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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
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
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
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

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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

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

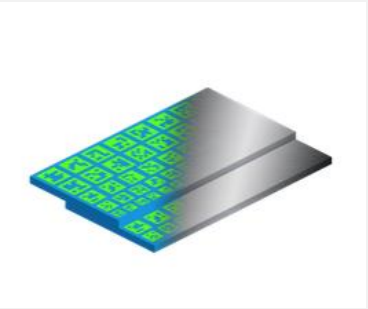
In order to carry out this type of welding in SOLDAMATIC, you will have to follow these steps:

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. Th**e** 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.

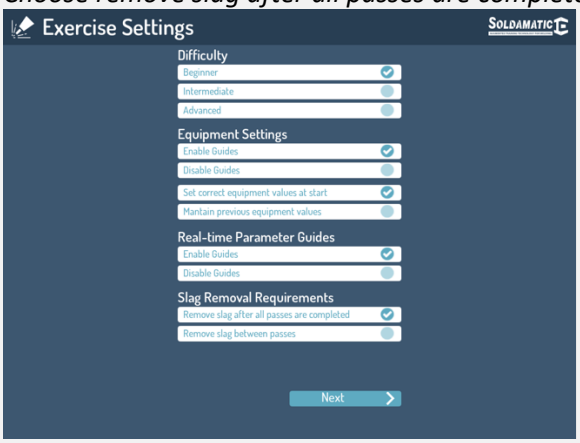
You can deactivate this option if you consider them not necessary because you are an expert welder.

Choose enable guides

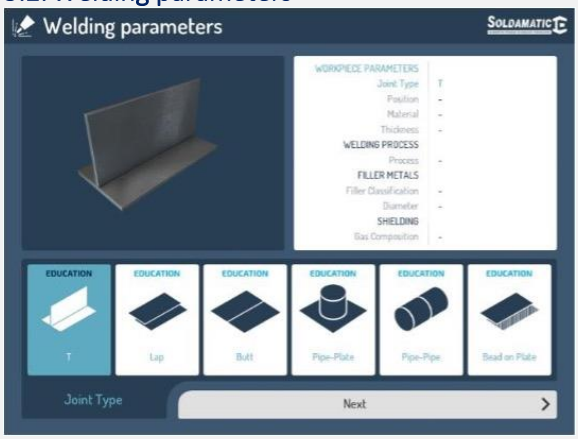
D) Slag Removal Requirements

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

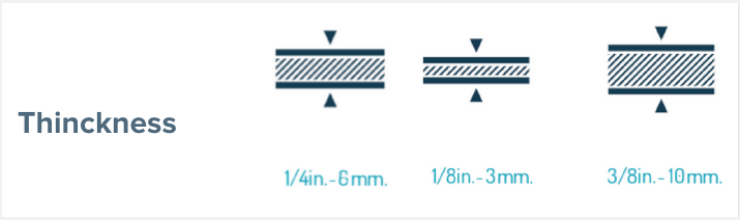


- Next, we have to select some of the parameters that intervene in the exercise.
- The system will guide you through so you will not leave any without being marked.
- The screens show you each one of them in an easy and intuitive way.
- We will begin by choosing the Coupon we are going to weld ***T angle plate to plate joint***

After choosing the coupon the following screens will appear:

Choose PB position

*Choose Aluminiu**m***

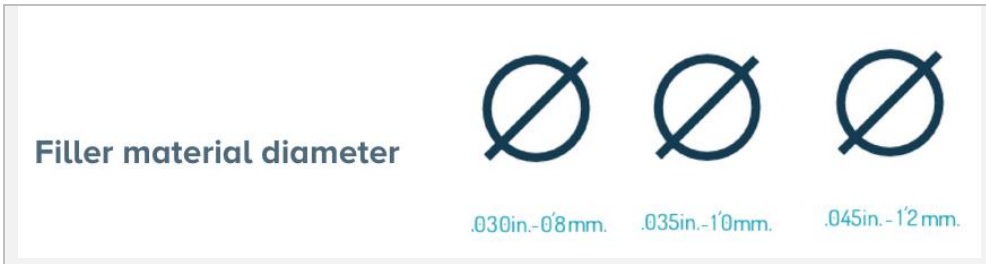


Choose 1/8in- 3mm

After choosing the coupon the following screens will appear:

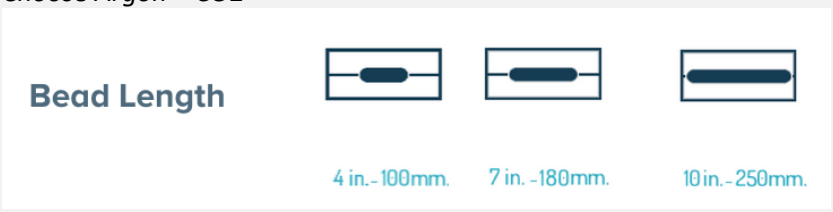
Choose GMAW

*The system only allow**s** you to choose ER70S-6*



Choose ,035in-1'0mm

Choose Argon – CO2



Choose 10in-250mm

Choose 1 pass

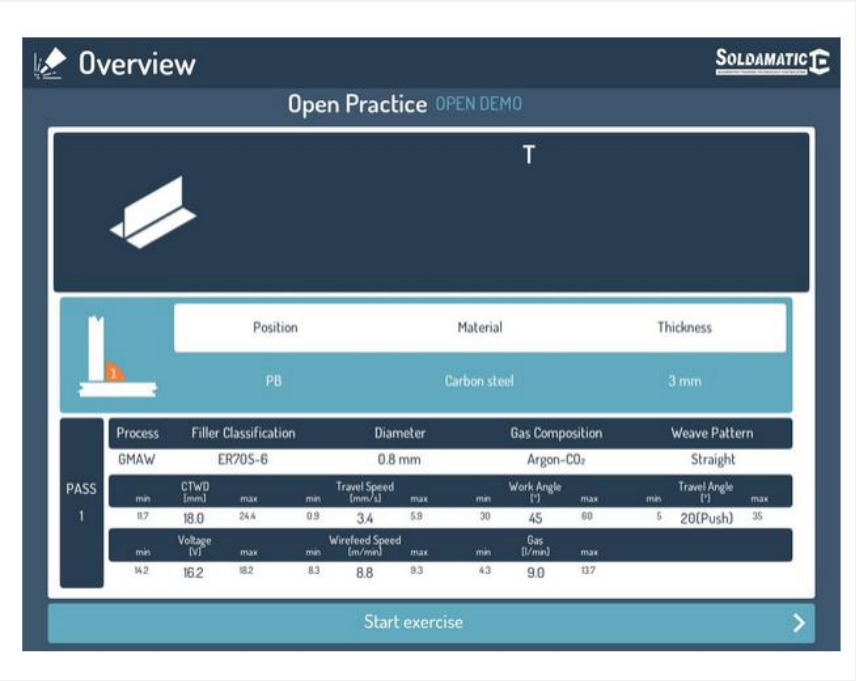
Choose straight

Choose continuous

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

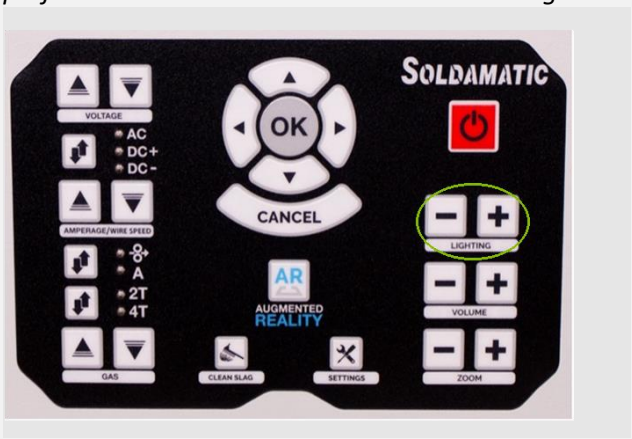
You must have well placed (welding position) the same coupon you have chosen in the previous menu.
And you must have corresponded the selected welding process torch connected to the unit.

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.*

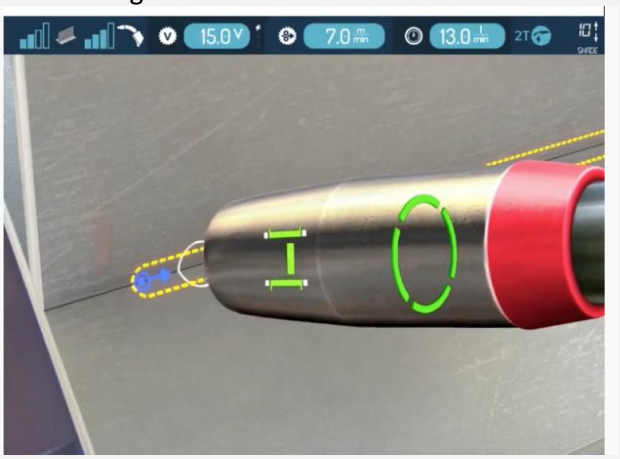


Helmet LED lights

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.

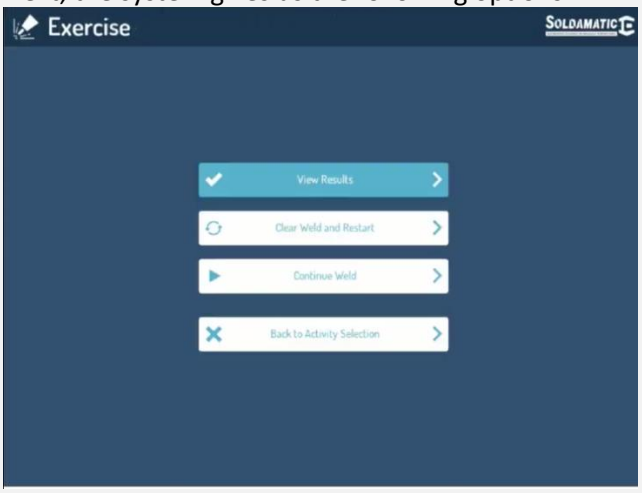


5. View results

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 olog**y** 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.

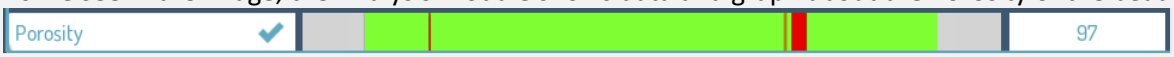
This graph shows the entire length of the welding bead path and next to it we see the total scoring obtained in each parameter.

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

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:

CAR BODY STRUCTURE - WPS WELD (profile to create the skelet of the structure)

Welding Procedure Number			12
Welding Procedure Qualification Record (WPQR)			Revision: 0
Manufacturer:		Method Of Preparation and Cleaning:	Cutting in dimension, cleaning impurities and grease, brushing base paint, remove slag after welding, remove spatter after welding
Location:		Parent Metal Specification:	AlMg3 / AW 5754 EN 573-1:2008
Welding Process:	131	Parent Metal Thickness	Plates: 2 to 2 mm
Joint Type:	Fillet weld (overlapped)	Welding Position:	PB (horizontal)
Joint Design		Welding Sequences	
Fig. 1		Fig. 2	

Run	Process	Size of wire mm	Current A	Voltage V	Type of current/ Polarity	Wire feed speed m/min	Travel speed cm/min	Heat Input J/cm
1	131	0.9	70-80	14-16	cc+	7	40-50	4200

Welding Consumables: Type, Designation		EN – ER 4043	Technique: Weaving: NO
Diameter, mm:		0.9	Inclination of the wire: 90°, 20° (pull)
Gas / Flux: Gas type		EN ISO 14175: I1 - 100%Ar	Post Weld Heat Treatment: -
Gas Flow Rate		12 - 14 l/min	Stick-out: 12-14 mm
Details of Back Gouging/Backing:		NO	

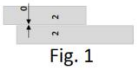


Fig. 1


Fig. 2

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	

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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

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

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

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.