professional development for teachers and trainers in VET for planning and delivering professional development for effective digital, open and innovative education and pedagogies. It focuses on the three key areas of the European Framework for the Digital Competence of Educators (DigiCompEdu)– digital resources, pedagogy and assessment introducing systematic approaches to, and opportunities for, the initial and continuous professional development of VET teachers, trainers and mentors in both school and work-based settings, with a focus on developing effective digital, open and innovative education and pedagogies.

The project aims to support the development of innovative practices in a digital era. The need for such practices has been starkly demonstrated by the COVID 19 crisis which has both speeded up digtalisation in enterprises but also demonstrated both the potential and the need for online learning. The project also aims to support educators, both VET teachers and trainers, in developing and implementing the use of technology for learning in VET. During the first stage of the project from October 2020 to November 2021 there has been developed an online tool for mapping and assessing teacher digital competencies to help VET teachers to understand their personal strengths and weaknesses, by assessing their level of digital competence development and bridge the gap between school assessment (SELFIE) and individual assessment. The tool contains sets of descriptors for 22 competences that are organised over six stages of the progression model of DIGICOMPEDU. The second state of the project deals with the development of learning scenarios for different sectors in VET and to testing these scenarios and associated technologies within VET schools or the workplace. Afterwards there will be prepared a digital repository of Open Educational Resources and best practice exemplars of using technology for teaching and training in VET

in school and workplace settings. The project focuses on three key sectors in VET: metalworking and machinery production, social care and hospitality. Through the focus on pedagogy, assessment and the development of digital learning materials the project team seeks to develop new models and programmes which can support teachers and trainers in the use of technology in all sectors of VET practice.

In this paper we will introduce and discuss the learning scenarios with the application of open and digital resources for the VET teaching in the field of metalworking and engineering prepared by the team of VET teachers from Alytus VET centre and researchers from the Vytautas Magnus University (Lithuania).

Idea, structure and content of learning scenarios

The learning scenarios provide structured information for the VET teachers and trainers which helps them to plan and implement the units of training – lesson, session of the practical training by providing the targeted competences. In the case of this project the learning scenarios aim to facilitate the application of the digital and open resources in the processes of learning and training.

Development of learning scenarios is based on the structured discussions with the VET teachers and trainers aiming to discover and to codify their innovative and effective training (educational) experience of using open and digital resources and tools for the solution of concrete didactic problems occurring in the theoretical or [practical training.

The scenarios provide the following structured information: 1) scenario title, 2) target audience (VET teachers and trainers), brief description of the educational problem to solve, or learning situation, 3) targeted level of qualification according to the European Qualification Framework, indication of the competencies from DigCompEdu covered by the scenario and corresponding curriculum constructs, 4) scenario objectives, 5) description of the requirements for training and learning (infrastructure, materials etc.), 6) description of the involved learning activities by outlining activity, timing, applied training methods, responsibilities of VET teacher or trainer, activities of learners, needed equipment and support, reference to DigiCompEdu, requirements for assessment of learning outcomes and relevant resources (references).

Development and content of learning scenarios for applying digitalised and open educational resources in the VET programmes of metalworking and engineering

After the brainstorming sessions and discussions with the VET teachers there have been developed 4 learning scenarios: 1) digital visualization for understand the principles of operating mechatronic systems; 2) facilitating the understanding and reading of technical drawings with the help of digital equipment and devices; 3) use of digital design software in developing the abilities of students to read and understand technical drawings, 4) teaching circular economy skills in the VET programmes related to welding.

Here we briefly present these scenarios.

1. *Digital visualization for understand the principles of operating mechatronic systems.*

This scenario is developed for VET teachers working in the field of mechatronics. It seeks to solve the didactic problem which occurs for VET teachers in mechatronic when the VET students at the beginning of the course struggle in understanding the principles of functioning and operating of the mechatronic system. In seeking to solve this problem it is recommended to apply simulators, microcontrollers and electro-pneumatical control equipment with visualization of the control process. It deals with the didactic problem of how to fill in the gaps of VET students' abilities and skills to understand the principles of functioning and operating of the mechatronic system. Drawing and design of electrical control circuits, control systems and other elements of mechatronic and electronic systems is important part of training in the VET programmes of mechatronics and electronics. Here VET teachers often face the problem of the lack of basic knowledge and skills of VET students in dealing with these tasks. Traditional training methods, like lectures, learning from the books and other written resources, are not sufficiently effective and attractive for the students. Here the approach of work-based learning with usage of digital resources can provide optimal solution. This scenario helps VET teachers and trainers in developing the design skills of students by applying:

- task analysis and development of possible algorithm for the operation of the circuit;

- autonomous designing an electrical control circuit by working in teams;
- design of an electronic control system using a microcontroller.

Implementation of this scenario requires equipped mechatronics laboratory with computers, CAD-CAM or equivalent software, platforms for programming/controlling the microcontroller and monitoring its processes, simulators Festo FluidSIM Pneumatics, Cade SIMU or equivalent. The learning scenario consists of three parts (activities):

1 - Task analysis, in which students analyse the devices used in the circuit, learn about the design requirements and develop a possible algorithm for the operation of the circuit.

2 - Designing an electrical control circuit. After familiarising themselves with the requirements of the task, the students design an electrical control circuit (creating a sequence of operation (algorithm) for the devices to be triggered), create the principle electrical control circuit and check its operation using a simulator. One of the students is responsible for designing the algorithm and the other is responsible for designing the control scheme.

3 - Design of an electronic control system using a microcontroller. One of the students programs the microcontroller (generates the code and loads it into the microcontroller's memory) based on the electrical control scheme designed by the other student and the similarity between the LD language and the principle electrical scheme.

Students are assessed on their independent work or part of their work according to criteria set by the teacher. The algorithm must be designed to be executed in a consistent and logical manner. The electrical control scheme designed and tested in the simulator must be operational and constructed using a minimum number of components. The program code shall be verified and tested. This scenario encourages students to think analytically, solve problems, communicate and cooperate (students can consult with each other and solve the problems related to the tasks together).

1) *Facilitating the understanding and reading of technical drawings with the help of digital equipment and devices.*

This scenario is developed for VET teachers working in the field of engineering – installation of renewable energy devices. VET teachers in the field of engineering very often face situations when VET students at the beginning of a course struggle in understanding and reading technical drawings, schedules and specifications. Using digital technologies and devices can be very helpful in coping with this problem. Lack of the ability of VET students to understand and read electric installation drawings, schedules and specifications present a major obstacle for successful learning of vocational subjects in the fields of electronics and requires a lot of teaching time for teachers to deal with this. Therefore, VET schools very often face the didactic challenge on how to ensure fast, effective and sustainable acquisition of this knowledge and skills, especially, when the traditional “classroom” teaching methods from the books are not so effective and attractive for the students. Here the orientation of teaching and learning to the work practice and usage of digital solutions can create a real difference and provide a trustful measure to deal with this deficit of knowledge and skills. The VET teachers of Alytus VET centre successfully and effectively use the digital solutions for developing of skills needed to understand and read electric circuit drawings, schedules and technical specifications. This approach can be effectively used both in the school-based and work-based learning environments.

At the beginning of the training activity information is provided on the management and operation of electrical equipment and controls. This is followed by the task of using the principal diagram to design a working electrical circuit according to the requirements, in accordance with the next activities.

Activity 1. After receiving the task, the students analyse the task by identifying, either orally or in writing, the devices and their connections in the diagram, distinguishing the controlled device and the power circuit from the control circuit and describing the operation of the whole system.

Activity 2: After the analysis of the scheme, the scheme shall be further modelled in the simulator. The student accurately redraws the scheme on the computer and runs the simulation. During the simulation, the circuit, if connected correctly, will operate in the right way and the algorithm of the circuit (i.e. the sequence in which the devices must operate) becomes clear. The student checks that he/she has analysed the circuit well in Activity 1.

Activity 3: Once the student has worked out how the circuit works in the simulator, he/she needs to build a real circuit by selecting real components, connecting them, checking the quality of the connections with a multimeter, and then, after connecting the power supply, checking that the circuit is working properly. When the circuit is not working properly, the student performs it's diagnostics.

The student is assessed in this scenario on: - neatly describing the circuit diagram for the task; - creating the circuit in the simulator, checking it; - constructing and operating a real circuit.

This scenario encourages analytical thinking, problem solving, communication and cooperation (students can consult with each other and solve the problems related to the tasks together).

2) *Use of digital design software in developing the abilities of students to read and understand technical drawings.*

Lack of the ability of VET students to understand and read technical drawings present a major obstacle for successful learning of vocational subjects and requires a lot of teaching time for teachers to deal with this. Therefore, VET schools very often face the didactic challenge on how to ensure fast, effective and sustainable acquisition of the knowledge and skills of reading technical drawings, especially, when the traditional "classroom" teaching methods from the books are not so effective and attractive for the students.

Here the orientation of teaching and learning to the work practice and usage of digital solutions can create a real difference and provide a trustful measure to deal with this deficit of knowledge and skills. The VET teachers of Alytus VET centre successfully and effectively use the digital design software and 3D printing for developing of skills needed to understand and read technical drawings. This scenario is based on their experience and didactic approaches and seeks to disseminate effective practice in the different contexts of training and learning. This approach can be effectively used both in the school-based and work-based learning environments. This scenario aims to develop the subject and methodological competences of vocational teachers to teach students how to read and understand technical drawings using design software (SolidWorks, AutoCAD and similar programmes) and 3D printers. Before working with digitised drawing software, students should already be able to explain simple drawings. It is very important that students are able to distinguish between lines in drawings and know what they mean (contour line, axial line, dimension lines, etc.). This activity can be carried out using both printed drawings on paper and digital drawings displayed on a whiteboard using a beamer. Once the students are able to understand the drawing of the part, the next step of the training is to design the part in 3D in a CAD environment, for example, using Solid works. It is not practical or efficient to use 3D design for simple parts, but it is very useful for more complex parts, where more complex geometric shapes intersect and the intersection points are not straight lines. Therefore, 3D design helps pupils with weaker spatial thinking. With the ability to design a part in CAD and availability of a 3D printer, it is easy to print a prototype and have it before machining or welding operations begin.

These tools are not compulsory for learning how to read drawings, but they greatly facilitate the acquisition of knowledge and, above all, compensate for the lack of spatial thinking. With a model of the part in hand, students can visually check that they have understood and done everything well. If not, they correct their mistakes, if so, they start machining the part. Most machining machines, like computer-aided CAM systems, have simulations of the machining of the part. This is another tool to make sure that the part will be manufactured according to the drawing. For example, there can be used a milling simulator with a simulation of a milling operation on the screen. This allows a visual assessment of whether all operations have been carried out correctly and whether the part to be produced will conform to the drawing.

4) Teaching circular economy skills in the VET programmes related to welding.

VET teachers today deal with important changes of curricula and training processes related to the provision of knowledge, skills and competencies needed for the "circular" handling of the work processes, in applying the principles of circular economy by saving materials and consumables, reducing the consumption of energy and resulting emissions, minimizing the volume of rests and their re-usage or recycling. These competencies include both theoretical knowledge and practical know-how, highly developed practical skills which ensure smooth and flawless production process (avoiding of non-conformities), good understanding of the circulation of materials and consumables in the work processes, as well as holistic view to the whole production process and profound understanding of the role and place of concrete workplace in this process. Besides, it requires active engagement

and motivation of the operator to follow the 'circular' approach of working. Implementation of 'circular' approach to work in the field of welding is highly important, when considering the environmental impacts of metalworking and metal production industry (including the huge impact to the climate change), as well as fast depletion of the main raw materials used in this sector. The role of welder and welding operator in implementing and following 'circular' principles of work is significant, despite very intensive regulation, prescriptiveness, and standardization of this occupational field. Including of circular economy related knowledge and skills in the training programmes of welding could be challenging for VET teachers because of the strict regulation and prescriptiveness of the technological processes of welding and strong attachment to the traditional work methods oriented to the maximization of the output and productivity, especially in the practical training. Digital solutions, especially digital simulations of the welding processes can be highly effective measures in such training.

This scenario seeks to develop the subject and methodological competences of vocational teachers needed to teach the "circular" performance knowledge and skills in the field of welding:

- explaining the principles of "circular" performance in the different work processes of welding;
- helping to notice and to understand the environmental and economic impact of the application of 'circular' principles in welding;
- preparing and implementation of digital teaching and training materials for the development of 'circular' performance skills and competencies in welding.

Conclusions

Application of the digitalised tools and measures significantly facilitates solution of learning problems of the VET students and can become a basis for the development of innovative learning scenarios in this field. This is particularly relevant for the VET teaching in the areas of metalworking and engineering.

Such learning scenarios can target provision of vocational knowledge, as well as development of vocational skills needed for handling of digitalized technologies at the workplaces.

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