DIGIWELD
DIGITAL EDUCATION AND TRAINING IN WELDING

Erasmus+

2021

Innovative digital tools for training in the field of welding

Digital Learning Materials for Welding Simulator

IO2 – TECHNICAL REPORT

2018-1-RO01-KA202-049218

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Executive Summary

DIGIWELD Innovative digital tool for training in the field of Welding is an Erasmus+ funded project that addresses the European Council's Communication "Rethinking Education: Investing in skills for better socio-economic outcomes, which states the importance of promoting the use of technology for an effective learning and for reducing barriers to education, allowing individuals to learn anywhere, at any time, in individualized learning pathways.

This project aims to develop:

- A proposal for updating the European EWF-IAB-08-05-14 Guideline (i.e. the European Welder Guideline) that supports the introduction of a new module about Digital Competences and the use of welding simulators in practical training, in specific conditions, as viable and innovative tools for education and training of future welders,
- A digital tool to be inserted in simulators as modules dedicated to the training of young trainees (aged 16 to 20 years old).

In this sense, DIGIWELD Partners (six entities from Belgium, Spain, Italy and Romania with expertise in Education, Welding and in developing welding simulators) gathered to propose an updated component of the education and training European Guidelines for welding to attract young trainees to the knowledge and responsibilities of the Welder profession. Another goal was to create an open and innovative digital learning system (SIMTRANET) in the field of arc- welding technology and digital educational materials that allow trainees to access information and to perform practice time using welding simulators. To achieve DIGIWELD purposes, partners are also working towards the creation of conditions for international groups of trainees to actively participate in simultaneous training and welding contests in the safest conditions possible by using specific stand-alone simulators or virtual classrooms. Trainees with difficulties in learning or struggling economically to use digital systems for their training are targeted by this project, which also targets:

- Trainees from Vocational Education and Training (VET) schools, who will learn welding technology in a digital environment using augmented reality,
- Teachers and trainers from VET schools and other non-formal education entities, who will acquire digital competences in the field of simulators/computer networks and improve their knowledge in welding processes and innovative teaching and training methods,
- Unemployed adults or people with fewer opportunities, who will have the opportunity to obtain new skills and competences both in Information and Communication Technology (ICT) and welding field or discover and develop other skills, bringing them closer to job positions.

The present result is one of the tasks that has been carried out in the scope of DIGIWELD project's **Intellectual Output (IO) 2- Digital learning materials for welding simulator**. It focuses on the work done by DIGIWELD partners towards the development of the digital learning materials dedicated to MIG/MAG, TIG and MMA welding processes and to Quality Assurance in Welding, which will be uploaded on SIMTRANET, a digital learning system created in the scope

of DIGIWELD. In addition, taking into consideration the restrictions imposed by COVID-19 pandemia, the DIGIWELD partners decided to develop supplemental material for welding processes: Gas Welding.

It aims to be a critical analysis towards standardization, applicability and relevance points of view, focusing on the compatibility of these contents with the European Welder Guideline having in consideration that these digital learning materials were based on the updates proposed for the European Welder Guideline (EWF-IAB-089r5-14 Guideline). Therefore, the topics addressed by *Module 2 Welding Processes* (MIG/MAG, TIG and MMA welding processes) and *Module 3 Quality Assurance in Welding*, part of DIGIWELD course, are in line with the referred Guideline.

Hence, this Technical Report explains how the alignment between the subjects/topics of the European Welder Guideline were ensured by DIGIWELD partners involved in the development of the learning contents and how the technical revision was conducted towards the final version of the above mentioned modules/contents, considering their compliance with standardization. Their applicability and relevance to trainees' education and training and theoretical knowledge complies with the European Welder Guideline and the most updated state of the art.
The report contains the results of the following activities:

- Elaboration of digital learning materials, in terms of theoretical issues, for three topics: digital competences, welding processes and quality assurance in welding
- Technical revision of digital learning materials from scientific content point of view
- Pedagogical analysis of digital learning materials from level of understanding point of view

1. Introduction

The present Technical Report is one of the tasks to be carried out in the scope of DIGIWELD project's Intellectual Output (IO) 2 - Digital learning materials for welding simulator. It focuses on the work done by DIGIWELD partners towards the development of the digital learning materials dedicated to MIG/MAG, TIG and MMA welding processes and to Quality Assurance in Welding, which will be uploaded on SIMTRANET, a digital learning system created in the scope of DIGIWELD. It aims to be a critical analysis towards standardization, applicability and relevance points of view, focusing on the compatibility of these contents with the European Welder Guideline having in consideration that these digital learning materials were based on the updates proposed for the European Welder Guideline (EWF-IAB-08915-14 Guideline). Therefore, the topics addressed by *Module 2 Welding Processes* (MIG/MAG, TIG and MMA welding processes) and *Module 3 Quality Assurance in Welding*, part of DIGIWELD course, are in line with the referred Guideline. This alignment was ensured by DIGIWELD partners involved in the technical revision of all materials developed during the elaboration phase (whose knowledge of the European Welder Guideline's contents is extensive), a process illustrated by the table below:

Table 1 – *Partners involved in the development of digital learning materials' contents and for the respective technical revision*

Subject	Partner responsible for developing the contents	Partner responsible for the contents' technical revision	Partner responsible for the contents' understanding revision
MIG/MAG	IIS Progress (IT)	EWF (BE)	CNT
TIG and MMA	CESOL (ES)	EWF (BE)	
Quality Assurance in Welding	EWF (BE)	CESOL (ES)	

Hence, this Technical Report explains how the alignment between the subjects/topics of the European Welder Guideline were ensured by DIGIWELD partners involved in the development of the learning contents and how the technical revision was conducted towards the final version of the above mentioned modules/contents, considering their compliance with standardization, their applicability and relevance to trainees' education and training and theoretical knowledge, according to the European Welder Guideline and the most updated state of the art.

2. Brief overview of IO1 – New curricula of guidelines AD-089r5-14

This IO consisted of proposing an update of the European Welder Guideline (EWF-IAB 089r5- 14), which is dedicated to qualification and certification of welders at European and International levels. The tasks involved in this IO were planned to allow the development of a curricula for training young trainees (between 16 and 20 years old) in welding using digital tools. These tasks considered the following topics:

a. Proposal for accessing the course,
b. Proposal for updating the curricula with a new module about Computer & Simulation,
c. Proposal for updating the number of hours related to practical training,
d. Proposal for updating Chapter 8.2 of the Guideline (Practical training and tests) regarding procedures for training (i.e. how to apply, number of hours and types of joints to address) and for examination (i.e. designing specific tests to prove trainees' skills and the practical knowledge to start practicing on real welding equipment).

The main conclusions for each of these topics, were:

a. **Proposal for accessing the course** – It is proposed to add to Section 2 of the European Welder Guideline (Standard Route Qualification Access) the following sentence: *If a welding simulator is used for the practical training, applicants must have basic knowledge and skills in digital tools.*
b. **Proposal for updating the curricula with a new Competence Unit (CU) about Computer & Simulation** - The implementation of Simulators and Learning Management Systems (LMS) in the European Welder training requires an introduction of the trainees to these new instruments. Hence, DIGIWELD proposes a new CU entitled "**Introduction to Computer and Simulations**" to be set as optional and to be implemented in training institutions (i.e. ATBs) that carry out their training using the Welding Simulator and LMS. It may be considered as a transversal (cross-cutting) CU to all levels of Welders as it is not directly linked to a specific job activity, so it might be mobilized in several job functions. Also, the consortium decided to attribute this CU 4 contact-hours and an Elementary depth proficiency level (comparable to Level 2 EQF).
c. **Proposal for the use of practical training hours, both for welding simulators and real welding equipment**- The proposal considered was to split the minimum recommended hours for practical training into a minimal of 40% of that time in the real welding equipment. This division might need to be evaluated individually by exercise, as there may be some cases, due to difficulty inherited to the process and position, where more time may be needed in the real welding equipment.
d. **Proposal for updating Chapter 8.2 of the Guideline (Practical training and tests)** - There are minimum recommended training hours, positions, material specifications and evaluation, which are described accordingly in each practical module of the European Welder Guideline. The welding simulator created in the scope of DIGIWELD will provide practical exercises related to all European Welder course modules (both theoretical and practical), offering the needed welding positions for

trainees to practice and to be prepared for a final exercise with a real welding machine. As part of the practical training, the Welding Simulator will be used before the real-life (i.e. practical) welding modules, allowing trainees to learn their positioning in relation to the piece to weld, learn to use the torch (angle and techniques) and adjust the needed welding speed. In this sense, DIGIWELD proposed the following:

- **Procedure for training (i.e. how to apply, number of hours, types of joints to address)** – The use of the simulator for practical training should constitute 50% to 60% of the training hours in each module, leaving a minimum of 40% of the recommended hours for the real practical training with welding equipment. This division might need to be evaluated individually by exercise due to possible difficulties associated to the welding process and position, where more time may be needed in the real welding equipment. It is recommended that trainees are given the opportunity to repeat, on the welding simulator, all welding exercises two (2) times before moving to the real-life practical welding exercises, using welding equipment. The simulator provides a specific score and allows the configuration of the level of difficulty (Beginner, Intermediate or Advanced) and aid (total, some or no aid) the exercises will require, which can be total, some or no aid at all. It is for the trainer to decide the level of aid to provide to trainees. As example, trainees must obtain at least 60% score, in each exercise, without any aid from simulator before moving to practical training in the real welding equipment. The welding simulator allows to practice the processes taught throughout the European Welder course, namely Process 111 (MMA-Welding), Process 135, 136, 138 (MAG-welding), Process 131 (MIG- Welding) and Process 141 (TIG-welding).
- **Procedure for examinations (i.e. designing specific tests to prove trainees' skills and practical knowledge in order to start the practical training in real welding equipment**) - DIGIWELD consortium recommends that the welding simulator should not be used for the realization of intermediate examination (exercises carried out by the end of each practical module, based on test pieces aligned with ISO 9606). However, if there is a chance in the future that the welding simulator could be used for this purpose, the level of difficulty should be Advanced, with no aid from the simulator.

Considering that all the work done towards the development of the digital learning materials was based, as previously mentioned, on the European Welder Guideline (EU Guideline IAB- 089r5-14) and on the results achieved in IO1, understanding these conclusions provides context to the tasks addressed by this Technical Report, explained in the next section.

3. Digital training contents – Development & Technical revision

3.1. Workplan

After reaching the above-mentioned conclusions, DIGIWELD Partners met to discuss how the contents of the digital learning materials would be addressed, developed and by whom.

Knowing that DIGIWELD course would need to have contents dedicated to welding processes MIG/MAG, TIG and MMA and Quality Assurance in Welding (in line with the European Welder Guideline), in addition to the CU *Introduction to Computer & Simulations*, ASR (partner leading DIGIWELD IO2) proposed the topics to be developed for each subject (i.e. welding process and Quality Assurance in Welding), to which all Partners agreed:

Table 2 – *Topics to be developed for each Welding Process*

Welding Process	Topics				
	Introduction	Technology	Equipment	Special Application	Health & Safety
MIG/MAG	• Principle • Application • Versions	• Parameters • Techniques • Consumables • Gas types • Transfer mode	• Power sources • Torches • Feeders • Mechanization	• Fully mechanized welding • High alloyed and high-strength steels • Aluminium	• General recommendations specific for the process • Risks • Protection equipment
TIG		• Parameters • Techniques • Consumables	• Power sources • Torches • W electrodes • Mechanization	• Piping • High alloyed and high-strength steels • Aluminium (TIG)	
MMA		• c.c., c.a.	• Power sources • Clamps		

Table 3 – *Topics to be developed for Quality Assurance in Welding*

	Topics				
	Quality in Welding	WPS, WPQR	Material Imperfections	Inspection	Welder Qualification
Quality Assurance in Welding	• Generals • Specific standards	• Standards • Description • Qualification	• ISO 6520 • ISO 5817	• Examination • Testing • Specific	• Test coupon • Range of qualification

	(ISO 3834, ISO 9001)	(ISO/TR 15608, ISO 15609-1 & ISO 15614-1)	• ISO 10042	standar ds	• Validity (ISO 6906-1)

Having in consideration that these contents will be uploaded on SIMTRANET and on welding simulators (together with real case studies prepared by Partners as basis for the exercises to be carried out by trainees in the scope of their training) as part of two of the three modules trainees can choose to carry out, each subject had a specific number of pages and was prepared to be carried out in a specific number of hours. These contents has been translated to the languages of the partnership (ES, IT, PT and RO).

3.2. Elaboration phase

Considering all DIGIWELD Partners have knowledge about the topics to be developed, they were given three months to work on each subject, complying with the suggested topics previously mentioned. For the development of the contents, Partners had a set of rules to prevent any issues related with the use of images uploaded from online search engines, the use of which need permission from their authors.

After developing all the contents, Partners sent their work for a technical revision, in accordance with the workplan illustrated on Table 1.

3.3. Technical revision

The technical revision was made by EWF and CESOL experts to check for the conformity and compliance of the learning materials' contents with the European Welder Guideline, as it addresses specific subjects related to the welding processes and quality assurance in welding, also covered by DIGIWELD course. This alignment must be ensured for the sake of the quality of the material and its applicability and relevance in terms of implementation on welding simulators. Therefore, this revision focused on:

- Conformity of the used terminology on the educational materials with the terminology used in the Welding context and/or in Standardization documents (e.g. ISO 3834);
- ISO Standards documents' references (e.g. reference to correct numbers, issuing dates and parts);
- Missing ISO standards or contents related to the topics as hand which must be included to the materials;
- Suggestions for clarification of definitions, concepts or ideas;
- Suggestions for deletion of information that is not relevant to the quality of the contents and that can be searched by the trainees as parallel activity in the scope of their training;
- Suggestions for images that could be used to better illustrate a concept or idea;
- Suggestion for the logic sequence between topics.

Considering that the subjects and contents of the European Welder Guideline (and consequently of DIGIWELD course) are in line with Industry requirements, this technical revision had in consideration the ISO standards to be addressed by Partners when developing the materials. In some cases, it was necessary to add reference to standards and to explain their importance for the topic at hand. In other cases, existing references needed to be rectified as ISO standards' titles have a specific structure due to their constant updating, allowing their correct identification. Other situations refer to ISO standards that no longer exist and whose reference needed to be rectified. This revision also had in consideration the fact that all materials were prepared to be used by young trainees. Therefore, the language and terminology used had to be simple and understandable, but still technical so that trainees have the chance to get familiar with the terms used in the Welding sector. For example, the definitions connected to some of the ISO standards' purposes had to be revised in accordance with this principle as they were too technical and had to be simplified so that it can be understood by young trainees.

Finally, the technical revision also had in consideration the structure of the paragraphs which, in some cases, had to be revised to ensure the organization of concepts and/or ideas, preventing contents from being too complex or confusing. After the technical revision, DIGIWELD partners had the chance to make the necessary changes to improve the contents towards the final version of DIGIWELD modules, to be uploaded on SIMTRANET and on welding simulators to be used by European VET schools for the training of future welders.

3.4. Pedagogical revision

The purpose of this study is to analyse curricular design experiences in the context of update curricula, which to be used in high school and VET entities, incorporating welding simulators into the European Welder (EW), from methodological point of view.

By integrating such tool in the EW curriculum, the DIGIWELD consortium aims to strengthen the link between theoretical and practical learning and to empower learners to acquire knowledge and digital skills through a practical and accessible tool adapted to the context of welding.

Of all the factors involved in the vocational training process, the main beneficiaries of the curriculum are students. The curricular paradigm emphasizes the partnership between the teacher and student, highlights the active role of the student in vocational training, but at the same time, we raise awareness the fact that it is the teacher who coordinates the training process.

The curriculum corresponding to the qualifications of the vocational and technical education (TVET) is elaborated based on the Standards of vocational training (SPP). The SPP represents the document in which are described the learning outcomes that a participant in a vocational training program, carried out in the professional education and technically, he has to prove them at the end of it; also the SPP is the document that underlies the evaluation for certification purpose

The reference framework for the 8 key competences is the subject of a recommendation made by the European Parliament to all Member States. The key competences are acquisition of learning (combinations of knowledge, skills and attitudes) that allows the flexible and rapid adaptation of the graduate.

The eight areas of competence defined by the European Commission are: communication in the mother tongue; communication in foreign languages; **competences in mathematics and elementary competences in science and technology; digital skills and use of new technologies (ICT);** the competence to learn to learn; interpersonal skills and civic skills; a spirit of initiative and entrepreneurship; cultural awareness and artistic expression.

A competence is defined **as a combination of knowledge, skills and attitudes appropriate to the context. Competence indicates ability application of learning outcomes** in the appropriate context in a defined context (education, work, personal or professional).The competence is not limits cognitive elements (implying the possibility of theory, concepts or tacit knowledge); it also encompasses functional aspects (involving technical skills) as well as interpersonal attributes (for example, skills social or organizational) and ethical values.

Learning outcomes are statements that describe the knowledge or skills students should acquire by the end of a particular assignment, class, course, or program, and help students understand why that knowledge and those skills will be useful to them. They focus on the context and potential applications of knowledge and skills, help students connect learning in various contexts, and help guide assessment and evaluation. Learning outcomes provide structures, from which courses and programs can be evaluated and can assist in program and curricular design, identify gaps or overlap in program offerings, and clarify instructional, programmatic priorities.

Digital skills and the use of new information and communication technologies involve the critical and confident use of electronic media at work, during leisure and for communication. These competences refer to logical and critical thinking, information management skills to high standards and to developed communication skills. At the basic level, ICT skills include the use of multimedia technology to receive, evaluate, store, produce, present and exchange information and to communicate and participate in networks, over the Internet. Between learning outcomes and content is a bi-unequivocal relationship, the competences determine the thematic contents, and their achievement ensures the acquisition of the desired skills by the students.

In order to achieve the **learning outcomes** established by the learning unit, the teacher has the freedom to scale contents over time, to use various learning activities, with emphasis on those with an application character, centered on the student. It is recommended to go through the contents proposed in the following order:

- Specification of the concrete activities of the students in relation to each unit content, so that it takes controllable forms.
- Directing the process of forming the notions through the game of examples and counterexamples.
- Anticipate the learning strategy to ensure the training the desired behaviors and specified by the operational pedagogical objectives.
- Anticipate the training strategy so that it corresponds directly to the learning strategy, aiming at a real differentiation of training on one problematic fund flexible and built from simple to complex.
- Control of mental operations through numerous exercises and applications.
- Predicting the sequences of recapitulation, fixation and synthesis;

- To make the education successful, it is necessary to set up conditions for acquirement of required practical skills and activities in the form of exercises (in laboratories, workshops, special classrooms, simulated companies, etc.) and practical training.

Starting from the principle of integration, which ensures access to school for all students, accepting that each student is different, consideration will be given to the use of specific methods for developing skills for those students who have integrative deficiencies, adapting them to the specific conditions of learning and behavior (the use of individualized programs, the preparation of individual sheets for students with slow learning rhythms, the use of learning aids, the praise of even the smallest progress, and the setting of the next steps together). The intellectual structures are formed in a generative and successive way, following the following stages (from the elementary ones, to the most complex ones): its sensorial-motor dimension (which represents the starting point of any learning, observational learning, concept learning (and specific terminology) appropriate), learning some rules, principle, learning some strategies, learning through research (creative learning and the process of discovery).

Vocabulary for writing Learning Outcomes:

It is important to find the right words when writing learning outcomes. The following list of words and terms is provided as an aid in the familiarization process.

- **Activities giving evidence of knowing may be described in terms of**:

Define, describe, identify, label, list, name, outline, reproduce, recall, select, state, present, be aware of, extract, organize, recount, write, recognize, measure, underline, repeat, relate, know, match.

- **Activities giving evidence of comprehension may be described in terms of:**

Interpret, translate, estimate, justify, comprehend, convert, clarify, defend, distinguish, explain, extend, generalize, exemplify, give examples of, infer, paraphrase, predict, rewrite, summarise, discuss, perform, report, present, restate, identify, illustrate, indicate, find, select, understand, represent, name, formulate, judge, contrast, translate, classify, express, compare.

- **Activities giving evidence of knowledge/ understanding may be described in terms of:**

Apply, solve, construct, demonstrate, change, compute, discover, manipulate, modify, operate, predict, prepare, produce, relate, show, use, give examples, exemplify, draw (up), select, explain how, find, choose, assess, practice, operate, illustrate, verify.

- **Activities giving evidence of analysis may be described in terms of:**

Recognize, distinguish between, evaluate, analyze, break down, differentiate, identify, illustrate how, infer, outline, point out, relate, select, separate, divide, subdivide, compare, contrast, justify, resolve, devote, examine, conclude, criticize, question, diagnose, identify, categorise, point out, elucidate.

- **Activities giving evidence of synthesis may be described in terms of:**

Propose, present, structure, integrate, formulate, teach, develop, combine, compile, compose, create, devise, design, explain, generate, modify, organize, plan, re-arrange, reconstruct, relate, re-organize, revise, write,

summarize, tell, account for, restate, report, alter, argue, order, select, manage, generalize, précis, derive, conclude, build up, engender, synthesize, put together, suggest, enlarge.

- **Activities giving evidence of evaluation may be described in terms of:**

Judge, appraise, assess, conclude, compare

3.4.1. Unit 1 – Introduction in Computer and simulation

CONCLUSIONS:

- The information may provide differentiated training support. There is a correlation between information transmitted through text/ images/ graphics/ tables/charts/ symbols/ multimedia elements / supporting texts referring to:

Elementary principles of:

- **Digital tools ;**
- **Learning management system (LMS);**
- **Welding simulators;**
  - The presentation of the contents is gradually realized as a difficulty, in a unitary conception, by a consistent style and by highlighting the keywords necessary for the realization of the conceptual scheme.
  - The information transmitted is oriented on the learner, respectively on his/her availability, and will better value them.
  - The learning outcomes are found in the standards of professional training, for the qualifications corresponding to the field of professional training.
  - The learning unit being an elastic structure can incorporate, at any moment of the educational process, new means or didactic resources;
  - It allows the individualization of learning and the articulation of formal and informal education.
  - Teachers can decide on the number of hours allocated to each topic, depending on: the difficulty of the topics, the level of previous knowledge of the trained group, the complexity and variety of the teaching material used the rate of assimilating the knowledge and forming the skills of the trained group.
  - Between learning outcomes and content is a bi-unequivocal relationship, the competences determine the thematic contents, and their achievement ensures the acquisition of the desired skills by the students. The proposed learning outcomes are in line with the specific training.
  - The information transmitted in the course support is focused on learning outcomes and acquiring the knowledge, skills and attitudes required in one of the occupations specified in the professional training standards corresponding to the professional qualifications of level 3, in the field of professional training Mechanical, professional qualifications: welder. It has a logical structure; coherent is presented in an attractive way for students.

The logical sequence of the contents corresponds to a constructivist approach referring to:

- Use learning management systems (LMS) for synchronous and asynchronous training;
- Identify the differences between simulated welding and real welding;
- Use welding simulators practice for preparing to real welding contexts;
- Identify additional welding digital tools used in training;

Use additional digital tools in the context of practical training in welding when applicable. It maximally activates the students' thinking, individualizes the act of learning and it ensures differentiated activities, eliminates dead or redundant times from student activities. The data and information, as well as the terms used, the concepts applied and the concepts covered and are accessible to students.

RECOMMENDATIONS:

- **Define the learning outcomes of the unit should be done.**

  As a proposal it could be :

  Unit: „Introduction in Computer and Simulation"

  The student is able to:

Knowledge	Skills	Attitudes	Contests of learning
Explain advantages and disadvantages of digital tools in welding;	Recognize digital tools used in welding training; Identify digital tools used in welding training Identify the advantages of the use of digital tools in welding learning process from economical, ecological, safety point of view;	Collaboration with the members of the working team in order to fulfill the task; Assumption within the work team of the responsibilities for the work task.	**Training Digital Tools and Methodology**
Describe Virtual Learning Environments and characteristics of LMS; Describe and explains setting and functionalities of a LMS;	Identify what Virtual Learning Environments consists; Give examples of different types of VLEs; Identify the characteristics of LMS; Relate setting and functionalities of a LMS; Compare LMS in learning process with traditional course; Identify available solutions for developing LMS;		**Learning Management System**
Identify the difference between welding simulator and real welding system; Describe and explain setting and functionalities	Present the characteristics and components of Augmented Reality (AR) technology; Present the characteristics and components of VR welding simulator technology; Compare Augmented Reality (AR) technology with VR welding simulator technology;		**Welding Simulators** Augmented Reality; Virtual Reality

of Welding simulators systems;	Prepare the welding environment using welding simulator technology. welding simulator technology		

- the use of methods that favor the student's direct relationship with the objects of knowledge, by using concrete models;
- combining and a systematic alternation of activities based on the individual effort of the student (documentation from various sources of information, personal observation, personal exercise, programmed training, experiment and individual work) with the activities that require the collective effort (team, group) of the kind of discussions, the assault of ideas, etc .;
- applying the student-centered methods, on activating the students' cognitive and operative structures, on exercising their psycho-physical potential, on transforming the student into a participant in their own training and education;

It is recommended to approach the student-centered training by designing a variety of learning activities, taking into account the individual learning styles of each student. These concern the following aspects: the acquisition of independent information and documentation methods, which offer the openness to self-instruction, to continuous learning. In order to reach the objectives and to develop the knowledge, skills and aptitudes /competences aimed at completing the Unit, the following teaching-learning methods can be used:

- **oral communication methods**: expository, interrogative (conversational or dialogical); discussions and debates; problem solving;
- **methods of exploring reality:**
  a. Methods of direct (direct) exploration of reality: systematic and independent observation; experiment;
  b. methods of mediated (indirect) exploration of reality: demonstrative methods; modeling methods;
- **methods based on action (operational or practical**):
  a. Methods based on real / authentic action: exercise; case study; the research project or theme; practical works;
  b. simulation methods -learning on simulators.
- **methods that stimulate creativity**: brainstorming, didactic play, star busting, thinking hat method, carousel, multi-voting, round table, group interview, case study, critical incident, Phillips 4/4, technique 4 / 3/5, creative controversy, aquarium technique, focus-group technique, "Four Corners", Frisco method, "Synectica", "Buzz-groups", "Delphi" method

Example:

Below is a learning material using the Starbursting method. Starbursting is a new method of developing creativity, similar to brainstorming. It starts from the center of the concept and spreads out, with questions, like a stellar

explosion. The purpose of the method is to get as many questions and thus as many connections between concepts. It is a way of stimulating individual and group creativity. The Starbursting facilitates the participation of the whole group, stimulates the creation of questions at questions, as brainstorming develops the construction of ideas on ideas. It starts from the center of the concept and goes outward, with questions, like the stellar explosion. Write the idea or problem on a sheet of paper and ask as many questions as possible about it. A good starting point is those of the type: What?, Who?, Where?, Why ?, When?

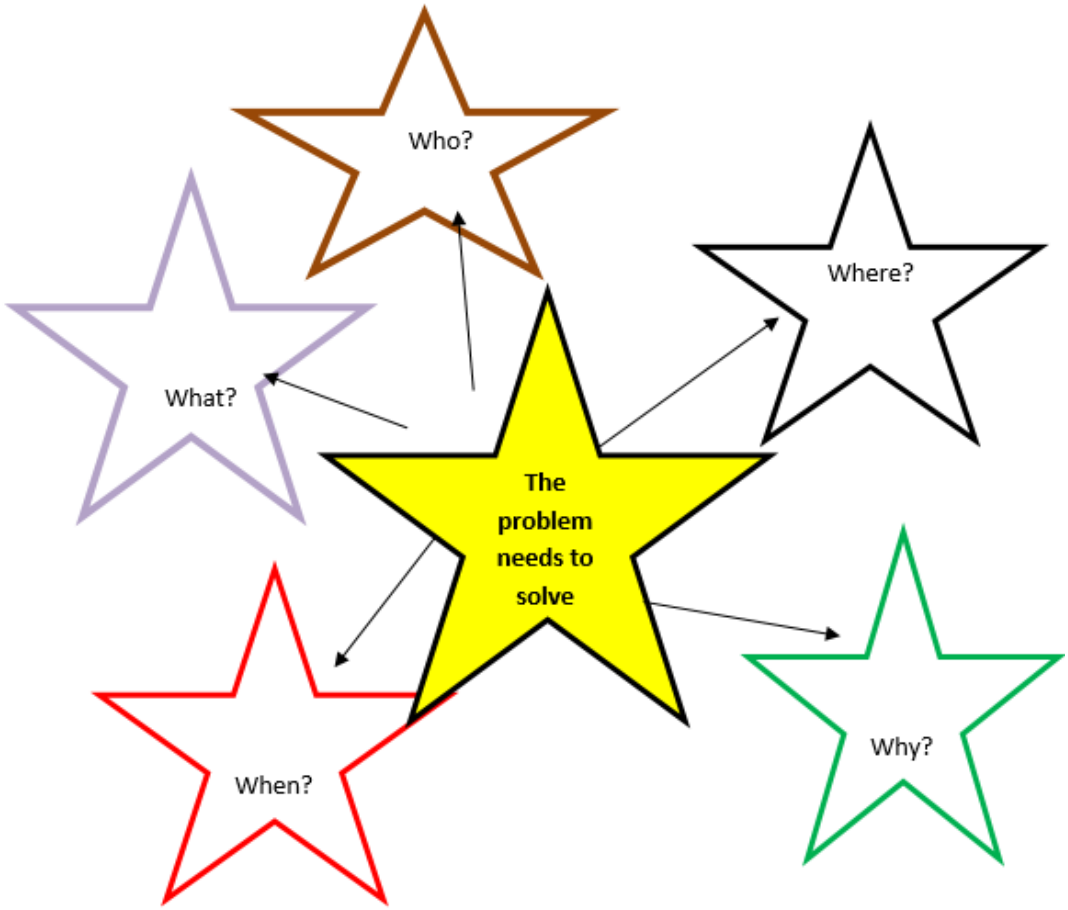

Fig. 1. Example

The steps of the method:

1. The students are placed in the semicircle. The central idea is written or drawn on a big star or on a sheet of paper.

2. Another 5 stars write a question of the type: WHAT? WHO? WHERE? WHY? WHEN? Five students ask one question. Each of the five students chooses three or four colleagues, thus organizing themselves into five groups.

3. The groups cooperate in the elaboration of the questions.

4. At the end of time, the students return to the semicircle and a representative of the group communicates the elaborated questions. Students in the other groups answer questions or ask questions.

5. Students' questions, their efforts to develop correct questions, as well as their cooperation and interaction are appreciated.

Theme: Augmented Reality vs. Virtual Reality

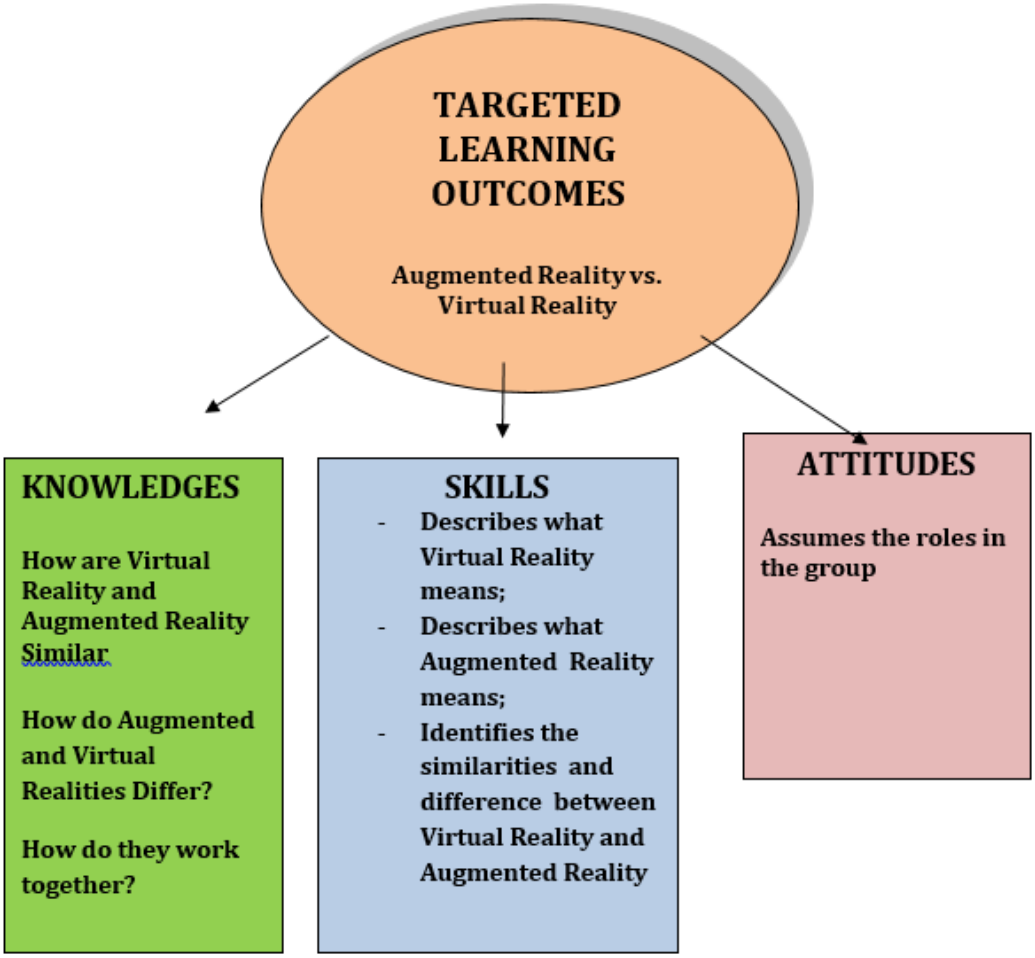

Fig. 2. Theme: AR vs VR

1. The teacher writes the central idea on a big star or on a sheet of paper: **Augmented Reality vs. Virtual Reality**
2. Five students ask one of the following questions: WHAT? WHO? WHERE? WHY? WHEN?
3. The five choose three or four colleagues, thus organizing five groups.
4. The groups cooperate in the elaboration of questions such as:

   WHAT is Real Enviroment?

   WHAT is Virtual Enviroment?

   WHO was at 3D movies? WHAT happened there? HOW it was?

   WHERE have they met Augmented Reality? Did they play with Pokémon Go app?

   WHY is Virtual Reality and Augmented Reality Similar?

   WHEN do we talk about Virtual Reality and Augmented Reality? Which are the differences?
5. At the expiration of time, a representative of the group communicates the questions asked. Students in the other groups answer questions or ask questions.
6. The teacher appreciates the students' questions, their effort to elaborate the correct questions, as well as the way of cooperation and interaction.

3.4.2. Unit 2 – Welding Processes – TIG Welding

CONCLUSIONS:

- The information may provide differentiated training support. There is a correlation between information transmitted through text/ images/ graphics/ tables/charts/ symbols/ multimedia elements / supporting texts referring to:

Elementary principles of:

- **Introduction of TIG Welding;**
- **Welding Equipment;**
- **Welding Technology;**
- **Health and Safety of TIG Welding**
  - The presentation of the contents of unit **,,TIG Welding"** is gradually realized as a difficulty, in a unitary conception, by a consistent style and by highlighting the keywords necessary for the realization of the conceptual scheme.
  - The information transmitted is oriented on the learner, respectively on his/her availability, and will better value them;
  - The learning outcomes are found in the standards of professional training, for the qualifications corresponding to the field of professional training of level 3 and 4, Mechanical, professional qualifications: welder respectively technician in welding processing.
  - The learning unit being an elastic structure can incorporate, at any moment of the educational process, new means or didactic resources;
  - It allows the individualization of learning and the articulation of formal and informal education.
  - Teachers can decide on the number of hours allocated to each topic, depending on: the difficulty of the topics, the level of previous knowledge of the trained group, the complexity and variety of the teaching material used the rate of assimilating the knowledge and forming the skills of the trained group.
  - Between learning outcomes and content is a bi-unequivocal relationship, the competences determine the thematic contents, and their achievement ensures the acquisition of the desired skills by the students. The proposed learning outcomes are in line with the specific training.
  - The information transmitted in the course support is focused on learning outcomes and acquiring the knowledge, skills and attitudes required in one of the occupations specified in the professional training standards corresponding to the professional qualifications of level 3 and 4, in the field of professional training Mechanical, professional qualifications: welder respectively technician in welding processing.
  - It has a logical structure; coherent is presented in an attractive way for students.

The logical sequence of the contents corresponds to a constructivist approach referring to:

1. Equipment used in TIG welding process;
2. Parameters (current, voltage, speed, etc.) which affect the process;
3. TIG welding technologies
4. Health and safety measures

- Use additional digital tools in the context of practical training in TIG welding when applicable;
- It maximally activates the students' thinking, individualizes the act of learning and it ensures differentiated activities, eliminates dead or redundant times from student activities.
- The data and information, as well as the terms used, the concepts applied and the concepts covered and are accessible to students.

RECOMMENDATIONS:

- **Define the learning outcomes of the unit should be done.**

As a proposal it could be:

Unit: TIG Welding

The student is able to:

Knowledge	**Skills**	**Attitudes**	**Contests of learning**
Use and explain the terminology associated with the TIG welding process. Describe the advantages and limitation of the TIG welding process; Identify of welding equipment such as tungsten electrodes, filler metal rods, or torch holders and specific component elements used in TIG welding process;	Identify, select and prepare the TIG equipment for the welding process.	Collaborate with the members of the working team in order to fulfill the task; Assume within the work team of the responsibilities for the work task.	Equipment used in TIG welding process
Explain the importance of the correct equipment	Identify Power source, tools and accessories used for TIG welding		Parameters (current, voltage, speed,

assembly, setting of the power source and choice of electrode and the consequences of incorrect selection	Describe the principle, formation, nature, power of the electric arc used for welding welded joints; Establish the parameters of use of the electric arc and the possibilities of protection of the electric arc;		etc.) which affect the process Power Source Cables Ground Devices Voltage Drops
Inspect and prepare the work-piece/s according to drawings and working practices, for TIG welding. Explain the importance of the correct equipment assembly, setting of the power source and choice of electrode and the consequences of incorrect selection. Explain the thickness of materials, in relation to size and type of welding electrode used, and the influence of electrode manipulation during the welding process Prepare the TIG welding environment using simulator /real equipment.	Identifiy what type of electrode to be use with DC or AC current; Select and use welding consumables as per requirements for welding carbon steel, aluminium and stainless steel plate. Use the gas tungsten arc welding (TIG) process in all positions. Weld the work-piece material in accordance with work instruction sheet and drawing requirements using simulator /real equipment. Apply quality checks on process. Inspect welded work-piece for defects (use visual and non-destructive testing), conforming to specifications as reflected on drawing or job requirement. Identify welding defects and take corrective action.		TIG welding technologies Arc Ignition on TIG Welding Sharpening of Electrode Non-Consumable Electrodes Classification of Filler Rods and Wires Classification of Shielding Gas for Arc Welding and Cutting Influence of Welding Parameters on TIG welding technologies Welding Positions

Identify and rectify possible welding hazards in accordance with standard work site practices. Explain the safety requirements relating to welded products. Provide examples of failures and explain their causes and consequences.	Observe safe working practice during welding; Apply other measures to be taken regarding the prevention of accidents related to noise, smoke, fire, electric shock.		Health and safety measures Safety precautions applicable to Welding machines, hand tools, equipments, tools and during welding operations

3.4.3. Unit 2 – Welding Processes – MMA Welding

CONCLUSIONS:

- The information may provide differentiated training support. There is a correlation between information transmitted through text/ images/ graphics/ tables/charts/ symbols/ multimedia elements / supporting texts referring to:

Elementary principles of:

- **Introduction of MMA Welding;**
- **Welding Equipment;**
- **Welding Technology;**
- **Health and Safety of MMAWelding**
  - The presentation of the contents of unit **,, MMA Welding"** is gradually realized as a difficulty, in a unitary conception, by a consistent style and by highlighting the keywords necessary for the realization of the conceptual scheme.
  - The information transmitted is oriented on the learner, respectively on his/her availability, and will better value them;
  - The learning outcomes are found in the standards of professional training, for the qualifications corresponding to the field of professional training of level 3, Mechanical, professional qualifications: welder.
  - The learning unit **,, MMA Welding"** being an elastic structure can incorporate, at any moment of the educational process, new means or didactic resources;
  - It allows the individualization of learning and the articulation of formal and informal education.

- Teachers can decide on the number of hours allocated to each topic, depending on: the difficulty of the topics, the level of previous knowledge of the trained group, the complexity and variety of the teaching material used the rate of assimilating the knowledge and forming the skills of the trained group.
- Between learning outcomes and content is a bi-unequivocal relationship, the competences determine the thematic contents, and their achievement ensures the acquisition of the desired skills by the students. The proposed learning outcomes are in line with the specific training.
- The information transmitted in the course support is focused on learning outcomes and acquiring the knowledge, skills and attitudes required in one of the occupations specified in the professional training standards corresponding to the professional qualifications of level 3, in the field of professional training Mechanical, professional qualifications: welder.
- It has a logical structure; coherent is presented in an attractive way for students.

The logical sequence of the contents corresponds to a constructivist approach referring to:

1. Introduction to MMA Welding ;
2. Equipment and specific component elements used in MMA welding process;
3. MMA welding technologies
4. Health and safety measures

- Use additional digital tools in the context of practical training in TIG welding when applicable;
- It maximally activates the students' thinking, individualizes the act of learning and it ensures differentiated activities, eliminates dead or redundant times from student activities.
- The data and information, as well as the terms used, the concepts applied and the concepts covered and are accessible to students.

RECOMMENDATIONS:

- **Define the learning outcomes of the unit should be done.**

As a proposal it could be:

Unit: MMA Welding

The student is able to:

Knowledge	**Skills**	**Attitudes**	**Contests of learning**
Explain the terminology associated with MMA Welding procedures	Use terms and definitions that are consistent with generally accepted welding terminology as recorded in national and international welding standards;	Collaborate with the members of the working team in order to fulfill the task;	Introduction to MMA Welding Welding process using covered electrodes

	Describe the applications, advantages and limitation of the MMA welding process;	Assumption within the work team of the responsibilities for the work task.	
Identify basic and major components of shielded metal arc welding equipment and explain their function and purpose. Explain the importance of correct assembly welding equipment, and the consequences of incorrect assembly. Explain the importance of the correct setting of the power source and choice of electrode and the consequences of incorrect selection. Explain the thickness of materials in relation to size and type of welding electrode used, and the influence of electrode manipulation during the welding process.	Identify, select and prepare of welding equipment and specific component elements used in MMA welding process: power sources, electrode holder; Choosing the materials, SDVs and equipment required to perform the assembly by MMA welding; Demonstrate setting up procedures using simulator/real equipment.		Equipment and specific component elements used in MMA welding process; Power Source Electrode Holder Ground Connection Cables and Terminals
Establish the parameters of use of the electric arc and the part of it ; Identify what type of electrode to be use with DC or AC current;	Prepare the welding environment. Identify potential causes of welding defects or imperfections prior to welding, and take		MMA welding technologies

	action to meet requirements. Choose welding consumables/ additives for welding joints through welding processes; Practice MMA welding of semi-finished products/parts using simulator/ real equipment. Execute the (MIG / MAG) welding of common welding joints in all positions using simulator/ real equipment. Inspect the end product for conformance to specifications as reflected on drawing or job requirement. Identify welding defects and take corrective action. Identify the different welding positions, defined in the ISO 6947: 2011 standard.		
Identify welding hazards and eliminate in accordance with standard working practices.	Adhere to safety precautions. Apply measures to be taken regarding the prevention of accidents related to noise, smoke, fire, electric shock.		Health and safety measures **in** MMA Welding

3.4.4. Unit 3 – Quality Assurance in Welding

CONCLUSIONS:

- The information may provide differentiated training support. There is a correlation between information transmitted through text/ images/ graphics/ tables/charts supporting texts referring to:

- **Generals about quality in welding.Specific standards;**
- **WPS & WPQR;**
- **Welding Imperfections;**
- **Welder Qualification and Inspection**

The presentation of the contents of unit **,,**QUALITY ASSURANCE IN WELDING**"** is gradually realized as a difficulty, in a unitary conception, by a consistent style and by highlighting the keywords necessary for the realization of the conceptual scheme**.**

- The information transmitted is oriented on the learner, respectively on his/her availability, and will better value them;
- The learning outcomes are found in the standards of professional training, for the qualifications corresponding to the field of professional training of level 3 Mechanical, professional qualifications: welder.
- The learning unit **,,**QUALITY ASSURANCE IN WELDING**"** being an elastic structure can incorporate, at any moment of the educational process, new means or didactic resources;
- It allows the individualization of learning and the articulation of formal and informal education.
- Teachers can decide on the number of hours allocated to each topic, depending on: the difficulty of the topics, the level of previous knowledge of the trained group, the complexity and variety of the teaching material used the rate of assimilating the knowledge and forming the skills of the trained group.
- Between learning outcomes and content is a bi-unequivocal relationship, the competences determine the thematic contents, and their achievement ensures the acquisition of the desired skills by the students. The proposed learning outcomes are in line with the specific training.
- The information transmitted in the course support is focused on learning outcomes and acquiring the knowledge, skills and attitudes required in one of the occupations specified in the professional training standards corresponding to the professional qualifications of level 3 in the field of professional training Mechanical, professional qualifications: welder .
- It has a logical structure and coherent.

- It maximally activates the students' thinking, individualizes the act of learning and it ensures differentiated activities, eliminates dead or redundant times from student activities.

- The data and information, as well as the terms used, the concepts applied and the concepts covered and are accessible to students.

RECOMMENDATIONS:

- **Define the learning outcomes of the unit should be done.**

As a proposal it could be:

Unit: ,,QUALITY ASSURANCE IN WELDING**"**

The student is able to:

Knowledge	**Skills**	**Attitudes**	**Contests of learning**
Describe and explain the role and operation of specific standards about quality in welding: • ISO 3834 Quality Requirement for Welding Group • ISO 9001- Quality Management Systems • ISO 14731: 2019 – Welding coordination – Tasks and Responsibilities	Use terms and definitions that are consistent with generally accepted welding terminology as recorded international welding standards.	Communicate to others; Assumption within the work team of the responsibilities for the work task.	**Generals about quality in welding Specific Standards**
Describe and explain the role of WPS (Welding Procedure Specification) and WPQR (Welding Procedure Qualification Record) for quality level referring to: • ISO 15607 Specification and qualification of welding procedures for metallic materials - General rules	Identify general rules for the specification and qualification of welding procedures for metallic materials. Reading WPS Understanding WPS abbreviations and terminologies Able to prepare his job according to WPS		**WPS & WPQR**

• ISO 15609-1 Specification and qualification of welding procedures for metallic materials — Welding procedure specification — Part 1: Arc welding • ISO 15614-1Specification and qualification of welding procedures for metallic materials - Welding procedure test - Part 1: Arc and gas welding of steels and arc welding of nickel and nickel alloys			
Identify potential causes of welding defects or imperfections prior to welding, and take action to meet requirements : • ISO 6520-1:2007 Welding and allied processes – Classification of geometric imperfections in metallic materials – Part 1: Fusion welding;	Carry out pre-operational checks in accordance with manufacturers' specifications. Identify welding defects and take corrective action.		**Welding Imperfections**

• ISO 5817:2014 - Welding — Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded) — Quality levels for imperfections; • ISO 10042:2018 - Welding — Arc-welded joints in aluminium and its alloys — Quality levels for imperfections			
Describe and explain standards for quality and co-ordination in welding reffering to: ISO 9606-1: 2012 Qualification testing of welders - Fusion welding - Part 1: Steels	Inspect welded work-piece for defects (use destructive testing) and apply quality checks on process. Inspect the end product for conformance to specifications as reflected on drawing or job requirement.		**Welder Qualification and Inspection**

- In order to achieve a better understanding of the course support and to ensure a greater attractiveness for the students, it is necessary to insert more images, diagrams;

Before analyze at sub-section:1.2 Specific standard it needs to include some aspects relating to: standardization an related activities, goal of standardization, what is a standard ;