Co-funded by
the European Union

PraLe

PraLe

Practical learning at remote
in the transport sector

Result 3: Practical work task testing as an independent remote implementation with different methods

Contents

1. Introduction

The purpose of the result was to select 2-3 sets from the topics of the Road Map created in Result 2. These topics in traditional education require the use of physical space or a tool, and they are already possible to implement as distance and online learning. The core competencies of these topics were broken down into small entities and suitable technologies were sought for them. The Result 3 focused on the design, creation and piloting of these 2-3 practical training units with students. The goal was to get assurance of the effectiveness of remote and network implementation in terms of acquiring and developing competence in practical training.

The selected competences, technologies and created applications are described in Section 2.

The created practical training units were piloted together with the students and feedback collected. The piloting is described in Section 3.

Finally, conclusions and recommendations are presented in Section 4.

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

2.1. Core competences for truck drivers

For the selected core competencies of truck drivers, several available online for free materials were developed. Although they are focused on truck driver training, the idea of these materials is transferable for remote learning of bus drivers.

2.1.1. 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

2.1.2. 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).

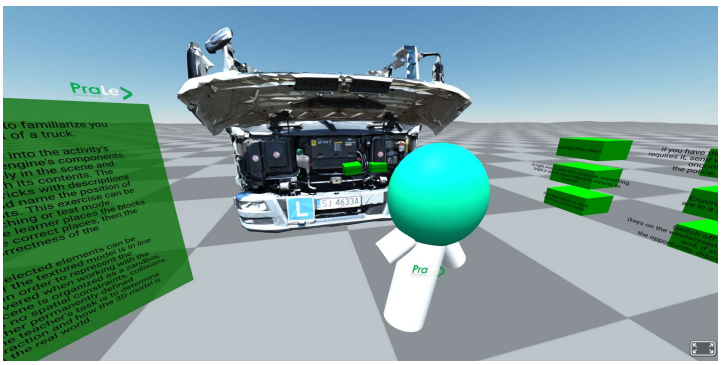
In the VR scene your activities can include observation but also practical tasks, in which you move objects.

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.

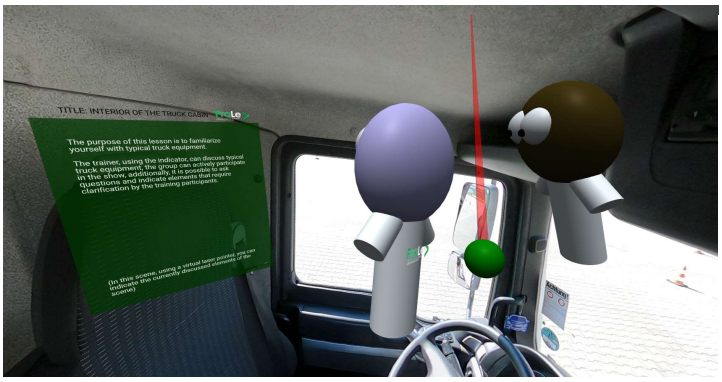
In the materials produced in PraLe project, each user present in the VR scene is reflected by their avatar. Each of them can also use a "pointer".

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



2.2. Distributed remote VR training for bus drivers

2.2.1. Introduction

Virtual reality (VR) technology has been utilized in professional training for nearly a decade, as the technology became available for the masses with the release of Oculus Rift (CV1) in 2016. The first developed VR systems (that were utilized in VR training) were all desktop PC based, due to the heavy processing power required to run VR applications. This meant that the usage of VR in professional training was limited to classroom training, or usage in special VR centers, as the cost of VR systems was very high, and they could not be easily transported from location to location when needed. Still, the usage of VR in professional training has steadily increased over the years, ever since its inception.

All was changed at the start of the global pandemic at the start of 2020, as classroom training and VR centers were suddenly forced to close. Even though the idea of VR is that users can be transported to “anywhere” by just putting a headset on, visiting virtual worlds still became impossible since the headsets were only available in locations that were inaccessible due to the pandemic. Even now, after the peak of the pandemic, it is rare for people to own VR headsets at home, making students dependent on the VR headsets provided by their training organizations. The idea of the VR application created in the PraLe project was to create an answer to these challenges and make practical training possible remotely.

2.2.2. Background

Bus driver core competences were studied extensively in the project, and one of the best targets for creating a VR training application was found to be bus pre-trip inspection training. A pre-trip inspection VR training application was already created in 2018, making practical training possible in VR. The application was in regular use in the TTS office, but like others, it became unavailable at the start of the COVID-19 pandemic. The existing application was utilized as base material for the application created, as the pre-trip inspection training procedure created for the application could be utilized in the new application as well. Although the functionality of the new application closely resembles the old application, everything was built from scratch to answer the challenges set by the project: distributed and remote use.

2.2.3. Remote presence in VR

Even when users are able to use their VR headsets at home, teachers should still be able to both teach and supervise them. This combination is only possible via a remote connection, making real time interaction between students and teachers possible. This makes it possible for teachers to both guide users through the training process, as well as supervise exams that are carried out in VR. Development of the functionality for the PraLe application was straightforward. The functionality makes it possible for teachers to see a list of all current use sessions of the application and then choose a session to join in. After joining a session, the student and the teachers can see each other as VR avatars and hear each other in real time. Since users of VR glasses cannot see the outside world, teachers can more easily help students by joining them inside VR. It becomes

easy to solve problems related to using VR hardware, as well as share knowledge related to aspects of bus pre-trip inspection that are not present in the application itself.

2.2.4. Mobile VR functionality

To make it possible to use VR elsewhere than in a classroom or a VR center, a mobile VR headset must be utilized. This requires a mobile headset compatible application. Creating mobile VR applications is usually fairly similar to creating desktop VR applications. Unless one is developing a native application, switching platforms might be as simple as selecting a different build target. However, it is never that simple in the end. The main difference is that desktop computers have much more graphical performance compared to mobile VR glasses. Although the basic functionality of an application (like locomotion, user interface etc.) might work in both a desktop and a mobile version of an application, the graphical assets used in a desktop PC application are usually incompatible with the graphical capabilities of mobile headsets. Therefore, old assets need to be heavily optimized and new, mobile ready assets need to be created. Much of the work in this project had to do with creating a simplified, lightweight 3D model of a bus that still contained all the details that are required for a bus pre-trip inspection, like the engine bay and the cockpit of the bus.

2.2.5. Conclusion

The combination of remote presence and mobile VR headsets worked as was predicted. A topic that was previously possible to practice only with a real bus and later in VR classrooms can now be practiced when and wherever, provided the students are granted access to mobile VR goggles. Making remote presence possible in VR is a relatively simple task, but making professional grade training applications that are also mobile hardware compatible can be a time consuming and resource intensive task. Based on the results of the project, it is still worth the effort, as the reusability and versatility of the resulting applications is almost endless.

Figure: Remote teacher meers with a student in the created VR application.

3. Piloting results and feedback

All the created applications presented in Section 2 were piloted with students and their teachers. The applications targeted for truck drivers were piloted in Finland and Poland, and the application targeted for

bus drivers was piloted in Belgium and Finland. The piloting arrangements are described in more detail in the following subsections.

A shared evaluation framework was designed in collaboration with all partners. It was then adjusted to the needs of different applications and piloting arrangements including translations. The questionnaires are provided in Annex.

3.1. Piloting result and feedback Poland

3.1.1. Background information

The following software has been tested:

- The following software has been tested:
    - 360 video on pre-driving truck inspection advisory application
    - 360 video on defensive driving
    - 360 panorama tour – instruction on vehicle operation and control
    - 360 panorama on vehicle operation and control – verification of trainees' knowledge
    - Panoramic 360 images inside the vehicle cabin – viewed on VR goggles
    - VR material – identification of components in the engine compartment of a truck ("cubes")
- Hardware: VR OCULUS Quest 2 goggles (two items), laptop, projector
- Place: CARGO Group, Karola Darwina 17, 43-603 Jaworzno, Poland
- Dates:
    - 10.10.2023 – Test preparation visit
    - 13.10.2023 – Pilot test
- 20 persons participated in the testing

As part of the pilot tests, driving instructors took part. These were professionals who train primarily professional drivers, driving trucks and buses. The second group of people testing the proposed tool solutions were participants of the truck driving course, and administrative staff involved in organising training courses.

3.1.2. Results and feedback

Overall, the piloting should be considered as a success. It was presented the main principles of the project and made people who deal with the training process on a daily basis (in a traditional way) aware of the fact that tools are available that enable practical distance learning to a considerable extent.

Each time you present this type of tools, you should pay attention to maintaining the interest of people participating in the pilot. For this reason, the size of individual groups should not exceed 2-3 people.

It seems that surveys should also include information related to the age range of people who test such software tools. This would allow for an additional correlation between a person's age and his or her assessment of new hardware and software solutions. There is no such question in the current version of the survey.

It should be taken into account that training conducted using the oculus system requires a sufficiently large free space in the room. Moreover, in the case of people who have never used this type of devices, each time before starting the actual training, an initial instruction in the use of the VR system should be provided. In order to conduct the training effectively and efficiently, it is also advisable to make the current preview from the VR goggles available to other training participants.

Most participants responded positively to the training using the VR system. It has been observed that this type of system is practically not used by those who purchased it for private purposes. This caused some concerns before the first use, which disappeared after the initial training.

Surveys were received and made available in a traditional way. Then, on their basis, their digital equivalents were created in the Google Forms software tool, which has useful functions for analyzing the obtained survey results.

The assumption that test groups should not exceed 3 people was confirmed. This is due to the fact that the average time that should be devoted to one student is 5-10 minutes, so in the case of a larger number of participants, the others will be bored and will not be focused on what we want to convey to them.

3.1.3. Findings and analysis:

All the materials developed in the project underwent pilot tests. Here, feedback from testers/trial users has been collected. The survey questionnaire used in tests of 360 media and XR materials (see Section 2.1) is provided in Annex. 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)

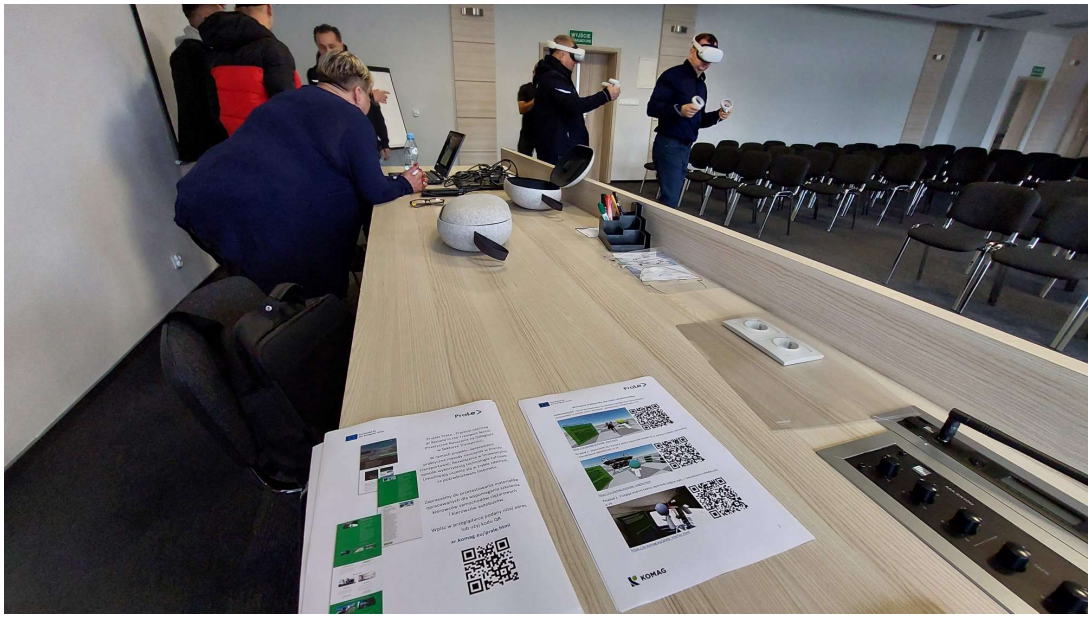
- Both VR and AR modes are suitable for users, however, the 33% prefer AR mode and 22% prefer VR mode
- It requires initial instruction (over 80%)
- Comments: improve graphics

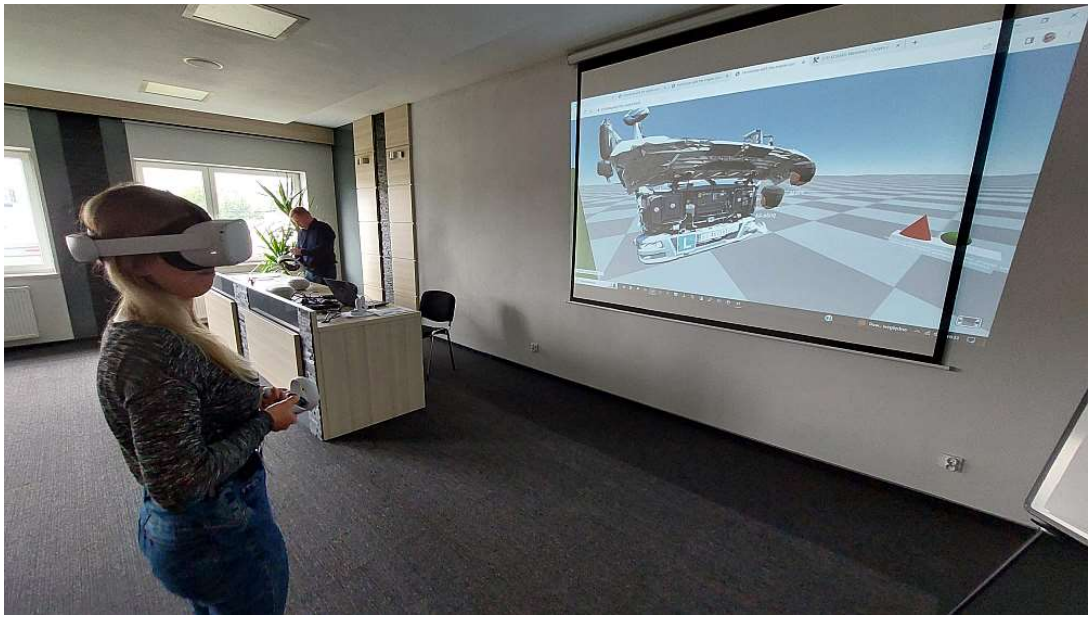
As a suggestion for improvement, in order to conduct the training efficiently and document it correctly, it is recommended that three trainers should participate.

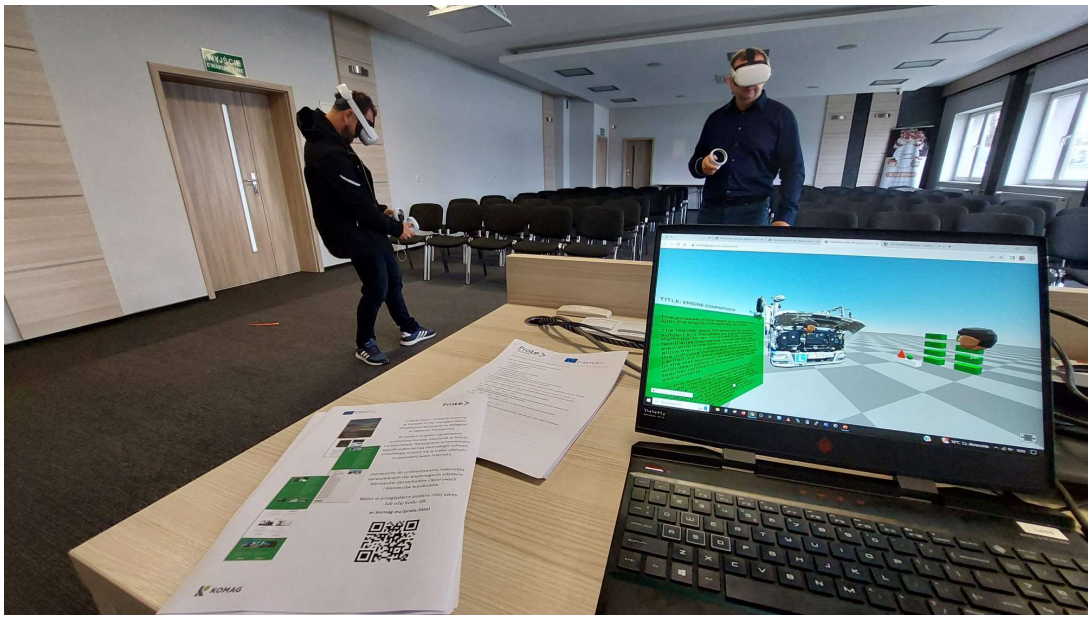
3.1.4. Pictures

Test preparation visit

Pilot test







3.2. Piloting result and feedback Belgium

3.2.1. Background information

FCBO is a training institute for bus and coach drivers. It is mainly active in the mandatory periodic training of bus and coach drivers in Belgium. For the initial training to obtain the driving licence D and professional competence, FCBO works through the sectoral Social Fund together with external partners, VDAB in Flanders, Forem in Wallonia and Bruxelles formation in Brussels.

Within this project, FCBO tested the application developed by its partner CTRL Reality with regard to the prliminary controls of the bus. This application uses 2 headsets metaquest, one for the student and one for the instructor.

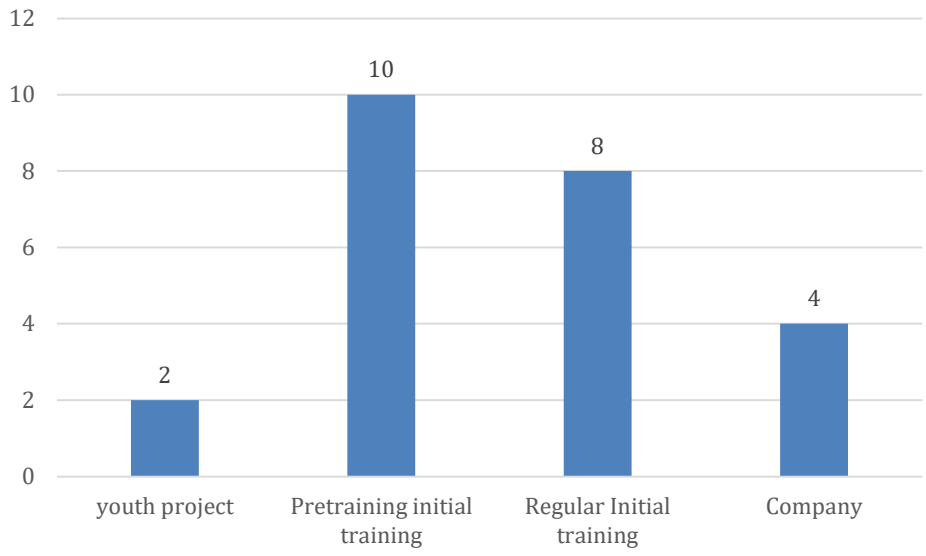
The tests ran from August 22 to November 17, 2023. The participants are students in intitial training in various channels:

- Unemployed jobseekers attending initial training at VDAB. This group included candidates who were non-native speakers.
- Unemployed jobseekers who have a big distance from the labour market in terms of general competences and who undergo preliminary training before entering VDAB's regular initial training. This group also included candidates who were non-native speakers.
- Young people (under 26 years old)who receive their initial training through a specific youth project
- Candidate drivers taking their training within a company

A total of 24 candidates from the above groups participated in the testing. Two of them stopped during the first testing, mainly because they had a very difficult time with the controls and no learning curve took place with them during the testing either.

The testing was done in a one-to-one setup. Several testings took place on a day when the candidate also had a first driving experience with a bus on a high-end driving simulator. The candidates first did the tutorial so that they could became familiar with the operation of the controllers. Those who completed the tutorial smoothly answered the first questionnaire and started the preliminary control of the bus immediately afterwards. Afterwards, they completed the second questionnaire. For the candidates who were less fluent in mastering the controls, several breaks were inserted between the different parts of the testing.

Below is the graph showing the distribution of students according to the training channel:



3.2.2. Results and feedback

A positive aspect of the testing is, first of all, that the candidates who took part in the testing came from different backgrounds both in experience with new technologies, age and language. We worked through 4 training channels as mentioned above. This also allowed us to work together with 4 different external training partners, namely VDAB (unemployed job seekers), ASAP Event (pre-training), Waaslandia and Autobus Penning (companies) and the sectoral Social Fund (youth project).

The partners were also enthusiastic to participate. They are all professional partners in training and are interested in new technologies they can use in that training, especially in the context of the ever-increasing necessary influx of new drivers in Belgium due to the ageing of active bus drivers. An increase in training capacity through quality training methods is therefore important.

The instructors themselves were also initially curious and a bit cautious at first, but after a first introduction to the tool, they were generally very enthusiastic.

As the candidates generally had very little experience with virtual reality technology and were therefore somewhat insecure, it was an advantage that the testing was done individually which meant there was no peer pressure.

It is extremely important that the instructor knows the application thoroughly. If not, the course risks being diluted by technical problems or by not being able to respond adequately to specific situations or questions from the student during the course. From a technical point of view, a stable internet connection is indispensable. The headsets lose battery capacity quickly during intensive use, even in the case of the headsets used during testing that had an extra battery.

During some tests, there was no access to the trainer function, so the trainer could not access the training session remotely. In that case, the casting of the training session in which the student was located had to be used and oral instructues could only be given on that basis. This significantly complicated the training session. As testings were taken with the instructor function and testings without it, the importance of the instructor's presence became clear. The learning process within the testings with the instructor function was smoother and faster. The visual cues together with the verbal instructions play a crucial role here.

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 of interest

- 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.

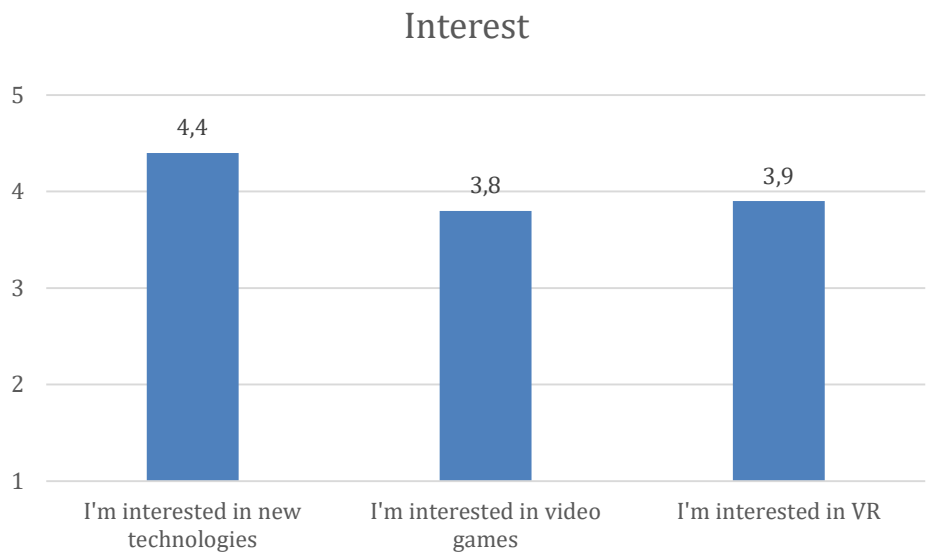
3.2.3. Findings and analysis:

Participants completed an initial questionnaire after using the tutorial. This assessed:

- Participants' interest in VR/AR applications or video games.
- Using the VR application
- Communicating with the teacher

The results below give an average score ranging from 1 (totally disagree) to 5 (totally agree).

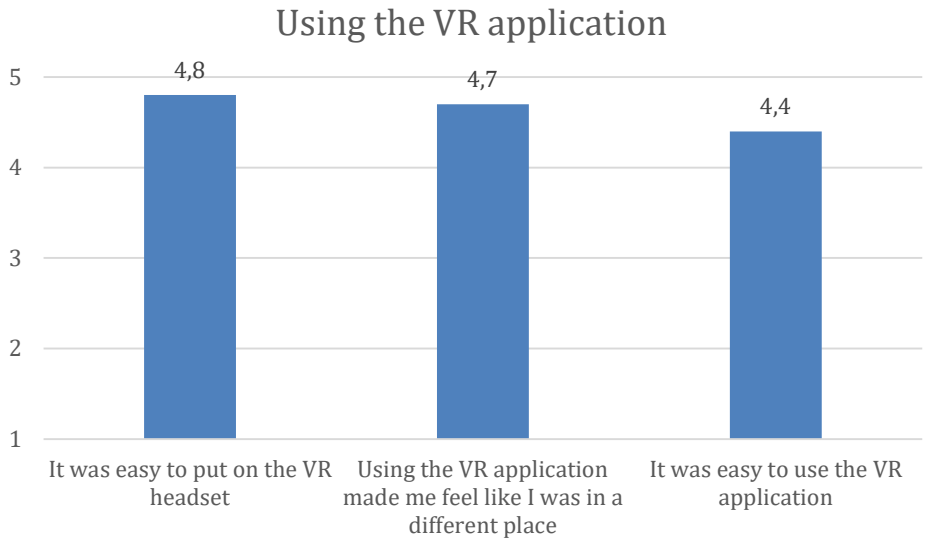
Participants' interest in VR/AR applications or video games:



The graph above indicates that there was a strong interest in new technologies and less pronounced interest in VR and video games among participants. This is possibly explained by the fact that the latter two are more associated with gaming and less with professional activities. This may be due to the age of the participants.

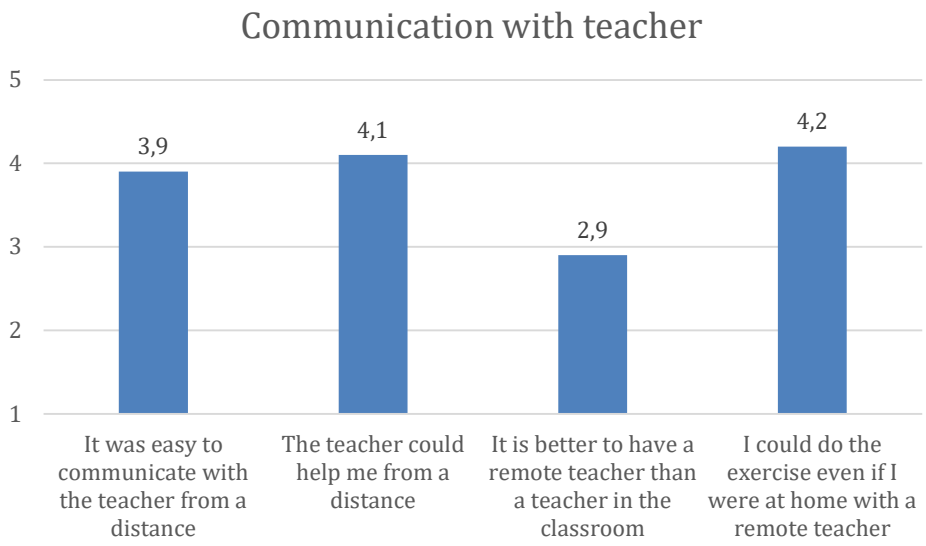
Using the VR application

In terms of overall use of the VR application and equipment, high scores were noted meaning that participants had little or no difficulty putting on the VR headset and using the application. Moreover, they reported that they felt they were effectively in a different environment.



Communication with the teacher

In general, participants are convinced that a remote tutor is sufficient to get good training. Nevertheless, some participants still prefer a classroom trainer. This result is possibly explained by the fact that technical problems occurred in some of the tests, making the physical presence of the trainer suddenly important.



A second questionnaire was then completed by the participants after the training.

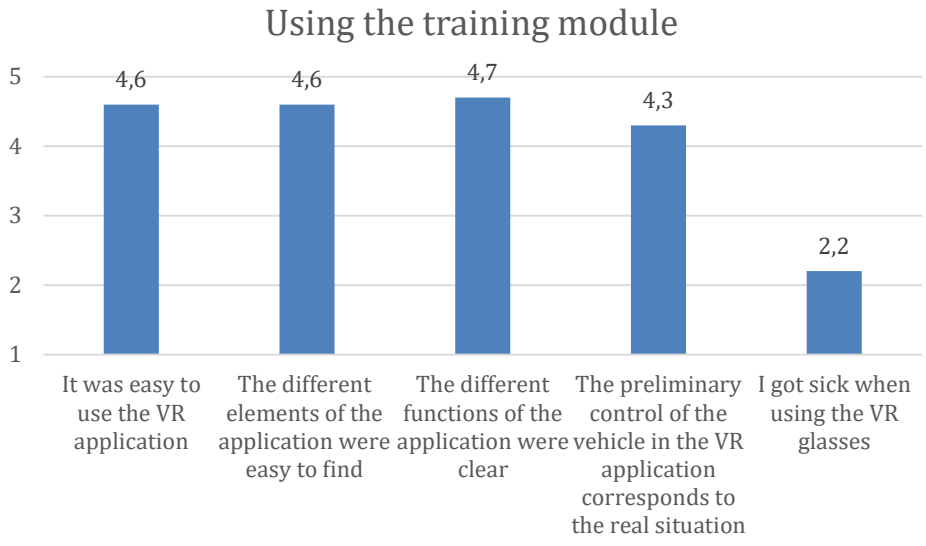
Again, the result of responses to this questionnaire is represented by an average score of 1 to 5.

This second questionnaire covered the following elements:

- Using the training module
- The instructions
- The Learning Process
- Practising

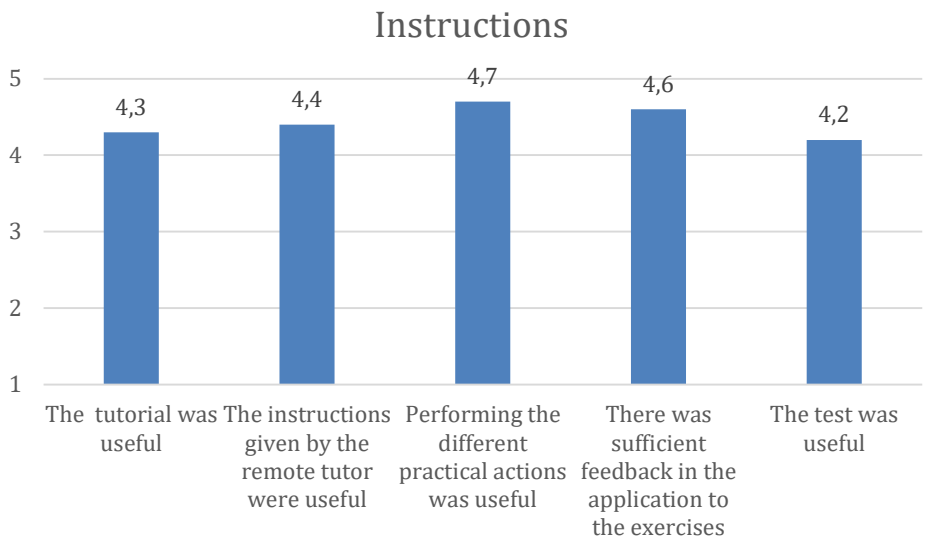
Using the training module

Overall, participants found the training module easy to use. The menus of the different parts of the training were clear. The function of the watch was also evaluated positively. People also found the module very realistic. Only a few participants felt uncomfortable during or after using the VR glasses.



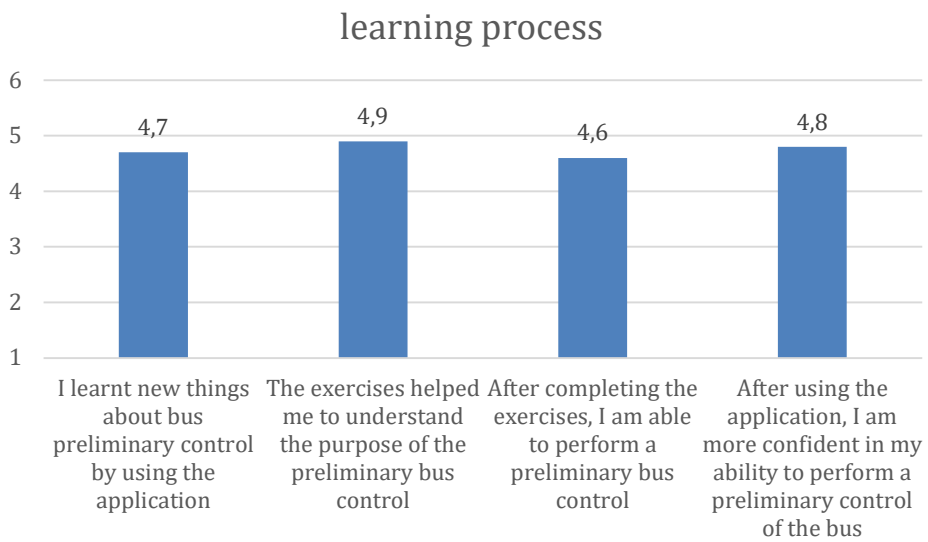
The instructions

Participants felt that sufficient instructions were given and that they were also clear and helped with training.



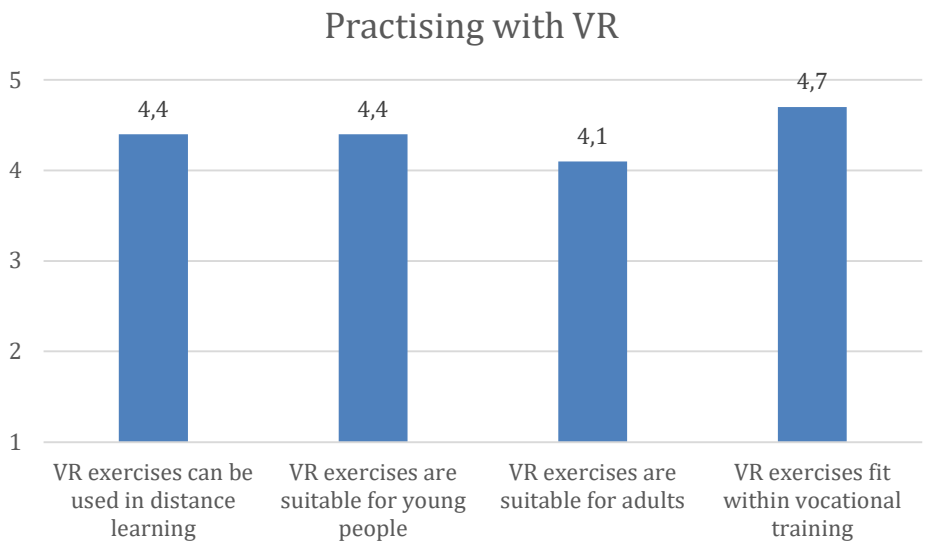
The learning process.

After the training, the general tenor of the participants was that they had acquired new useful skills. They also expressed confidence that they would be able to apply what they had learned in practice.



Practicing with VR

Participants reflect that VR in vocational training is appropriate regardless of the age of the learner and proximity to the instructor.



3.2.4. Possible other applications

In the questionnaire, trainees also gave some other possible elements that could be taught through a VR application:

- Replacing tyres
- Handling of luggage
- Dealing with passengers
- Extinguishing of fire

3.3. Piloting result and feedback Finland

3.3.1. Introduction

Testing at TTS Työtehoseura ry was carried out at the educational institution 8/2023-11/2023. The structure of the project's output was presented by Susanna Korpi.

Background information:

- Place: TTS Työtehoseura ry, Nuolikuja 6, 01760 Vantaa
- Applicatios tested: VR TRAINING Bus Pre-Trip Inspection and KOMAG Truck 360 and VR excercises
- Target group: 22 busdriver students and 20 truckdriver students, age 23-61,recruitment and/or apprenticeship training and unemployed jobseekers, 3-4 in a piloting group
- 3 vocational teachers also took part in pilots by acting as remote teacher

3.3.2. Results and feedback:

In general, students were satisfied with the VR and 360 learning environments.

About 50% of the students who took part these pilots had never tried VR exercises before, and a tutorial with a teacher was very necessary at first. Sufficient time was reserved for tutorial learning how to use the

controllers, and instructions on how to perform the actual pre-check were given with examples performed by teacher.

Students were interested in new tecnology, they found headset easy to wear and apps quite easy to learn. They found excercises useful and good way to learn. They got more confidence with pre-check and anticipatory driving skills and understanding of demands of requirements and standard of competence.

Truck excercises in AR are completely new for TTS students and teachers and they liked it a lot. It gave unique aspect to teaching by bringing the truck to the classroom.

VR and 360 environment are cost-effective and enables an alternative way of studying. TTS have some other VR and 360 exercises , but learning the pre-check with remote teacher is a new way of learning practical skills needed at work.

42 students gave feedback that was collected by Microsoft Forms with set questions and open questions.

The free-form comments were

- An interesting experiment, you can learn in different ways
- Fun and different
- The app looked great and the fact that you could actually get close to the vehicle being checked was great.
- Good visual quality
- It was very good, we learned a lot
- It helps your memory
- You could practice at your own leisure, there was no rush
- It was a nice exercise
- I was able to do it independently
- Clarity of the image
- Training is a fun way to bring the engine into the classroom for inspection
- 360 images are great for independent training and are easy to use

Some challenges were also observed

- Battery capacity
- Clearer instructions on how each button/controller works
- Moving around was difficult, using the controls difficult at first
- Not everything worked out, even though I did, eg. Inspection of straps
- Some things were not acknowledged or it was difficult to acknowledge as done
- VR glasses do not take into account human bifocal spectacles
- I don't know, the right car makes more sense in teaching
- Now all we could do was look at the engine compartment of the truck. I would like to see a huge variety of exercises for this
- I don't have my own glasses, I don't know how I could do the exercises remotely
- I couldn't do it for long, I felt bad
- It might be good if you could get closer to see
- Finnish was not spoken in the video, translations were missing
- The picture on the phone is too small, it is easier to look at pictures on the computer
- I couldn't do anything independently

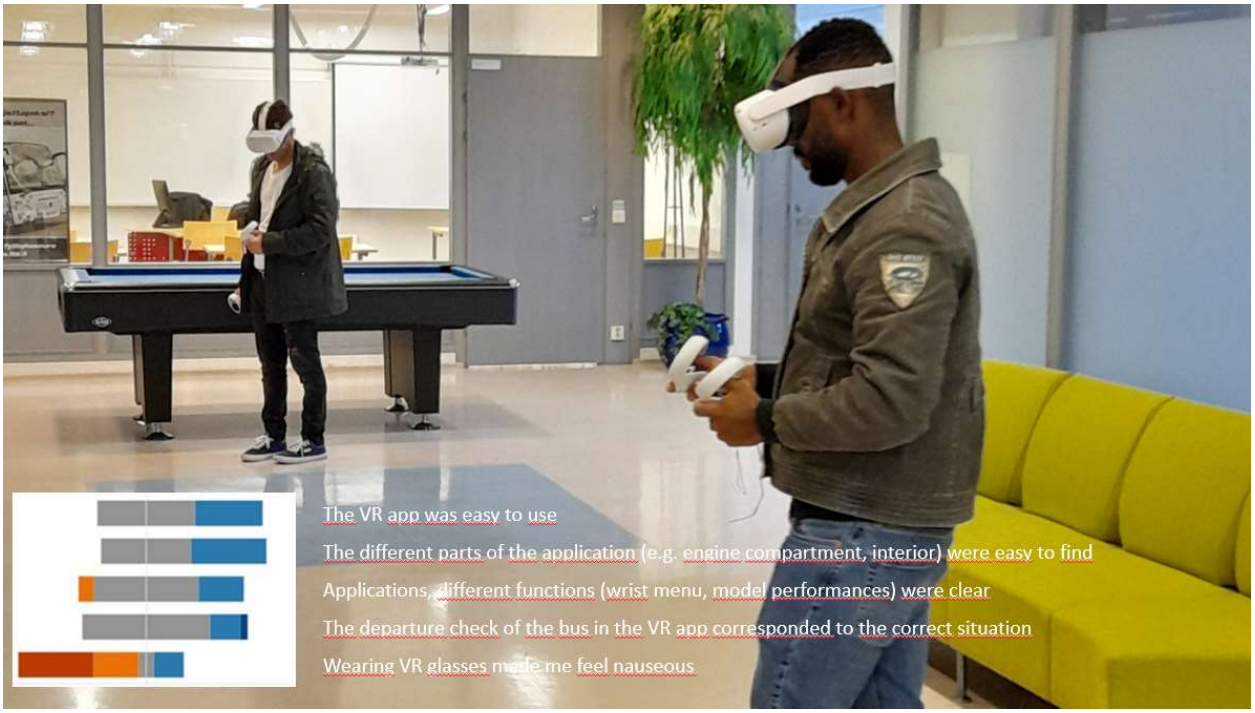
Ideas how to use VR/360 in the future

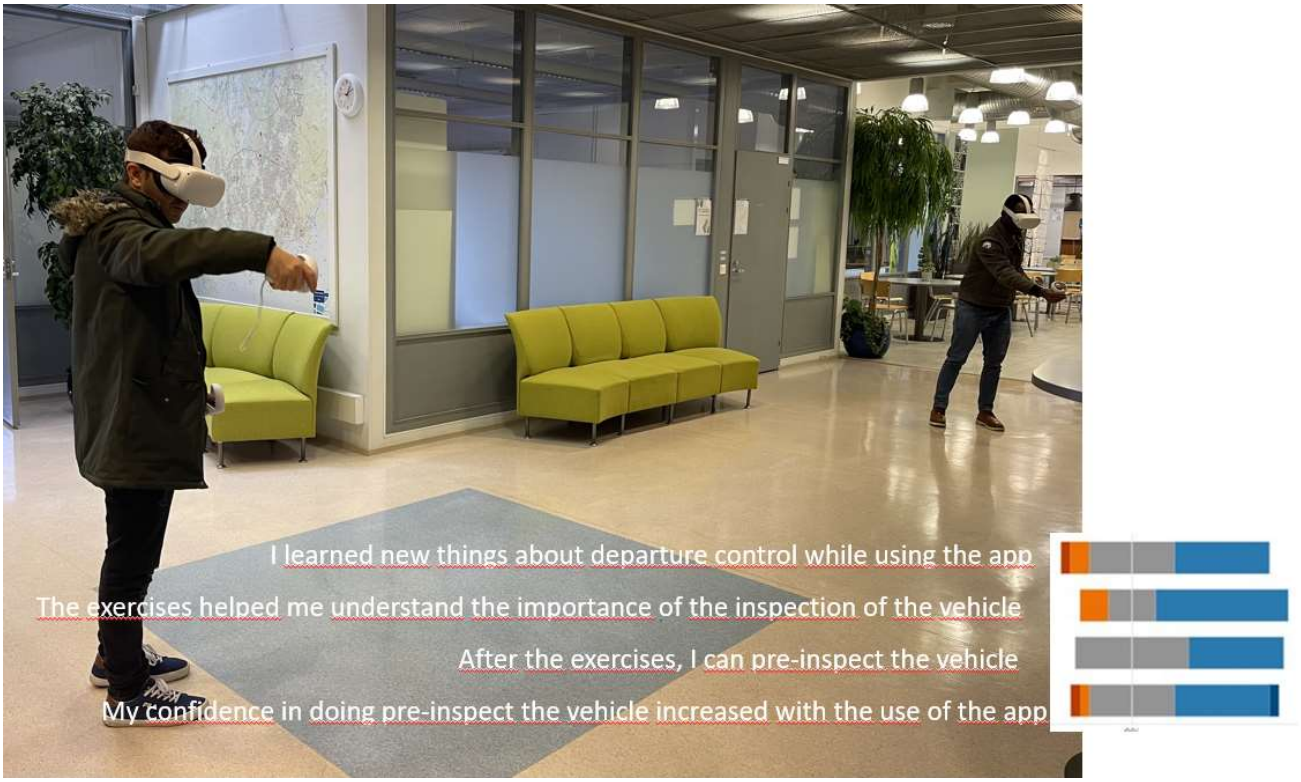
- Departure preparations/Customer service/cargo handling
- wheelchair attachment, bus stop situations with passengers
- A walkthrough of cockpit buttons and functions

- 

- What you learn without joy, you forget without sorrow

- 

- 
The VR app was easy to use
The different parts of the application (e.g. engine compartment, interior) were easy to find
Applications, different functions (wrist menu, model performances) were clear
The departure check of the bus in the VR app corresponded to the correct situation
Wearing VR glasses made me feel nauseous
- 
The saved sample performances were useful
The instructions given by the distance teacher were helpful
Practicing different activities was useful
The feedback given by the program on the exercises was sufficient
The test was useful
0%
100%

- 
I learned new things about departure control while using the app
The exercises helped me understand the importance of the inspection of the vehicle
After the exercises, I can pre-inspect the vehicle
My confidence in doing pre-inspect the vehicle increased with the use of the app

4. Conclusions and recommendations

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.

Virtual reality is a prominent technology to be used in creating the training units. The power of immersive virtual reality technology comes from 3-dimensional (3D) visualization and user experience in contrast to flat screens on computers. Immersive 3D visualization coupled with life-like hands-on interaction are the keys for creating effective solutions for remote practical training scenarios. Virtual reality has already been used successfully as part of the training in a simulator training center with fixed installations and physical support personnel. The COVID-19 pandemic closed the doors for training centers and a more distributed approach was needed. Fortunately, the recent development of VR devices (e.g. Oculus Quest 2) enables stand-alone (i.e. no computer needed) and easy to set up (no external device installations required) operation and as well as offering a lower price per unit. Even though it is not reasonable to assume that students have the devices themselves, it has become financially feasible for educational institutions to provide such equipment for the students to be used at home. In a distributed (students at home) virtual training scenario the main goals are to enable self-learning, enabling a remote connection between the teacher and students and making it possible to track and verify the progress of students. Remote connection means that teachers entering the virtual reality space can join the same virtual space where students are currently practicing and/or undertaking tests. The participants in these remote sessions can see and hear others in VR as “avatars”.

The conducted piloting shows that it is technically possible to create such remote practical training that the concept of remote teacher in VR works and benefits the learning. The received feedback points out the importance of technicalities such as network connection, the learning path to VR for students such as the tutorial and its relevance to the actual training, as well as the role of teacher who need to study the application thoroughly to be able to guide the students.

Immersive virtual reality is not the best option for all the training contents due to its requirement for VR glasses and a training scenario prepared in detail. Other technologies such as interactive 360 media and web/mobile based solutions are potential for such cases. The piloting in connection to these technologies revealed that mobile devices with small screens (ie. phones) were not seen appropriate but instead tablet and PCs were preferred. The piloting with XR devices (see through VR) received good feedback and may be a prominent technology for further study.

The teacher’s role changes in remote learning, since the students no longer share the same physical space with the teacher or with each other. This makes it necessary to closely plan how the teachers should lead the training sessions, and how each student should be introduced to remote technologies. Regarding teachers being present in training versus fully independent learning, a hybrid mode was seen as a promising one. Due to the limitations of the time for piloting only teacher present was possible to be tested, although some piloting was also done in a one-to-one setup. However, it was seen possible by the participating teachers that once the students have learned the practicalities of VR, more independent learning could take place. The applications could support this by providing both a small group mode where teachers meet several students at once, and a separate mode for independent learning where teachers can support students one by one.

Although the project was a success, some challenges were still left to be solved. These challenges are not so technical, but more so related to embracing new technologies as well as creating new ways to think about teaching. VR technology still has room to grow, but it is still ready to be utilized in a wide spectrum of topics related to practical training in the transport industry. It is the role of the teacher and the classroom that requires re-thinking in the context of new technologies. How should teaching be arranged when students can learn when- and wherever? How should teachers’ schedule be arranged to support distributed and remote practical learning? How can VR be introduced to all teachers, regardless of their level of enthusiasm related to new technologies, and how can the integration of VR training into training processes be made simpler and more straightforward?