Scenario title

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

Target audience

VET teachers working in the metalworking training programmes (CNC machining and welding)'

Problem to solve - Learning Situation

VET students very often face difficulties in reading and understanding technical drawings, which creates major obstacles for theoretical and practical training. Traditional training methods applied in the classrooms are not very effective in solving this problem, but the application of digital design software and 3D printing could make an important positive difference.

Overview of scenario

EQF levels 3 and 4

This scenario of VET teacher training deals with the problem of how to fill gaps in VET students' abilities and skills to read and understand technical drawings by applying 3D design and 3D printing software.

Competencies covered from DigCompEdu

Innovating digital strategies for active learning.

02	**Digital resources**		
	2.2 Creating and modifying digital resources	To modify and build on existing openly-licensed resources and other resources where this is permitted. To create or cocreate new digital educational resources. To consider the specific learning objective, context, pedagogical approach, and learner group, when designing digital resources and planning their use.	
	C1 Leader	Creating, co-creating and modifying resources according to the learning context, using a range of advanced strategies.	*I create and modify digital resources and activities adapted to the learning context and the group of trainees, using innovative strategies such as online assessment sheets, online surveys,*

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			thematic games, collaborative platforms.
			I use tools like h5p, Padlet, Mentimeter, Kahoot, and others to create interactive activities for my graduates.

03	**Teaching and Learning**	
	3.1 Teaching	To plan for and implement digital devices and resources in the teaching process, so as to enhance the effectiveness of teaching interventions. To appropriately manage and orchestrate digital teaching interventions. To experiment with

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		and develop new formats and pedagogical methods for instruction.	
	B1 Integrator	Integrating available digital technologies meaningfully into the teaching process	*I can integrate the use of several different digital technologies and tools in the theoretical lesson and in supporting the independent learning of students.*
			I can integrate several different digital technologies and tools in practical training and work based-learning environments.

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	3.3 Collaborative Learning	To use digital technologies to foster and enhance learner collaboration. To enable learners to use digital technologies as part of collaborative assignments, as a means of enhancing communication, collaboration and collaborative knowledge creation.	
	B2 Expert	Using digital environments to support collaborative learning	*I can use online (Internet) learning environments to support collaborative learning of the VET students in the classrooms.*
			I can apply digital environments used for the collaboration and communication in the work processes for the purposes of collaborative learning.

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05	**Empowering Learners**	
	5.3 Actively engaging learners	To use digital technologies to foster learners' active and creative engagement with a subject matter. To use digital technologies within pedagogic strategies that foster learners' transversal skills, deep thinking and creative expression. To open up learning to new, real-world contexts, which involve learners themselves in hands-on activities, scientific investigation or complex problem solving, or in other ways increase learners' active involvement in complex subject matters.

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	B2 Expert	Using digital technologies for learners' active engagement with the subject matter.	*I can explain and demonstrate to VET students and apprentices the advantages of using digital technologies for the active and effective acquisition of vocational knowledge, skills and transversal skills in the classrooms and practical training environments.*
			I can initiate and implement the training projects which involve using of digital technologies for the active engagement of the VET students and apprentices in the acquisition of vocational

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			knowledge, skills and competence.
	C2 Pioneer	Innovating digital strategies for active learning.	*I can design the new methodical-organizational approach of active learning for the VET students and apprentices based on the application of digital technologies.*
			I can develop new technological solutions of digital applications for the active learning for the VET students and apprentices.

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Curriculum Construct(s)

According to Revised Bloom's Taxonomy (Anderson and Krathwohl, 2001)

https://www.researchgate.net/publication/264675976_Transitioning_from_Teaching_Lean_Tools_To_Teaching_Lean_Transformation/figures?lo=1

Understanding

Level	Description	Coverage
Creating	Putting elements together to form a coherent or functional whole; reorganizing elements into a new pattern or structure through generating, planning, or producing	FL
Evaluating	Making judgments based on criteria and standards through checking and	FL

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Analyzing	Breaking material into constituent parts, determining how the parts relate to one another and to an overall structure or purpose through	FL
Applying	Carrying out or using a procedure through executing or implementing	FL
Understanding	Constructing meaning from oral, written, and graphic messages through interpreting, exemplifying, classifying, summarizing, inferring, comparing, and explaining	LP
Remembering	Retrieving, recognizing, and recalling relevant knowledge from long-term memory	LP
LP = Learning Prerequisites, FL = Focus of the Learning Scenario		
Source: Anderson & Krathwohl (2001)		

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Scenario description

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.

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Scenario Objectives

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.Here the responsibility of tutor is to train the VET teachers and trainers in applying the described didactic approach.

Requirements

Training infrastructure and technology: vocational training classroom equipped with computers, SolidWorks, CAD-CAM or similar software, 3D printer.

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Outline plan

Activity	Reading and analysing printed technical drawings.
Timing	3 hours
Methods	Lecturing, presentations, questions-answers, execution of independent/group tasks.
What the tutor is doing	The tutor discusses with teachers on how to explain to the students the principles of technical drawing, the symbols used and their meanings, the design methods, the layout of projections and other necessary information.
What the learners are doing	Teachers explain to the students the principles of technical drawing, the symbols used and their meanings, the design methods, the layout of projections and other necessary information. Students read the printed drawings provided and explain the information contained therein.
Equipment and Support	Technical drawing demonstration materials (slides, posters, tutorials), printed technical drawings.

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Reference to DigCompEdu	03 Teaching and Learning - 3.1 Teaching 03 Teaching and Learning - 3.1 Collaborative Learning 05 Empowering Learners - 5.3 Actively engaging learners
Assessment of/for learning	Observation of the teaching process and communication between the VET teachers and students.
Resources/links/relevant content/Examples	

Activity	Designing of the drawings of welded and CNC machined parts or components by using SolidWorks or similar software and printing of the prototypes with a 3D printer.
Timing	2 hours per week
Methods	Demonstration of the execution of tasks, explanation, observation, independent execution, supervision of the execution.
What the tutor is doing	The tutor explains to VET teachers on how to provide basic know-how and skills for working with SolidWorks or similar software of designing and 3D printing.

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What the learners are doing	The VET teacher explains the students' principles and steps of drawing with SolidWorks or similar software, demonstrates each stage of drawing, prints the drawn part/component on a 3D printer. The teacher then gives the students the task(s) of drawing and printing the parts independently. The students independently (with the teacher's help/advice if necessary) draw the part/component in SolidWorks or similar and print the drawn parts.
Equipment and Support	- Sufficiently powerful computer equipment. (Most design applications require a lot of computer resources, so the hardware must be powerful). - Beamer and screen. - Printer (for printing assignments). - 3D printer (for model production). - Measuring instruments. - Machining or welding simulators (depending on the training programme).
Reference to DigCompEdu	01 Professional Engagement - 1.3 Reflective practice 02 Digital resources - 2.2 Creating and modifying digital resources 03 Teaching and Learning - 3.1 Teaching 03 Teaching and Learning - 3.1 Collaborative Learning

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	05 Empowering Learners - 5.3 Actively engaging learners
Assessment of/for learning	Methods used to assess learning outcomes: - Theoretical testing of knowledge. - Practical test of knowledge. Computer aided design of the drawing provided and printing of the model.
Resources/links/relevant content/Examples	Jeli, Z., Popokonstantinovic, B., & Stojicevic, M. (2016). Usage of 3D Computer Modelling in Learning Engineering Graphics. In (Ed.), Virtual Learning. IntechOpen. https://doi.org/10.5772/65217

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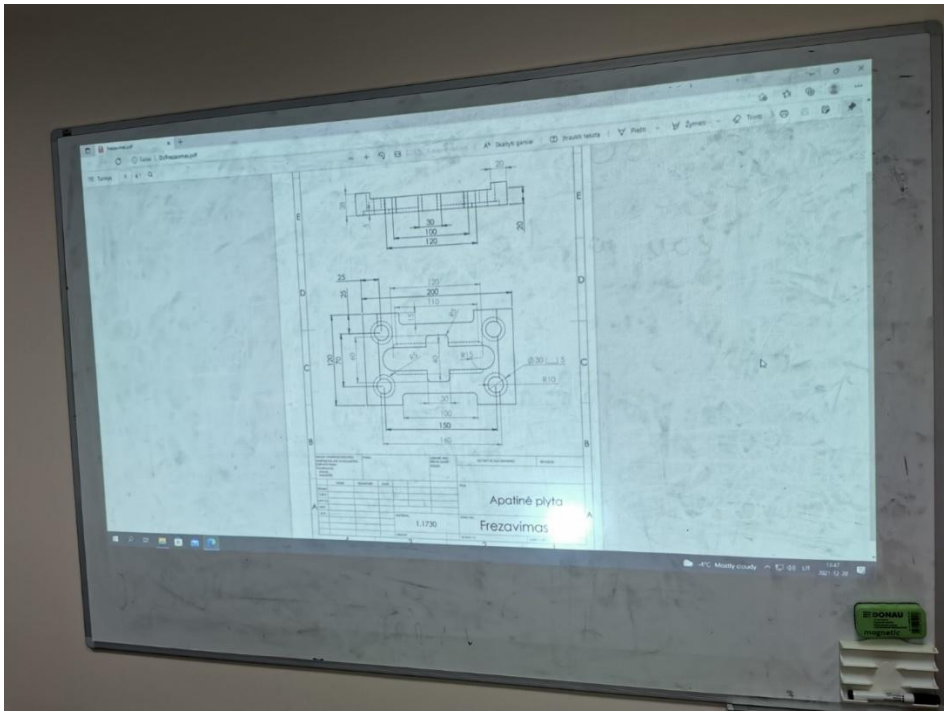
Our notes from practice

It is necessary to start with the first indicated activity. Before working with digitised drawing software, students should already be able to explain simple drawings. It is very important that pupils 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 (Figure 1).



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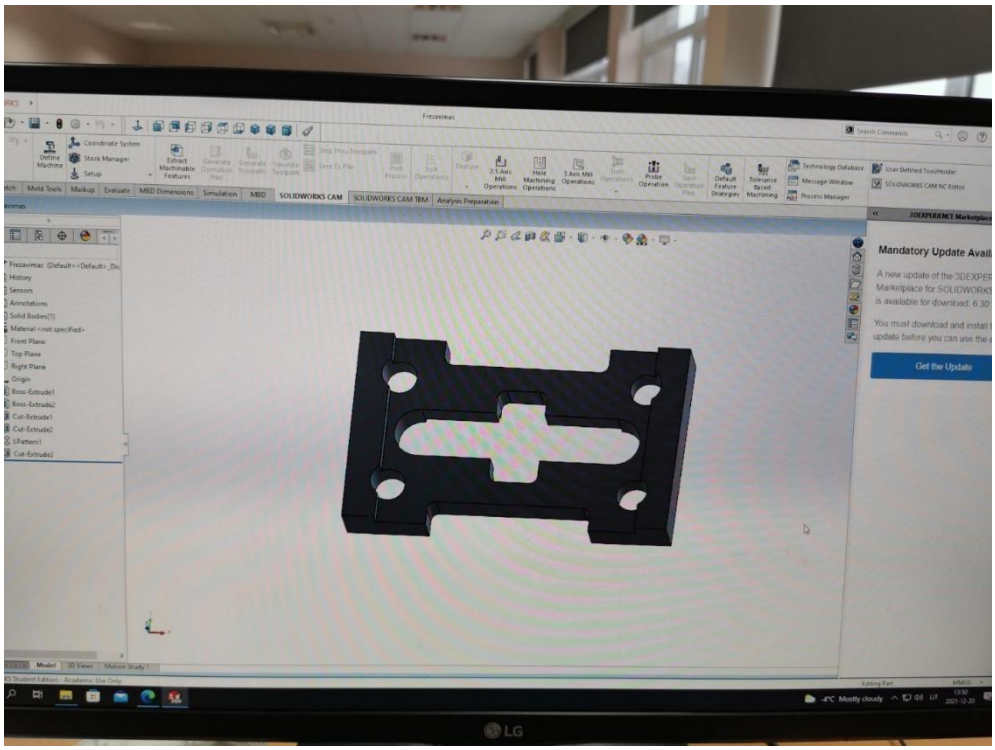
Once the students are able to understand the drawing of the part, the next step of the training is to design the part in 3D in a CAD environment. In the example above, this is Solidworks (Figure 2).



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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. (Fig. 3; 4; 5.).

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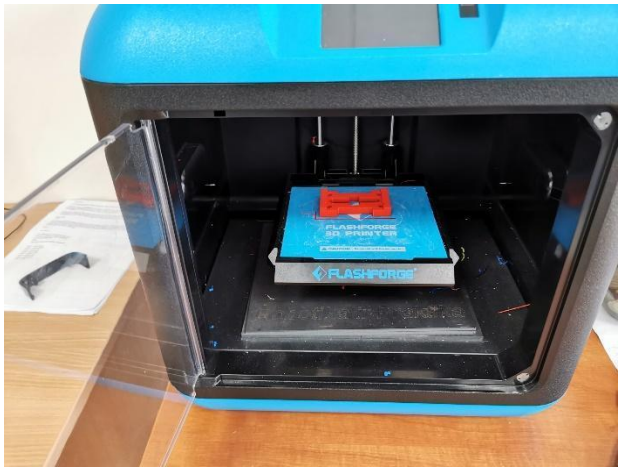

Fig. 3 Beginning of printing.

Fig. 4 End of printing.

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Fig. 5 Printed part.

As the technical capabilities of the printer are considerably lower than those of a CNC milling centre, the part was printed at a scale of 1:5 to take this into account.

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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 (Figure 6).

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Fig. 6 Milling simulator.

The figure above shows 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.

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