Guideline for Online Assessment

Tools with procedures to perform harmonized online assessment of learnings gained through virtual environment

DRinVET

DIGITAL REALITY - THE BASIS OF SKILLS TRAINING

Prepared by

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DRINVET

DIGITAL REALITY - THE BASIS OF SKILLS TRAINING

EWF

virsabi

AT AUGMENTED TRAINING

LVE Learn Virtual Europe

#STRUKA

Executive Summary

Intellectual Output six (IO6) consists in the development of a guideline and online tools for digital/virtual assessment of learning outcomes, to ensure quality when performing it. The guideline describes the procedures and conditions in which the online assessment shall be conducted and also consider best-practices in the development of the assessment tools, which might be in the form of case study projects, multiple choice questions, and/or short essays. EWF led this activity and provided guidance/templates and the structure of how this activity should be performed. All DRinVET partners contributed by identifying best practices and by developing relevant assessments. The internal review of the assessment's examples, by the project partners was organized in a peer-review format, to ensure that the standards of the assessments are consistent with the Guideline and aligned with a harmonized implementation (meaning following the same quality criteria). This Guideline is available in EN.

TABLE OF CONTENTS

Introduction

One of the main goals of DRinVET project is to allow teachers and trainers in Vocational Education and Training (VET) to recognize the potential of performing skills training and teaching through the use of simulators based on Digital Reality (DR).

All partners from the project – except Virsabi – have experience related to the use of simulators. Some manufacture them – Augmented Training Service (ATS) and Learn Virtual Europe (LVE) – others use them in the education process – University of Craiova (UCV), Industrial and Trade School (IOS) and #STRUKA – and in the case of the European Federation for Welding, Joining and Cutting (EWF), who develop and manages education programmes and participates in projects that introduce Digital Reality (DR) in the field of European Qualification and Training Systems. Virsabi, on the other hand, counts with a vast experience in applying DR technologies to various fields, such as Maritime safety training – Maersk Behavioural training, ambulance staff and administrative workers training in General Data Protection Regulation (GDPR) compliance, improving offshore safety with training in Virtual Reality (VR), Energy solutions practical training, products visualization and marketing, process explanation of mineral processing, Danish healthcare design, technical drawings in 3D, and remote support with the use of Mixed Reality (MR). Virsabi utilizes development of VR, Augmented Reality (AR), MR, WebAR, Virtual Production, Augmented projection, 3D modelling, Virtual projection, motion capture and recently also NFTs.

On this basis, the consortium aims to create, within the VET community and beyond in the Science, Technology, Engineering, and Mathematics (STEM) area, a space where is possible to discuss and share the potential of using DR simulators in the learning and training skills process. For that the partners aim to direct the DRinVET project results to teachers and trainers in charge of educational programs.

Procedures and conditions for online assessment to be conducted in a harmonized way

Having EWF qualification system for harmonized assessment and guidelines for the welding sector as a base, in the present document, is presented an overview of the specific assessment for the training of Welders, Welding Inspector and Welding Coordinator; what is considered to be online assessment and online remote assessment; and a distinction between theoretical and practical assessment.

2.1. Assessment within EWF qualification system for each profile/level International/European Welder (IW/EW)

The profile for a Welder[1] comprises a person, familiarized with the principles associated with the welding process; who has general concepts of the welding field and activities linked to joining and weld joint fit up; can complete chores and solve problems by applying welding process and related technologies; can take accountability to perform welding work in an autonomous way on construction sites and guarantee the appliance of the proper welding practice.

There are two possible routes to access the European Welder (EW) qualification: Standard Route and Alternative Route.

STANDARD ROUTE

The standard route is recommended by EWF as it corresponds to the most thorough a pproach in which the training syllabus may be covered. In order to take this route, it is required a successful completion of the training syllabus, since it was designed to meet all the EW Guideline requirements.

[1] Taken from Redesigning Welding Profile for the Needs of Industry 4.0 (pág.6) according to General Description of the Welders Profile based on the EQF descriptors

ALTERNATIVE ROUTE

The alternative route is available for everyone who have previously acquired the knowledge and expertise (know-how), through informal and non-formal learning, specified in the instruction programme in the EW Guideline, and are able to demonstrate their competence in all aspects, in order to be examined without compulsory attendance at an approved training center.

Also, every applicant who provides a valid welder qualification (i.e., ISO 9606) under the scope for the diploma wanted, or has 3 years of experience as a welder, can access this route. If the candidate is successful in the theoretical and practical examinations, according to the EW Guideline, the diploma is awarded. This means that it is required that the candidates, to access the course, possess adequate knowledge of education in metalworking.

ASSESSMENT

The assessment process includes a number of steps, each with its own criteria, linked to theoretical and practical examinations. The full EWF European Welder Course contains Modules separated into theoretical education (Modules A, B and C, and also Modules S[2] for specific processes and Modules P[3] for specific materials), practical training (Modules 1 to 6) and examination (based on ISO 9606 and equivalent standards). To access the Modules, the candidates also need to comply with the following requirements: for Module 1 – the candidates have to demonstrate a level of health, both physical and mental, to endure the training for which they are applying; and for Module 2, the candidates must demonstrate the required level of skills by passing the tests described in Module 1, meaning that a successful completion of the previous Module is necessary for the candidates to follow for the next one (this logic applies to all levels).

[2] Modules S – Related to Gas Welding, MMA Welding, MIG/MAG Welding and TIG Welding processes
[3] Modules P – Related to Stainless Steel and Aluminium materials

If the candidate is unable to successfully complete both the theoretical and/or the practical examination, has the opportunity to undergo a re-examination, according to the following:

THEORETICAL EXAMINATIONS

Candidates are allowed to have two more attempts (in total three attempts). In case of failure on the third attempt, the candidate must take the theoretical module(s) failed.

For the theoretical examinations, a candidate for the Tube Welder Diploma must perform for Modules A, B, C, Examination Process related (SX) and the Examination Material related (PSS or PAL); for the Plate Welder Diploma, must perform for Modules A, B, Examination Process related (SX) and the Examination Material related (PSS or PAL); and for the Fillet Welder Diploma must perform for Modules A, Examination Process related (SX) and the Examination Material related (PSS or PAL). For the practical examinations, the candidate for the Tube Welder Diploma must perform for Module 2, 4, 5 and 6; for the Plate Welder Diploma must perform for Module 2, 3 and 4; and for the Fillet Welder Diploma must perform for Module 1 and 2.

PRACTICAL EXAMINATIONS

Candidates are allowed to have one more attempt. In case of failure on the second attempt, the candidate must take the practical module failed again.

For the practical examinations, the candidate for the Tube Welder Diploma must perform for Module 2, 4, 5 and 6; for the Plate Welder Diploma must perform for Module 2, 3 and 4; and for the Fillet Welder Diploma must perform for Module 1 and 2.

Welding Coordination

To be able to access the courses for Personnel with Qualification for Welding Coor-dination – International/European Welding Engineer, Technologist, Specialist or Practitioner –, there are two general conditions applied to all. The first is to successfully pass the inter-mediate examination, also known as Part 1 of the course, that will determine if the student is ready to move for Part 2 and then Part 3. The second is from the Authorized National Body (ANB) responsibility and determines the access conditions. These qualifications, within the EWF Qualification, guarantee that trainees will achieve, at the proper level, the relevant knowledge to perform welding coordination activities, recognised by other international organisations like CEN, ISO, CEOC-CABF, and EA. Some EWF Qualification levels answer to the requirements for welding coordination personnel according to EN ISO 14731.

International/European Welding Engineer (I/EWE)[AA1]

The entry level for this programme is postgraduate with a primary degree in an engineering discipline or equivalent as long as it is recognized by the national government and assessed by the ANB. Participants are expected to have at least a bachelor's degree at university level (minimum study of 3 years), e.g., a relevant qualification from an accredited programme in accordance with the Washington Accord for professional qualification of engineers, or a First Cycle Bologna Framework engineering qualification, or an engineering qualification at EQF Level 6, or equivalent.

Internacional/European Welding Technologist (I/EWT)

There are two possible paths to enter this programme Both paths 1 and 2 are based on a higher technical education, so participants to enrol need to have a primary degree in an engineering discipline, e.g., a relevant qualification from an accredited programme in accordance with the Sydney Accord for professional qualification of engineering technologists, or a Short Cycle Bologna Framework engineering qualification, or an engineering qualification at EQF Level 5, or equivalent. There is also the experimental route that applicants can take if they have relevant industrial experience .

International/European Welding Specialist (I/EWS)

To enter this programme the candidate needs to go through the same basis of the specific technical education for International/European Welding Technologist (through Path 1 and Path 2) but higher than a professional worker, e.g., a relevant qualification from an accredited programme, in accordance with the Dublin Accord for the professional qualification of engineering technicians, or an engineering qualification at EQF Level 4, or equivalent .

International/European Welding Specialist (I/EWS)

In order to enter this course, candidates are required to be proficient in practical welding and to have experience as a welder in industry, since this course is planned to develop the theoretical knowledge and practical welding skills .

International Welding Inspection Personnel (IWIP)

For personnel who don´t have knowledge in welding inspection the qualifications for International Welding Inspector Level Basic (IWI-B), International Welding Inspector Level Standard (IWI-S) and International Welding Inspector Level Comprehensive (IWI-C) are the efficient way to achieve them, since they have quite a comprehensive training covering welding technology, inspection and practical training is one of the key aspects.

The role of the welding inspector begins before the start of the welding and extends itself through its operation, until after its completed and the results are appropriately reported. The inspector is often in charge for delivering documents that ensure traceability of the components and related fabricating action. Prior to welding, the inspector must be assured that the materials are appropriate and that the place has approved welding procedures and aptly qualified welders. The theoretical part, in terms of procedures is important to the production of a quality welded product, but the practical part, in terms of execution of the weld is also a crucial point for the inspector. For this reason, there are two critical parts here: guaranteeing that the written procedures are being followed and verifying for any physical signs of non-conformance of the final product.

The responsibilities of the inspector are to verify base metals and welding consumables, observe the fit-up and preparation for the weld, and watch the welding operation itself. The inspector must know enough about the technique, the equipment, and the reports to have confidence in the results.

Based on those factors, admission to the examination leading to the award of the International Welding Inspector Level Basic, Standard or Comprehensive diploma is restricted to those who comply with the minimum requirements specified in the Guideline. For the Standard Route, those who have attended at least 90% of the course (exemptions are at the discretion of the Authorized National Body (ANB)), approved by the ANB, according to the IIW Guideline, or those who have attended a Distance Learning Course approved by the ANB fulfilling the requirements of the Guideline IAB-195 (see latest edition). For the Alternative Route, those who have successfully passed the ANB detailed assessment.
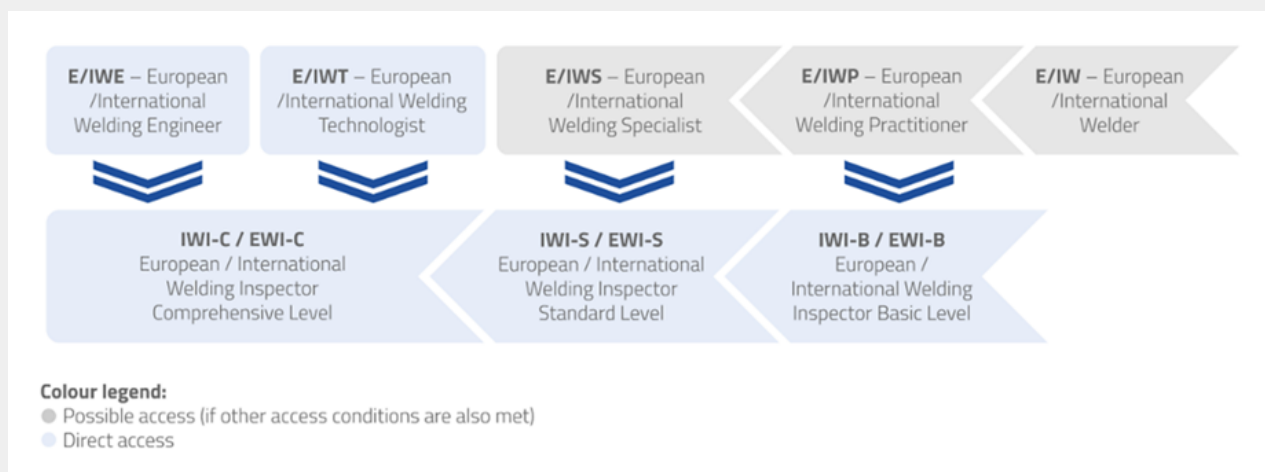
[Figure 1 Training and Qualification System for Welding Coordination, Welding Inspection and Welders

2.2. Online Assessment versus Online Remote Assessment

ONLINE ASSESSMENT

The online assessment is considered to be the one performed through an online tool, like a platform, while supervised by a teacher or trainer, in a controlled environment, where teachers/trainers and students/trainees share the same space.

This way it is possible to reduce the risk of questions dissemination/sharing, thus clearly identifying the person who is taking the assessment, ensure not only that it is not cheating but also not collecting data, regarding the contents on the assessment, to pass onto others. **Within the EWF system, this approach is used for written exams.**

ONLINE REMOTE ASSESSMENT

On another hand, online remote assessment is considered to be, also performed through an online tool, yet it is not supervised in person. The people taking the assessment can be anywhere for as long as they can access the online platform to take the assessment.

However, there are a couple of issues identified, concerning the clear identification of the person who is taking the assessment, in order to prevent cheating, and the guarantee that information regarding the contents of the assessment stays confidential and it is not passed onto others (e.g., through print screen).

There are techniques such as computer cloning that allow other people to take the assessment for the person who is supposed to do it. There are also methods to copy the questions, passing them to a third party and breaking confidentiality.

Even though there are ways and/or platforms that can be used to mitigate these situations from happening, such as running and having the cameras and audio, from the computers, on throughout the assessment time; having the people taking the assessment show their environment/surroundings; downloading an application that controls everything that happens on the computer during the assessment time; and examination platforms with specific methods to ensure the quality of the assessment, there is no definitive way to ensure that the issues identified above do not happen.

For that reason, on an international level and concerning the harmonised EWF assessment, this type of assessment is not applied within the EWF qualification system. Whereas nationally there is a way being adopted to assure that students/trainees have appropriated the knowledge, by conducting online remote assessment followed by oral online assessment.

2.3. Theoretical versus Practical Assessment

For written harmonized exams there is a common matrix that determines the time, questions and difficulty level of the assessment. For welding, in particular, within EWF qualification system, there exists a set of minimum access requirements to guarantee the harmonization of the training programme and common rules for the assessment in all member countries. For the national level there is not only the multiple-choice questions by themselves but also essay questions or both combine, like it happens the majority of times. For welding, the number of questions foreseen in the examination is equivalent to the number of hours from the teaching programme. For this purpose, there is a database containing multiple-choice questions, that randomly generates the exams. In terms of harmonized practical assessment, in the welding sector, there is only ways to ensure it for welders' qualification, through test pieces (in accordance with the EN-ISO 9096).

There are three levels of education and training, comprised in the European Welder Course: Fillet Welder, Plate Welder and Tube Welder, which is composed by modules, divided between theoretical education, practical training, and examination. This course is part of the EWF Education, Training and Qualification System, that guarantees that the process of transferring knowledge is developed in a harmonized way, by every authorized organization internationally. This is possible since the System is recognized worldwide and provides training guidelines for all professional levels in welding technology and associated areas. Therefore, the EW Guideline (EWF-IAB-089r5-14) is applied, in all countries where its used, under the same conditions regarding its theoretical part, practical training and examination procedures. This System is also recognized as a best practice at European Level and is mentioned in several European documents, such as International Qualifications, CEDEFOP, ISO and CEN Standards, EA - European Co-operation for Accreditation, CEOC-CABF - International Confederation of Inspection and Certification Organisations-Conformity Assessment Bodies Forum, since it addresses the specific industry needs and involves trainers from the industry and case studies based on real industrial problems.

Identification of best practices concerning online assessment

A questionnaire on Online Assessment was open from the 28th of June until the 17th of September 2021 and gathered a total of 19 answers, from project partners, Vocational, Education and Training (VET) schools, Training institutes and Universities. The main goal behind the creation of this questionnaire was to evaluate if online assessment was a current practice within the DRinVET partners organisations, and other educational establishments, as mentioned above.

The core of the questions focused on the participants experience with online assessment for the following aspects: identification of profiles in Welding, topics (theoretical or practical contents or both), supporting tools, resources, constrains and/or barriers, online assessment was currently being used or should be used for; and two other questions aiming to collect best practice examples and efficient online platforms to perform online assessment. The answers collected are analysed bellow, having in consideration the relevant information for the Intellectual Output 6 (IO6) Guideline.

3.1. Result analysis

From the total of 19 answers, only a small percentage of the participants (3) don't perform online assessment, as represented in the Figure 2.
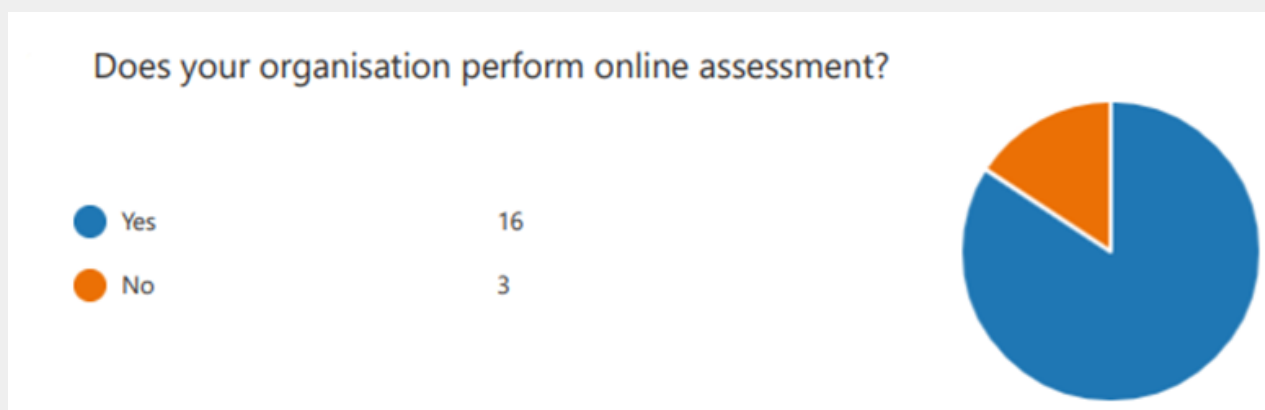

Figure 2 Assess if organisations perform online assessment

According to Figure 3, for all of the profiles in the Welding sector there is online assessment currently being performed for all.
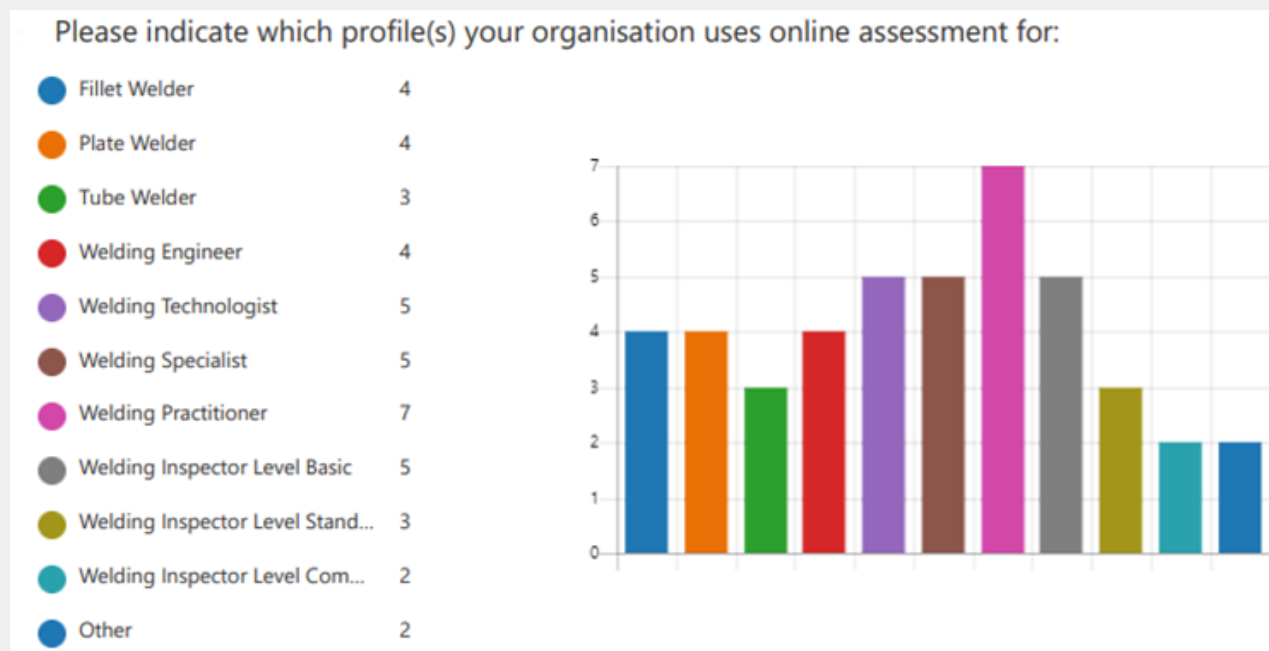

Figure 3 Assess which profiles online assessment is used for

From Figure 4 we can identify that online assessment is mainly used for Theoretical Contents.
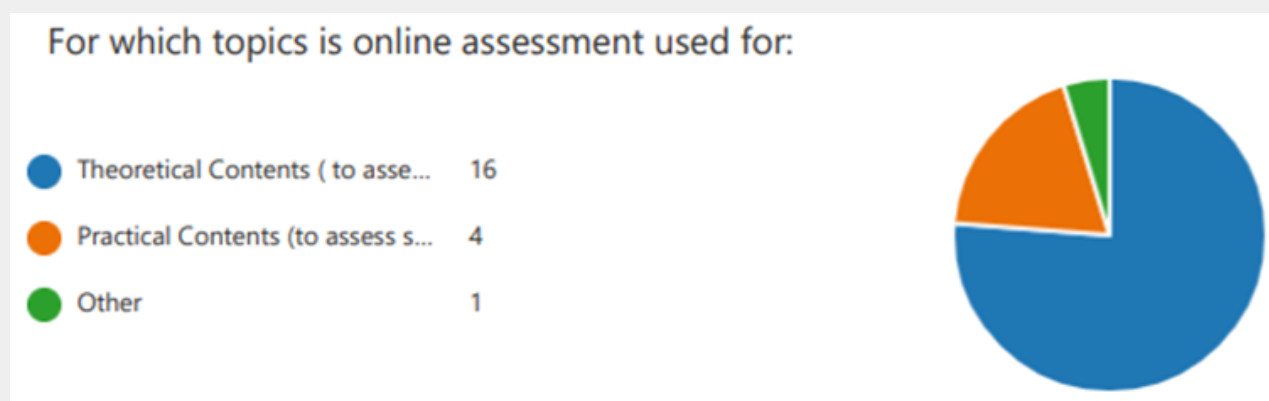

Figure 4 Topics online assessment is used for

As for the tools to support the performance of online assessment, as seen on Figure 5, there exists an almost equivalent mix between the most commonly used available options – Microsoft Teams, Zoom, Google Meet, Google Forms and Microsoft Teams – and some other interesting suggestions, such as: Testmoz, Moodle, Vulcan, Wizer, Kahoot, Quizizz, Worldwall, Liveworksheets, LearningApps and eXaminer.

Please indicate which supporting tool(s) your organisation uses to perform online assessment:

Microsoft Teams	6
Zoom	4
Google Meet	4
WebEx	0
Microsoft Forms	2
Google Forms	3
Other	6

Figure 5 Supporting tools to perform online assessment

From Figure 6 we can conclude that Multiple Choice Questions is the preferred resource to use to perform online assessment, closely followed by Essay, Paper or Study Cases developed by students. Practical Demonstrations and Case Studies come next. Other options were also given, such as: DIGIWELD LMS and Oral Exams on theoretical content.
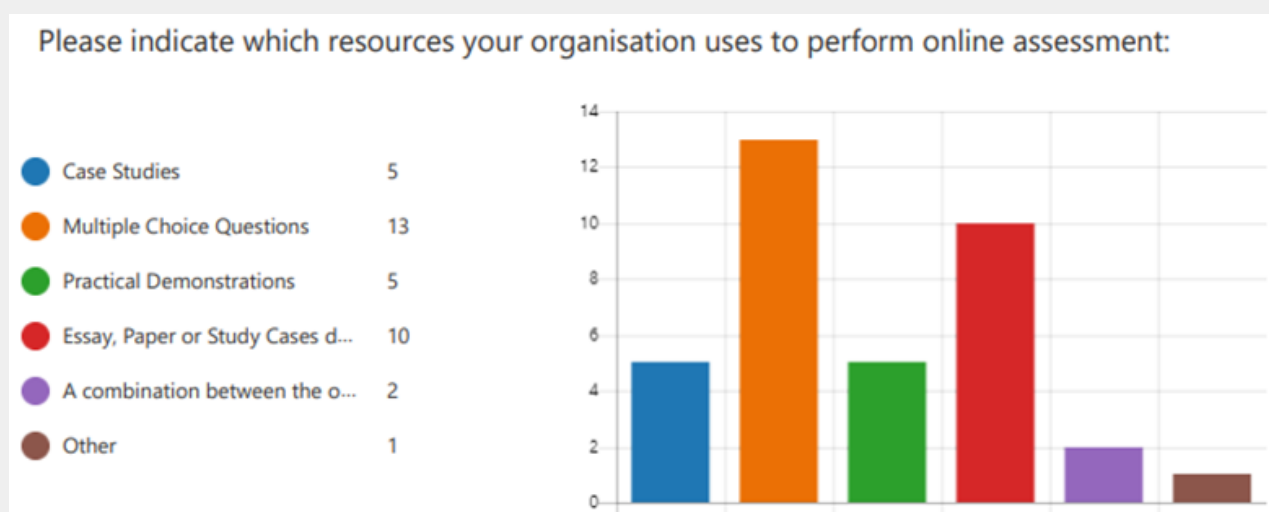

Please indicate which resources your organisation uses to perform online assessment:

Case Studies	5
Multiple Choice Questions	13
Practical Demonstrations	5
Essay, Paper or Study Cases d...	10
A combination between the o...	2
Other	1

Figure 6 Resources to perform online assessment

As for **constraints and/or barriers encountered when performing online assessment**, the following were identified by participants:

It takes a lot of time to create the assessment; It is hard to find good questions; Internet connection; Getting everyone to agree; Educating without changing structures or expectations; Tackling everything at once; Measuring nothing or everything; For self-directed courses where there is no tutor or teacher present, it is difficult to use other assessment tools - apart from tests - to "automatically" assess learners' learning; Because of the type of programme developed for the more practical evaluation, we are missing some to export the work done in Soldamatic and to be able to send such files to the tutor; Pandemic situation; Distance problems to be able to attend to the course; Lack of equipment among students; Since there is no direct interaction, questions need to be clear and well elaborated; Teachers have to elaborate points and grading well in order for the tests to be effective; A secure browser is required so that the Internet cannot be used (Safe Exam Browser 2.0); You can still cheat in distance learning; Asking competence-oriented questions is a challenge; The difficulty of students interaction; The connection of the students could not be possible whenever it was needed. Best practice examples to perform online assessment were the following Online quizzes; Essay questions; Drag-and-drop activities; Use tests for self-learning; Use tests to assess theoretical aspects; Use tests to receive feedback from learners (e.g., satisfaction test); MS Teams; To be able to review as many times as you want, viewing a video of the practice, the execution of the exercises that the student has done; To be able to propose individualised reinforcement activities; Online welding training courses; Online simulator training courses for spray painting technologies and abrasive blasting; Online training courses for electrical; Moodle; Merlin; Loomen; Moodle offers good evaluation functions; Google slide; Google document; Google forms.

Efficient online platforms to perform online assessment were Google Forms; Microsoft Teams; Google Meet; Zoom; Moodle; Vulcan; Google Classroom; eXaminer; LearningApps.

3.2. Best Practices Platforms

By cross checking the answers gathered in the questionnaire regarding the supporting tools used to perform online assessment with the identification of efficient online platforms to perform online assessment and the platforms mentioned in the best practice examples to perform online assessment, the following five were selected, to be further exploited: -Microsoft Teams; -Moodle; -Google tools; -LearningApps; -Zoom.

Microsoft Teams is available to everyone and allows people to interact at any time through chat or call with or without video. In these interactions, documents such as photos, videos, chat history and meeting notes are always available, making it easier to work together.

Some functionalities that might facilitate training and assessment through this platform are the 24 bots available that offer different functionalities to help increase productivity (e.g., answering questions about Teams, do research and consult with colleagues, create and send periodic reports, among others); the ability to tag someone by drawing more attention to them specifically; share, through the chat, reminders or documents with the participants before the meeting, as well as record the meeting; raise a "virtual" hand when you have a question or doubt without interrupting the speaker, and the latter will be notified allowing you to speak when convenient; bring your physical board onto the screen if you have the Teams Room System content capture cameras ("magic whiteboard"); amongst others.

MS Teams, also encrypts all data, in compliance with the standards, including ISO 27001, the LGPD, and GDPR, Europe's privacy laws. The platform is also part of Microsoft's global network of datacentres, which has a transparent operating model, ensuring that the data will be protected with the world's most advanced security measures.

Moodle is a learning platform designed to provide educators, administrators and learners with a single robust, secure and integrated system to create personalised learning environments.

Moodle delivers a powerful set of learner-centric tools and collaborative learning environments that empower both teaching and learning. A simple interface, drag-and-drop features, and well-documented resources along with ongoing usability improvements make Moodle easy to learn and use.

Moodle is provided freely as Open Source software, under the GNU General Public License. Anyone can adapt, extend or modify Moodle for both commercial and non-commercial projects without any licensing fees. You can download the software onto your own web server.

Moodle's multilingual capabilities ensure there are no linguistic limitations to learning online.

Moodle provides the most flexible tool-set to support both blended learning and 100% online courses.

Its modular set up and in-teroperable design allows developers to create plugins and integrate external applications to achieve specific functionalities.

Committed to safeguarding data security and user privacy, security controls are constantly being updated and implemented in Moodle development processes and software to protect against unauthorised access, data loss and misuse. Moodle can be easily deployed on a private secure cloud or server for complete control. Moodle is web-based and so can be accessed from anywhere in the world. With a default mobile-compatible interface and cross-browser compatibility, content on the Moodle platform is easily accessible and consistent across different web browsers and devices.

Google offers an assortment of useful tools that can be used not only for training but also for online assessment, such as: **Google Docs**, **Sheets** and **Slides**. These tools facilitate collaborative work as multiple people can edit the same document at the same time and/or give instant feedback on the content that is being produced.

Another practical tool specially for online assessment is **Google Forms**, as this tool allows the creation of questionnaires from a range of question options (e.g., multiple choice to drop-down menus to a linear scale), add images and YouTube videos, or design more sophisticated surveys with page branching and question skipping logic. The answers are automatically collected and presented with information and in graphics that can be viewed in real time. In addition, you can also view all the data in Spreadsheets.
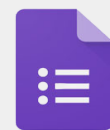
As for **Google Meet** this resourceful tool allows high quality, secure and accessible online meetings, since it provides instant captions created by Google's voice recognition technology.

Google Classroom

Google Classroom is another valuable tool that can be used to deliver and assess training as it allows:

Teachers/trainers to track student progress, export scores and keep grading consistent and transparent with comments displayed alongside student work;

Store frequently used phrases in a customizable comment bank; prepare and schedule tasks, assignments, and quizzes across multiple classes and track how students/trainees are engaging with classroom tools;

Give students/trainees the ability to adjust accessibility settings so they can learn in the way that works best for them — even in multiple languages;

Keep everyone on track with to-dos and due dates that automatically appear on calendars when classwork is created;

Upload coursework documents automatically as templates;

Enable students/trainees to check their own work for recommended citations by scanning it against hundreds of billions of web pages and over 40 million books with originality reports;

Allow students/trainees to snap and submit a picture of their paper homework quickly and easily with improved image capturing.

In terms of security, Classroom has rigorous standards for security and privacy — and is regularly audited by third-party organisations.

LearningApps is a web 2.0 app created to support the learning and the teaching processes. Offers small interactive modules that can be used directly in learning materials but also for self-study. The goal is to collect reusable building blocks and make them available for everyone. The blocks (called Apps) do not include a specific structure or specific learning scenario. The blocks are therefore not suitable as complete lessons or tasks but should be incorporated into an appropriate teaching scenario.

Zoom is a tool that can be used to manage classes (e.g., waiting rooms, customisable virtual seating chart, multi-fixing, multi-stacking, among others); increase engagement and participation through content sharing, annotation, digital sharing board, simultaneous classrooms, polling, feedback and hi-fi music mode; record lessons and lectures to allow students/trainees to learn at their own pace; personalize the learning/training experience by integrating LMS providers such as Canvas, Blackboard, Desire2Learn, Moodle, Schoology, Sakai and others, create custom integrations with Zoom's LTI Pro, and access to other educational apps with the Zoom App Marketplace; accessible through closed captioning, live transcription, keyboard shortcuts and other accessibility features give students access to the services they need.

In terms of security Zoom provides classroom SSO, meeting security features and other measures to help protect and prevent disruptions as well as enable FERPA and GDPR compliance.

Digital Learning Management System

A Learning Management System (LMS) consists of a system that provides educational materials such as courses, presentations, videos and software applications. A classic Learning Management System can also include blogs, forums for students and teachers. However, one of the most important characteristics of Learning Management System consists of opportunity to create a classroom with students and a section for grading of students' performance. The COVID-19 crisis revealed a lack of functionality of classic Learning Management Systems taking into consideration the need for online education in terms of online meetings and tools for online teaching. Therefore, a new development of Learning Management System has been done at the beginning of COVID-19 pandemic, in order to offer modern digital tools for academia and students in their teaching, learning and assessment activities.

Major players in the field of software development such Google and Microsoft created Digital Learning Management Systems with new features including videoconference, digital boards, presence list, possibility to record the meeting and other characteristics. On the other hand, the Digital Learning Management Systems should be able to integrate practical training on simulators covering different areas of specializations.
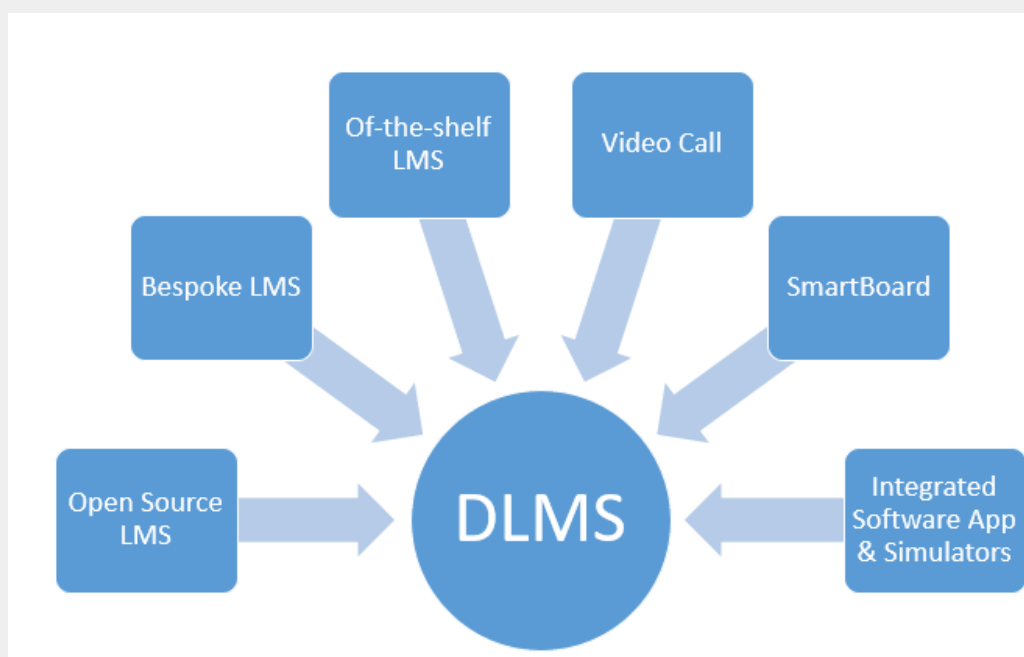
Figure 7 Basic structure of Digital Learning Management System

4.1. Result analysis

The Digital Learning Management Systems which are currently available have been identified through a survey among the partnership and outside the consortium in order to have a clear view of what digital tools are available on market and to what extent these Digital Learning Management Systems covers the needs of teachers and students for educational process. This survey was open from the 28th of June until the 17th of September 2021 and gathered a total of 19 answers. The majority of the questions could have multiple answers, therefore in some cases, despite the 19 participants, there are more than 19 answers. The collected data is presented below.

The first question was regarding the type of LMS used by the participants in their organisations. 9 participants answered "Open source: LMS is offered free of charge for use and adaptation but in most cases a fee is required to support activities.", followed by 4 answers "Of the shelf: LMS represents a package solution adapted to satisfy the needs of the purchasing organisation, rather then the commissioning of custom made solution.", and 2 "Bespoke: LMS is developed by your organisation in order to comply with its needs.", as represented in Figure 8.

Please indicate what type of LMS is used in your organisation:

More Details

- Open source: LMS is offered fre... 9
- Bespoke: LMS is developed by y... 2
- Of the shelf: LMS represents a p... 4
- Other 5
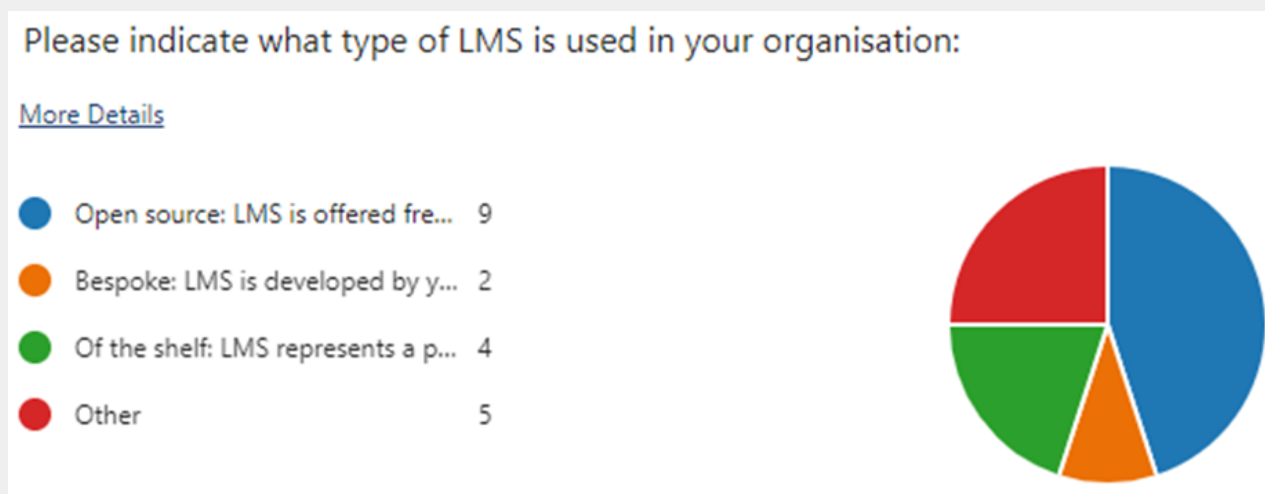
Figure 8 Types of LMS used

In terms of the participants that answered "Other", when asked to describe what type of LMS is used in their organisation, the answers were as follow: "ILIAS"; "Moodle + GoToMeeting"; "Google Classroom"; "VULCAN"; "MS Teams".

In relation to the type of LMS used by the participants in their organisations, the main functionalities offered were also assessed.

As seen on Figure 9, below, the main functionality is to "Upload or create and deliver content related to educational materials."; followed by "Monitor the student participation and continuous assessment to improve the learning process and student performance."; then "Tool for interactive features: threaded discussions, video conferencing, forums, etc."; and "Minimum functionalities: reports, analysis, customization of the e-learning experience, assessment and communication.".
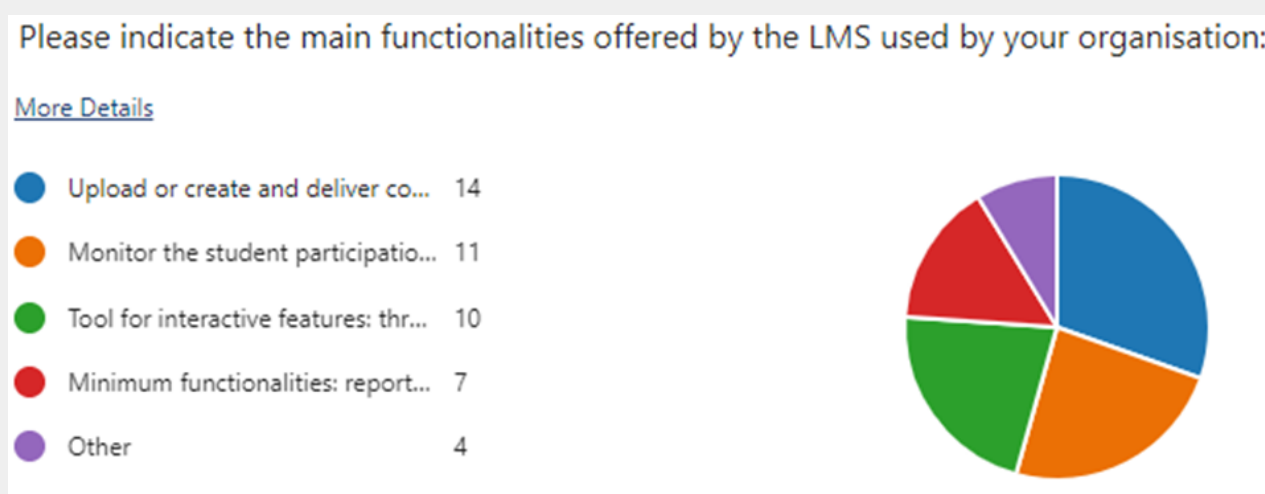
Figure 9 Main functionalities offered by the LMS

In terms of the participants that answered "Other", the following answers were gathered: "A filedepot via login on our website: upload of training presentations and documents in pdf."; "The Its Learning LMS system"; and "Electronic Assessment".

In reference to the supporting tool(s) used, in the participants organisations, to perform online teaching, "Microsoft Teams" is the most used, followed by: "Google Meet"; and "Zoom", as seen on Figure 10 below.
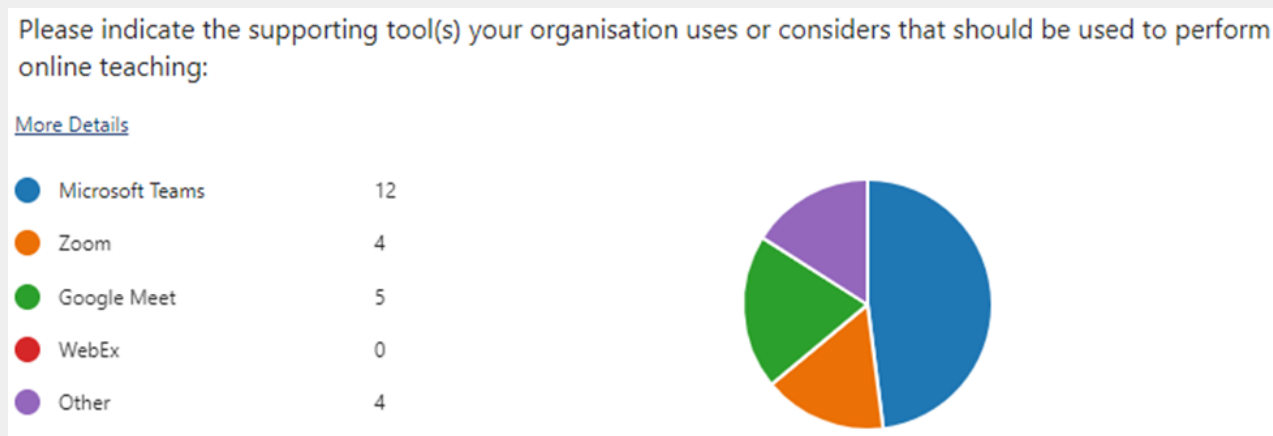
Figure 10 Supporting tools for online teaching

In terms of the participants that answered "Other", the following answers were gathered: "Its Learning"; "OneNote"; "Moodle" and "GoToMeeting".

Related to the supporting tool(s) used, in the participants organisations, to perform online teaching, they are integrated in the LMS as follow: "Students are registered in LMS with username and password to access the digital tool for online teaching."; and "Students access a link created by the teacher (i.e., Zoom), not having a direct connection with a organisation LMS.", as seen on Figure 11 below.
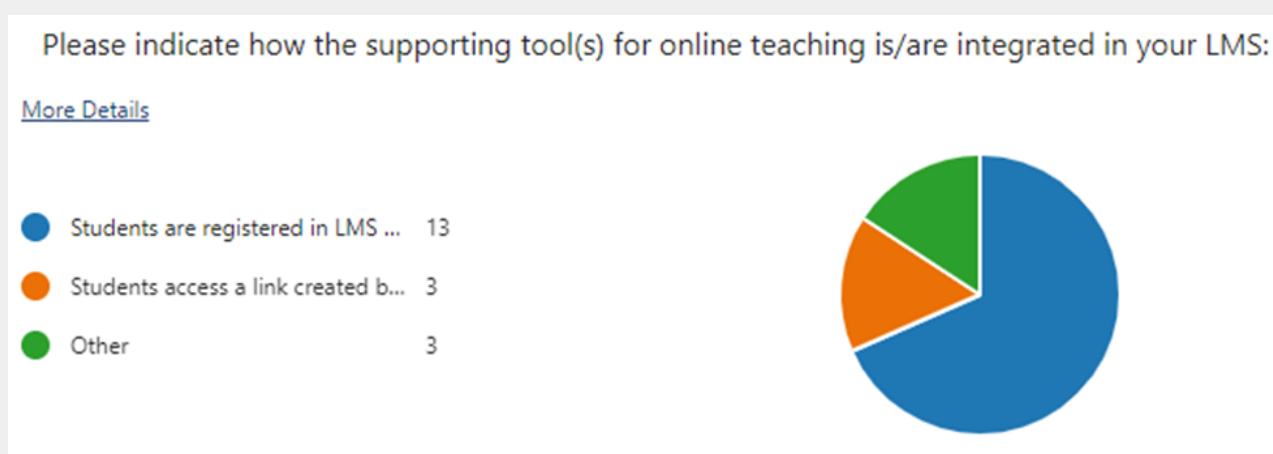
Figure 11 How supporting tools for online teaching are integrated in the LMS

In terms of the participants that answered "Other", they are as follow: "Moodle login with username and password, access to certain files, GoToMeeting login via link."; "We use it to host client sent development meetings."; and "Meetings."

Assessment template and implement the assessments in a suitable platform

Prior to the COVID-19 pandemic, teachers/trainers were used to apply a range of face-to-face assessment methods. However, there are a selection of useful online tools that can be used when performing assessment, on the way of verifying to which amount the students/trainees have met the course learning objectives. Even though the majority of these tools are now available since all training went from being in person to online to hybrid, it exists a number of variables that need to be considered, specially to ensure the quality of the assessment.

5.1. Guideline and online tools to ensure the quality of the evaluation of digital learning outcomes

Student Progress Report and Tracking

In order for students to keep track of their own learning progress and easily identify which are the subjects they need to deepen their knowledge or focused on practicing more, a few examples of tracking features that can be used to enhance/facilitate this process are listed below:

Grade book (e.g., using excel) to keep track of student progress, in the beginning of the course. This approach will allow the teacher/trainer to easily provide frequent feedback to the student/trainee on their work; facilitate the learning process and promote student/trainee motivation throughout the course. In line with this method, individualized feedback should also be given preference as it will foster motivation and optimize the student/trainee learning experience.

Tools for course management system to keep track of student/trainee assessment therefore contribute to a more comprehensive evaluation, such as student assignments, discussion postings, presentations, quizzes and essays.

Academic honesty/transparency promoted by asking deep thinking questions, taking preventive measures, utilizing plagiarism detection tools and features of course management systems.

Teachers/Trainers should promote honesty from the beginning of the course by sharing the content, format, rules and honour codes with the students/trainees, in particular for summative assessment. This environment should also be reflected in the syllabus and course materials (e.g., statements about academic honesty, definitions of cheating/plagiarism and consequences of academic dishonesty).

Use questions that can challenge students/trainees in their answers.

5.2. Quality requirements to conduct online assessment

Good assessment begins with the clear definition of learning outcomes (e.g., intended instructional outcomes, that should be specific and measurable, as well as concerned with student learning).

The assessment is used to contribute to the improvement of student/trainee learning and to identify students' strengths and weaknesses.

By clearly defining the learning outcomes and aligning your assessments accordingly, it is easier for students/trainees to prepare themselves for each stage of the assessment.

Getting familiar with the writing style of the students/trainees can also be beneficial to understand the though process being a final paper.

Establishing intermediate deadlines to submit drafts along with references might facilitate this and can also act as a mean of preventing cheating.

Some suggestions of best practices for online assessment that teachers/trainers should implement are as follow:

Ensure that the assessment is kept in line with the learning outcomes and scope of the course, to guarantee it is relevant.

Make sure when creating materials (e.g., case study projects, multiple choice questions, short essays) for online assessment that the How, When and Where are clearly identified and outlined. Followed by instructions on what to do if facing technical difficulties, as a preventive way of diminishing the anxiety and stress caused by the assessment situation.

Timed online tests (e.g., multiple choice, fill-in, and short answer); open book quizzes are also a great option.

Use test security measures such as:

1. issuing a password to access the test and using features of course management system such as locking down a browser to prevent printing, copying, going to another URL, or accessing other applications;

2. establish a limited time per question (e.g., 1 minute per multiple choice and 15 to 30 minutes per discussion questions/resort to management system features);

3. development of parallel forms of tests with randomizations of items;

4. create open book/notes tests and use items that require higher-order thinking so that answers cannot be easily copied and pasted from external sources.

Attribute points to assignments/quizzes for completion.

Assign low percentages of course grade to practice quizzes/tests.

Use other methods besides online testing, such as essays, discussion participation, real time online chat sessions.

Create a FAQ (Frequently Asked Question) section to respond to common and recurring questions.

If you see students who are not actively participating, follow up with them through email.

In DRinVET project, the assessment tools proposed are in the form of case study projects, multiple choice questions and short essays. These forms are explored below, where the rules for the creation of each type, followed by an example are provided.

Templates for online assessments in the form of case study projects, multiple choice questions, and short essays

In order for the partners from the DRinVET project to produce examples of online assessment, three types of templates for case study projects, multiple choice questions and short essays, were developed, to be applied during students/trainees' online assessment, followed by instructions.

6.1. Case study projects template

Instructions for the development of case study projects

For each section the following, must be applied:

a) **Case Study name**: name the exercise

b) **Qualification** (example for a Welding Qualification): Fillet Welder, Plate Welder, Tube Welder, Welding Engineer, Welding Technologist, Welding Specialist, Welding Practitioner, Welding Inspector Level Basic, Welding Inspector Level Standard, Welding Inspector Level Comprehensive

c) **Subject title**: topic of the case study project

d) **Learning Outcome(s)**: specific knowledge, skills, or expertise being evaluated by the question

e) **Completion Time**: indicate the exact duration to complete the exercise

f) **Assessment Criteria**: identify which are the assessment criteria that will be considered to determine the performance of the student/trainee

g) **Summary**: provide an overview about the practical assessment itself; identify the goal(s) in a teaching perspective (e.g., practical demonstration of metal transfer modes (dip, globular, spray and pulsed), controlled transfer mode and their application)

h) **Instructions**: provide a full description of the steps or tasks needed for conducting the exercise/case study; when applicable: indicate the minimum and maximum number of students/trainees per group

i) **Resources Needed**: indicate the resources (e.g., materials and equipment) are necessary for supporting the execution of the practical assessment (e.g., Welding Procedures Specifications (WPS), drawings, standards, PowerPoint, etc. (the supporting material have to be attached to the study case project); when applicable: describe where the exercise is performed, and which conditions may have influence in the performance of the exercise/case study (e.g., classroom with adequate light; welding shop, etc.)

j) **Solution**: provide the solution for the practical assessment case by explaining the correct reasoning for solving a specific problem, case, etc; when applicable: provide information about the assessment methods/tools and criteria (e.g., verify if results are matching with the LOs; comparative analyses of group answers and working-out major keys (trainers); quality of the outputs/products; reasoning behind the problem resolution, etc.)

Table 1 Case Study Template

Case Study name:	
Qualification:	
Subject title:	
Learning Outcome(s):	
Completion Time:	
Assessment Criteria:	
SUMMARY (detailed presentation of the exercise/case study)	
INSTRUCTIONS (steps and tasks necessary to conduct the case study)	
RESOURCES NEEDED (identification and their attachment)	
SOLUTION	

6.2. Multiple choice questions template

Instructions for the development of multiple choice questions

For each section the following, must be applied:

a) **Qualification** (example for a Welding Qualification): Fillet Welder, Plate Welder, Tube Welder, Welding Engineer, Welding Technologist, Welding Specialist, Welding Practitioner, Welding Inspector Level Basic, Welding Inspector Level Standard, Welding Inspector Level Comprehensive
b) **Subject title**: topic of the question
c) **Learning Outcome(s)**: specific knowledge, skills, or expertise being evaluated by the question
d) **Question**: 1 question
e) **Answers**: 4 possible answers for each question
f) **Correct answers**: 1 to 4 correct answers for International Welding Engineer (IWE) (corresponding to EQF levels 6, 7 or 8 – bachelors, masters or doctors' degrees), for other levels only 1 correct answer

Table 2 Multiple Choice Questions Template

Qualification	Subject Title	Learning Outcomes	Question	Answer 1	Answer 2	Answer 3	Answer 4	Correct Answer(s)

6.3. Short essays template

Instructions for the development of short essays

For each section the following, must be applied:

a. **Qualification** (example for a Welding Qualification): Fillet Welder, Plate Welder, Tube Welder, Welding Engineer, Welding Technologist, Welding Specialist, Welding Practitioner, Welding Inspector Level Basic, Welding Inspector Level Standard, Weld-ing Inspector Level Comprehensive
b. **Subject title**: topic of the question
c. **Learning Outcome(s)**: specific knowledge, skills, or expertise being evaluated by the question
d. **Question**: 1 open question (e.g., Identify the test that is presented in the following figure and explain the test and the responses obtained from that test.); if necessary, images, figures or schemes can be used
e. **Recommended Solution**: for each question a recommended solution should be pro-vided to serve as a guide to the correction, by the topics that must be addressed in the answer

Table 3 Short Essays Template

Qualification	
Subject title	
Learning Outcome(s)	
Question	
Recommended Solution	Topics that must be addressed in the answer: • •

ANNEXES

Examples of online assessments in the form of case study projects, multiple choice questions and short essays

1.1. Examples of Case Study Projects

Table 1 Case study example 1

Case Study name: CORRECTION OF WELDING TECHNIQUES OF PROFESSIONAL WELDERS
Qualification: Fillet Welder, Plate Welder, Tube Welder
Subject title: correction of welding techniques using welding simulators
Learning Outcome(s): - to correct the welding technique
Completion Time: Training lasts until the welder fulfills the set tasks.
Assessment Criteria:
Passage of the score threshold on all three characteristics that are monitored.
SUMMARY (detailed presentation of the exercise/case study)
The evaluation of training results is performed by a device - welding simulator. The trainer determines the minimum level of skills required to perform the set task at the required quality level defined by the WPS. The minimum level is defined by the percentage where 100% is the ideal task execution. In the exercise for professional welders, three characteristic elements for the welding technique are evaluated: … the welding speeds … the distance from the workpiece … the tilt angle of the welding torch Each of the characteristic elements must cross the scoring threshold for the assessed result to be positive.
INSTRUCTIONS (steps and tasks necessary to conduct the case study)
Step 1: The trainer creates the WPS together with the employer's welding coordinator. Step 2: Based on the required quality of the welded joint in WPS, the minimum level (in percent) required for the welder to operate with such a welding technique that guarantees quality weld is determined. The ideal weld is rated 100%. Step 3: The trainer enters the minimum level into the computer of the welding simulator computer for the intended exercise. Step 4: The passing grade in this case is when the welder reaches the minimum level for all three characteristics being measured. This information is provided by the simulator immediately after the end of the exercise. Example: - The trainer has defined a minimum level of 70% for the required quality per WPS. The simulator turns that data into 700 points. In order for the welder to receive a positive assessment, the result of all three characteristics should be a minimum of 700 points. It looks like this: … the welding speed................................min. 700 points … the distance from the workpiece........min. 700 points … the tilt angle of the welding torch.......min. 700 points
RESOURCES NEEDED (identification and their attachment)
To perform the exercise, you need to have: - WPS - welding simulator The described case study was performed on a Fronius welding simulator.
SOLUTION
The best independent assessment of the welder's welding technique, for a particular welding process, is performed using a welding simulator. This is an effective way for three reasons: 1. Evaluation of results is current, 2. Using a playback, the welder can see where he made a mistake during welding, and 3. The trainer has information about all the welds that the welder has performed

Table 2 Case study example 2

Case Study name: Car body structure WPS weld using SOLDAMATIC	
Qualification: Welding Practitioner	
Subject title: Practice with SOLDAMATIC	
Learning Outcome(s): Correct fillet weld (overlapped) in PB (horizontal)	
Completion Time: 30'	
Assessment Criteria: Approved if the quality of the bead has achieved the score set by the teacher in the exercise (90 points or above); and Fail if the score has not been reached (Less than 90 points).	
SUMMARY (detailed presentation of the exercise/case study)	
The objective of this case study is to know how to set up and perform a simulated welding practice on car body structure WPS fillet weld (overlapped) in PB (horizontal)using SOLDAMATIC.	
INSTRUCTIONS (steps and tasks necessary to conduct the case study)	

To carry out this type of welding in SOLDAMATIC, you will have to follow these steps:

1. **Choose the torch**

The welding process is 131 Gas Metal Arc Welding, so you need to choose GMAW Torch

2. **Choose the welding joint**

Fillet weld is in PB horizontal position, so you need to choose an overlapped plate

3. **Configure the exercise in SOLDAMATIC**

3.1. Exercise settings

A) Difficulty

There are 3 levels, and each level makes the bead assessment more restrictive. Each parameter has an "objective" value and a range that delimits what is "allowed". The difficulty adjusts that range to make the exercise assessment less permissive. The greater the difficulty, the less margin of error, in other words, the user should get closer to the objective value.

Choose advanced level

B) Equipment Settings

You may activate or deactivate the on-screen indicators that appear during the exercise referring to voltage, wire speed, amperage, gas, etc. Some users may prefer to hide them in order to make experience seem more real.

You will also have to choose if you prefer the exercise to begin with the equipment parameters correctly adjusted or not. If you choose the second option, the exercise will not begin until the equipment adjustments are the correct ones.

Choose disable guides and set correct equipment values at start

C) Real-time Parameters Guides

This refers to the on-screen guides the user finds to perform the welding practice correctly.

You can deactivate this option if you consider them not necessary because you are an expert welder.

Choose enable guides

    D)   Slag Removal Requirements

You many choose to clean the slag in between passes or do it after you have completed them. This option will activate only in the SMAW-MMA and FCAW processes.

Choose remove slag after all passes are completed

3.2. Welding parameters

    ○   Next, we have to select some of the parameters that intervene in the exercise.

    ○   The system will guide you through so you will not leave any without being marked.

    ○   The screens show you each one of them in an easy and intuitive way.

    ○   We will begin by choosing the Coupon we are going to weld *T angle plate to plate joint*
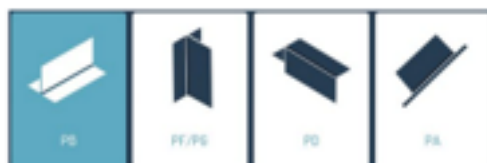
After choosing the coupon the following screens will appear:

Choose PB position

Choose Aluminium

Thinckness

1/4in.-6mm.   1/8in.-3mm.   3/8in.-10mm.

Choose 1/8in- 3mm

After choosing the coupon the following screens will appear:

Welding process

Choose GMAW

Filler material

ER70S-6

The system only allows you to choose ER70S-6

Filler material diameter

.030in.-08mm.   .035in.-10mm.   .045in.-12mm.

Choose ,035in-1'0mm

Gas
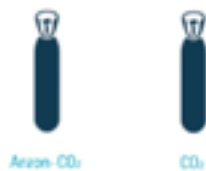
Argon-CO₂   CO₂

Choose Argon – CO2

Bead Length

4 in.-100mm.   7 in.-180mm.   10in.-250mm.

Choose 10in-250mm

Number of passes

1 pass   2 passes   3 passes

Choose 1 pass

Pattern — Zigzag | Straight | Triangle | Circular | Balance

Choose straight

Welding sequence

2 Segment | Continuous

Choose continuous

Welding technique

Drag | Push

Choose Drag

3.3. Overview

Now you already have all the necessary parameters to begin doing the exercise.

You will see a summary of them in this screen.

You will be able to review all parameters that appear in this WPS and if there is one you want to change, you may go back pressing the Cancel button.

3.4. Getting ready for the welding practice

You must have well placed (welding position) the same coupon you have chosen in the previous menu.

And you must have corresponded the selected welding process torch connected to the unit.

NOTE

If we take a piece different from the one selected in the exercise configuration the system will not recognize it, you will have problems for the mask to detect it correctly and you will not be able to start the exercise. It is also important that there are no other pieces nearby that may interfere when generating the AR.

3.5. Light calibration

The first time you use your simulator you must perform the Light calibration of the helmet to adjust the video device settings (temperature, intensity) based on the room lighting conditions where the simulator is located.

Light is essential for a proper detection of the coupon and the welding torch, so it is very important that you perform this calibration to ensure the best Augmented Reality experience.
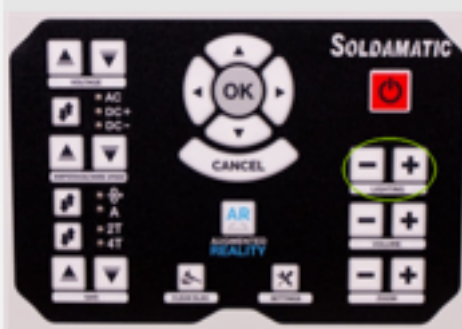
Helmet LED lights

In the calibration process, the system will find the most adequate intensity so that the mask will be in its optimum point of detection. We recommend maintaining this measure, but if you want more or less light, remember we have on the frontal panel a button +/- to increase or lower the intensity.

4. Let´s Weld

As we can see on the metal piece there are some arrows and marks in red, yellow, blue and green. These signs are the Help Icons that will guide us during the exercise to give us information about the correct way to execute the Welding.
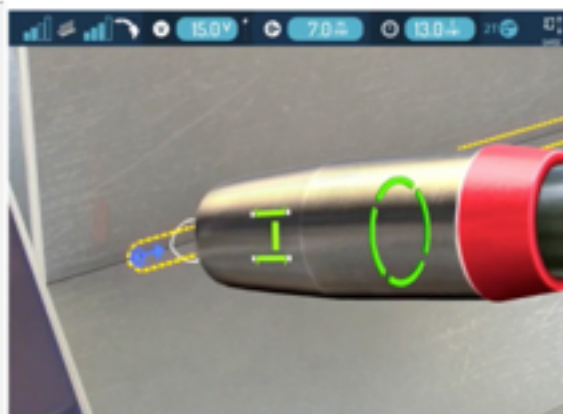
5. View results

5.1. Analysis module

Soldamatic has a system that collects all the data of the execution of the weld bead for later analysis.

It will give us details of each analysed parameter that we could hardly see in the real weld.

This will allow us to know in more detail what are the aspects that the student should improve, and therefore, we will be able to design reinforcement exercises that focus on these aspects.

In addition, it contains the video reproduction of the execution from different angles, as well as a view of the piece in 3D. *We call this system the Analysis Module, and you have access to it once the exercise has been completed.*

As we have seen previously, at the end of the weld bead we must press the Cancel button on the front panel to confirm that we have finished.

Next, the system gives us the following options:

5.2. View result

If we click on this option, all the results will be saved, and we will access the Analysis Module that is available in both the simulator and the e-learning platform.

5.3. Clear Weld and Restart

The data of the exercise carried out will not be saved and you can start again.

5.4. Continue Weld

We will press this option if we want to review what we have done before confirming the exercise.

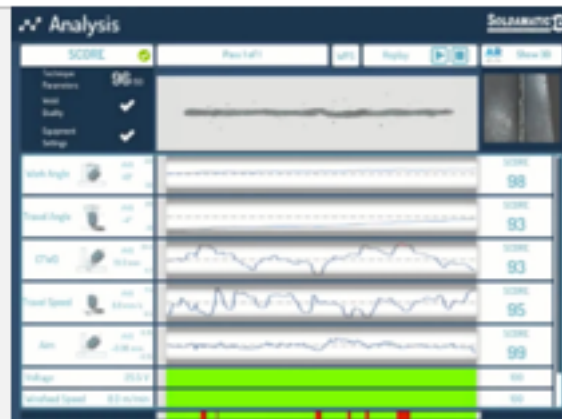If you don't like the result, you can repeat it.

5.5. Back to Activity selection

This option takes us back to the Open Demo screen or to the course we are in.

5.6. Interpreting results

Once in the Analysis Module, we will see the following graphic.

Let's detail which information is given by each of the options it is composed of.

5.7. Scoring

It indicates the score obtained as a result of an equation that considers the parameters, equipment settings, defect ology and everything that is involved in the welding process that makes the bead qualified or not.

✓ will appear if the quality of the bead has achieved the score set by the teacher in the exercise (i.e., 90 points or above); and an X if the score has not been reached.

The total scoring of an exercise is the average of the score of all the passes.

In the previous image we see a total evaluation of 96 points, the minimum required grade was 90, for this reason the welding bead is considered of quality.

The maximum mark would be 100 points.

5.8. Technical Parameters

These data are related to each one of the parameters and their progression throughout the exercise performance.

We can press the Ok button to locate ourselves at the desired point on the bead for further analysis.

The white background of the graphs indicates that we have stayed within the values of the range.

And the red background is informing us, that for a period of time (considered excessive) we have gone out of range.

In this image we see that, throughout the length of the bead, the working angle has been brought to an average of 48º. Therefore, we have not gone out of the established range (60º-30º).

The interval will be more closed depending on the exercise's level of difficulty that we have selected. In other words, the greater the difficulty, the lower the range or margin of error.

The total score for this parameter was 98, as shown to the right of the exercise graph.

Pass

It indicates the number of passes that have been carried out and it allows us to analyze each one of them, showing a different graph for each pass.

WPS

Shows the summary of the parameters that are configured for the exercise we are analysing. It will help us to see, in just one click, the values that have been considered for the evaluation.

Replay

This system allows us access to the exercise replay. If we click on this section, we will see how the bead has been performed with all the details from the beginning to the end.

You can start or pause the execution of the video and watch it from different perspectives.

Show 3D

If we were in a real welding workshop, we could take the welded coupon and see its appearance from different angles.

If we click on this section, we will see the same, although, we will not be able to touch the coupon, of course.

This graph shows the entire length of the welding bead path and next to it we see the total scoring obtained in each parameter.

When the line is in the grey area of the graph it is shown in red, and it means that you have gone out of the marked range.

If we see it in the white area, it appears in blue and means that you have stayed within the allowed range.

If we press the OK button on the front panel, in this section of the Analysis Module, we will obtain more detailed information about the parameters' progression at each stage of the welding execution. Using the navigation buttons to scroll through the graphs, you will see the obtained values, on the point of the bead that you desire.

Defects

As we see in the image, the Analysis Module shows data and graph about the Porosity of the bead.
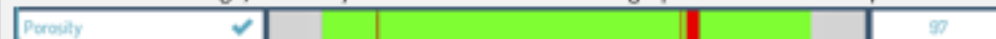
The part of the bead where this defect occurs will be shown in red, and the part of the bead that is free of defects will be shown in green.

The score will indicate the percentage of the bead where this defect does not occur. For example, a 90% porosity means that in 10% of the bead there is the possibility pores and 90% of the bead is theoretically free of pores.

We will see the same rating when evaluating (depending on the welding process) the Spatters and Contamination defects.

RESOURCES NEEDED (identification and their attachment)

SOLDAMATIC: Is the name of the simulator where the Augmented Reality welding practices are performed.

Both its external elements (welding torches, helmet, etc.) and its functionalities (welding sound reproduction, vision module, etc.) have been designed to make this experience as close to reality as possible.

WPS:

SOLUTION

After the practice in SOLDAMATIC, the teacher will use this evaluation grid to check that the student correctly executes the welding practice in terms of quantity and visual appearance of welds. The student will pass with a minimum of 10 points.

	ASPECT	NOT ACCEPTABLE (0-2.5)	LOW MINIMUMS (2.5-5)	GOOD (5-7,5)	EXCELLENT (7,5 -10)	GROUP:	
						POINTS	%
50%	Quantity	Many critical welds are missing.	Some critical and visible welds are missing.	Some welds are missing but these are not critical.	All the unions have been welded.		
50%	Visual appearance of welds	Many incomplete welds, with holes and bad dimensioning.	Some welds with holes and incomplete.	There are no incomplete welds and holes, but the dimensioning is inadequate.	Good looking welds with good dimensioning.		
						TOTAL	

Table 3 Case study example 3

Case Study name: Virtual reality enhances safety training in the maritime industry: An organizational training experiment with a non-WEIRD sample

Link to the article and experiment: https://onlinelibrary.wiley.com/doi/full/10.1111/jcal.12670

Qualification: Not applicable

Subject title: VR in safety training

Learning Outcome(s): Not applicable

Completion Time: 1 hour

Assessment Criteria:

Research question 2a: Are there significant differences between a stand-alone VR safety simulation and the same VR simulation followed by a reflection activity?

Research question 2b: Are there significant differences between a safety training administered through a personal trainer or a manual?

Pre- and post-test measures

The pre-test questionnaire measured demographic characteristics (age, gender, degree programme and educational level), experience using VR, and prior knowledge. The post-test consisted of scales measuring enjoyment (Tokel & İsler, 2015); intrinsic motivation (Deci et al., 1994); self-efficacy (Pintrich et al., 1993); extraneous cognitive load (Andersen & Makransky, 2020), safety attitudes (Lu & Tsai, 2008), perceived learning (Lee et al., 2010), and behavioural change (Baceviciute, Lopez-Cordoba, Wismer, et al., 2021). A complete list of items is available in Appendix S1. All items were on 5-point Likert scales ranging from (1) strongly disagree to (5) strongly agree.

Passage of the score threshold on all three characteristics that are monitored.

Enjoyment:

Intrinsic motivation

Self-efficacy

Extraneous cognitive load

Safety attitudes

Perceived learning

Behavioural change

SUMMARY (detailed presentation of the exercise/case study)

Procedure

The experiment was implemented as part of students' safety training in dynamic risk assessment on board a vessel on the topic of safety during a mooring operation. It took place over the course of 2 days with participants entering in groups of eight students at a time. The procedure for all groups followed the same set-up and took approximately 1 hour to complete.

The four conditions

The training material consisted of four versions of a dynamic risk assessment training on the topic of safety in a mooring activity on board a vessel (manual, personal trainer, VR and VR Reflection). Extreme care was taken to ensure that the training material included identical information.

1 Manual condition

Participants in the manual condition were asked to study a safety training manual individually. The manual was composed of screenshots from the VR simulation with explanations of the content. It consisted of the same information as the VR simulation in order to maintain consistency across conditions.

This condition mimicked a scenario that is currently the most common training method in the industry, where trainees are provided with manuals related to risk assessment and training and are asked to learn the material on their own.

2 Personal trainer condition

In this condition, a trainer well-known to the students presented a PowerPoint slide show with the same pictures and information used in the manual to ensure consistency across conditions. Students were given the personal training two to four trainees at a time. During the training lesson, they were able to ask questions and discuss the topics in more detail.

This was designed to mimic a personal training situation where an expert could introduce trainees to the topic in detail.

3 VR condition

In this condition, participants engaged in the VR simulation described below. This condition was designed to mimic a scenario where trainees had access to a stand-alone VR training simulation, without access to assistance or help from a professional trainer, which is a scenario that would be practical on-board vessels in the maritime industry.

It reflects a situation in which HMDs could be readily available making just-in-time training possible anywhere, anytime.

4 VR Reflection condition

Trainees engaged in the VR simulation as described in the previous condition. However, in addition, they were able to reflect on the training material in a semi-structured session with a teacher from the school. It was structured around four slides with screenshots from the simulation identifying the safety hazards that the trainees had encountered in the simulation.

The reflection activity gave trainees an opportunity to discuss the dynamic risk situations: how they dealt with them in the simulation and how they would deal with them in a realistic scenario. This condition was designed to mimic a scenario where trainees could access professional help after having engaged in the VR simulation.

An example would be on board a vessel where a captain or another responsible person could provide additional support following the training, for example by acting as an instructor who helps the trainee reflect on the content of the simulation.

INSTRUCTIONS (steps and tasks necessary to conduct the case study)

The VR simulation was administered on Oculus Quest HMDs and developed in Unity 2020. Interactivity in the simulation occurred through movements of the head and the use of controllers. The simulation was designed as a collaboration between the experts from a VR development company, an international shipping company, a maritime education academy and a research team from a large European University to ensure that important work criteria were considered. The simulation targeted individual dynamic risk assessment during a mooring operation, that is, when the vessel is secured to a permanent structure such as a quay or a pier on the shore. The simulation was designed based on multimedia design principles (Makransky, 2021; Mayer & Fiorella, 2021), and to mirror the recent change in safety training focus from what can go wrong to making sure things go right.

Therefore, it was structured around abilities which can be considered the functional cornerstones of resilience (Hollnagel, 2011). This includes being able to anticipate (events beyond the current operation) monitor (know what to focus on and perceive changes in performance and environment), react (successfully detecting, recognizing, and assessing events in time) and learn (promote, facilitate, and enhance learning from experience).

The learning goals of the safety training simulation were therefore being aware of potential dangers, recognizing signs of dangers in varying conditions, responding to dangerous situations, and learning from the outcome of actions during a mooring operation.

RESOURCES NEEDED (identification and their attachment)

VR Equipment
VR solution (applicable for the case study you would like to do)
Students and professionals

SOLUTION

There is no specific solution as this sort of study case can be developed to any VET education. The need is in the development of the VR scenario (software) reflecting the needs of the students.

Citation of the study:

Makransky, Guido & Klingenberg, Sara. (2022). Virtual Reality Enhances Safety Training in the Maritime Industry: An Organizational Training Experiment with a non-WEIRD sample. Journal of Computer Assisted Learning. 10.1111/jcal.12670.

1.2. Examples of Multiple Choice Questions

Table 4 Multiple choice questions example 1

Qualification	Subject Title	Learning Outcomes	Question	Answer 1	Answer 2	Answer 3	Answer 4	Correct Answer(s)
Not applicable	Not applicable	Basic knowledge about Augmented Reality	1. The basic architecture of AR System is composed by:	Hardware, software and remote server	Eyeglass, virtual images and internet	Eyeglass, mobile phone or tablet	Answer 1 and 3 are correct	1
Not applicable	Not applicable	Basic knowledge about Augmented Reality	2. From an economical point of view, the use of digital tools in learning process…:	Reduced costs with teachers and trainers.	Reduced costs with preparation of base materials and increasing the time on arc of the trainees.	Specific industrial components for welded structures can be simulated.	All answers are correct	4
Not applicable	Not applicable	Basic knowledge about Augmented Reality	3. In AR, Virtual images, used for overlapping over the real live image, can be generated using…:	2D software	Special cameras	3D software	Head Mounted Displays (HMD)	3
Not applicable	Not applicable	Basic knowledge about Augmented Reality	4. Hardware components of an AR system consist of:	HMD, SS, EG	Virtual images stored from web or cloud server	Webcam, GPS, sensors	A processor, a display device and position sensors	4
Not applicable	Not applicable	Basic knowledge about Augmented Reality	5. Augmented Reality (AR) technology allows the blending the real and virtual worlds:	True	False			1
Not applicable	Not applicable	Basic knowledge about welding simulators	6. Welding simulators can support:	Theoretical training and assessment	Practical training and assessment	Theoretical and practical training and assessment	Online or offline theoretical and practical training and assessment	4
Not applicable	Not applicable	Basic knowledge about welding simulators	7. In terms of economical aspects please select the most appropriate benefits regarding Welding simulators:	Reduced costs with energy, human resource	Reduced training time	No waste materials which can affect the environment	No risks regarding safety issues	1
Not applicable	Not applicable	Basic knowledge about welding simulators	8. The main differences between welding simulator and real welding system are:	Practice in different environment, level of pollution, safety issues, number of attempts, arc time, level of qualification	Simulator is a computer, real system is a specific equipment	There are no differences between simulator and real welding system	First two options are good	1
Not applicable	Not applicable	Basic knowledge about welding simulators	9. Please select the advantages of simulated welding:	Economical, Ecological, Safety, Educational	Economical, Safety, Educational	Economical, Ecological, Safety, Educational, Social	Economical, Social, Educational	1
Not applicable	Not applicable	Basic knowledge about welding simulators	10. Please select the main disadvantages of simulated welding:	Cost of technology	Lack of digital skills of trainers and technology limitations	Cost of operation	No disadvantages identified regarding the simulators or simulated welding	2
Not applicable	Not applicable	Basic knowledge about welding applied to industrial sectors	11. The manual welding is employed mainly in:	Low-demand production Systems	High-demand production Systems	a and b are correct	None of the above	1

Not applicable	Not applicable	Basic knowledge about welding applied to industrial sectors	12. In ship building industry:	More than 75% of the joints are welded	More than 85% of the joints are welded	More than 90% of the joints are welded	100% of the joints are welded	3
Not applicable	Not applicable	Basic knowledge about welding applied to industrial sectors	13. The materials used to build a railcar body are:	Aluminium	Steels mainly	Nickel and tin	Copper alloy	2
Not applicable	Not applicable	Basic knowledge about welding applied to industrial sectors	14. Pressure vessels can have different shapes but the most used are:	Spheres	Cylinders	Cones	All answers are correct	4
Not applicable	Not applicable	Basic knowledge about welding applied to industrial sectors	15. In Civil construction, gussets are used for:	The stiffening of different intersections of elements which are or not welded together	The stiffening of same intersections of elements which are or not welded together	The stiffening of same intersections of elements which are welded together	The stiffening of different intersections of elements which are not welded together	1

1.3. Example of Short Essays

Table 5 Short essays example 1

Qualification	All qualifications in vocational education (all welding qualifications are included)			
Subject title	Assessment of interactive digital educational content			
Learning Outcome(s)	- create interactive digital educational content; - use the Internet, virtual space of social networks, computers and mobile devices to create interactive digital educational content; - research, compare and select materials for interactive digital educational content; - evaluate interactive digital educational content based on adopted criteria.			
Question	Evaluation of interactive digital educational content based on adopted criteria. **Criteria:**			
		Level of realization of criteria		
		3	2	1
	Creating a teaching topic	The teaching topic is well covered	The teaching topic is treated with minor errors that do not significantly affect learning outcomes	There are processing errors, but they can still be linked to learning outcomes
	Examples and explanation	Examples are well written and explained	The examples are well written, but there are minor errors in the explanations	There are errors in both examples and explanations
	Multimedia and interactive content	There are at least 5 multimedia or interactive contents in the paper that are author's work and related to the topic	There are at least 3 multimedia or interactive contents in the paper that are author's work and related to the topic	There is at least 1 multimedia or interactive content in the paper that is the author's work and related to the topic
	Additional contents	There are at least 3 examples that are not from textbooks or links to various topics related to the topic	There are at least 2 examples that are not from textbooks or links to various topics related to the topic	At least 1 example is provided that is not from textbooks or links to various content related to the topic
	Note: If the component is not achieved even at the lowest expected level or does not exist, then 0 points are awarded for it.			
Recommended Solution	Topics that must be addressed in the answer: • creating a teaching topic • examples and explanation • multimedia and interactive content • additional contents			

Note: This assessment method is linked to an example of good practice: DIGITAL EDUCA-TIONAL CONTENT (IO3)

1.4. Examples of good assessment practices using simulators

Table 6 Good Assessment Practices Using Simulators Example 1

Software: Fronius Welding Simulator
Qualification: All qualifications in vocational education (all welding qualifications are included)
SUMMARY
Teachers and/or trainers, in vocational education, assess/evaluate using Fronius welding simulator. This simulator works on the principle of serious play.   It has three levels related to the management of the welding process.   The minimum number of points for each level is 0 points and the maximum is 1000.   The teacher/trainer determines the pass threshold, e.g., 60% (that is 600 points).   When performing the exercise, the simulator scores. You cannot go to a higher level if you have not passed the threshold (600 points).   The teacher determines the scale of grades according to the national standard in relation to the achieved points on the simulator.   The assessment is performed similarly to simulators from other fields

Table 7 Good Assessment Practices Using Simulators Example 2

Software: Google Classroom
Qualification: All qualifications in vocational education (all welding qualifications are included)
SUMMARY
Teachers develop practical scenarios for both online and offline assessment. Students connect on Google Classroom and run de scenarios. The teachers evaluate their performance using predefined rubrics. Teachers organize virtual classroom in online education. Students receive invitations to join to the classroom. Each student receives individual scenario fir practice assessment. All class receive one quiz with multiple choice answers for theory assessment.

Table 8 Good Assessment Practices Using Simulators Example 3

Software: SOLDAMATIC	
Qualification: All qualifications in vocational education (all welding qualifications are included)	
SUMMARY	

Soldamatic has an evaluation system where you have access to it once the exercise has been completed , that shows in the analysis module the results of the executed exercises. This analysis module gives us details of each analysed parameter that we could hardly see in the real weld.

This will allow us to know in more detail what are the aspects that the student should improve, and therefore, we will be able to design reinforcement exercises that focus on these aspects.

In addition, it contains the video reproduction of the execution from different angles, as well as a view of the piece in 3D.

The execution of the exercise is evaluated by passes.

When an exercise is created in the e-Learning Teacher, each welding parameter is set to Target Value and a range below and above (Target Range), this for each welding pass. These values are used to evaluate the parameter in the analysis module.

Score of each welding parameter (e.g., feed rate) in a pass is the arithmetic mean in this pass with respect to the Target Value and Target Range. The exact formula is a bit complicated, but in general it says: In Target Value you score 100, in Target Range the score drops to 80, otherwise the score drops rapidly. The total score of a run is the geometric mean of the score of all parameters in this run. The total score of the exercise is the geometric mean of the scores of the passes. For an exercise the following are evaluated: manual skills, equipment settings, defects and if you want to add a bend test even if it is for the new version.

Manual Skills: When an exercise is created in the e-Learning Teacher, you define a cut-off score for the total exercise (target). The total score of a run is the geometric mean of the score of all the parameters in this run. The total score of the exercise is the geometric mean of the scores of the passes and must exceed the target value of the exercise. There are default ranges according to the level of difficulty of the exercise.

Equipment Settings: The score is calculated as the average of the score of all the parameters that comprise it, which must exceed the target value of the exercise.

Defects: We evaluate the possibility of occurrence of a defect in a finished weld point. The score is calculated as the average of the score of all the parameters that make it up, which must exceed the target value of the exercise.

Bend Test: it is only evaluated as pass or fail. In beginner and intermediate it does not impact the grade of the exercise. In advanced, if the exercise is failed, the exercise is failed.