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Practical learning at remote in the transport sector

Result 4: A handbook for the independent learning of the main work tasks of a truck and bus driver as a distance and online implementation, as well as recommendations for vocational schools in the transport sector to digitize training in the field

Content

1. Introduction

In the PraLe project the focus was on development of materials that support distant learning of truck and bus drivers. Although the idea of the project was proposed and accepted at the period of COVID-19 pandemia, the applicability of proposed materials and methods is not conditioned by presence of extraordinary circumstances, like pandemia.

The first step was identification of core theoretical and practical competencies being a subject of training of – separately – truck drivers and bus drivers. Next, a survey research was carried out to investigate how - during the pandemic – the training providers coped with carrying out of the training. The main two phases of training were covered, i.e. learning (knowledge acquisition) and assessment (verification of trainees' knowledge). Respondents answered whether distance learning and assessment were used, which competences they covered, what ICT solutions were applied, or why distance learning and assessment was not used (reasons to postpone). As regards solutions used for distance training – the learning phase, the following were considered (included in the questions):

- Learning with live lessons through distant video solutions with active teacher.
- Learning with recorded lessons.
- Learning with non-interactive digital materials.
- Learning with interactive platforms/software with feedback from the teacher.
- Learning with interactive platforms/software with automatic (robot) feedback.
- Learning with simulating software.
- Learning with Virtual Reality (VR)
- Learning with Augmented Reality (AR).

The following solutions used for distance training – the assessment phase were considered (included in the questions):

- Assessment through distant video solutions with active assessor
- Assessment with recorded videos
- Assessment with non-interactive digital materials
- Assessment with interactive platforms software
- Assessment with Simulating software
- Assessment with Virtual Reality (VR)
- Assessment with Augmented Reality (AR)

Respondents could also report on other solutions used for the distance training.

The survey questionnaire was prepared in 5 languages: Finnish, Polish, Dutch, French and English, and was distributed (link to it) to organizations that provide training in the transport sector, in project partners' countries (Finland, Belgium, Poland).

The next step was analysis, what ICT-based materials and related learning methods can be proposed for distance learning of particular core competencies. In this research a specially prepared matrix was used. Based on the results, decisions were taken, for which core competencies training materials will be developed by the project partners.

2. Training of professional truck drivers and bus drivers

2.1. Core competencies related to the truck and bus driver profession

The following theoretical and practical competencies are covered by training of professional truck drivers and bus drivers:

1. **Theoretical** core competences of **truck drivers**:
   - Traffic regulations
   - Theoretical principles of ecodriving and defensive driving
   - Loading / Unloading
   - Load securing
   - Regulation on driving- and resting times and tachograph
   - Knowledge on behaviour in case of accident
   - Knowledge on ergonomic principles
   - Knowledge of the basic technical principles of the vehicle
2. **Practical** core competences of **truck drivers**:
   - Preliminary inspection of the vehicle
   - Understanding and handling the dashboard
   - Loading / Unloading
   - Load securing
   - Handling the digital tachograph
   - Basic vehicle manoeuvres
   - Riding on public roads
   - Applying principles of eco- and defensive drive
   - Behaviour in case of an accident
   - Applying ergonomic principles
   - Filling in legal transport documents
3. **Theoretical** core competences of **bus drivers**:
   - Traffic regulations
   - Theoretical principles of ecodriving and defensive driving
   - Regulation on driving- and resting times and tachograph
   - Knowledge on behaviour in case of accident
   - Knowledge on ergonomic principles
   - Knowledge of the basic technical principles of the vehicle
   - Handling luggage
   - Passenger safety
   - Communication skills (with customers, management and maintenance)
4. **Practical** core competences of **bus drivers**:
   - Preliminary inspection of the vehicle
   - Understanding and handling the dashboard
   - Handling the digital tachograph
   - Basic vehicle manoeuvres
   - Riding on public roads
   - Applying principles of eco- and defensive drive
   - Behaviour in case of an accident
   - Applying ergonomic principles
   - Communication skills
   - Handling luggage
   - Filling in legal transport documents

2.2. Distant training in the truck and bus driver profession – during pandemic period

COVID-19 pandemic strongly affected education and training, which manifested in a varied way. This depended among others on the nature of knowledge and skills being a subject of teaching, possibilities and

limitations of E&T units, abilities and capabilities of teachers/trainers and students/trainees, and legal background that also shaped possibilities and limitations. Some insight to the situation was brought by the survey carried out within the project. Further, the main findings are mentioned.

2.2.1. Learning phase

Theoretical competencies.

In each partner's country, i.e. Belgium, Finland, Poland, necessity to postpone the training varied, depending on the competencies. In Poland the problem appeared to be the least significant and most training could continue. In Belgium, on the other hand, almost for all competencies more than half of the training courses could not be given remotely and were therefore postponed. Deeper analysis brings conclusions that the theoretical training of those competences that have a very direct link to practical training were given least remotely. These include subjects such as load securing, loading itself, luggage handling, etc.

In Finland, where many theoretical training courses could continue, the main reason for postponement was the fact that distant solutions were not suitable for theoretical training. In fact, this was the main reason in every country. By contrast, in Belgium, where distant training was least present, several other reasons were indicated. In particular, for training of truck drivers it was firmly indicated that distance learning is not formally accepted/allowed and is also too expensive.

Regarding the training in theoretical competencies that was carried out in distance mode, in all countries, the main/most popular solution used were live lessons through distant video solutions. Only in Finland, virtual reality technology was also used for some training. In most countries, training platforms where feedback from a trainer was provided were also used. Detailed data regarding ICT solutions applied for distance teaching of theoretical competencies in particular countries are provided in the table below.

ICT solutions applicable for distance learning	Belgium (%) [TRUCK/BUS]	Poland (%) [TRUCK/BUS]	Finland (%) [TRUCK/BUS]
Learning with live lessons through distant video solutions	40/89	67/86	92/100
Learning with recorded lessons	20/22	33/29	17/14
Learning with non-interactive digital materials	0/56	33/43	58/71
Learning with interactive platforms software with feedback from the teacher	60/33	33/43	33/29
Learning with interactive platforms software with automatic (robot) feedback	0/0	11/0	0/0
Learning with Simulating software	0/11	22/14	8/14
Learning with Virtual Reality (VR)	0/0	0/0	17/29
Learning with Augmented Reality (AR)	0/0	0/0	0/0

Practical competencies.

In Belgium, distance learning in practical competencies – both in case of bus drivers and truck drivers – was not carried out. Similarly, in Finland, an overwhelming majority indicated that solutions were not given in distance mode. In Poland, answers were more moderate – for truck drivers' competencies the percentage of postponed learning ranged from 22% to 44%, and for bus drivers' competencies this percentage ranged from 0 to 29%. In all countries, as the main reason for not carrying out distance teaching in practical competencies was that this learning mode was not suitable. A large number of respondents also indicated that no proper/applicable solutions were available.

As regards use of ICT for distance training, most popular appear to be live lessons delivered via remote video applications. In addition, simulating software is also used in some cases. Again, Finland is the only country where the survey indicated that virtual reality applications are also used.

Detailed data regarding ICT solutions applied for distance teaching of practical competencies in particular countries are provided in the table below. In Belgium all the training in practical competencies was postponed.

ICT solutions applicable for distance learning	Belgium (%) [TRUCK/BUS]	Poland (%) [TRUCK/BUS]	Finland (%) [TRUCK/BUS]
Learning with live lessons through distant video solutions	0/0	63/71	82/100
Learning with recorded lessons	0/0	25/29	18/40
Learning with non-interactive digital materials	0/0	38/29	55/100
Learning with interactive platforms software with feedback from the teacher	0/0	25/14	18/40
Learning with interactive platforms software with automatic (robot) feedback	0/0	25/14	9/0
Learning with Simulating software	0/0	25/29	18/20
Learning with Virtual Reality (VR)	0/0	0/0	18/40
Learning with Augmented Reality (AR)	0/0	0/0	0/0

2.2.2. Assessment phase

Theoretical competencies.

In Belgium in the training of truck drivers, no assessment of theoretical competencies was carried out in distance mode, and almost all assessment was postponed in case of bus drivers. In Poland all the assessment could be carried out in distance mode, and in Finland this varied depending on the competence.

For Belgium, for assessment of theoretical competencies of truck drivers and bus drivers, 50% and 45% respondents respectively indicated that this is just not allowed. However also lack of proper solutions was also indicated as important factor that makes such distance assessment impossible. In Finland, distance mode was indicated as unsuitable for this purpose in training of truck drivers and bus drivers – by 89% and 75% of respondents, respectively.

In Poland assessment in distance mode was carried out with use of distant video solutions with active assessor, assessment with recorded videos and assessment with non-interactive digital materials – both in truck drivers and bus drivers training. These solutions and assessment with interactive platforms software were used in Belgium, in bus drivers training. As regards Finland, among all the ICT solutions considered, assessment with recorded video and assessment with AR was not applied at all, and assessment with interactive platforms software was not applied in training of bus drivers. Details are presented in the table below

ICT solutions applicable for distance assessment	Belgium (%) [TRUCK/BUS]	Poland (%) [TRUCK/BUS]	Finland (%) [TRUCK/BUS]
Assessment through distant video solutions with active assessor	0/100	100/100	71/75
Assessment with recorded videos	0/100	100/100	0/0
Assessment with non-interactive digital materials	0/100	100/100	57/50
Assessment with interactive platforms software	0/100	0/0	29/0
Assessment with Simulating software	0/0	0/0	14/25
Assessment with Virtual Reality (VR)	0/0	0/0	14/25
Assessment with Augmented Reality (AR)	0/0	0/0	0/0

Practical competencies.

In Belgium no assessment of practical competencies was carried out in distance mode. In Poland all the assessment could be carried out in distance mode, and in Finland this varied depending on the competence, however generally application of distance assessment was lower.

Respondents from Belgium (50% of them) indicated that distance assessment was not allowed. Additionally, they (70%) underlined lack of proper solutions and that (63%) distance mode is not suitable for the assessment of practical competencies. The later one was also indicated by approx. 90% of the Finnish respondents, and 22% of them indicated lack of suitable solutions.

In Poland assessment in distance mode was carried out with use of distant video solutions with active assessor, assessment with recorded videos and assessment with non-interactive digital materials – both in truck drivers and bus drivers training. In Finland Assessment with recorded videos and with AR was not used at all. Details are presented in the table below.

ICT solutions applicable for distance assessment	Belgium (%) [TRUCK/BUS]	Poland (%) [TRUCK/BUS]	Finland (%) [TRUCK/BUS]
Assessment through distant video solutions with active assessor	0/0	100/100	50/50
Assessment with recorded videos	0/0	100/100	0/0
Assessment with non-interactive digital materials	0/0	100/100	50/50
Assessment with interactive platforms software	0/0	0/0	50/0
Assessment with Simulating software	0/0	0/0	25/50
Assessment with Virtual Reality (VR)	0/0	0/0	25/50
Assessment with Augmented Reality (AR)	0/0	0/0	0/0

2.2.3. Conclusions

The collected answers revealed that both learning and assessment in distance mode was possible to apply in training of truck drivers and bus drivers, during the pandemic. Taking into account general progress in integration ICT in training/courses that happened due to the COVID-19 pandemic, we can assume that the reasons indicated by the respondents as barriers to apply the distance mode are no more so strong as they were. We can expect that both trainers and students are more open and more capable to carry out/undergo distance learning and assessment than they we were during the lockdowns, and this openness and capabilities will continuously increase.

3. ICT solutions for distance and on-line-learning to enable independent learning of core competencies in the transport sector - recommendations

To establish what types of ICT solutions are recommended for distance training of truck drivers and bus drivers, a special matrix has been developed. For each competence, topics it is consisted of were identified. Scores that indicate how well particular ICT solutions match particular topics (learning of them) were assigned by a group of trainers in units providing training of truck drivers and bus drivers. For each topic, depending on the considered relevance/applicability of ICT solutions, numbers from 1 (meaning the highest score) to 5 could be assigned. If a given ICT solution was not taken into account, no number was assigned. The assessment was carried out separately in Belgium, Finland and Poland.

To make the matrix most clear for the trainers, each of the core competences has been divided smaller entities – topics that a given competence encompasses. Additionally, a short explanation about ICT solutions listed in the matrix was provided – see the table *Remote technologies selection*, below. The further two tables show the summing up of data collected via the matrix – first for remote learning for bus drivers and next – for truck drivers.

Table. Remote technologies selection

Technique	Description	Examples
Learning with live lessons through distant video solutions with active teacher	Students at home, connect to remote online telco from their PC or mobile, see and hear the teacher, comments	Teams, Zoom, Webex, Hangouts
Learning with recorded lessons	Students at home, watch standard videos from their PC or mobile teachers instructs	Vimeo, YouTube
Learning with non-interactive digital materials	Students at home access traditional, albeit digital, learning materials via web pages or MS Office like tools. Text, photos.	web pages, PowerPoint
Learning with interactive platforms, software with feedback from the teacher	Students use learning platforms where they can study and complete (or retrieve and return) exercises which are evaluated by teachers.	Moodle
Learning with interactive platforms, software with automatic (robot) feedback	Students use learning platforms to study and complete exercises that are instantly evaluated by the platform. Can be used for both exercises and tests.	Ville, Quizlet
360 media (photos & videos)	360 (mono or stereo) Images and videos taken from the training site added with additional information such as text, normal photos. Or 360 videos taken from the training site showing the procedure with audio. Students view with their own PC or mobile device through web pages or students view with VR glasses.	CTRL Training 360, Thinglink
3D Environments with animated contents, non-interactive / 2D or VR	A 3D modelled environment with animations. Students can use their own PC or mobile for a 2D view to the environment. Students use VR glasses to view the 3D content or students use VR glasses to view the 3D content.	Matterport
Learning with Simulating software	A separate software for simulating certain task. Students can use on their own PC or mobile,	
Simulated excercises in VR	A hands-on exercise created for specific task includes the 3D environment and practical tasks. Used with VR glasses and controllers.	Bus pre-inspection (created by CTRL to TTS)
Simulated excercises in VR with remote teacher	A hands-on exercise created for specific task includes the 3D environment and practical tasks. Used with VR glasses and controllers. Teacher can join remotely as an avatar.	Tire change demo (PraLe)
Virtual classroom / 2D	Students join a virtual classroom with their own PC or mobile device. They can move in the environment and see the content. Teacher and other students as avatars.	Mozilla Hubs, Viverse, Altspace VR
Virtual classroom / VR	Students join a virtual classroom with VR glasses. They can move in the environment and see the 3D content. Teacher and other students as avatars.	Meta Horizon, Viverse, Altspace VR
Learning with Augmented Reality (AR)	Students utilize AR hardware (mobile phones, goggles) to learn.	

Table: ICT for distance learning of core competencies in the transport sector – professional bus drivers

CORE COMPETENCE	TOPIC (smaller entities of the core competences)	Software or method												
		Learning with live lessons through distant video solutions with active teacher	Learning with recorded lessons	Learning with non-interactive digital materials	Learning with interactive platforms/software with feedback from the teacher	Learning with interactive platforms/software with automatic (robot) feedback	360 media (photos & videos)	3D Environments with animated contents, non-interactive / 2D or VR	Learning with Simulating software	Simulated excercises in VR	Simulated excercises in VR with remote teacher	Virtual classroom / 2D	Virtual classroom / VR	Learning with Augmented Reality (AR)
Preliminary inspection of the vehicle	Engine inspection	3	3	3	2	2	3	2	2	9	7	5	4	3
	Vehicles body inspection	3	3	3	2	2	3	2	2	9	7	5	4	3
	Cabin inspection	3	3	3	2	2	3	2	2	9	7	5	4	3
	Electricity and start	3	3	3	2	2	3	2	2	9	7	5	4	3
Understanding and handling the dashboard	Buttons	2	3	2	2	2	4	3	3	5	2	2	2	2
	Gearswitch	2	3	3	3	3	4	3	3	7	6	3	3	3
	Meters	3	3	3	3	3	4	3	3	7	6	3	3	3
	Pedals	2	3	3	3	3	4	3	3	5	3	3	3	3
Handling the digital tachograph	Using drivers card	5	2	3	2	4	3	3	4	2	2	2	2	2
	Functions	5	2	3	2	4	3	3	4	2	2	2	2	2
	User interface	5	2	3	2	4	3	3	4	2	2	2	2	2
Basic vehicle manoeuvres	Moving vehicle	9	6	4	5	3	5	8	3	4	3	8	4	4
	lateral displacements	4	3	4	3	3	4	4	2	2	2	2	2	2
	Reversing	9	6	4	5	3	5	8	3	4	3	6	2	2
	Meander / zigzag	9	6	4	5	3	5	8	3	4	3	8	4	4
Riding on public roads	Bus lines	3	2	2	4	2	6	3	3	2	5	6	2	2
	Bus stops	3	2	2	4	2	4	3	3	2	4	5	2	2
	Using doors	5	4	4	5	3	5	5	3	2	3	5	3	3
	Depot and terminals	3	2	2	4	2	6	3	3	2	2	5	2	2
Applying principles of eco-defensive drive	Ecodrive	5	3	3	4	3	6	6	3	2	2	6	3	3
	Defensive drive	5	3	3	4	3	6	6	3	2	2	6	3	3
	Emergency braking	5	3	3	4	3	5	7	3	2	2	6	3	3
	Passenger safety	4	3	3	4	3	5	6	3	2	2	5	3	3
Behaviour in case of an accident	First aid	4	3	3	3	3	6	3	2	6	9	7	4	3
	In case of an accident	4	3	3	3	3	3	3	2	6	5	7	4	3
	Avoiding new accidents / Traffic control	4	2	3	3	3	3	3	2	6	8	7	4	3
	Passenger safety when evacuation	4	3	2	3	3	3	3	2	6	8	7	4	3
Applying ergonomic principles	Adjust seat	3	2	3	2	2	3	5	2	6	5	8	4	3
	Driving position	2	2	3	2	2	3	4	2	6	5	5	4	3
	Lifting	3	3	3	2	2	3	3	2	8	5	8	4	3
	Job maintenance	3	3	3	2	2	3	3	2	6	5	7	4	3
Communication skills (with customers, management and maintenance)	Customer service	5	5	3	3	2	4	4	2	2	2	2	2	2
	Fault reports	5	5	3	3	2	4	4	2	2	2	2	2	2
	Customer guidance	5	5	3	3	2	4	4	2	2	2	2	2	2
	Announcements	5	5	3	3	2	4	4	2	2	2	2	2	2
Handling luggage	Handling luggages	5	5	4	3	2	3	2	2	6	5	4	4	2
	Handling parcels	5	5	4	3	2	3	2	2	6	5	4	4	2
	Loading sequence	5	5	4	2	2	3	2	2	9	5	4	4	2
	Special baggage	5	5	4	2	2	3	2	2	6	5	4	4	2
Filling in legal transport documents	Freight list	3	4	2	5	2	6	2	3	2	2	2	2	2
	Crash report	3	4	2	5	2	6	2	3	2	2	2	2	2
	Border documents	3	4	2	5	2	6	2	3	2	2	2	2	2
	Waybill	3	4	2	5	2	4	2	3	2	2	2	2	2

Table: ICT for distance learning of core competencies in the transport sector – professional truck drivers

CORE COMPETENCE	TOPIC (smaller entities of the core competences)	Software or method												
		Learning with live lessons through distant video solutions with active teacher	Learning with recorded lessons	Learning with non-interactive digital materials	Learning with interactive platforms/software with feedback from the teacher	Learning with interactive platforms/software with automatic (robot) feedback	360 media (photos & videos)	3D Environments with animated contents, non-interactive / 2D or VR	Learning with Simulating software	Simulated excercises in VR	Simulated excercises in VR with remote teacher	Virtual classroom / 2D	Virtual classroom / VR	Learning with Augmented Reality (AR)
Preliminary inspection of the vehicle	Engine inspection	3	3	3	2	2	3	2	2	5	4	3	3	3
	Vehicles body inspection	3	3	3	2	2	3	2	2	5	4	3	3	3
	Trailer inspection	3	3	3	2	2	3	2	2	5	4	3	3	3
	Electricity and start	3	3	3	2	2	3	2	2	5	4	3	3	3
Understanding and handling the dashboard	Buttons	2	3	2	2	2	3	3	3	3	2	2	2	2
	Gearswitch	2	3	3	3	3	3	3	3	6	5	3	3	3
	Meters	3	3	3	3	3	3	3	3	6	5	3	3	3
	Pedals	2	3	3	3	3	3	3	3	3	3	3	3	3
Loading / Unloading	Loading cargo	3	2	3	3	3	3	2	1	4	3	6	2	2
	Using cargotools	3	2	3	3	3	3	7	1	4	3	6	2	2
	Loading order	3	2	3	3	3	3	2	1	4	3	6	2	2
Load securing	Using straps	3	2	3	3	3	3	2	1	4	5	4	2	2
	Using chains	3	2	3	3	3	3	2	1	4	5	4	2	2
	Load placement	3	2	3	3	3	3	2	1	4	5	4	2	2
	Load supporting	3	2	3	3	3	3	2	1	4	5	4	2	2
Handling the digital tachograph	Using drivers card	5	2	3	2	2	3	4	2	2	2	2	2	2
	Functions	5	2	3	2	2	3	4	2	2	2	2	2	2
	User interface	5	2	3	2	2	3	4	2	2	2	2	2	2
	Functions	5	2	3	2	2	3	4	2	2	2	2	2	2
Basic vehicle manoeuvres	Moving vehicle	5	3	4	3	3	4	4	2	5	6	4	4	4
	lateral displacements	5	3	4	3	3	4	6	2	5	6	2	2	2
	Reversing	5	3	4	3	3	4	6	2	5	6	2	2	2
	Meander	5	3	4	3	3	4	6	2	2	2	4	4	4
Riding on public roads	Low bridges and tunnels	5	6	4	4	4	4	4	2	2	2	6	3	4
	Weight restrictions	5	6	4	4	4	4	4	2	2	2	6	3	4
	Route planning	3	5	3	3	2	4	7	2	2	2	5	2	4
	Using navigator	3	5	3	3	3	3	3	3	3	3	6	3	4
Applying principles of eco-defensive drive	Ecodrive	4	6	3	3	3	7	4	2	2	2	3	3	3
	Defensive drive	4	6	3	3	3	7	4	2	2	2	3	3	3
	Emergency braking	4	6	3	3	3	5	6	2	2	2	3	3	3
	Blind angles	4	6	3	3	3	5	6	2	6	2	3	3	3
Behaviour in case of an accident	First aid	5	4	3	3	3	6	7	2	2	2	3	3	3
	Traffic control	5	4	3	3	3	3	3	2	2	2	3	3	3
	Avoiding new accidents	5	3	3	3	3	3	6	2	6	2	3	3	3
	Dangerous goods	5	4	2	3	3	3	3	2	2	2	3	3	3
Applying ergonomic principles	Adjust seat	4	3	3	2	2	3	6	2	2	2	3	3	3
	Driving position	2	2	3	2	2	4	3	2	2	2	3	3	3
	Lifting	4	4	3	2	2	3	3	2	5	2	3	3	3
	Job maintenance	4	4	3	2	2	3	3	2	2	2	3	3	3
Filling in legal transport documents	Freight list	4	3	2	2	2	4	2	2	2	2	2	2	2
	Crash report	4	3	2	2	2	4	2	2	2	2	2	2	2
	Border documents	4	3	2	2	2	4	2	2	2	2	2	2	2
	Waybill	4	3	2	2	2	2	2	2	2	2	2	2	2

4. Implementation of methods for remote learning of practical work of professional drivers

A variety of ICT-based materials can be applied for remote training of truck drivers and bus drivers. Depending on the materials a variety of hardware can be used: PC, laptop, tablet, smartphone, VR googles, VR set: VR googles + controllers. Skills/abilities to use most of them are common. As regards materials used with use of VR googles and controllers, prior training to use the devices can be necessary. Additionally, it is recommended to provide users with prior instruction how to use the particular VR-based material, e.g. how/where to move around in the particular VR scene or how to operate with the controller (e.g. point objects, grab objects). Otherwise, the effective use of the training materials might be impossible. Another important issue is cyber sickness that can be experienced by a user. Prior interview with the users on this should be carried out. In case of fresh/new VR users, they should be informed/warned about possibility to feel sick and should be asked to inform immediately if it actually takes place. As 'users' we mean here both trainees and trainers.

4.1. 360 media – photos and videos

Both 360 photos and videos enable to observe and get acquainted with places (rooms, interiors, open spaces etc.) without being physically present there. In case of video 360, you can additionally observe

everything what was happening at these places. You can view the material with different devices – a PC, laptop, tablet, smartphone or – and this gives the highest level of "being there" – with VR googles.

360 photos can be composed to form an interactive 360 panorama, in which there are active elements – hotspots that enable particular actions within the material. The most common one is moving from one 360 photo to another, thus making a virtual walk. Other ones enable to display different materials on the observed part of 360 photo, e.g. labels, descriptions, images, videos, tests, "find and click" tasks, etc. and/or play some audio. Depending on the hotspots added, an interactive 360 panorama can be use for acquisition or for verification of knowledge.

In case of interactive 360 panoramas, displaying it on a computer (PC, laptop, bigger tablet) is recommended, to make the displayed content clear/properly visible.

Possibility to see places without actual being there, and with use of commonly used equipment (VR google are an option not a requirement), makes 360 media a great tool for distant learning.

Examples of 360 media for training of drivers (produced in the PraLe project, and available for free)

Video 360: Pre-driving inspection of a truck; Select https://youtu.be/vfd7sSsDeVs or use the QR code

Video 360: Eco-defensive driving a truck; Select https://youtu.be/sKRj2eEAlfA or use the QR code

Interactive 360 Panorama for learning purposes: Operation and inspection of a truck; Select https://tinyurl.com/2nt6yuhw or use the QR code

Interactive 360 Panorama for testing purposes: Operation and inspection of a truck;
Select https://tinyurl.com/2l4k23ny or use the QR code

4.2. XR materials

XR materials developed in the project combine VR and AR. In practice this means that you run VR materials in a web browser, view it with use of VR googles and at the same time still see the real world around you. So, the “immersion” is not full, which for many persons is a great option. Therefore, you along with the VR scene at which you are present are composed into/placed in the real world, namely the place where you are physically present while working with the XR material. In the scene 3D models but also 360 image can be displayed. In the later one you can move inside in any direction (as opposed to traditional 360 panorama viewed in a browser, where your observation is done only by “moving your head”, and zoom a particular part of the image, if you wish).

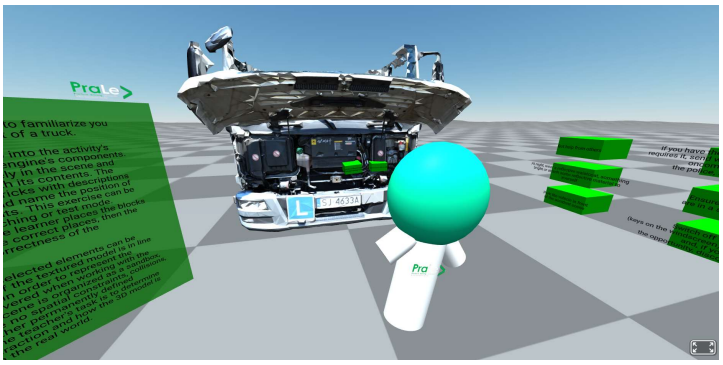
In the VR scene your activities can include observation but also practical tasks, in which you move objects.

The materials are browsed via Internet browser, so you can run them also on a computer or other device. But only use of VR googles and controllers gives possibility to effectively use these materials.

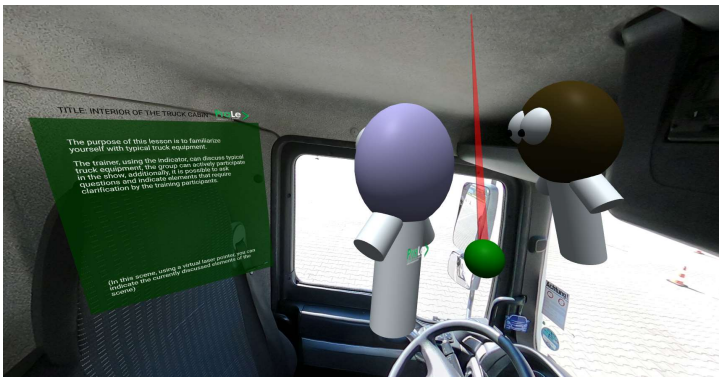
In the materials produced in PraLe project, each user present in the VR scene is reflected by their avatar. Each of them can also use a “pointer”.

Examples of XR materials (produced in the PraLe project, and available for free)

- Structure of truck engine compartment; Here your tasks is to move the labeled boxes/cubes to the right place in the engine compartment. The labels include names of components.
Select https://xr.komag.eu/prale_engine.html or use the QR code



- Interior of a truck; Select https://xr.komag.eu/prale_interior.html or use the QR code

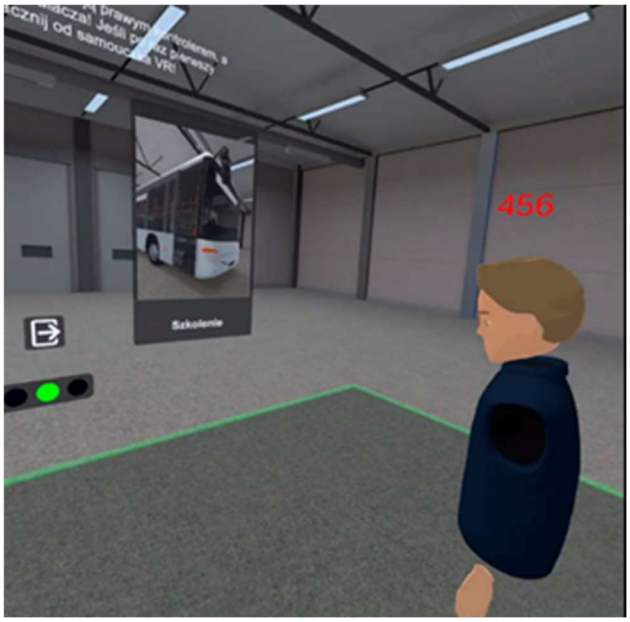


4.3. Hands-on VR training

Fully immersive VR materials are used with VR googles and controllers. A user experiences a full presence in the VR world, which means moving and interacting in the 3D scene. The main focus of the practical training scenarios built in PraLe was to research the feasibility of utilizing remote technologies in conjunction with VR to enable collaboration between teachers and students in practical, yet remote training.

An example of such material is – developed by CRTL - a training material in which a trainee, guided by a trainer, learns how to carry out a pre-drive inspection of a bus. The material can be used by users who have never used VR before, as a tutorial is included that teaches the basic VR interactions to users. The scenarios also contain information that makes it possible to use the scenarios for self-learning, as all necessary information is included in the scenarios themselves.

In a remote multiuser session, both the trainee and trainer are represented by avatars. All persons that enter the VR scene can be physically at different places, because they are connected to each other via an internet connection. In the material two main modules are available – 'tutorial' in which a user learns how to use the training material and 'training' that contains the actual training material. Tasks to be carried out are listed on a little display at user's hand. Once a given task has been completed, the item becomes checked on the list. When a user starts a training session, another user can join in as an observer. Both the trainee and the observer can see and hear each other, and the observer can remotely guide the trainee through the scenarios.



The hands-on VR training scenarios developed in the PraLe project can be accessed by following the instructions on the project web page.

5. Recommendations (Pilot test results)

All the materials developed in the project underwent pilot tests.

5.1. 360 media and XR materials for training of truck drivers

To collect feedback regarding the training materials presented in the points 4.1 and 4.2 a survey was carried out. Below, conclusions and remarks as regards particular materials are listed.

⇨ Video 360: Pre-driving inspection of a truck:

- Most respondents indicated access by means of PC
- Developed materials were easy to use and intuitive

- The materials clearly present and provide preparation for what activities the driver must carry out before starting the vehicle
- Users agree that they are prepared and able to conduct such inspection

⇨ Video 360: Eco-defensive driving a truck

- A half of respondents use a desktop computer
- The vast majority of respondents indicated that the materials clearly demonstrates the principles and prepares for defensive driving (rather agree or agree)
- Particular attention should be paid to the ability to run training materials on various types of electronic devices

⇨ Interactive 360 Panorama for learning purposes: Operation and inspection of a truck

- Majority of the responses received indicate that the materials developed are easy to use, but initial instruction is required
- More than a half of respondents agreed that the developed educational material facilitates the location of truck cabin equipment indicators and the sequence of activities to be done before driving the vehicle
- Developed materials are well suited for the use before the first contact with the vehicle and as a training support material
- ¾ respondents indicates that developed materials are above all convenient to use by means of PC

⇨ Interactive 360 Panorama for testing purposes: Operation and inspection of a truck

- Majority of respondents indicate that the materials developed are easy to use, but initial instruction is required
- Most received answers confirm that the developed materials facilitate the verification and consolidation of the acquired knowledge in the field of truck cabin equipment and its inspection
- Developed materials are convenient with the use of PC (over 60%)

⇨ XR material - interior of a truck

- For less than one third, developed material was difficult to understand when used for the first time
- The material requires an instructor before first use

⇨ XR material - structure of truck engine compartment

- This material was mostly presented in a VR system (66%)
- Most people had no previous experience with VR systems including AR mode
- Oculus VR goggles does not negatively impact users (applies to both AR and VR modes)
- Both VR and AR modes are suitable for users, however, the 33% prefer AR mode and 22% prefer VR mode
- It requires initial instruction (over 80%)
- Comments: improve graphics

5.2. Fully immersive VR material for training of bus drivers

VR materials to train to carry out preliminary inspection of a bus was used. The use of the material requires participation/presence in the VR scene of two persons at one time – a trainer and a trainee. The candidates first did the tutorial so that they could became familiar with the operation of the controllers. Those who completed the tutorial smoothly, continued participation in the tests – used the very VR material. For the candidates who were less fluent in mastering the controls, several breaks were inserted between the different parts of the testing. All participants expressed their opinions on the tested material by filling in a questionnaire.

Good points

- Using the headset and the application was perceived as quite easy by most students
- In general, trainees saw the benefits of the training, and are convinced that they could carry out the training if they had a remote teacher.

- The tutorial is perceived to be extremely useful. The controls covered in the tutorial are also known enough to start and go through the training module.
- Several participants believe that they learnt key issues from the preliminary control of the bus.
- Although it is a virtual environment, participants experience the application as realistic.
- They enjoy the training and some experience it as playful learning

Points for further consideration

- All technical elements must work optimally because it is training that uses them. If any of the elements are missing or not working optimally, the training cannot be delivered effficiently.
- If this training method is used, care must be taken to ensure that the main focus is on the learning objectives of the training and not on learning how to use the equipment.
- Some students are not open to technology applications and/or even get frustrated if they keep getting blocked due to lack of understanding or not being able to get control of the various operations in the course. For two of the candidates, the training was stopped because they indicated that they could not complete the tutorial.
- Both in the tutorial and in the training module itself, most of the objects to be manipulated highlight in green, with the exception of some elements in the training module that highlight in red. This causes confusion because incorrect manipulations are generally shown in red.
- Also, the use of the same colour of text and objects sometimes causes confusion.
- Using the menu and opening the subtasks is not practised in the tutorial, but is covered in the training. This element then has to be taught and explained during training whereas it would be better done in the tutorial.
- A message that the exercise went well at the end just like in the tutorial would be useful.