

E-education in Refrigeration Technologies for Students and Technicians in the Workplace

Marnik Lenaerts

Limburg Catholic University College (KHLim)
Campus Diepenbeek, Agoralaan Gebouw B, B-3590 Diepenbeek, Belgium
marnik.lenaerts@khlime.be

Marc Schreurs

Limburg Catholic University College (KHLim)
Campus Diepenbeek, Agoralaan Gebouw B, B-3590 Diepenbeek, Belgium
marc.schreurs@khlime.be

Walter Reulens

Limburg Catholic University College (KHLim)
Campus Diepenbeek, Agoralaan Gebouw B, B-3590 Diepenbeek, Belgium
walter.reulens@khlime.be

Abstract— The demand for broadly educated engineers, installers and service technicians is growing because of the strong growth in refrigeration, air conditioning and heating. The rapid technological evolution makes it impossible for a school or training centre to invest in all HVAC and refrigeration fields. It is here that eLearning, blended learning and virtual labs provide the answer.

Students need new forms of learning where the course materials are available anytime, anywhere and are adapted to the needs and prior knowledge of each individual student. This is why in 2004 we started with the development of eLearning courses, which are all hosted on an open-source learning management system.

Six years later we have 30 interactive eLearning courses on cooling, heating and air conditioning, ranging from the basics to the latest technologies and systems. We are still developing new ones to keep up-to-date with the latest evolutions.

But education is more than just gaining theoretical knowledge. Our blended learning modules unite the theoretical and the practical aspects of education, by combining eLearning with practical sessions in our labs. Each course

participant that uses blended learning does not only benefit from the many advantages of eLearning, but can also gain practical experience this way.

By integrating eLearning in virtual reality we created virtual labs. We made 3D models of our labs complete with installations and equipment using 3D modeling software. Instead of looking at an image of an installation inside the eLearning course, a course participant can now walk around in our labs, walk up to an installation and look at real-time data from the actual installation itself. Or go into a virtual classroom and take an eLearning course.

Keywords— blended learning, education, eLearning, virtual lab

I. CLARIFICATION

First a clarification: when in this paper there is spoken of “student”, this means a learner or someone who attends an educational institution either full time or part time as his main occupation.

A “technician” is defined as a person who is not a student but comes to an educational institution for the purpose of

training. This can be an engineer, installer or service technician.

“Course participants” is the collective noun for both students and technicians.

II. eLEARNING

Education in a school is traditionally done by a teacher who stands in front of a group of students who are attending his class. This approach has both advantages and disadvantages. An advantage of this type of education is that there is a direct interaction between the students and the teacher. This makes it possible to quickly address questions and learning problems.

So why change to eLearning? The traditional approach to education targets the course participants as a group, where with eLearning it is possible to accommodate the wishes and needs of each course participant at an individual level.

A. What Is eLearning?

eLearning can be defined as a learning method which enables the transfer of knowledge and skills where the course participant can learn anytime anyplace by the use of technology (computers, networks ...)

B. Anytime Anyplace

All that is needed to attend an eLearning course is a computer with an internet and/or network connection. This makes it a very flexible method of learning.

Traditional education demands that all course participants have to be at a certain place and time to take part in the course. By using eLearning each participant can take the course where he wants, when he wants. While still be able to contact a teacher or expert for any questions or problems.

C. Adapted to the individual

Every course participant has a different amount of prior knowledge and has its own learning pace. This makes it impossible to have one single course that fits everyone perfectly.

With eLearning it is possible to give every course participant a different learning course that fits to the needs and wishes of the individual.

Because eLearning is done on a computer it is easy to receive guidance from a teacher or expert. It also let you use social networks, forums ... to discuss problems and/or experiences with other course participants.

D. Stay Up-to-Date

Because all the learning materials are accessed via a computer there is no need to have handbooks. This does not only save money and paper, but it makes it very easy to update the eLearning course with the latest technologies and evolutions. As changing a website is much quicker then reprinting a handbook.

E. Active Form of Learning

A good eLearning course always makes sure that the course participant plays an active role in the learning process. Interaction between the participant and the course can for instance be done by the use of interactive content.

An eLearning course is not made by just putting plain text on a computer screen. Use the advantages of the medium (computer) by enriching the eLearning course, and the learning experience, with moving images, video material, papers, websites, presentations, audio files, (interactive) animations ...

F. Our Experiences

The development of our first eLearning courses started in 2004 to answer the growing demand for broadly educated engineers, installers and service technicians in the fields of refrigeration, air conditioning and heating.

In the beginning people were a bit hesitant when we introduced them to this form of learning. But soon after they started using eLearning they saw the benefits of it and were all positive mainly because of the flexibility of it.

Our own studies, surveys and the use of assessment tools show that course participants who use eLearning (with the proper guidance) obtain the same amount of skills and experience in a shorter amount of time than they would if they were using traditional education.

G. Software We Use

All the content of our eLearning courses is made in Adobe Flash, as shown in Fig. 1, 2.

The main advantage of using Flash is that you can insert your rich content (animations, video materials ...) directly with the content of the course. This makes interaction very easy and flexible.

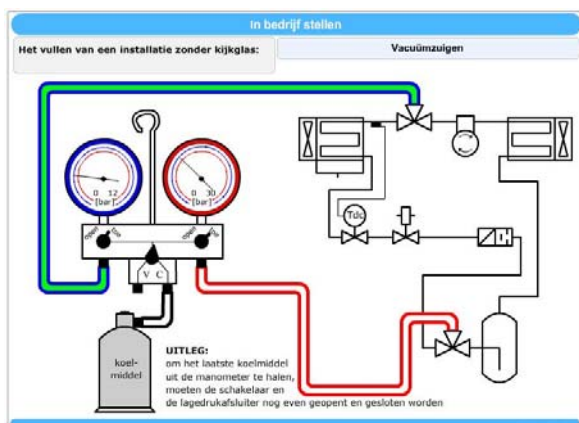


Fig.1 A screenshot of an eLearning page with rich content

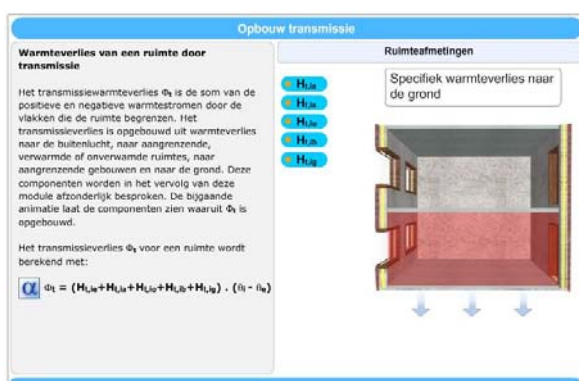


Fig.2 A screenshot of an eLearning page with rich content incorporated into the content.

For hosting the eLearning courses we use Moodle as learning management system (LMS, learning platform) [1]. Moodle is an open source web based software application

for the hosting, managing and tracking of eLearning courses.

When the content of a course is completed it is wise to convert it to a SCORM-package [2]. SCORM stands for Sharable Content Object Reference Model. It is a collection of specifications for eLearning which makes it easy to import the eLearning-course into a learning platform, or transfer it from one learning platform to another.

III. BLENDED LEARNING

To be fully educated means more than just gaining theoretical knowledge. Practical experience is also needed. This is why the development of blended learning modules started.

A blended learning module is a combination of eLearning and specific designed practical sessions in the labs of our school.

A. eLearning

When a course participant enrolls in a blended learning module he will receive a login to our learning platform. Once logged in via computer he can start learning the theoretical part of the module by means of eLearning, at his own time and pace.

B. Practical sessions

The course participant is also given a list of dates at which he is required to come to our school to participate in the practical part of the blended learning module.

During these practical sessions each course participant will get hands-on exercises specifically designed to transform his theoretical knowledge into practical experience. An example of a practical session is shown in Fig. 3.



Fig.3 An example of a practical session.

IV. VIRTUAL LABS

By combining eLearning with 3D Virtual Reality and Real-Time Data a complete virtual lab can be build [3].

A. Why

Learning from examples and simulations works good, but nothing is better than being able to work with actual real-time data from actual installations and even be able to manipulate them.

B. 3D Virtual Reality

The first step into building our virtual environment is the creation of lifelike 3D representations of the labs and classrooms in our school. This can be done by using 3D modeling software and a game development tool. Unity 3D is used as engine [4].

But a lab (virtual or real) is nothing without installations. That is why the next step is to create 3D representations of all the installations, tools, systems ... and place them in your virtual environment. Fig. 4 shows a photo of the PV-installation and Fig.

5 shows the 3D representation of it as use in the virtual lab



Fig.4 Photo of the PV-installation in our educational institution



Fig.5 Representation of the PV-installation in the virtual lab.

C. Real-Time Data

In order to receive real-time data all the installations need to be equipped with sensors for obtaining data and with control units if you want to be able to manipulate them.

Last thing that is needed is to build an interface that takes the data from the sensors and makes them visible in the virtual lab, as shown in Fig. 6, 7.



Fig.6 The interface to view the real-time data

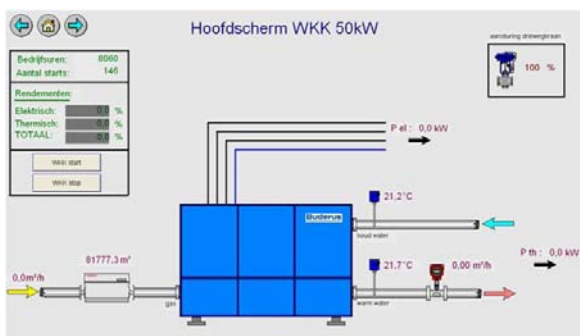


Fig.7 Screenshot of real-time data from our 50 kW CHP-installation

D. Usage

A course participant can now walk around virtually in our lab looking at the installations and interact with them. For instance by looking at the real-time data or manipulating them and see what influence it has on the data, without ever having to leave his computer.

Even walk into a (virtual) classroom can be done start or continue an eLearning course.

V. CONCLUSIONS

The possibilities of eLearning, blended learning and virtual labs are endless. They are all part of a new type of education which can add a totally new dimension to learning.

But don't think that once the content is created that your job as an educational institution is done. A good course (eLearning or in a classroom) needs proper guidance and constant updating.

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