Smart home models in VET

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Recommendations for developing and implementing courses about Smart Home technology

PROJECT INFORMATION

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Introduction

As a part of the Work package 3 Smart home VET programs several types of activities are to be implemented.

This includes activities:

3.1 Defining modalities of instruction
3.2 Development and accreditation of a short programme of studies on smart home technology
3.3 Smart Home Clubs programme development
3.4 Smart Home Clubs programme piloting and evaluation
3.5 Innovating existing courses with new smart home content

As four of the partnership schools are in the secondary, vocational and adult education they will be implementing activities as an extracurricular activity during the school year (Elektrotehnička i prometna škola Osijek, Panevežio Mokyomo Centras, Ida-Virumaa Kutsehariduskeskus, and Baranya Varmegyei Szakképzési Centrum). Only higher education institution in the partnership Visoka tehnička škola strukovnih studija u Novom Sadu has overseen developing short learning program for those who have either finished secondary education or higher education studies to gain specific knowledge and skills needed in the workplace about smart environments.

Also, for future curriculum update needs that may occur within the partner institutions there is a suggestion of the course for Smart home technician. For gifted and highly motivated students it is suitable to integrate parts of the short program developed by the VTSNS.

Learning materials developed in the project are defined in the activities of the work package 4 Smart home model in teaching and training

4.1 Workshop for teachers/trainers from VET organisations on the project
4.2 Creation of instruction materials
4.3 Peer reviewing
4.4 Glossary of terms frequently used in smart home technology
4.5 Video on making the model and its operation
4.6 'Home Smart Home' animated short film

Workshop for the teachers and trainers is organized by VTSNS for all of the partner schools. A variety of learning resources has been created in the project main being Handbook for the teachers with theoretical background, E-books with activities for students, Lesson plans, Glossary of terms, Videos of each partner model being developed and “Home Smart Home” animated film developed by the ELPROS. These materials are translated to national languages, but there is also material individual schools created due to their specific needs and activities like detailed Handbook created by the BMSZC for their implementation of the activity and booklet for the elementary school students for Open days etc.

Besides the material translated and used by the teachers in several different courses there is an added cultural dimension and developing language skills for enhancing student’s VET capacity. Glossary, and other resources created in English can be used in CLIL (Content and language integrate learning) to

improve student's technical and vocational vocabulary which is one of the key skills for successful participation in international labour market. Schools in the Pannonian region have the specific advantages since they are in proximity. Besides this convenience there is also the number of bilingual students who are native speakers. Therefore, students can use material in their native language and learn terms and content this way as well. It is not something that would normally be available to them since they rarely have the opportunity to use their mother tongue in class.

All the materials have been peer reviewed within the institution and within the partnership to ensure quality and alignment to project goals.

All three approaches: extracurricular activity for VET students, short course for technicians, engineers or higher education students, and possible Smart home technician program are addressing high demand for these specific skills in the labour market. Smart home technician course would be more of a long-term solution and difficult to create since vocational programs that are implemented in regular education programs take a lot of time to be approved but this can partly be mitigated with short courses for the adult learners and extracurricular activities for the secondary students. As more and more homes are getting automated, the need for expertise regarding smart home system development, implementation, installation and integration is more in demand and expected to grow higher in the future.

1. Extracurricular activity Smart Home Club

Selected modality for the Smart Home Club is Blended learning model because it enables students to develop social skills, cooperation and sense of community during in person lessons, and supports their autonomy of study with online activities and individual work. Also, this model is more inclusive for students with learning difficulties enabling them to learn in their own pace with resources available online. During in person lessons, it is important to allow students to collaborate and develop their own plans for smart home technology implementation by building upon theoretical knowledge they are provided in the lesson and via created resources.

By integrating online learning and practical hands-on activities it is possible to accommodate better individual student needs, and to improve student engagement.

As blended learning can be challenging to implement with younger student groups in lessons for elementary school student online and individual activities are adapted to their skillset. If the activities are organized during Open days for elementary school students, there is a suggestion of activities for them as well.

1.1. Elementary school student activities

Elementary school students are often visitors and participate in activities which are used to promote VET studies and new technology in general. To introduce Smart home content to younger students during open days, project activities or excellence centres in schools here are the topics and suggestions of the activities adapted to them:

1. Introduction to Smart homes- model demonstration
2. Safety procedures and equipment - What not to do
3. Basics of electrical installation
4. Basics of programming
5. Introduction to sensors and actuators
6. Developing parts of the small-scale smart home model using LittleBits kit or Micro:bit
7. Sustainability
8. How to make my home smart home?

Activities can be implemented during elementary school visits, Open days, workshops etc.

1.2. VET student activities

1. Introduction to Smart homes and smart home technology
2. Networking
3. WIFI

4. Bluetooth
5. Zigbee
6. KNX
7. DALI
8. HUB
9. Electrical installation and construction
10. Programming
11. Sustainability and economy of Smart Home implementation
12. Project: Building small-scale model of Smart Home using Arduino

Here is the basic information about the Smart Home Club implemented as an extracurricular activity. More detail is provided in the Lesson plan and in the student E-book. The Handbook offers theoretical background of the topics and activities.

Course duration:

- 40 academic hours of theoretical work, and
- 8 academic hours of practical work on developing small scale model.

Prerequisite competences for VET students:

- fundamentals of electrical engineering and electronics;
- safety precautions when working with electrical installations;
- topology of local networks;
- PC network settings;
- tools for working with electrical engineering and electronics.

These prerequisites may vary depending on student group occupation, so some of it may be additionally explained by the teacher if it is not an integral part of student's curriculum.

Learning outcomes:

- Students can read and follow installation, architectural and project documentation;
- Students can use documentation keys, scales and revision numbers;
- Students can follow electrical and constructional health and safety procedures and policies for human safety and accident prevention;
- Students know the principles of safe isolation & accessory replacement;
- Students can connect and configure various network connected devices (e.g. typical domestic routers, network switches and wireless access points), securing a network using physical and cryptographic means;
- Students can install and test typical access control hardware;
- Students build a small smart home model guided by their teachers.

Topics covered by the activity:

- Introduction to Smart homes and smart home technology
- Networking
- WIFI
- Bluetooth
- Zigbee
- KNX
- DALI
- HUB
- Electrical installation and construction
- Programming
- Sustainability and economy of Smart Home implementation

2. Smart Environments short-term study programme

As most of the project activities are focused on creating programs and materials to be used in the secondary education courses it was important to offer learning of these skills on a higher level as well. Student who finished their secondary education, student in the higher education programs or engineers who are in need of the specific skillset necessary to develop smart environments can acquire it through this course.

Higher Education Technical School of Professional Studies in Novi Sad has prepared and validated course Smart Environments, a short-term study programme. Here is the basic information about the course, more can be found in the course segment of the project website.

2.1. Curriculum

Goal of the programme

The goal is to educate personnel who will know how to: plan, design, implement, maintain, monitor and manage different types of smart environments (such as: smart homes, smart buildings, smart cities, smart factories, etc.). Also, they will know modern technologies and trends in the field of smart environments, as well as the principles of their operation.

Outcomes of the programme

After completing the study programme, the student is able:

- to plan,
- to design,
- to implement,
- to maintain,
- to monitor,
- and to manage different types of smart environments.

Also, the student is trained to relate and apply specific knowledge and skills in the field of smart environments in order to solve practical problems.

Scope of studies expressed in ECTS credits: 30 ECTS

Course duration:

- One semester (15 weeks)

Teaching implementation plan:

- The courses are performed in the order in which they are listed in Table 1.
- All courses are mandatory. The programme includes Professional practice in the company at a workplace for which the participant is being educated.
- Classes are planned in the evening to accommodate the needs of the employed students.

- Active teaching includes theoretical lectures and practical exercises in the volume of 20 classes (that is, integrated lectures and exercises) per week and additional practice/training at the workplace in the volume of 20% of the classes of active teaching (10 days, six classes a day).
- On-the-job training is carried out at the end of the semester.
- Teaching is organized in three ways, namely: classically in the premises of the school, as distance learning and by combining these two methods implementing blended learning suggested for all of the programs created.

Job description

- Participants of the study programme are prepared to perform various jobs, such as: planning, designing, implementing, maintaining, monitoring and managing different types of smart environments (smart homes, smart buildings, smart cities, smart factories, smart traffic, smart agriculture, etc.) using the Internet of Things (IoT).
- Also, they are prepared for teamwork, and trained by using professional literature, advancement and career development in the field of smart environments, etc.

Table 1 – List of courses

No.	Course title	Field	Semester	Number of classes	ECTS
1	Electrical installations and lighting	Technical and technological field	1	3+2 (weekly)	6
2	Process automation	Technical and technological field	1	3+2	6
3	Smart environments	Technical and technological field	1	3+2	6
4	Smart homes	Technical and technological field	1	3+2	6
5	Professional practice	Technical and technological field	1	60 (in total)	6
Active teaching classes in total				(12+8) x 15 = 300 + 60 = 360	
Total ECTS					30

3. Smart technician - Specific VET module on Smart Home

When considering implementation of a full technician program here are the specific VET topics that need to be covered in order to specialize in the smart home technology. Since education system in each country is different it is not possible to create and validate technician program during the project, as procedures, duration and structure would be different. However, we have created a suggestion of areas and expertise needed to work with smart home technology and to adapt to different smart home system technology.

Proposed vocational technician module duration is aligned with ECVET credit system. Specific vocational education modules are planned for 30 Credit Points, which is 750 hours.

Course description: This course is for the students to be smart home installers and is suitable for the students who wish to get sufficient knowledge in the sphere of smart home systems installation.

Course type: Blended course

Course objectives:

- To study the basics of designing and constructing the "Smart Home" system;
- To master the principles of calculation and the technology for collecting and configuring the "Smart Home" system.

Learning outcomes:

- Students can read and follow installation, architectural and project documentation;
- Students can use documentation keys, scales and revision numbers;
- Students can follow electrical and constructional health and safety procedures and policies for human safety and accident prevention;
- Students know the principles of safe isolation & accessory replacement;
- Students can connect and configure various network connected devices (e.g. typical domestic routers, network switches and wireless access points), securing a network using physical and cryptographic means;
- Students can install and test typical access control hardware;
- Students can install, configure, troubleshoot, maintain audio, video, and home entertainment systems;
- Students can install, configure and test communication devices;
- Students can use applicable test equipment to check compliance with agreed specifications;
- Students can make modifications to existing construction (e.g. drilling, channeling, cable running, choosing and using appropriate anchoring devices),
- Students can troubleshoot basic systems to rectify simple faults.

Prerequisite competences:

- fundamentals of electrical engineering and electronics;

- safety precautions when working with electrical installations up to 1000V;
- topology of local networks;
- PC network settings;
- tools for working with electrical engineering and electronics.

Table 2 – List of modules

Knowledge Area	In-Class Instruction	Independent Work	Practical Work	Total Hours/Credit Points
Module 1: Introduction, overview of Smart Home systems, standards, and regulations.	21	4	0	25 / 1
Module 2: Information transfer protocols, network topology, and VPN connections	29	17	28	74 / 3
Module 3: Automatic control systems and equipment for the implementation of the Smart Home project	63	23	63	149 / 6
Module 4: Development of a Smart Home project based on an apartment or a detached house	38	23	88	149 / 6
Module 5: Creating a Smart Home prototype and setting up a Smart Home	19	38	191	248 / 10
Module 6: Economic and marketing analysis of the use of the Smart Home system	40	15	43	98 / 4
Total	**210**	**120**	**410**	**750 / 30**

4. Final project development

In most European countries both secondary and higher education require a final graduation project or vocational practice to finish programme. Within the blended learning modality, it is possible to organize completion of the graduation project. As it requires in person lessons or meetings with teacher to keep track of the progress, and student's independent work on developing project it is both blended and project-based learning. This is suitable in both secondary and higher education students as project can be as simple or as advanced as programme requires it. One of the VTSNS videos features this kind of project where one of the students developed small model of the smart home.

Vocational placement in the company can be a part or an alternative approach. For example, Erasmus+ vocational practice can provide students with practical and hands-on activities which can be documented as a final project. Vocational practice approach with documentation, but without final project is more suitable for secondary students, as it does not require advance level of skills project design requires. If vocational placement and graduation project are incorporated in the curriculum as a regular activity it is also a great way to introduce relevant topics and include student's specific interests without putting more pressure on students with additional courses and hours spent in school.

5. Recommendations for implementation of the activities

Points to consider when implementing activities in school:

Lesson design should start with theoretical background using the materials created and to move gradually to practical lessons involving project design, assembly, and programming small-scale smart home model.

Integrate Handbook and Lesson Plans as a guideline, highlighting sections on sustainability, EU priorities, and technology integration. Structure of the lesson may stay consistent, but it may also be adapted to specific student group, their previous experience and vocation to ensure better engagement. Although schools share several vocational courses approach, level of studies, practical work students have can be different, so it is important to keep activities flexible and in tun with the student group.

Learning Methods

- Blended learning
- Combine project-based learning in the practical part of the activities
- Encourage group collaboration for peer learning.

Utilize the Industry Collaboration: Local companies and their support are irreplaceable resource. They can help students to get familiar with local economy and to see their skills are applicable in the labour market. Companies can provide practical insights and share their real-life projects

Assessment:

- Self-assessment of the student engagement for ensuring student engagement and collaboration
- Can be graded if implemented in the innovated lessons

Hands-on Practice is crucial to develop prototypes or systems for real-world smart environments

Conclusion

Most of the program implementation during the project is related to extracurricular activities for the VET students. When planning an extracurricular activity, it is important to adapt lessons to the group and individuals in it. Lesson planes listed in this document are suggestions on how to cover the topics important for developing smart home model and to gain basic knowledge and skills about smart homes.

Other resources created during the project may be a useful tool for developing alternative lesson ideas.

For elementary school students it is important to stress safety procedures, basic concepts, demonstration exercises and comprehensive project ideas. VET students have more experience with this type of technology therefore some of the content can be completely up to them. Topics can be altered having in mind school's resources, student's vocation and age group, experience and knowledge and also motivation to learn new skills.

Final graduation project are great way to implement a variety of topics on smart home technology including developing student model by students independently using created learning materials and teacher mentoring the process.

Higher education students or adult learners can benefit from the short course designed for them to acquire skills and knowledge needed and to apply it directly in the vocational practice. Technician program is something to be considered in the future as in individual countries Smart Home technology and courses developed about it is recognized as an important topic to introduce future technicians to.

Resources and References

Modalities of instruction, 2022

Smart home technician program, 2023

Smart Environments short-term study programme, 2024 https://vtsns.edu.rs/kratki-program-studija-pametna-okruzenja/

ELPROS Final project organized through long-term KA1 Erasmus+

Small-scale smart home model video: https://www.youtube.com/watch?v=OXS9DJGHerM