CRAFTS ARE GETTING READY FOR NZEB – DEVELOPMENT OF E-LEARNING PLATFORM

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Abstract

Since 1 January 2020 it is prohibited to build other than nearly zero energy buildings (nZEB) in the EU countries. This introduces more stringent requirements on all professions from architects to crafts. The construction of new buildings brings higher demand for technology but also for life-long education. The information and knowledge we learned at school is hardly sufficient today, therefore CraftEdu project introduced now qualification and training scheme for nZEB. Due to the restrictions in 2020-2021 the education for the craftspeople was transformed into the fully electronic way. The goal of the paper is to introduce new method and approaches of e-learning we used in four countries. Education courses for eight selected crafts were prepared for the winter and autumn 2021. Most of them did not take place in classrooms but were performed online, using online training platform, video content, mock-ups, or a webinar form. Even in the category of craftspeople there is significant demand for e-learning courses. This significantly increased the interactivity and attractiveness of the training courses. The courses took place in the Czech Republic, Slovak Republic, Bulgaria and Austria. The e-learning showed possibility of upscaling of the training process.

Keywords

Construction industry, craftsmen, e-learning, life-long education, nZEB

JEL Classification

I25 Education and Economic Development
A29 Economic Education and Teaching of Economics: Other
P46 Consumer Economics, Health, Education and Training, Welfare, Income, Wealth, and Poverty
A33 Collective Works, Handbooks
J24 Demand and Supply of Labor, Human Capital, Skills, Occupational Choice, Labor Productivity

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Introduction

CraftEdu is a Horizon 2020 project, which aims to develop innovative qualification and training schemes for craftsmen and on-site workers in the field of energy efficiency and use of renewable energy sources in buildings. Project´s activities concentrate in the Czech Republic and Slovakia, also involving Austria as source of motivation and experience, and Bulgaria as a potential replicator. Inevitably, the proximity of languages and building traditions helps, and the first results are definitely promising.

Particularly the project leads to:

- Development of 7 *training programmes* and appropriate *training courses* for further education and training of craftsmen and on-site workers in the field energy efficiency and use of renewable energy sources of buildings.
- Development of *on-site training course* based on the training course developed by CrossCraft project (IEE project BUS Pillar II).
- Setting up *permanent network of trainers* delivering the programmes developed under the project;
- *Training of trainers for delivery of the programmes*.
- Development of *e-learning programmes* for targeted craftsmen and construction professionals in Austria, Bulgaria, the Czech Republic and Slovakia.
- Proposals to governments for incentives boosting demand for highly qualified workers.

Especially nowadays, when many activities are being moved to a virtual environment, e-learning methods are gaining in importance. Therefore, within its activities, CraftEdu project emphasizes on utilization of the gained know-how and study materials developed within the project via the e-learning programmes. This paper further discuss the process of selecting a suitable e-learning tool along with along with a description of the options of the chosen tool and the content of the developed e-learning programmes.

Methodology

A study of the available software tools was performed to select the appropriate form publishing the e-learning content for training programs in target countries. The most suitable one was chosen out of the examined methods. The development of content for the user, courses have been set up in selected countries (language variants). CraftEdu courses include access to study documents created in previous parts of the project, links to video lectures and links to e-learning courses. E-learning courses include practical exercises, stop/go questions and multiple-choice questions for self-evaluation. Prototype courses for the Czech Republic were created and presented. Courses for other countries are created and added to the database.

Review of available tools

There are various definitions of e-learning. Lee & Lee state, that "*E-learning is an on-line education defined as the self-paced or real-time delivery of training and education over the internet to an end-user device.*" [1], whereas Marquès defines e-learning as "*…distance education though remote resources*" [2]. More comprehensive definition is provided for example by Bermejo, who states that "E-learning is education that uses computerized communication systems as an environment for communication, the exchange of information and interaction between students and instructors." [3] Very comprehensive article called Building an Inclusive Definition of E-Learning: An Approach to the Conceptual Framework on this subject was published by Sangra, Vlachopoulos and Cabrera, stating

that the topic of e-learning is so comprehensive, that creating a single, inclusive definition of e-learning, that would be widely accepted, is very difficult [4].

The semantic questions about e-learning are not part of this review though. For the purpose of this review, e-learning is a process of education with the use of information, communication and digital technologies for creation and distribution of education content, communication between students and lecturers and education management.

Learning management system (LMS) is an electronic or digital platform. Its main purpose is to realize e-learning activities. It is not widely defined, because as Kats states, it is not *"…productive to try to find one all embracing 'essential definition' of what LMS is…*" [5, pp 17]. E-learning tools are any tools, used for realizing e-learning activities. One of the definition states, that such tools are usually very project specific or are united into platforms, i.e. LMS.

Review basics

The main aim of this research was to review main e-learning possibilities across the market with the relation to the project. As defined, e-learning is a process. Therefore its comparison is only relevant project-wise. On the other hand, comparison of specific e-learning tools might not be relevant enough, due to their granularity and complicated categorization. This might not fit to the needs of the project and could provide too many dead-ends, which would not be relevant to the project. The best way to approach the topic is to do a review of existing LMS, along with their tools description and comparison. The best value for future decision-making process will be achieved this way.

Over 50 LMSs were identified and briefly reviewed. Based on this preliminary research, following LMSs were examined more thoroughly and reviewed [7]:

1. Moodle
2. Courselle
3. Canvas
4. TalentLMS
5. Schoology
6. Google Classroom
7. Litmos
8. Docebo
9. iSpring Learn
10. Blackboard
11. Chamilo
12. Asentia
13. Thought Industries

While difficult to compare, each LMS has its unique features. Key aspects and features were identified and outlined in a unified table. Each LMS was described in following unified pattern (paragraphs):

- General background and history;
- License and pricing;
- Basic description, deployment, strengths and weaknesses.

LMSs review

LMSs review were based mainly on the internet research and authors' personal sources. As a foundation source, a high-quality internet web page dealing with e-learning industry was used [6]. Basic information about all reviewed LMSs were gathered and then cross-references with official LMSs sources (usually official web pages). Data were cleaned, updated, and corrected, according to review requirements. For every reviewed LMS, main page print screen was included, but this might not have necessary value, as it doesn't explain any of the LMSs feature properly, it is merely informative. Information presented in following chapters are sometimes based on trusted reviews of described LMS [7].

Description of the selected form of e-learning

For the purpose of publishing e-learning within the CraftEdu project, it was decided that the displayed systems are suitable, but it will be more beneficial to create own system, which will fully correspond to the goal of the CraftEdu project. It was decided to create own database. The core of the software solution is based on October CMS which is built on PHP Laravel framework. All software parts are based on open source technology. The basis of the October CMS was extended by a programmer with required database entries, courses and tests management and basic e-learning environment. The October CMS backend was extended and is accessible according to the user levels defined by Operational rules [8]. The frontend of the database is accessible at craftedu.eu subdomain: database.craftedu.eu. The frontend provides list of open courses, possibility to register new users, courses, browse open courses and e-learning lessons and tests (quizzes).

Description of the CraftEdu course database (Frontend)

A custom database has been created that meets the requirements of the CraftEdu project. The user has access to the database using a web application. The user has the option to view available courses and can choose a course that is useful for his profession. After registration and login to the database system, the user can log-in as a course participant. The course participant has access to all available training methods available in the CraftEdu database.

Language variability

It is currently viewable in the database in four language variants. Setting up national qualification and training scheme for craftsmen in the Czech Republic and developing the further offer of training courses in Slovakia, Austria and Bulgaria. The supported languages are:

- Czech;
- Slovak;
- German;
- Bulgarian.

Professional focus of courses

The distribution of courses varies by country. Each country has its own requirements and legislation. The following list shows the total range of courses provided; 8 professions in total:

- HVAC installer;
- Carpenter;
- Low-voltage electrician;
- High-voltage electrician;
- Windows fitter;
- Hydro-insulator;
- Stove and chimney builder;
- Stove and chimney - Inspecting technician.

Structure of courses

The purpose of the course for individual professions is to acquaint the participant with the basic principles in the field of construction of nZEB buildings and to help develop his skills and awareness of the issue. The course focuses on constructions, working procedures, technologies and materials, correct execution of details and connections of constructions and quality control of performed works.

The courses consist of three parts, three learning areas. It is appropriate to combine these areas and gain a more comprehensive view of the issue.

Text training materials

The first part of the course is text training materials, which are accessible to course participants after registration and binding enrollment in the course below on this page. The study text of the training materials is divided into two main parts - the general part, which every worker on the construction site should know, and the professional part, which is intended for specific trades. The texts are practically oriented, with a number of explanatory pictures and comments.

Video courses and lectures

In addition, videos with lectures are available to deepen knowledge. The link to the videos can be found on YouTube, during the course the listener will get links on which videos he will find. Lecture videos are divided according to thematic areas. Videos are prepared for a common theoretical part, which deals with an introduction to the nZEB topic, and videos are prepared dealing with individual professions.

E-learning

The third part of the course is e-learning, which can be used to verify the acquired knowledge and its subsequent testing using interactive tests created for comprehensive areas of the topic. The prepared e-learning for professions contains a summary of essential information, procedures and principles that must be known when performing constructions in the nZEB system. A course participant can enter an e-learning course using the links provided after registering for the course.

Interface procedures and controls

The following text describes in detail how to control the database. It describes how the user registers for the course, obtains study materials and links to spread knowledge.

Step 1: Course registration procedure

Those interested in registering for a CraftEdu course can register on the course registration page. Login is available at:

- https://database.craftedu.eu/cs – for the Czech Republic (Czech)
- https://database.craftedu.eu/sk – for the Slovak Republic (Slovak)
- https://database.craftedu.eu/at – for Austria (German)
- https://database.craftedu.eu/bg – for Bulgaria (Bulgarian)

Figure 1: Login/Introduction screen – for the Czech variant (source: authors)

Step 2: Procedure for obtaining study material

After logging in, the course participant will get access to download the created study materials (PDF format). These training materials are available on the page of individual courses in the block *training documents*. The *Student´s handbook* prepared within the CraftEdu project is available to the course participant. There are also *Trainer´s guidebook* and *Tests* available for trainers, which should help trainers in teaching the course.

Step 3: Procedure for obtaining video material

After registering, the course participant will have access to links to created videos with lectures and video courses. These training materials are available on YouTube. Access to individual videos for each course. Each course refers to videos that are relevant to the profession.

Step 4: E-learning - registration and e-learning completion process

After registering for the course, the course participant has the opportunity to use e-learning material. E-learning courses offer the possibility of verifying the acquired knowledge by studying the S*tudent´s handbook*. Here, the course participant can check his knowledge and repeat important information. Common courses are available for each profession. These courses deal with the topic of a general introduction to the issue of nZEB, airtightness of buildings and acquaint the course participant with detailed models of case structures. Each profession also has its own e-learning course. When the user uses the e-learning link, he gets to the e-learning web application. The first page contains a description of the e-learning course, there is important information about the course and brief content of the course.

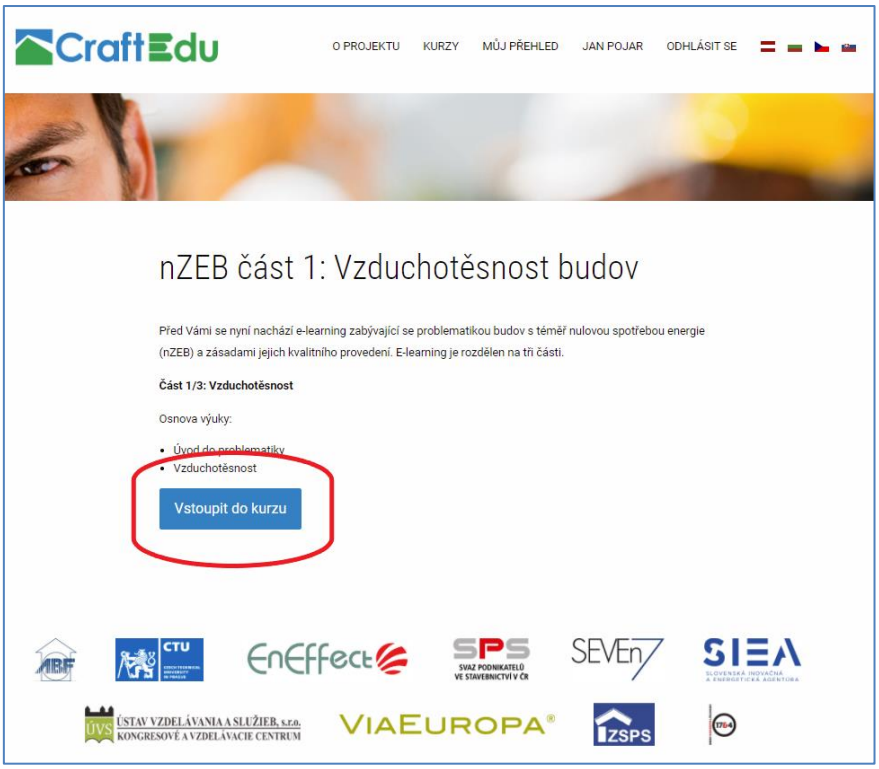

Figure 2: E-learning course introduction page – Airtightness – for the Czech variant (source: authors)

Each course has its own progress bar. The progress bar shows the number of pages in the course, the current position in the course (page displayed), and the number of pages already completed.

- Blue Cells - Already read pages and answered quizzes;
- Green cell - Currently displayed page;
- Gray cells – Unexplored pages.

Figure 3: E-learning course – Course progress bar (source: authors)

The progress bar can also be used as a button to return to the already displayed pages of the e-learning course. Study topics for the selected profession are divided into chapters and displayed on pages of the e-learning course based on technological and technical focus. The content of the page consists of text, tables and pictures (see Figure 4).

The user can proceed to the next page by clicking on the button at the bottom of the page, after studying the displayed page. After clicking on the button, the participant of the e-learning course is moved to the next page or a quiz corresponding to the lesson just completed is displayed. Course participant in the context of e-learning can test their acquired knowledge through quizzes. The quiz is part of e-learning courses.

Figure 4: E-learning course – forms of the e-learning course pages – for the Czech variant (source: authors)

The quiz evaluates the answers for the user, and he knows which questions he answered incorrectly (red color). The participant obtains the information he/she must add to successfully complete the course. Quizzes are positioned so that it always after the closing of the thematic area. They help the participant to understand the basic information of the issue. Quiz questions take various forms. They can look like a simple question with one correct answer or question with more than one correct answer than user must mark them all. Furthermore, the questions may look like a blind table, where the user must correctly assign the answers to the correct columns and rows. Last but not least, there are very interesting questions for compiling the right order. These questions are mainly used for questions related to technological processes.

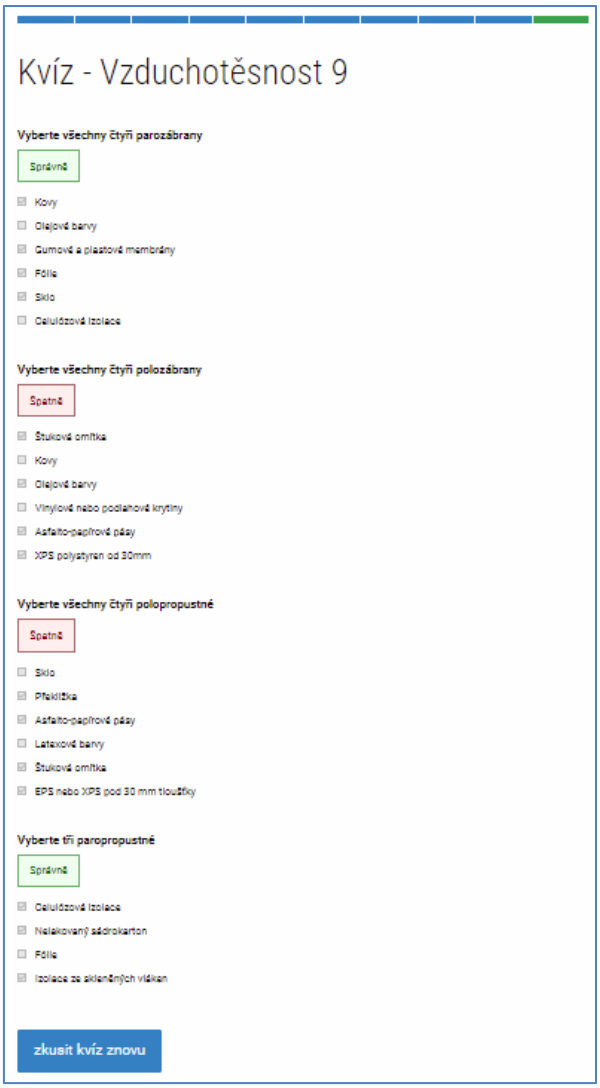

Figure 5: Selected page of e-learning - one of the Quizzes – for the Czech variant (source: authors)

Country specific results and approaches

Specific approach in Slovakia

Prior the project, the use of e-learning in the education of craftsmen in the construction sector has been questioned. Therefore, there was little experience with it. The main argument was that this form of education lacks the transfer of practical experience and the development of manual skills. However, it should be noted that the lack of experience with e-learning and the typical aversion to innovation in the construction sector was the real reason.

However, the pandemic of the new coronavirus has forced vocational training practitioners to look for ways to use digitization in the training of craftsmen, and the project has made a breakthrough in the thinking of all stakeholders.

Although the degree of interactivity during online education could not reach yet the level of in-class education, the undeniable advantage of the e-learning course has been its flexibility. The participant could choose the time when he/she wants to study, could repeatedly complete selected parts of the

course, downloaded all the materials immediately, and could choose the appropriate pace of the training.

On the part of the participants of e-learning courses, the project partners highly value this form of vocational education and training. There was a milder wave of enthusiasm on the part of teachers because the preparation of e-learning was very time consuming for them. The lecturers lacked feedback, based on which they could react promptly and adapt the lectures and/or curriculum. What the trainers evaluated positively was the fact that they developed extensive highly professional training material that will be widely used in the future.

We consider the main success to be the fact that the interest in e-learning persists beyond lockdowns due to Covid-19. The number of retrained professionals using e-learning is constantly growing. Some vocational schools have taken over the training materials and incorporated them into their full-time vocational education and training curricula. The financial support of the Horizon 2020 programme made this possible to happen without additional costs for the vocational schools and therefore the risk of their "investment" into digitalization of the vocational training has been minimal. Therefore, the goals of the CraftEdu project have been exceedingly met.

The partners are considering further advance of the e-learning to increase its instructiveness and effectiveness in transferring the practical experience and in developing manual skills by

Each course consists of three parts, which are supposed to be combined to get full understanding of the learned subject.

- First part of the course are text learning materials, which are accessible to course participants after registration for the course. These texts are divided into two parts - the general part, which should be known by every construction worker, and professional part, which is intended for a specific craft. The texts are practically oriented, with a number of explanatory pictures and comments.
- Second part are videos with lectures and practical demonstrations for course participants, which are accessible to course participants after registration for the course.
- Third part of the course is e-learning, with which it is possible to verify the acquired knowledge using interactive tests, which are created for specific areas.
- These courses are aimed at 5 different professions: Carpenter, Window installer, Hydro-insulator, Electrician (including E-mobility) and Electrician for smart technologies.
- The training topics are covered by more than 30 videos offering over 20 hours of instruction to the trainees to illustrate the topics covered by the e-learning.

The step change in accepting digitalization of the training process commits project partners to further improving the digitalization of educational and training process. The main challenge is to increase interactivity and the transfer of practical skills to trainees during the vocational training process. This means to meet the challenge of digitalization in the construction sector and address the specific barriers for the sector to be more innovative in terms of implementing the digital layer.

Digitalization in the construction sector is lagging the other sectors such as mechanical engineering, processing, and car sectors. Digital models of production plants, the whole production/assembly process, including information models for supplies used in these processes are extensively used in guiding and navigating workers and technicians throughout the production/assembly process to achieve rigorous technological discipline and the highest possible quality of the works and produced products. Applications of such approach in the construction sector start to emerge, specifically in the form of Augmented, Mixed and Virtual Reality.

Adding a digital layer to reality creates Mixed Reality (MR) rich environments, which allows going beyond the used technologies to make possible to make the training truly interactive and hands-on in transferring practical skills to the trainees.

Moreover, it makes possible the assessment of skills and knowledge of skilled professionals and their maturity across the teams of professionals participating the whole lifecycle of the buildings to facilitate their consistent and effective exploitation. This will bring another impetus to the demand for skilled construction professionals due to enabled innovations in the whole building value chain and throughout the building lifecycle.

MR assessment for learning outcomes will involve the following options:

- Remote assessment (indirect, synchronous): Construction professional with MR glasses carries out task and assessor can see the work of the professional in real time over a video stream on his computer/laptop/smartphone. Remote assessment means assessment is on a distance (assessor and construction professional can be any distance, while having high-speed Internet connection, indirect and synchronous assessment means that assessor and construction professional are not in the same room, but they communicate in real time;
- Indirect, asynchronous assessment: The construction professional carries out work and creates video documentation. External assessor reviews the video later and assess it. Indirect and asynchronous assessment means that assessor and the construction professional are not in the same room and working/reviewing not at the same time;
- Direct synchronous assessment: Assessor supports the construction professional in carrying out a task. The construction professional wearing the MR-lens, the assessor gives him/her instructions. The session is recorded. So, the skills and knowledge of the construction professional is assessed by assessor that is in the same room and the same time.

Above are described options using 1:1 visualization. The partners will consider test adding more construction professionals to one assessor or more assessors assess one construction professionals. (1:n or n:1). This could test maturity of the skills and knowledge across teams, including sequences in which one team hands over the work to another etc.

Besides the desktop interface, a dedicated mobile application could be developed to facilitate more practical use for check up and assessment of the skills and knowledge, for example directly on construction sites.

Specific approach in Bulgaria

The CraftEdu database in Bulgaria has been populated with numerous online training courses, offering both comprehensive general knowledge on the basic principles of nearly zero-energy buildings and specialized educational content of various construction crafts. Thus, a generic training course “General principles of nearly zero-energy buildings” is already available and operational, consisting of six separate modules:

- E-learning for the role and functions of the building envelope;
- E-learning for effective thermal insulation;
- E-learning for efficient windows and doors;
- E-learning for airtightness of buildings;
- Electronic training for mechanical ventilation with heat recovery;
- E-learning for heat loss and gains in buildings.

The successful completion of these modules is recommended, although a not being a mandatory requirement, for proceeding to the specialized training courses developed under the CraftEdu project, namely:

- CraftEdu course for installers of window systems;
- CraftEdu course for construction waterproofing installers;
- CraftEdu course for HVAC installers;
- CraftEdu course for construction carpentry (under development, to be launched in September 2021).

These courses provide in-depth information regarding craft-specific knowledge, skills and competences which are crucial for achieving high quality of the on-site construction works under project for highly efficient nearly zero-energy buildings.

The online platform is intended to serve as an integral part of various upcoming training and certification initiatives designed in blended learning format, as the users who complete the online courses successfully are invited to join significantly shorter practical training courses organized in specialized training labs, and then proceed to examination and certification. Thus, a new course is being set up in collaboration with the nZEB Roadshow Horizon 2020 project, whereas the successful passing of the “General principles of nearly zero-energy buildings” course will secure access to practical training sessions in the Professional high school for construction and architecture in the city of Pazardzhik within the local nZEB days on 2-4 September 2021. The combination between the two modules will result in covering the learning outcomes of some of the most prominent international certification schemes, and will be recognized by a dedicated certificate issued by the Bulgarian Construction Chamber and the local expert consultancy and CraftEdu partner EnEffect. In the next phases, it is planned that the database will serve as a stepping stone for elaboration of nationally recognized continuous professional development and expansion of the training initiatives supported by the Horizon 2020 projects BUSLeague and INSTRUCT.

Specific approach in Austria

In the Austrian section of the CraftEdu E-earning courses for flatroofing and the right installation of windows are provided. Both trades are very important and relevant for the function and quality of the building skin of nZEBs, especially for airtightness and avoiding of thermal bridges. Moreover, the proper function of a flat roof is responsible fort he water-tightness, and mistakes and poor quality can lead to structural damages. As both crafts are done not only by skilled, but also by unskilled craftsmen, the offer of low-entrance-level information and trainings is of high importance and this is provided by the CraftEdu online courses.

Conclusion and next steps

After researching the available software for creating online courses and creating a registration system for courses and distributing study materials, it was decided to create its own database for the CraftEdu project (https://database.craftedu.eu). A database has been created that allows administrators to manage online and offline courses and create e-learning courses. Courses are now being created in the CraftEdu database. The prepared documents in the previous phases of the project are interconnected. *Student´s handbook* documents and links to created video lectures and e-learning courses are made available to course participants. As part of the project, e-learning was created in the database. E-learning courses are divided into two parts. The first part focuses on common theoretical issues (airtightness, cooling and heating, mechanical ventilation, etc.) The second part is prepared for

each profession separately, this part focuses on the use of materials, proper technological procedures within the profession. In the coming months, the creation of e-learning courses and other necessary study materials will be completed. The created e-learning courses and other study materials will be linked to the CraftEdu course database. So far more than 350 persons have registered in the courses which exceeded the originally planned goal 280 in a short time of several months. We expect further demand for the courses after second round of the communication campaign in autumn 2021. The courses allow preparation of on demand courses e.g. for construction companies in less than one hour. Furthermore, experienced teachers of the professional high schools will be allowed to develop their own courses and to share them with other. It build a new environment for educational business. The creation of the English version of the e-learning for further extension of the project´s impact is being considered.

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