Poster Session

Development of an interactive on-line training course for testers of plant protection equipment

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Abstract

The testing of plant protection application equipment in Finland is carried out by private testers. The system is very distributed and relies on the availability of testers around the country. In the recent years a risk of poor availability of testers around the country has been identified. To mitigate the risks more testers are needed, which means attracting new people to the business. One obstacle in attracting and recruiting new testers is the availability and accessibility to the training. Trainings are arranged at fixed times at fixed locations and can be difficult to access. There are also other challenges to training of testers. The increasing level of automation and complexity of user interfaces in sprayers requires revisiting and supplementing the training material constantly.

New digital technologies for training and education offer new possibilities to arrange trainings and present possible solutions to the challenges facing the training of testers. New e-learning technologies like Massive Open On-line Courses (MOOCS) and virtual reality environments have progressed considerably and have been employed especially during the COVID-19 outbreak.

The Finnish Chemicals and Safety Authority (TUKES), Häme University of Applied Sciences (HAMK), and Natural Resources institute Finland (Luke) explored possibilities of new e-learning technologies in arranging training for testers of plant protection application equipment. The study was carried out by identifying challenges facing the training today, deconstructing the current training course and constructing a pedagogical script for a new online training course. Available e-learning platforms and virtual reality environments was studied. From these studies a new concept for arranging training of testers was created. The objective is not to completely replace the current system but to supplement it and make the training more accessible, extendable, re-usable and more interactive.

This paper presents the proposed e-learning platform, first experiences and discussion on using such an environment.

Introduction

The testing of plant protection application equipment (PAE) in Finland is carried out by private testers. The system is very distributed and relies on the availability of testers around the country. The testers are trained and overseen by the competent authority for testing of PAE in use by the Finnish Chemicals and Safety Authority (TUKES). There is a clear demand for more testers of PAE, but the number of authorized testers has remained at around 75. Further, the geographical distribution of testers is an issue. As Finland is a large country and the testing is mostly carried out by local testers, the availability of testers in certain regions has become a problem and poses a risk of unavailability of a tester and a risk of non-tested equipment. Feedback from new testers and people considering becoming a tester has revealed that one of the reasons for the low number of testers is the availability and accessibility of the required training. Currently, the training is arranged as on-site training held once a year, every other year focusing on basics and every other focusing on specialities. This makes the training difficult to access and often the training is not available when a potential candidate is considering becoming a tester. Other feedback focuses on the geographical locations of the trainings arranged. The training requires some candidates to travel long distances and are therefore inconvenient and possibly inaccessible. There is also feedback that the training material is not available after the training and that many of the topics discussed in the training are forgotten quite soon. For the student, the training is also often passive receiving of information instead of active participation. Testers also mentioned the constant need for new information, especially related to the user interfaces of the different types of equipment.

E-Learning and distance learning has gained popularity in recent years, especially due to the COVID-19 pandemic. New distance learning technologies have emerged and become more popular. These allow immersive and interactive experiences and new ways to learn and present information. The testing of the sprayers is an activity best learned by doing and these technologies allow this approach to be experienced without the need to be physically in contact with the equipment.

To answer the need to develop the training of new testers, Finnish Safety and Chemicals Agency (TUKES), Häme University of Applied Sciences (HAMK) and Natural Resources Institute Finland (Luke) have studied and developed an online environment and course for training of new testers of PAE. This paper presents the objectives, solutions and first experiences of the online training system.

The resulting system uses a common learning management system LMS as a basis and extends it by using more immersive components and virtual reality environments. The objective of this system is to create a more accessible option for the training, increase the number of testers of PAE in Finland, improve the availability of the training material for the testers, act as a channel for additional training and material available on demand and to improve the quality of the training, both in pedagogical aspect and in terms of evenness of the content.

It was identified that the training of the testers is a more complex activity than just the training course and that the training courses serve more functions than just conveying the information from the trainer to the trainee. Therefore, the virtual training cannot replace the training activity alone. There is a need to facilitate interaction between the testers to allow for knowledge sharing and problem solving. The virtual learning environment could potentially provide a platform for communication between testers. The virtual training course offers possibilities to improve the training and the quality of the training, when implemented properly.

Material and methods

The design of the virtual training course was determined by creating a pedagogical script of the online training course, considering the testing guideline and instructions, the contents of the current training courses, student and tester feedback and the objectives of the regulating body.

A pedagogical script is a pedagogical tool used to plan and design the learning courses. The script contains learning objectives, the activities needed to reach each said objective, the materials and tools used in the activity, the desired outcome and the means for feedback and verification [1]. The technology-enhanced collaborative knowledge creation should include1) technical aspect - choosing the right technologies, 2) social aspect - how to organize collaboration, 3) epistemic aspect - how to create and process knowledge and 4) cognition aspect - how to support students' autonomy, learning and reflection [5].

To identify all the goals of the new online training course, a deconstruction of the current training courses was done. The deconstruction observed each content and activity in the current training course to identify its learning objective. Also, the feedback of the students and other testers was taken into consideration.

The outline of the online course was to cover the relevant topics of the responsibilities of the tester and the implementation of the testing scheme in Finland and how it is connected to the European scheme, safety and protection of the tester and the contents of the testing itself. In addition to the contents of the testing guideline, it was identified that the training also carried other functions. The training events also served as a place where the testers could communicate with one another, share their problems, discuss the testing methods and criterion and this way harmonize the quality of the testing activities. The trainings were also a place to acquire new knowledge about the application equipment in the field, especially about the automation systems of various makes and models and their user interfaces.

The pedagogical script described the activities, material and tools needed for reaching the pedagogical goal. Based on this, a selection of suitable digital tools can be made. To make the selection, a survey of existing technologies and tools was carried out. The study surveyed available learning management systems and virtual, augmented and mixed reality environments suitable for online learning.

Learning management systems (LMS) are computer systems that facilitate on-line course management, content, feedback and progress, and facilitate asynchronous learning. There are several systems available on the market, but the market leader is an open-source software project Moodle LMS. Moodle is widely used and is often used as a background system to other learning [3] environments. Many learning environments also integrate into Moodle LMS allowing the use of several different learning environments as a part of an integrated on-line course [4]. Moodle LMS is also already used by TUKES to facilitate various trainings and registrations, such as the training for professional users of plant protection products. It was therefore decided that Moodle LMS shall be used as the basis of the learning environment and facilitate the course material that can be in various formats. Moodle LMS allows presenting different types of learning material, such as documents, audio and video material and can be used to test the student in various ways. The LMS can also track students' progress and performance.

The pedagogical script requires several interactive and immersive sessions to be used especially in demonstrating the practical execution of the testing. This requires the use of suitable immersive technologies. Immersive technologies are technologies like virtual, mixed or augmented realities, where an environment can be created, in which information can be presented in multimedia format and which allows interaction between the student and the environment.

The testing of PAE is often learned by doing. Also, the current training course includes a practical session, where the testing is performed on a real PAE. To facilitate these, two different tools were chosen. The testing activities contain several small activities, where various systems, like the induction hopper or the tank lid are tested. There are also more complex parts, like testing of the pressure gauges, pump or homogeneity of the spray. These require different tools. A H5P system was selected for the shorter and more straight forward content. H5P integrates directly to the Moodle

LMS as a plug in. The system allows the presentation of interactive video with multimedia and presenting interactive 360 environments with multimedia.

For more complex content Wonda is utilized. Wonda is a virtual environment where 360 pictures and videos can be presented with multimedia. In Wonda learning experiences can be created by combining different scenes and transitions between those. This allows presenting more complex scenarios than H5P. Wonda also permits more complex interaction between the student and environment than H5P and makes possible to present additional multimedia more flexibly than H5P. [6]

Both virtual environments can be used using a standard office laptop/computer and mobile devices. This was essential as the analysis of the potential user profile revealed that only basic IT equipment and infrastructure can be expected of the students. These tools also allow the use of more advanced equipment such as virtual glasses. This allows using the content in several ways.

The usability and effectiveness of the developed on-line course was tested on two occasions. First test was done with agrotechnology students focusing on usefulness, clarity and learning capabilities of the platform and course. The second test of the learning platform was carried out to PAE tester candidates and experienced testers of PAE focusing on evaluation of usefulness of the platform.

Results

As a result, the project, based on an existing pedagogical script and set objectives, an on-line course and training environment was created. It consists of three main elements: Moodle LMS as a base platform for static content, H5P plugin contents for interactive content in Moodle and Wonda for immersive learning content. Static content includes mostly PDF documents and presentations about theoretical parts of training. H5P plugins are used to create interactive videos, where questionnaires are implemented inside the videos. Also 360 image based H5P content is used. In these, added information or video clips are embedded in 360 pictures of PAE in the form of points of interests (POIs).

With Wonda immersive learning platform, three interactive learning experiences were created. These are accessible through Moodle LMS. These three experiences consist of testing scenarios for pressure gauges, pump and homogeneity of spray. Wonda experiences are built on top of 360 pictures and videos. An example view on the environment is given in figure 1. In addition, the 360 pictures and videos include questionnaires to activate students and to ensure learning outcomes. It also includes different kind of interaction elements e.g., tools for navigation inside experience and user-guiding elements.

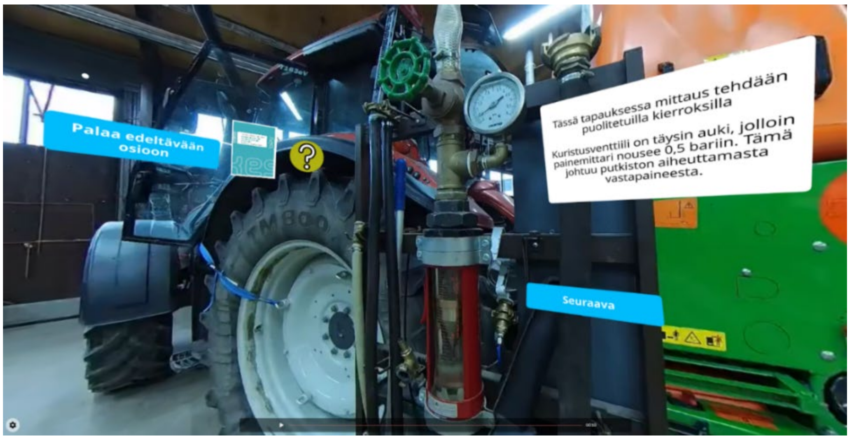

Figure 1: View on Wonda training experience on testing of a pump. In the Wonda environment the image is 360 image and the user can look around freely.

Moodle, H5P and Wonda content all make it possible to monitor student progression and evaluate the learning by grading different sections. In this case, grading was not implemented, but progression is monitored to ensure that students go through all learning objectives and related content.

During the development project, the online course was tested twice with the different target groups. First, by the agricultural technology students of HAMK in February, while development of the online course was still under progress. Course they were studying included among other things structure, principle and use of plant protection equipment. Based on this they were studying the course material and after that asked for feedback. Students were asked opinions about usefulness, clarity, learning capabilities related to online course and Immersive learning elements delivered with Wonda. This student group consisted of 12 students. In their answers students pointed out that the online course supports self-learning and it was easy to use. It also increases motivation and interests towards learning content and studying.

> “Videos and interactivity are a good addition and increase interest in studying.”

> “The platform environment enables self-learning well.”

“Pictures and videos that tell you what is being done are the best for learning. Just reading the text is numbing.”

From students’ answers was also possible to make notice that in virtual learning environment they recognized the real possibility and advantage to teach and introduce multiple different machinery, configuration and special characteristics of these, instead of just one single setting, which is usually the case in traditional training arranged in a physical learning environment.

The second data collection was done in March 2023 in the product testing training. The data collection was done in two parts; before the training and after the training (pre-post set-up). The survey was based on the Brooke’s System Usability Scale and open-ended questions. The System Usability Scale (SUS) provides a reliable tool for measuring usability. It can be used with small sample sizes with reliable results [7]. Users answered their expectations to the questionnaire before the training which was based on SUS. After the training the users answered the same SUS questionnaire. Users also answered open ended questions to supplement their experiences about the training.

The results suggest that users' expectations were met and SUS scale on pre-post setting raised up after the training on average half (0,5) scale up (scale 1-7, 1=low, 7=high). Post-questionnaire results were averaging between 4,8-5,0 and post-questionnaire results were averaging between 5,2-6,0.

The questionnaire results are presented in tables 1 and 2.

Table 1: Expectations before the training

n = 5	1 = low	2	3	4	5	6	7 = high	Average	Median
Using the application is fast.	0,0%	0,0%	0,0%	60,0%	20,0%	0,0%	20,0%	4,8	4,0
Using the application is pleasant	0,0%	0,0%	0,0%	60,0%	20,0%	0,0%	20,0%	4,8	4,0
Using the application is clear.	0,0%	0,0%	0,0%	60,0%	0,0%	20,0%	20,0%	5,0	4,0
Using the application correctly is effortless	0,0%	0,0%	0,0%	60,0%	20,0%	0,0%	20,0%	4,8	4,0
The application works flawlessly: as it should work as a result of my own actions	0,0%	0,0%	0,0%	80,0%	0,0%	20,0%	0,0%	4,4	4,0
The use of the application is easy to learn	0,0%	0,0%	0,0%	60,0%	0,0%	20,0%	20,0%	5,0	4,0
Using the application is natural.	0,0%	0,0%	0,0%	60,0%	20,0%	0,0%	20,0%	4,8	4,0
The app is useful	0,0%	0,0%	0,0%	60,0%	20,0%	0,0%	20,0%	4,8	4,0
I would use the app in the future	0,0%	0,0%	0,0%	60,0%	20,0%	0,0%	20,0%	4,8	4,0

Table 2: Experiences after the training

n = 5	1 = low	2	3	4	5	6	7 = high	Average	Median
Using the application is fast.	0,0%	0,0%	0,0%	20,0%	20,0%	40,0%	20,0%	5,6	6,0
Using the application is pleasant	0,0%	0,0%	0,0%	20,0%	20,0%	60,0%	0,0%	5,4	6,0
Using the application is clear.	0,0%	0,0%	0,0%	20,0%	40,0%	40,0%	0,0%	5,2	5,0
Using the application correctly is effortless	0,0%	0,0%	0,0%	20,0%	20,0%	40,0%	20,0%	5,6	6,0
The application works flawlessly: as it should work as a result of my own actions	0,0%	0,0%	0,0%	40,0%	20,0%	20,0%	20,0%	5,2	5,0
The use of the application is easy to learn	0,0%	0,0%	0,0%	20,0%	0,0%	40,0%	40,0%	6,0	6,0
Using the application is natural.	0,0%	0,0%	0,0%	20,0%	0,0%	60,0%	20,0%	5,8	6,0
The app is useful	0,0%	0,0%	0,0%	20,0%	0,0%	60,0%	20,0%	5,8	6,0
I would use the app in the future	0,0%	0,0%	0,0%	20,0%	0,0%	40,0%	40,0%	6,0	6,0

Open ended survey result data suggests positive experiences about the training environment. Results indicate that the environment is suitable for training and the environment gives a good overall description of the testing process. The feedback data also suggest that there’s good feedback from the questionnaires that "teach" the student during the study process. The answer also indicates uncertainty on the testing process in real-life. This means that students express the need for practical testing to supplement the training materials.

Discussion

The on-line training course provides an easily accessible option for new potential testers to train themselves. The platform allows for constant access to training, compared to previous once a year training. This type of training is equally available despite the geographical location of the student and will hopefully solve the lack of testers in remote areas. The on-line material also provides support for already authorized testers of PAE and serves as a communication platform among the testers, as well as between the testers and the authorities.

The contents of the on-line course are static in the sense that the contents of the course are the same for all of the participants. This improves the quality, but also forces the course organizer to analyse and focus on the contents and delivery of the training. Use of pedagogical tools such as the pedagogical script is very useful for realizing and planning the course contents and materials.

The resources freed from organizing annual on-site basic training, can be directed to further develop the on-line training. The platform can be supplemented with more content about different types of PAE and further by presenting different makes and models of the same types of equipment. This would strengthen the know-how of newly authorized testers and of course support the experienced testers as well.

The persistent and constant availability of the learning platform also allows extending the contents and materials presented. The environment can be used to provide additional information for the tester candidates, but also for existing testers. The differences in various PAE makes and models and the differences in their user interfaces is a constant problem for the testers. The platform could easily accommodate examples from various makes and models giving the testes a knowledge base to which they can refer.

Traditional on-site trainings have been arranged only about once a year, which leads to large group sizes in the trainings. This has made it impossible for all the participants to receive sufficient hands-on training and the trainings have mainly consisted of trainer led demonstration. The on-line course gives all students the possibility to explore the parts and functions of the PAE at their own preferred phase.

The tests done on the on-line course indicate that the users are familiar with on-line courses. The results indicate that the users were expecting the platform to be easy to use. After the use the evaluation confirmed that the expectation was met and exceeded. The self-contained instructions within the platform were sufficient for use of the system.

As the LMS keeps track of the individual student performance. The competent authority can also have feedback on the candidate's performance and have better confidence on the learning results, than with the traditional courses.

Even though the on-line course has many positive aspects. There are also other aspects that are not properly facilitated by the platform. One of these is the communication between the testers and tester candidates. This discussion is important for maintaining testing quality. It also gives the tester candidates confidence in testing and provides them with tips and best practices. Also, the testers expressed the wish to participate in live testing. It is therefore clear that the on-line training cannot be the only training provided, but the overall training scheme must contain other aspects as well.

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