ENERGYDUCATION

Strategic Partnership for vocational education and training Project (KA202) 2018-2021

VET Teacher's Handbook

Implementation of project based learning methodologies

Version 2020-2021

Co-funded by the Erasmus+ Programme of the European Union

KA2 Nr. 2018-1-ES01-KA202-050327

COMMENT on the current HANDBOOK VERSION 2020-2021

Due to the Pandemic, several partners could not implement and experience PBL in usual space and time settings, with normal class size and schedules.

This is why the current Handbook version will be updated in the future by the participating partners when face-to-face teaching will be back to the classrooms and more practical experience in implementing PBL inside physical classrooms, with a large number of students and fulltime schedules, can be added to the current case studies.

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Introduction

Context

In a globalized world, the workplace is changing rapidly, as well as peoples' lives in general. Therefore, society is also changing. Economic, productive, and technological changes such as climate warming, Industry 4.0, and connectivity, which since the beginning of the 21st century are accelerating, force us to reconsider the purposes and methods of teaching and learning at all educational levels, especially in vocational education.

There is an increasing demand in the market for professionals who, in addition to technical skills, must also be trained in the use of transversal or soft skills such as teamwork, learning to learn, creativity, adaptation to change, digital skills, communication, personal and social responsibility, etc.

Companies require a new worker profile, different from those they have needed in the past.

Introduction to PBL (Problem Based Learning)

To meet the need for this new type of employee, and to address future challenges, vocational training centers need to transform their approach to the teaching-learning process.

The methodological option that we want to apply in this new approach is Problem-Based Learning (hereinafter PBL, not to be confused with Project-Based Learning), which has the advantage that it allows developing the technical competencies, the transversal competencies, and facilitates the practical implementation of new knowledge.

Another of the main objectives for which this methodology has been chosen is that students, in most teaching-learning situations, will become an active subject and above all responsible for their learning, while teachers are guides or mentors in the process.

Compared to more traditional (hierarchical) teaching methods, PBL is much more interactive, and students are invited to play a more active role.

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The underlying philosophy of the PBL

The recent focus on competency curricula has revolutionized the view on education. Thus, in addition to technical skills, elements such as the student's attitude become increasingly relevant.

Learning is understood as an evolutionary process, where students are protagonists and responsible for their path to achieving competencies.

Working in teams and sometimes individually, but always trying to overcome the challenges encountered in their academic journey, Problem Based Learning (PBL) is a model that avoids the usual classroom practices of short, isolated, and teacher-centered lessons.

Instead, PBL's learning activities are long-term, interdisciplinary, student-centered, and integrated with real-world problems and practices.

While working on solving the problems posed (which later become challenges for the student), students explore, make judgments, create alternatives, choose, interpret and synthesize information.

Working with problems

How do you work at PBL? The problem arises, which then with the help and guidance of the teacher, becomes a challenge for the students. Rephrasing the problem as a challenge invites students to be ambitious.

The challenge must be clear and well-defined. The group of students is divided into teams that will tackle the challenge together.

The process of solving the challenge in teams provides a natural learning space, motivates students to generate and apply the necessary knowledge, and to find the best solutions to the challenge. The main objective should not be to solve the challenge but to learn during the process of solving it.

The presentation of a problematic situation, its transformation into a challenge, as well as the entire work process until obtaining a result, is structured according to the technical and specific competencies of each professional qualification, as well as the transversal competencies that are strategic in that work environment. Such

competencies can be autonomy in learning, teamwork, or orientation towards extraordinary results.

Steps in the teaching-learning process

The teaching-learning process can be defined in the following steps:

1. A problematic situation is proposed that is close to reality and provides a contextual learning model.
2. The problem becomes a challenge. It is essential to internalize this situation as a challenge, to motivate and involve students more.
3. The necessary information is collected and organized and alternatives are generated. At this stage, many questions will arise, and the teacher's role will be to help students ask the most important questions and provide the information they need to solve the problem. Sometimes the answers to the questions will lead to more questions.
4. Proposals are made. Once the questions are asked and answered, students will have to consider different alternatives for solutions. In this stage, the creative capacity of the students will be stimulated. Cooperation with other teams may be required.
5. The proposal is selected. Once all the alternatives are on the table, the most suitable one will be chosen. Among the different alternatives, it is important to choose one that meets our objective.
6. Actions are planned. It will be essential to assign tasks within the team, including a risk analysis in planning.
7. The chosen and planned actions are executed and developed. Practice and experimentation will develop students' competencies and skills.
8. Results are presented. Students will present the results of the challenge. This can be done individually or in teams.
9. The evaluation is carried out. The evaluation must take into account not only the results of the project but also the process and attitudes. Students should reflect on how they developed their skills during the project and the definition of future challenges.

We should not leave the evaluation process until the end of the process. We must assume that our role as process guides. Constant feedback (either formal or scheduled, or informal or unplanned), will help the student to self-regulate in their process of

achieving competencies. Therefore we have to try to leave the rating and focus on evaluating to create evolution.

Various reference diagrams

To better understand the process to follow, we present some diagrams of PBL processes that are being used in different countries today:

1. The VET system of the Basque Country, of which Usurbilgo Lanbide Eskola is a part, proposes a diagram based on the nine steps mentioned above, which is the following 11-stage process:

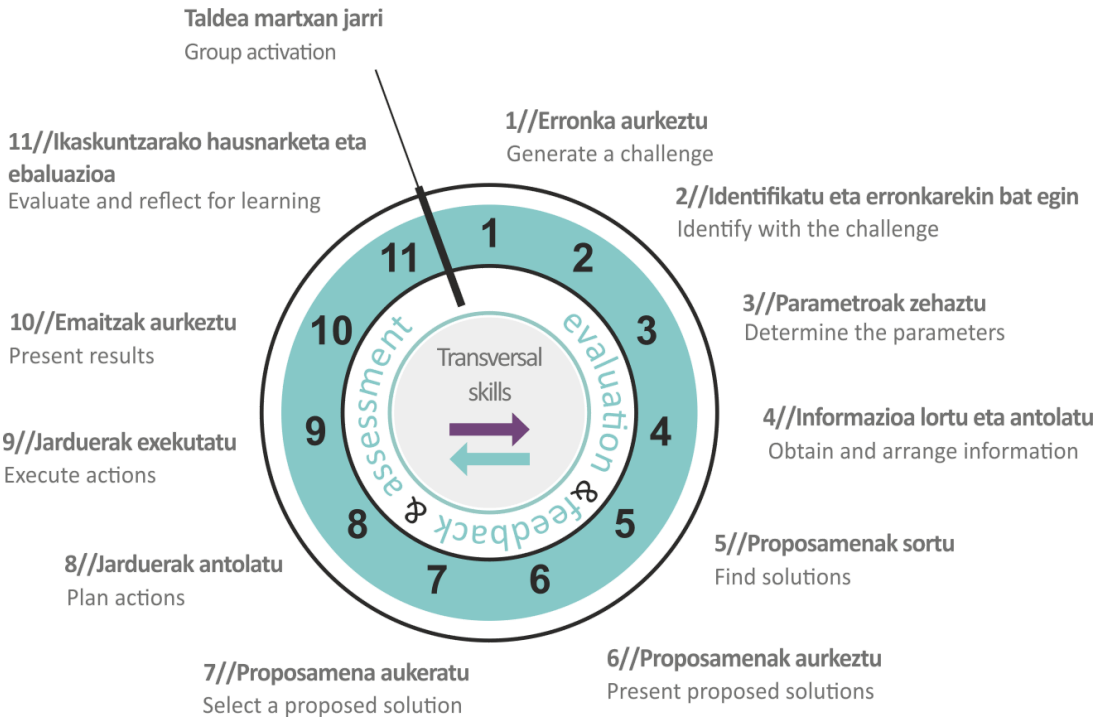

Figure 1.1: PBL-Diagram in 11 steps

https://ethazi.tknika.eus/es/competencias-evaluacion/

This process can be reduced or modified according to the criteria of the group of teachers, as we will see later.

2. Any of the phases may come together creating different process diagrams as we can see below:

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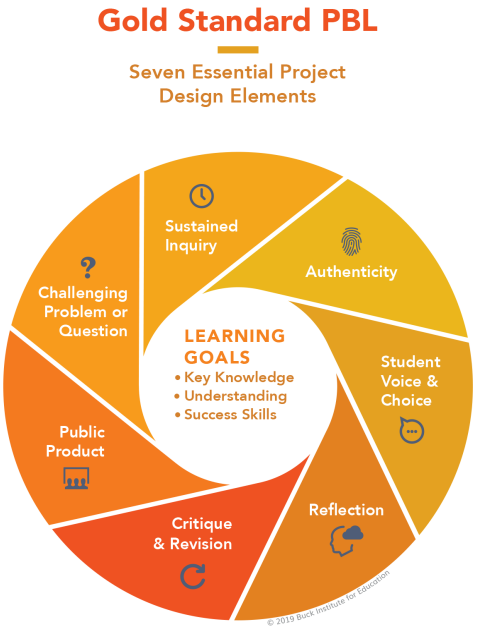

Figure 1.2: Gold Standard PBL

https://www.pblworks.org/what-is-pbl

But regardless of the specific diagram applied, the process always follows a similar development:

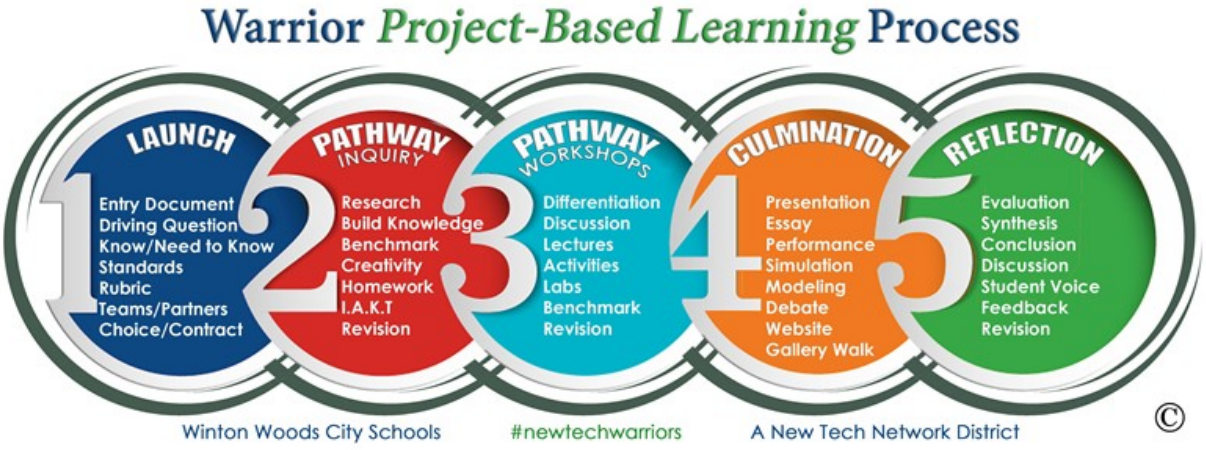

Figure 1.3: Warrior PBL process

http://www.wintonwoods.org/Content/project-based-learning

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All these process diagrams refer to the process itself, but we must not forget that we want students to work as a team. Therefore, before developing the process and posing the problem, we should create groups of students.

In theory, it is one more step, but there are times when during the school year, as long as we work with different challenges, this previous step of creating groups/teams is not carried out because the composition of specific teams does not change.

If the group/team change is necessary, this previous step that we can call phase 0 is essential.

Conclusion

At Usurbilgo Lanbide Eskola we have chosen the 11-step process described above (which is used by the VET system of the Basque Country), but with some minor modifications, and reducing the process to 9 steps as previously described.

We chose this process because it addresses different situations that will be beneficial for the student during their learning process, not only of technical skills but also of transversal skills.

We are implementing this process in the Basque VET centers, with more or less development. At Usurbilgo Lanbide Eskola we are implementing it with satisfactory results for the student.

Even so, we must not forget that the greatest change must be carried out by teachers. This type of methodological change cannot be made without a great contribution and dedication from the teachers involved. It is in these cases that the group of teachers must become a true team. Otherwise, the process will fail, leading to the demotivation of the students.

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Chapter: Applying PBL - Process and resources

Context

In general, all active methodologies have the same common denominator: the learner is the main protagonist of the teaching-learning process. In our case, PBL allows learners to face a real problem situation and resolve it in a proactive and teamworking approach, with the guidance and support of the teaching staff. This scenario offers learners opportunities to apply what is needed in real work-life situations where they face challenges and problems, test solutions, and interact with others within a given context. It is based on the fundamental principle that students learn better when they actively participate in open learning experiences, than when they passively participate in structured activities. As a teacher of vocational training, one of the main, if not the most important task, is to prepare learners so that they can successfully enter the actual labor market. This means, to provide learners with the greatest possible number of tools that allow them to adapt to future changes. One of the options we consider is to have direct contact with the companies in the area where our students could work in the future, to guide us when planning the projects. However, it is even better to let companies participate in the project, if possible, by designing the project and, for example, by assessing the products or competencies of the students. Teaching-learning methodologies offer mechanisms to achieve this objective, but they must also adapt and provide teachers with various means to face this task. The use of one methodology or another is given by the context teachers may have in the classroom. The implementation of one methodology or another must also be based on a need that the teacher detects, but moreover the teaching team.

Design of problems or challenges

When designing a problem or challenge, we will take into account that a preliminary preparation and planning of the project represents a high probability of success.

First of all, to carry out the planning of the didactic programming of the classroom it is important to in-depth know the learning outcomes that should be achieved:

- The technical learning outcomes
- The transversal learning outcomes

1. The technical learning outcomes

In most countries, professional certificates/titles are based on the demand of the labor market. A certificate can be obtained through initial vocational education or occupational training courses. In both cases, the qualification description of a specific certificate is divided into units, which describe the learning outcomes that should be achieved, specifying the professional context in which the know-how will be applied. The problem or challenge that you are going to design needs to be directly related to the qualification description and a specific professional work task described within it. But as mentioned previously, you can also look at the training needs of labor profiles of the surrounding companies, to identify these professional work tasks. When looking at professional work tasks, it is possible that a learner may require the learning outcomes of a single professional unit or that the learner needs to achieve the learning outcomes from more than one professional unit. Thus, the integration of learning outcomes from these various professional units into the design of the challenge is necessary. In the curriculum of each training description, we need to know about the learning outcomes and the evaluation criteria of each training unit. This will facilitate the design of the challenges or problems, as the learning outcome will set the starting point for creating the challenge. To take an example of a unit out of the qualification description “Higher Technician in Energy Efficiency and Solar Thermal Energy”:

Energy Certification of Buildings

The Holder:

- Assesses the insulation provided by buildings siding, relating the properties of their components with hygrothermal behaviour.
- Determines energy demand limitations in building envelopes verifying that their constituting elements comply with stated regulations.
- Calculates the necessary energy demand in order to guarantee habitability, verifying that the same complies with the limitations stated by applicable regulations.

Here, the unit is called “Energy Certification of Buildings”. The related learning outcomes are listed below in the example.

If we take into consideration the listed learning outcomes and at the same time, the competencies, skills, and knowledge demanded by the surrounding companies, you have set the ground for designing a map of student learning outcomes, and define how they should have been achieved after the learning process.

Once it is clear which learning outcomes can be combined to become part of a challenge and which learning outcomes should be achieved independently and cannot be combined into one challenge, it is possible to define good planning of the schedule, the timing of the process, and its weight in the didactic programming.

It is important to emphasize the teamwork of the teaching staff in charge of the different modules involved in the didactic approach. Being able to count on moments of coordination will be essential. The incorporation of this type of methodology requires great commitment, dedication, and teamwork by teachers.

As an example, we can suppose a problem/challenge of EQF level 4 in VET linked to the qualification of a “Higher Technician in Energy Efficiency and Solar Thermal Energy”. We want to design a problem based on three different training units called “Energy Certification of Buildings”, “Management of Solar Thermal Installations Fitting and Maintenance” and “Energy and Water Use Efficiency Promotion”.

From here, the teacher will be able to identify which of the learning outcomes of these specific units are necessary to integrate into the design of the challenge and will serve as the basis for the definition of training activities that will be part of the learner’s project.

As an example, the following learning outcomes had been selected to become part of a challenge:

Energy Certification of Buildings:

- Assesses the insulation provided by buildings siding, relating the properties of their components with hygrothermal behavior.

Management of Solar Thermal Installations Fitting and Maintenance:

- Plans solar thermal installations fittings specifying their stages and determining the expected resources.

Energy and Water Use Efficiency Promotion:

- Organizes informative actions on energy and water use efficiency, relating the designed activities with the identified target customers

2. The transversal competences

We can define them as those characteristics that a person needs and that allow him/her to develop in an organizational environment, beyond technical knowledge. We all know that being competent in a professional field does not only require theoretical knowledge but also requires knowing how to solve problems, how to work in a team and to work autonomously. The greatest difficulty that teachers are confronted with, is to fairly evaluate this type of competence and to give fair marks to the learner. Therefore, it is very important to have instruments that allow teachers to quantify the degree of acquisition of the transversal competencies. An instrument that will allow us to quantify these competencies very effectively is the “rubrics”. They are defined as a set of criteria directly related to the learning objectives of the students and are described in a way to be as objective as possible, thus achieving a more fair and transparent evaluation.

Basic Rubric Template				
	Lowest Quality	Average Quality	Good Quality	Exceptional Quality
Criteria 1	Performance descriptions here			
Criteria 2				
Criteria 3				

Figure 2.1: Structure of the competences in rubrics

If this information on how a learner will be assessed, is shared with the learner before the actual evaluation takes place, learners will show a greater interest in working on the key aspects of the competencies and may even decide which level of competence they want to achieve.

As an example of how to assess these transversal competencies, a set of competencies (grouped along with four main interest areas: personal, digital, communication, and collaborative) is shown together with the criteria and rubrics that allow assigning a certain mark to each student carrying out a PBL based challenge. This set of competencies is based on the work done by the Basque VET system while carrying out the deployment of the PBL methodology among the local VET centers. The specific competencies to be assessed in the challenge should be agreed upon by the teacher team according to the priorities regarding their students' profiles and the demanded profiles on the local job market. The aim should be to emphasize the assessment of those competencies which should be improved regarding the student's initial situation by increasing their weighing on the final mark.

PERSONAL		Excellent job	Great job	Good job	Enough work	In need of improvement	Insufficient result
Competencies	Score	5	4	3	2,5	2	1
	Entrepreneurship	Formulates a goal about ongoing ideas, projects, or improvements and defines an implementation plan.	Defines a plan for implementing ideas, projects, or improvements and takes risks in execution.	Independently puts ideas, projects, self or team improvements into practice.	Puts ideas, projects, self or team improvements into practice with the help of others.	Defines ideas, projects, or improvements that could be implemented in the field.	Does not have ideas, projects, or improvements that can be put into practice.
	Autonomy	Demonstrates the will to overcome when dealing with unforeseen situations and has resources and the ability to find solutions independently.	Schedules tasks while adhering to goals and timelines.	Independently completes assignments within a specified time frame.	Completes tasks independently and requests support when needed.	Can develop activities as directed by teachers or teammates.	Requires constant support from teachers or teammates for any type of activity.
	Implication	Seizes the initiative in the team and takes the lead.	Consistently participates in activities and contributes regularly.	Actively participates in and proposes actions and team activities.	Participates in promotions and team activities and demonstrates appropriate behavior in adherence to time, materials, and compromises made.	Is just in time and participates in actions and team activities but does not suggest them and does not demonstrate appropriate behavior in keeping to time, materials, and compromises made.	Demonstrates inadequate behavior for basic rules of assistance, punctuality, handling of materials, and adherence to compromises made.

Table 2.1: Personal competencies

COMMUNICATION		Excellent job	Great job	Good job	Enough work	In need of improvement	Insufficient result
Competencies	Score	5	4	3	2,5	2	1
	Verbal communication	Communicates efficiently: in a calm tone, adheres to agreed-upon compromises, refrains from empty phrases, and maintains eye contact.	Speaks clearly and can be easily understood, provides written reports as needed, does not exceed scheduled time when presenting.	Expresses ideas, opinions, and feelings without hesitation and invites the rest of the staff to communicate with each other.	Shares own ideas, opinions, and feelings as soon as it is necessary.	Rarely expresses own ideas, opinions, and feelings and when he/she does, they remain unclear.	Has trouble expressing own ideas, opinions, and feelings and does not sow respect for other communications (interrupts, cheats)
	Written communication	Composes written reports that are presented in an original, enjoyable, engaging, and visually good manner (e.g., using pictures and mind maps)	Composes written reports that are well-structured and easy to follow logically (e.g. with a table of contents).	Composes written reports which are properly structured.	Composes written reports which do not contain spelling errors.	Composes written reports that have some spelling errors and are poorly structured.	Composes written reports that have many spelling errors and are poorly structured.

Table 2.2: Communication competencies

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DIGITAL		Excellent job	Great job	Good job	Enough work	In need of improvement	Insufficient result
Competencies	Score	5	4	3	2,5	2	1
	Handling information	Uses advanced search strategies (e.g. uses search operators in search engines or advanced search).	Researches using search strategies (e.g., uses search operators in search engines).	Researches information using several different internet search engines.	Researches information using only one Internet search engine.	Researches information using individual websites.	Does not research information on the Internet.
	communication	Actively uses a wide range of communication apps to keep in touch and collaborates online, using clouds.	Actively uses a wide range of communication apps to keep in touch and collaborates online.	Communicates in advanced ways (shares documents and digital content) via smartphone, email, or chat programs.	Communicates synchronously via smartphone, email, or chat programs.	Communicates asynchronously via smartphone or email.	Does not use digital media to communicate.
	Content creation	Produces complex digital content (multimedia) with advanced options and edits the content produced by others.	Produces digital content (multimedia) and edits content produced by others.	Produces digital content (single media) and edits content produced by others.	Produces simple digital content (e.g., PowerPoint presentations) and edits content produced by others.	Produces simple digital content.	Consumes digital media but does not produce content.
	Security	Responsibly assumes administrative duties.	Takes advanced measures and uses advanced IT security software.	Takes advanced measures (e.g. strong passwords) and uses VPN channels to protect electronic devices.	Takes advanced measures (e.g. strong passwords) to protect electronic devices.	Operates basic measures for securing electronic equipment.	Does not operate cyber security of its own electronic devices.

	Problem-solving	Solves almost all problems that arise concerning communication technology.	Contributes significantly to solving problems related to communications technology.	Solves the most common basic difficulties related to communication technology.	Uses own equipment correctly, but is helpless when difficulties arise.	Is able to find answers to technical problems, does not use own equipment correctly.	Is not able to find answers to technical problems, does not use own equipment correctly.

Table 2.3: Digital competencies

COLLABORATION		Excellent job	Great job	Good job	Enough work	In need of improvement	Insufficient result
Competencies	Score	5	4	3	2,5	2	1
	Teamwork	Works through conflicts as a team according to a plan.	Is able to handle conflict within the team and contribute to resolutions.	Makes significant contributions and is able to identify conflicts within the team.	Makes appropriate contributions and creates a good atmosphere within the team.	Does not contribute to the team, but also does not contribute to a bad mood in the team.	Does not contribute to the team and contributes to a poor team atmosphere.
	Problem-solving	Works through conflicts as a team according to a plan and incorporates various areas of improvement into the project.	Is able to deal with conflict within the team and contribute to resolution and identifies areas for improvement.	Suggests creative alternatives considering the preceding process.	Identifies the problems, proposes different strategies, decides on the most useful one, implements and evaluates the results.	Identifies the problems but does not present a strategic approach to solving the problem.	Does not identify the problems.
	Decision making	Creates a plan for implementation of decisions made and possible adjustments.	Is able to take initiative and make correct decisions even in unfamiliar situations.	Participates in decision-making considering the group's goals as his/her own, and is responsive to compromises made.	Makes decisions considering various options and analyzes the situation.	Makes decisions without weighing different options.	Hides and does not make decisions.

Table 2.4*:* Competencies in cooperation

Phases of the challenge and the problem

First, it is necessary to build a story, context, or scenario that represents a problematic situation related to one or more training units and that allows learners to work on the selected learning outcomes. This problematic situation will have to meet the following requirements:

- It has to be a situation as realistic as possible and related to their profession,
- It should be close to the problems that can occur in the real life of a learner or it should be a problem the learner could encounter in his professional life (e.g. “the lights turn off if you want to use the microwave while your brother is playing with a play-station…”),
- The description of the problematic situation should not include all the information in a structured way to make the learner thinking and investigating,
- A situation that requires collaboration between different learners,
- A problem that needs a solution that is evaluable,
- A problem that requires research, consulting an expert, or other kinds of information support of a specific product or service and interpretation of this information.

As an example, we can take a specific example developed during the present project. The reference will be the SME qualification description. In this case, the challenge will cover unit 2 of aggregated learning outcomes “Design and Analysis of Smart Energy Measurement Systems”. Specifically, in this case, all five learning outcomes will be covered by the challenge including all their technical competencies (skills and knowledge descriptors).

Co-funded by the Erasmus+ Programme of the European Union	Energyducation	ENERGYDUCATION
Generic Title of the Unit:	**U2 – Design and Analysis of Smart Energy Measurement Systems**	
Energyducation EQF Level:	**4**	
ECVET Points:	**(if applicable)**	
ECTS Credits:	**(if applicable)**	

NQF Level:	**ES**	**NL**	**SE**	**NO**	**DE**	**CH**
	5	**4**	**5**	**4**	**4**	**5**

Learning Outcomes

Energyducation – U2 Design and Analysis of Smart Energy Measurement Systems	Training Module Code	Competence	
		Knowledge	Skills
2.1: Identification of measurement points and parameters	4/3/2	Is able to define energy measurement parameters in the system	
	4/3/3	Knows how to calculate thermal energy (air/water) and energy balance (generation, distribution, consumption)	Interprets a certain energy system scheme identifying where to measure energy

Figure 2.2: Abstract of the SEM- qualification:

In the corresponding challenge description for students, a short remind will be made about the learning outcomes to be achieved by students.

Objectives / Learning outcomes
M01.- Design and analysis of Smart Energy Measurement Systems
Learning outcome 1: Can define energy measurement parameters in the system
Learning outcome 2: Can identify and mount the most suitable sensors for measurement of parameters
Learning outcome 3: Can identify and implement which platform to use for integration of monitored data
Learning outcome 4: Can identify energy balance and efficiency rates
Learning outcome 5: Can identify consumer behavior related patterns and their accordance with estimated use

Table 2.5: Learning outcomes

At the same time, certain transversal competencies will be covered and assessed during the challenge. The teacher's team will decide which ones will be included

depending on the student's team and the requirements that both teaching staff and recruiters demand in the specific job sector and the local area.

Transversal skills
Team work: ability to manage conflicts and propose solutions
Report, presentation, and ICTs: ability to deliver clear reports and presentations employing ICTs-2.
Individual Work (autonomy and implication): ability to find solutions to problems arisen and commitment and compromise
Oral communication: ability to deliver ideas in a clear and ordered way. Presenting them with the suitable rhythm and tone

Table 2.6: Transversal competencies

Once the learning outcomes and their evaluation are defined, the next step will be to choose and design the activities that will lead to these learning outcomes, the results that will allow the work to be carried out, and to collect the evidence necessary for the evaluation of the student performance. With this information, we will generate two documents: a guide for the teaching team, which will be used to collect the design of the process by teachers, and a guide for learners to inform them about the planning of activities.

The guide for the teaching team will contain:

- The criteria for learning outcomes and evaluation that will be part of the challenge,
- The planning of time and interactive elements,
- The information necessary for the development of the challenge/problem,
- The ways of coordinating the teaching team and ensuring communication between each teacher, e.g. weekly meetings, blogs, workbooks, etc,
- The evaluation system, e.g. rubrics.

The learner guide will contain at least information on:

- The goals to be achieved,
- How the learners will be evaluated,
- What has to be delivered by the learner (products to be made), and
- What resources are available.

Next, the teachers are going to describe the work process or rather how to introduce each phase of the process that leads to the solution of the problem to the learners. As

explained previously in the first chapter, the process should have nine phases. These nine phases will allow learners to achieve the technical and transversal learning outcomes accordingly to the specific qualification level. During this process, learners will work on skills or aspects such as searching for and management of information, problem-solving competencies, creativity, and above all, cooperative and collaborative teamwork. In other words, the problematic situation is a challenge that should be resolved through all nine steps of the process. This process doesn't depend on the time a learner has to spend to get through the nine steps: a process can last two hours, one month, or three months. Your job as teachers will be to detail each phase of the process and above all to guide and support learners properly so that they will acquire the necessary skills. The learner must know what she or he has to do in each phase and which will be the support of the teaching team. But most importantly the learner must be aware of the importance of all the steps to be followed.

Phase 1: Outline the problem situation

The problem situation will be presented. We can use different computer media (Powerpoint, Prezi, Visual Thinking, YouTube, movies, ...) to make this presentation. Conveniently, the teacher-team who will participate as guides in the teaching-learning process is present at this moment. In the description of the problem, it is interesting to introduce keywords that the learner shall learn and use during the process of resolving the problem so that the learner becomes familiar with new concepts, technical vocabulary or knowledge, skills, and competence descriptions that have to be achieved. It has to be detailed which are going to be the results and products that the learners will have to hand in (memories, assemblies, calculations, schemes, presentations, ...).

Let's take the following problematic situation as an example. This challenge could be applied in a training course on maintenance of thermal and fluid installations, to elaborate several learning outcomes of the units renewable energies and energy efficiency.
In a residential house located in a block of flats, owners are arguing about the bills of natural gas consumption (fossil fuel) they are paying with the actual heat generator. Learners are asked to propose a feasible solution for a reduction in the energetic cost and environmental impact. This proposal has to take into account the possibility of including solar energy."

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The evidence of the learning outcomes achieved through the process will not only demonstrate the level of knowledge, skills and, competencies that the learner has reached but will also detail the learning progress. That is why learners should also give track of the learning process by documenting each step through photos, videos, memories, etc.

Regarding the Energyducation project and, following with the previously mentioned qualification and learning outcomes (LOs), the problem could be defined as stated below

Tasks to carry out
A self-sufficiency analysis of the building has to be carried out monthly extracting data from existing monitoring systems. There has to be analyzed generation of electrical energy as well as consumption energy to check if we are self-sufficient and, if not, propose the possible options to achieve it. An energetic analysis of the MVHR + ground heat exchanger unit has to be carried out monthly, extracting data from existing monitoring systems. There has to be analyzed the variation of the thermal efficiency rate monthly to guess which are the best conditions under which works the equipment. You will have to deliver the files you have used for carrying out the analysis and present a report with the tasks carried out as well as the main conclusions from the work. An oral presentation will have to be done in front of the class explaining the main conclusions of the work as well as the performance of the group (task division, team performance…). The support material for the oral presentation will have to be delivered.

Phase 2: From the problem to the challenge

In this phase, learners identify the key aspects of the problem, assuming their role while connecting and engaging in the solution of the problem and taking it as a personal and collective challenge. Possible activities to do it:

The problem situation is read again.

- Each learner takes notes on what is demanded,
- Notes are shared with another classmate,

- In a team, all learners will share their understanding of the problem to make sure that everyone understood the challenge correctly.

Possible techniques to identify the key aspects:
Questions: "what, who, how, where". You could use a template in which each student will write down, contrast, and discuss these questions:

What are the main tasks that should be carried out to face the problem?
What is the specific result of each task?
How and where do I have to perform these tasks?
What would be an excellent solution to the problem for me?
What would be a bad solution to the problem for me?

Finally, each team will be asked to identify milestones, results, and related deadlines (e.g. documentation to be submitted, individual work, or collective evidence)

Phase 3: Obtain and organize information. Generate alternatives

The learners will have to look for information that they do not know, investigate and practice procedures, and train skills and competencies that they still are lacking. It is very important at this point that the didactic tools to help the learners face the challenge are defined beforehand. These tools can be a set of questions, documents, links, etc. that enables the learner to define the knowledge, skills and, competencies that they need to carry out for each task.

NOTE: From Alfa College's experience, these didactic tools are essential for the learning progress, as learners will realize themselves which knowledge, skills, and competencies they have to acquire. Teachers must be prepared to program the training content accordingly to what the individual detects as their training gap. Teachers also must assure that all the different training contents they want their learners to study during the challenge will be addressed.

These didactic tools are also very helpful for the teachers to detect training gaps and act accordingly, e.g.: have an extra class, invite an outside expert, include extra training, etc.

Teacher-teams can carry out a student self-assessment or use questionnaires about the concepts and procedures that will be learned during the different phases of the challenge. As an example, we could use the same group technique as in Phase 2:

What should I know?	What should I know to do?	What information or resources do I need?

Table 2.7: Group techniques with W-questions

This phase of information search becomes a phase of training or self-training of the learner in which the teacher of each module has prepared specific training activities that fits the learning outcomes. That way, the learner will acquire the knowledge, skills, and competencies that will subsequently be used to solve the problem.

During the training phase, the teachers will collect evidence (individually of each learner or a learner team) of the technical and transversal learning achievements. These can be tests and exercises that will be carried out individually or in teams.

As support in this phase, digital tools such as Moodle, Google Classroom, or such could be used either to manage knowledge (information bank) or as evidence collection and use.

In this phase, the transversal competencies should also be trained, for example, the learning-to-learn competency.

Phase 4: Generate and present proposals

With the knowledge, skills, and competency acquired in the previous phase, the learner will be able to face the challenge and propose solutions. The proposals will be directed, for example to the type of solar hydraulic installation: type of boiler, types of sockets, types of lighting of lights, types of lights, overall picture dimension, hydraulic scheme of the installation, electrical scheme, etc.

Once the learner teams are defined, the teacher can use the tool “brainwriting” that will allow the team to generate solutions:

- The task is listed for every student to see, e.g. on a blackboard.
- Each learner will receive a blank sheet.
- Each learner is asked to write down at least one solution-proposal
- After, the learner passes the sheet to another learner of the team, sitting to the left side.
- This learner will receive the proposal of his/her colleague and will have 5-10 min. time to bring improvements to it.
- This process will be repeated until each learner has gone through all proposals

There is a range of other collaborative learning tools (e.g. pencils in the centre). Make sure to select one tool that makes the learner generate proposals, discuss them as team work and finally, ask learners to choose one out of all proposals generated by the group or a combination of several proposals.

It is important to “force” learners to generate a certain number of solutions (at least as many as there are members in the team) to avoid that the team agrees on the first or most obvious solution, and does not try to imagine more.

In this phase, evidence will be taken off of the transversal competence of teamwork for which the teacher will collect the sheets with the proposals.

Phase 5: Select proposals

This phase is about making decisions. The learner's team has to select a proposal or agree on the one that combines in the best way the proposals elaborated in the previous phase 4. During this decision-making process, the teaching team must check the communication of the learner's team, the roles that each learner adopts in this process, and the strategies the team employs to analyze the proposals.

You can also work with decision-making tools, such as the Ishikawa diagram, the Pareto diagram, and/or diagnostic tools.

Once the learner's team agreed on the proposal, they have to present their idea to the teaching team. This is essential to make sure that the solution is viable to the problem and if it doesn’t fit, the teaching team should propose changes that make it possible to realize. The learner’s communication skills might be also addressed during the presentation of the proposals.

Phase 6: Planning tasks

To implement this phase, the teaching team can make use of organization and planning tools, such as Canvas or Gantt charts. It is convenient for learners to know how these tools work before this phase. If you look at the challenge described above, the following task list would be required to carry out the design and installation:

1. Make the plans and schemes
2. Define the collection of materials and tools
3. Carry out the calculation and design of the installation
4. Carry out the installation of the system
5. Carry out the functional and commissioning tests
6. Carry out the technical report
7. Carry out the final presentation

In the beginning, it might be difficult to get the learners working on the planning phase, since they may want to immediately move on to the next point and begin to implement the solution. Step by step, through solving different problems that arise during the course, the learners become aware of the fact that being more efficient means good planning.

Once the learner's team declares that they have everything planned (which gives evidence of the competence of working and planning in a team), they can move on to the next phase to carry out the actions.

Ideally, the learner's team has assigned a responsible person for all the tasks alongside an estimated timeframe. That way learners can make sure that they finish the tasks within the deadline.

Id.	Activity	Duration	Resources	Responsible	Day									

Table 2.8: Planning of activities, runtimes, resources, and responsibilities

Phase 7: Execute the tasks

The objective of this phase is to execute the planned tasks while monitoring them (e.g. through a status column, red if it is not done, orange if it is in process, and green if it is completed). Learners should take the quality criteria required for resolving the problem into consideration. At the same time, the teacher team also carries out the monitoring and validation of the tasks (validation actions column). The teaching team must make sure that learners will have all the necessary resources (templates, diagrams, tools, computer programs, ... etc). It could happen that a learner, in some activity or task, needs further advice or relevant information to move forward. It is convenient that in these cases, the teaching team tries to guide the entire learner team or even the entire class. The schedules of the learner teams for carrying out the task must be flexible, to promote the autonomy of the learners (it must be taken into account that they have carried out a planning of the execution phase). Although teachers maintain their teaching schedule, learners will work based on their planning, and if necessary the help of the "expert" teacher will be arranged accordingly to the teacher's schedule. It could also be the teacher who is present at the moment in the class, when the question arises, who will guide the learners to resolve that doubt, provided that the criteria of the expert teacher are followed. The teaching staff must know at all times what the students are doing currently and what they have planned to do, to check the progress in the learning, and to take significant evidence.

Phase 8: Present results

The objective of this phase is to share and present the work of each of the teams. For doing so, the use of ICTs will be promoted to create presentations in different formats. Above all, the communicative competence of the learners should be "trained".

To make this phase more interactive, each learner will value the work and presentation of their classmates' teams, e.g. using the following graphical support:

 **What I liked**	

 **Aspects to improve**	

Table 11: Evaluation table

1.1.1 Phase 9: Evaluate results

Throughout the PBL-process, the teaching team has been gathering evidence about the learning progress of each learner and its "achievement" of both technical and transversal competences, as have been defined previously through the rubrics.

By collecting evidence throughout every phase of the challenge (and not just at the end of it) the teaching team gathers information about the learning process of each learner. If necessary, the teaching team has to correct deviations or react to problems that have not been expected (continuous evaluation.)

Therefore, it will be important for the teacher of the module or the teaching team to make a classroom feedback after each phase so that learners realize opportunities for improvement and have room to improve.

The teaching team will assess the challenge (individually for each learner and for the learner team) based on all the evidence that the teaching team has collected during the challenge.

This assessment is based on the principles of a **formative evaluation**. It is an evaluation whose objective, as the name implies, is to **inform learners** about their strengths and those aspects on which they have to work harder (aspects to improve). This assessment should be a continuous evaluation throughout the whole process of the challenge.

The formative evaluation should also be made at the end of the challenge. We propose that it is not accompanied by a qualification / a mark to foster the understanding of the evolution as a learning achievement related to both technical and transversal learning outcomes.

In the picture below, there is an image that shows a possible way of assessing a student’s performance in a challenge-based curriculum where each of the items is

assessed on a pass/fail basis. Specifically, it shows a scheme of assessment and marking of challenges using the SET tool (one only competence tree for each challenge) developed by the methodological innovation Dept. of TKNIKA.

Description	Weighting %	Weighting %	Internal evaluation weighting			
			Teacher %	Student %	Teammates %	Student Assessment
Challenge 1	20					
Performance		50	70	10	20	Yes
Welded junctions		10	70	10	20	Yes
Box finishing		10	70	10	20	Yes
Measurement of the plate		20	70	10	20	Yes
Components		10	70	10	20	Yes
Challenge 2	20					
…		20	70	10	20	Yes
…		30	70	10	20	Yes
…		50	70	10	20	Yes
Challenge 3	20					
…		40	70	10	20	Yes
…		40	70	10	20	Yes
…		20	70	10	20	Yes
Transversal competences	40					
Autonomy		25	50	0	50	Yes
Problem-solving		25	50	0	50	Yes
Implication		25	50	0	50	Yes
Management of resources		25	50	0	50	Yes

Table 2.9: Evaluation scheme

Specifically referring to the Energyducation project, and continuing with the example described above, it is important to decide among the teacher team which is going to be the rubrics that define the degree of fulfillment of the learning outcomes (technical competencies) covered by the challenge itself.

Assessment criteria	1	2	3	4
Learning outcome 1: Can define energy measurement parameters in the system				
He/she does not know which are the parameters (electrical energy in generation and consumption) to measure to analyze self-sufficiency and neither how to measure thermal efficiency rate for MVHR unit and ground-air heat exchanger	1			
He does know which are the parameters to measure but is not able to identify where to measure them.		2		
He knows which are the parameters to measure and, even if not all the sensors are located, he knows where to locate them.			3	
He knows which the energy parameters to measure are and where to locate them with its sensors				4
Average:				
Learning outcome 2: Implementation of measurement sensors and grid analyzers (thermal/electric)				
He has no idea about the kind of sensor to place into the installation	1			
He knows what kind of sensor to place but is not able to accomplish the connection and register of data		2		
…			…	

Table 2.10: : Assessment criteria

Once these rubrics have been defined, it is needed as well the definition of the transversal competencies to assess and their rubrics. In the tables below there is a table in which these competencies appear as well as the evaluation type for each of them (co-evaluation, self-evaluation, traditional teacher's evaluation). The rubrics can be taken from the table appearing below.

%	Competence	Who will assess			
		Teachers (via Google Forms)	Teammate	Autoassessment	Avarage
10	Teamwork				

10	Report, presentation, and ICTs				
10	Individual work and autonomy (implication)				
10	Oral communication				

Table 2.11: Types of evaluation of competences

Finally, it is needed a kind of quantification of the challenge to have numerical evidence to introduce in the different academic subjects whose learning hours have been covered through the challenge implementation. For doing that it is needed, even if the main goal of the challenge is to help students carrying out an evolution (dependent on their initial starting point) on their competencies, to put numbers that give evidence of a certain overall challenge mark. At this point, a specific example is shown in the table below.

Technical competencies (60%)	Transversal competences (40%)			
Design and Analysis of Smart Energy Measurement Systems	Teamwork	Report, presentation, and ICTs	Individual work (implication and autonomy)	Oral communication
60%	10%	10%	10%	10%

Table 2.12: Weighting of competences

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Chapter: ECVET and its comparison with Energyducation

Context

The meaning of the word globalization is changing very rapidly.

This leads us to the need for global accreditations that allow our students, according to the needs of the countries, to quickly adapt to the required professional profiles.

ECVET is a tool that allows students and workers from any country to become accredited and work in different countries. Is a global accreditation for any worker to go to any country where they are needed possible?

What is ECVET?

ECVET is the European Credit System for Vocational Education and Training, a tool to help lifelong learning and flexibility of training pathways, including mobility within the EU. It is based on a series of common objectives, principles, and technical elements that facilitate comparability and transparency in vocational education and training.

The most important aspect is the approach focused on learning outcomes, intending to show what a student knows, understands, and can do after completing a training process. This recognition should not depend on a specific context, place, or teaching method, but should be based on what the student knows and learns.

Thanks to ECVET it is easier to obtain validation and recognition of job-related skills and knowledge acquired in different vocational training systems in different countries. Above all, it benefits and promotes mobility between countries and regions on the one hand, and lifelong learning on the other. Lifelong learning, recognition, and skills are intended to facilitate the transition between different jobs, companies, or sectors, as well as the transition from unemployment to employment. We are facing an ideal tool to facilitate the exchange and standardize the qualification of workers within the European Union.

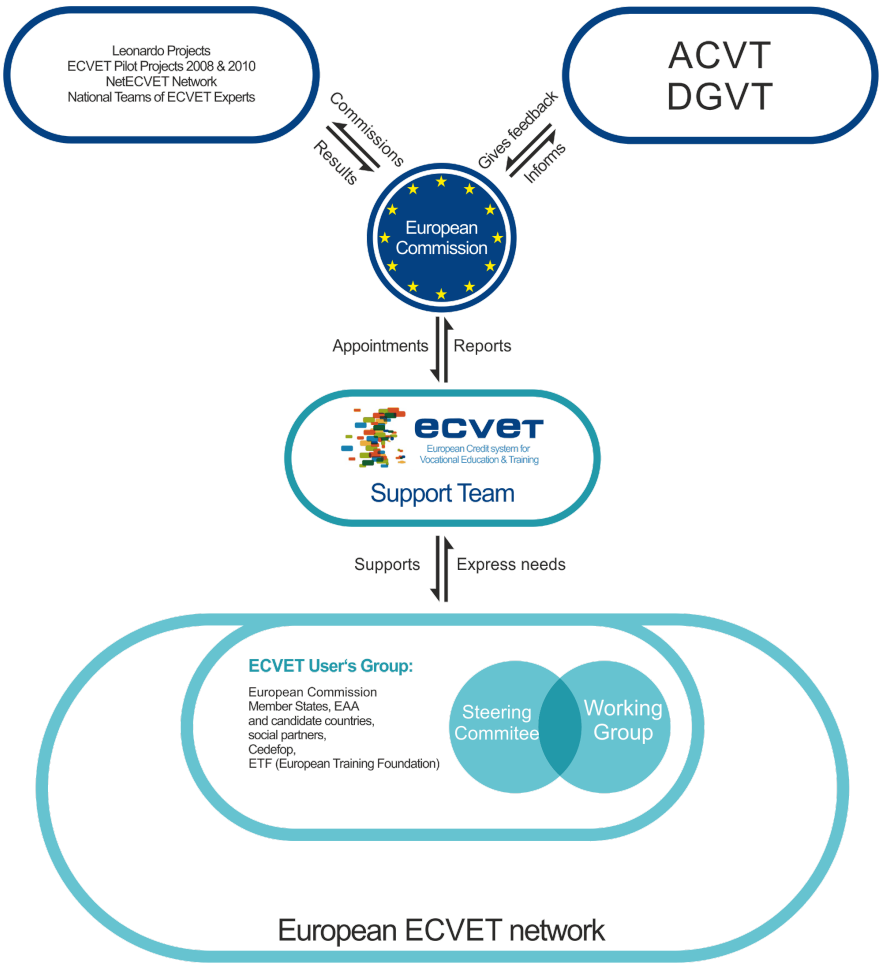

Figure 3.1: Structure ECVE

This system is not intended to replace national qualification systems, but to provide a greater degree of comparability between them. In summary, ECVET systems allow European citizens to combine different learning experiences in different settings across the European Union in one certificate. ECVET is applied to all learning outcomes obtained by a person in the different education systems that are transferred, recognized, and accumulated to provide a qualification. This initiative makes it easier for citizens of the European Union (EU) to see their training, skills, and knowledge recognized in a different EU country than their own.

Figure 3.2: The way to a diploma

How can we use ECVET to achieve the learning objectives of the Energyducation project?

The first thing we have to take into account is the qualification description in the ECVET standard to which we are relating our course. In our case, the Smart Energy Manager qualification is the one we defined among partners and used as a framework for preparing the modules inserted in the toolkit. The qualification is divided into different aggregated units of learning outcomes. These comprise a set of learning outcomes which, overall, present coherence and a common objective. These later ones are divided into comprehensive learning outcomes which can be detailed in terms of knowledge, skills, and competencies contents.

Co-funded by the Erasmus+ Programme of the European Union	Energyducation		ENERGYDUCATION www.energyducation.eu				
Energyducation SQF- Level:	4						
ECVET Points:	(if applicable)						
ECTS Credits:	(if applicable)						
EQF (NQF) Level:	ES	NL	SE	NO	DE	CH	
	5	4	5	4	4	5	
Aggregated Units of Learning outcomes	Energyducation – U1		Introduction to Smart Energy Management				
	Energyducation – U2		Design and Analysis of Smart Energy Measurement Systems				
	Energyducation – U3		Implementation of Smart Energy Management Systems				
	Energyducation – U4		Smart Lightning				
	Energyducation – U5		UX-Design				

		Disclaimer This is one of the actions of the Energyducation project which has been funded with support from the European Commission. This document reflects the views only of the project partners, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

Table 3.1: Toolkit listing

Co-funded by the Erasmus+ Programme of the European Union	Energyducation		ENERGYDUCATION www.energyducation.eu			
Generic Title of the Unit	U1- Introduction to Smart Energy Management					
Energyducation EQF-Level	4					
ECVET Points:	(if applicable)					
ECTS Credits:	(if applicable)					
EQF Level:	ES	NL	SE	NO	DE	CH
	5	4	5	4	4	5
Learning outcomes						
Energyducation – U1 Introductions to Smart Energy Management	Training Module Code		Competence			
			Knowledge	Skills		
1.1: Climate change and the need to save energy	1/1 1/3		Can understand the importance of saving energy Knows the phenomena of climate change and the need for CO2 reduction	Bring together climate change with the own living basics		

Table 3.2: Example Case Study

In collaboration with the partner school, the teachers should define the learning outcomes covered in the exchange program (taking into account the resources available and the schedule for delivering the different contents in the host school). The learning activities performed during the exchange program could be complementary to

the ones taught in the sending institution or a common task to be performed together with local students in the receiving institution.

At this point, what is needed, is to set up a common challenge that can enable students from both countries to implement PBL methodology adapted to the contents covered in the ECVET qualified learning outcomes.

The challenge should be based on the principles of PBL methodology, as set in the present handbook. Additionally, the contents of the toolkit (learning contents in MOOC format for developing different modules) are a valuable tool for international students participating in exchange programs to reinforce their practical abilities while taking part in the activities in receiving institutions. The theoretical contents could be worked out in advance and, this way, the language-related problems would be solved as it is much easier and more interactive and lively to work together while doing practical tasks.

The key part of any preparation and planning of an exchange program is to precisely define the learning outcomes - completely or partially covered - (and their corresponding knowledge, skills, and competencies) to be acquired by students when they carry out the tasks of the challenge in the receiving institution. Teachers from receiving institutions need to have a clear understanding of what is the objective and the evaluation criteria of the learning outcomes since their assessment will influence them.

From here we must generate common learning situations that allow us to work on these learning results in any of the countries of the European Union. This design of learning situations would be convenient to be carried out between different educational and institutional agents (business associations, labor unions...).

All the information mentioned above can be found on the website of the Energyducation project (www.energyducation.eu).

For any student from the European Union to be certified in the SEM (Smart Energy Management) qualification, the design of the learning tasks must be carefully planned. That is why the Energyducation project can be a starting point to design other learning processes related to technologies that are not related to energy. For example, mechanics, carpentry, welding, administrative management, etc.

In our case, we can design a learning path through different countries and agents participating in the Energyducation project, working in each of them, as long as the

design of the learning path and the learning outcomes identified to obtain the qualification are common to all.

Even so, this design must be flexible for each student, taking into account the curricular path of each student and each country. Therefore, the common route designed in principle can be adapted based on the experience of the student or worker, in any of the countries of the European Union.

Case studies and ECVET

In chapter 8 of this handbook, a short description of the case studies implemented in the project is shown. Together with information about the PBL methodology steps and their implementation, there is a part in which ECVET qualified learning outcomes are mentioned.

This is a crucial part of the accreditation process and is the one to be agreed upon by teaching staff from receiving and sending institutions. The following aspects should be detailed:

- Professional qualification whose learning outcomes will be accredited.
- Aggregated unit/s of learning outcomes to be covered in the challenge executed by students.
- Specific learning outcomes to be accredited (totally or partially) due to knowledge, skills, and competencies developed by students through the implementation of the different tasks.
- If there is partial coverage of the full content corresponding to a certain learning outcome, the specific contents (knowledge, skills, and competencies) worked out during the challenge.

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Aspect 1	**Toolkit on „Smart Energy Management"- Training Modules Piloting**	
Specific Modules	M1: Introduction to Smart Energy Management M2: Energy Technician in "Energy Efficiency and Solar Thermal System"	
Piloting groups qualification	Higher Technician in „Energy Efficiency and Solar Thermal Systems"	
SQF Level	4	
SEM qualification: Aggregated Unit of Los (Learning outcomes)	U1 – Introduction to Smart Energy Management	LO1: Climate change and the need to save energy LO2: Basics of Smart Energy Management LO3: Smart Energy Management Experts
	U2 – Design and Analysis of Smart Energy Measurement Systems	LO1: Climate change and the need to save energy LO2: Implementation of energy measurement sensors and grid analyzers (thermal/electric) LO3: Implementation of monitoring platforms LO4: Analysis of energy balance and efficiency rates LO5: Analysis of consumer behavior related energy consumption patterns
Aspect 2	**Definition of the Project Task**	
General task	Thermal and Electrical efficiency analysis of the F building of School. 	
Specific tasks which cover Los of Training Modules	- Analysis of existing energy system interface, designing and testing user interface	

Table 3.3: Example Case Study Thermal Installations

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Finally, the assessment criteria should be established clearly and in a detailed way so as the receiving institution's teaching staff could register the evidence to support undoubtedly when students have accomplished the minimum requirements and accredit them correspondingly.

Assessment criteria		1	2	3	4
Learning outcome 1: Designing a paper prototype					
He/She does not know the character and goal of the user interface, can not create user flow charts, and can not create a paper prototype		1			
He/She knows the character and goal of the user interface, but can not create user flow charts or a paper prototype			2		
He/She knows the character and goal of the user interface, creates user flow charts but can not create a paper prototype				3	
He/She knows the character and goal of the user interface, creates user flow charts, and creates a paper prototype					4
	Average:				
Learning outcomes 2: Designing a digital prototype					
…		…			

Table 3.4: Example Assesment Criteria

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Chapter: Process management

Context

In this chapter we will talk mainly about the non-methodological part of process management, focusing on time flexibility, both for the group of teachers and for the students.

Traditional teaching-learning formats are mainly based on rigid and immovables schedules. Generally, the student's schedule is focused on the development of topics (for example, from 9h-10h, mathematics; from 10h-11h, graphic design; from 11h-12h, assembly of facilities).

But in the working life, the work schedule of an employee does not necessarily focus on topics strictly structured in time, but moreover on the needs of the company, and the solution of tasks and problems that arise.

When using active learning methodologies, the schedules must be adapted to the didactic needs of the teaching-learning process.

Self-managed teaching teams

Structuring the work of teachers through the creation of teaching teams has raised the question of how much autonomy a teacher may have in structuring his/her work plan inside and outside the classroom. We understand the "teaching team" as the group of teachers of the same academic subject who share spaces related to skills, content, methodology, and evaluation, and aim to improve the quality of training for future workers.

Structuring the classes into challenges requires an evolution of the schedules based on modules. To enable new approaches, we need teachers with greater capacity for self-management.

All the previous points discussed require an organization with management that makes this structure possible, both from the organizational point of view (schedules, dates, etc.) and from that of the spaces (assignments and design).

That is why the teaching team responsible for the training cycle must have sufficient flexibility and adaptability to respond to complicated situations. The process itself, which, as discussed in chapter 2, can be divided into nine phases, requires planning in

which the teaching teams decide whether any of them should act or guide the student teams individually or in groups.

It is not rigid planning, such as the traditional programming of each module or subject, but it is an estimate of performance that must be carefully planned by the teaching team. As in any other methodology, it is important to define the what, the how, the when, and the who, but above all, it is necessary to define why we should do what is planned.

We should not fall into the trap of using infinite dynamics, for example, collaborative, in our sessions with students if they do not have a specific purpose. Nor should we be tempted to take an exam every two or three sessions, if we are not clear about why we are doing it or what we want to achieve with it.

Therefore, all this process must be planned by the teaching team before carrying it out and must be documented on a platform where all the teachers of that cycle, including those who have decided not to participate but who belong to the teaching team of the training cycle, can have access. This could be any of the existing platforms: Google Drive, Classroom, Microsoft Teams, etc.

Role of the self-managed teaching team on PBL process

If the nine steps of the PBL process (explained previously in chapter 2) are considered, the role of the teachers will vary depending on the specific tasks. Sometimes these tasks will require expertise and some others any teacher will be able to carry out the job because it will rely more on coordination and guidance actions.

Any of the teachers of the team will be able to implement step 1 *Outline the problem situation* and step 2 *From the problem to the challenge,* because both the presentation of the problem and the identification of what has to be done, can be defined by anyone of the teaching team. In these two processes, collaborative activities will have to be carried out with the students.

For example:

A problematic situation can be presented to them using a motivating video (https://www.youtube.com/watch?v=Z7eAKn0MUnA) through which some examples of what their work might be in the future can be given. A video can be shown to the whole group and it will represent a starting point for a debate about energy and what is the correct management of energy.

Once this previous task has been fulfilled, group dynamics can be used so that the students identify what they have to do and how far they should go in the planning process. One of the most effective dynamics methods may be “boundary examination” (https://www.business-online-learning.com/boundary-examination.html) which is a technique that allows improving the redefinition of the problem (e.g. rewrite the problem in an understandable way referring to its goal). This method also distinguishes between important and less important topics. In small groups, each group will redefine the problem and share it with the whole group.

Starting from step 3 *Obtain and organize information.* To generate alternatives, the expert teachers for each subject (theoretical and practical or workshop teachers) will start to work with the learners, guiding them with the objective that they will acquire the minimum knowledge, skills, and competencies identified for this challenge. Taking into consideration all the information supplied by the teaching team and in coordination with them, teachers must guide and train learners, collecting evidence of the achievements of each one of them and each team of learners.

The schedule of this step 3 for obtaining information will be based on the traditional week’s subject timetable. In this step, the teacher of each subject deals with his/her specific subject, but always bearing in mind that the teacher must take into account what the other teachers of the team are doing. In short, they must work as a team, just as we are demanding that students work. Nevertheless, whenever students find any difficulty which demands expertise (not available from the teacher who is with the group) of a certain subject, the teachers in charge at that moment won’t hesitate to tell students to leave this doubt for the teacher of that specific subject.

From a learner's point of view, traditional timetables can be "broken", meaning that learners can become responsible for planning autonomously the tasks they are going to do. Still, teachers should not lose the “control” and supervision of the learner's team or leave students alone. Teachers must always check what the learners are doing and which tasks remain open to do or to learn.

In step 4 *Generate and present proposals,* learners must generate alternative proposals, present them to the team, and defend them. Teachers can use dynamics of idea generation (brainstorming or brainwriting for example), or dynamics of choosing one of the alternatives (SWOT, for example).

In step 5 *Selection of proposal*, a teacher's team should confirm the suitability of chosen solution so as it can be worked on and fit the objectives.

Once the student teams have chosen what they are going to do, teachers should ask them to plan in Step 6 *Planning of actions* (a Gantt chart, for example). Their outline should be confirmed by the teacher's team.

In step 7 *Execution phase*, students work based on the planning made by themselves and not based on the assigned teacher's schedule (e.g. not carrying out tasks following the same timing as conventional lectures - practical tasks of the challenge when workshop lectures are scheduled on their traditional school calendar and so on - but when they are required as they go on with the implementation of the challenge). The teaching team may have a defined schedule (each teacher has got certain lecture hours scheduled throughout the week), but that does not mean that the students will work on his/her specific subject when that teacher is in class. A teacher may be in class with the students and they are working on another subject.

For example, students may be doing some calculations and the teacher will be in charge of the workshop. In these situations, the teacher should act as a guide, not as an expert in the subject. In some teaching teams, these situations can generate discomfort and loss of credibility or "power" in front of the students. We believe that it enriches the teaching team, involving the entire group in the guidance of the students.

In the project material the students get, it should be clearly defined which teacher is the expert for which task. This way every teacher can be the guide but only one will be the expert and there is no loss of credibility for the teachers and there is no uncertainty for the students.

The students must realize that the team is made up of all of us, the teaching team together with the students of the training cycle. Together we must learn and together we must work so that we all learn.

In step 8 *Presentation of results,* all the teaching teams will be part of the audience and the objective will be to improve students' skills in communication both in oral abilities and graphical/written support for the message throughout the implementation of the different challenges. Consequently, the important fact is not the actual achievement level but the evolution of the student in communication skills regarding the starting point. The role of the teaching team should be to supply students with different

techniques and advice to get an effective message supported by the right graphical software.

Finally, the in 9th and last step *Assessment of results,* the teaching team has got a key role in both grading and marking the technical competencies in which each teacher has got expertise (previously it will be clearly defined who is going to be responsible regarding the different learning results worked on through the challenge) and those - especially the transversal competences - which require sharing evidence and viewpoints to get a common and agreed grading and mark.

Role of management teams

As we have previously said, the teaching team must have sufficient flexibility to adapt the schedules to what is planned. It is also important that these teaching teams are supported by the management team of the training centers.

There are times that traditional training has allowed us to normalize and standardize documentation, schedules, and evaluation times. The implementation of PBL methodology does not mean that we should not follow uniform criteria, but that we should allow greater flexibility and adaptability to teaching teams. Therefore management should have attention to facilitating enough time for teachers to fill in their coaching role guiding students through team working and carrying out further training for their teachers.

Why should we plan the same moments of evaluation in all the training cycles of the center? These evaluation moments must be planned by the teaching teams of each cycle, adapting them to their criteria and experience. Of course, the center must demand common minimums from all of them, otherwise, the management teams will be overwhelmed by chaos.

For example, when we pose a problematic situation to a group of students, we must know when their resolution will be finalized, and what minimum documentation will be required of that teaching team to continue maintaining the quality criteria of the teaching-learning processes. In this case, it is the head of studies who must be flexible in his work but maintaining his position of unifying the quality criteria of the teaching-learning process. That is documentation, reports, statistics, student and teacher satisfaction surveys, and others.

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Chapter: Adequacy of spaces

Context

We often talk about new changes we are experiencing in education. New methodologies, ways of working and teaching, to adapt to the demands of today's society and think about the future. From early stimulation, multiple intelligences, learning, and cooperative work, to PBL or project or problem-based learning. But how do these changes affect physical space?

The classroom is one more element of the teaching-learning activity that requires it to be rethought, restructured, and properly organized to adapt to the new methodological and technological requirements.

Many times we forget the importance of the role of the space for students, where they spend most of the school day. A space in which he/she interacts with others and in which, year after year, he/she develops as a person and prepares for the future.

In summary, the implementation of these new methodologies requires classrooms, equipment, furniture, and specific spaces different from those that usually exist in training centers. Their design mainly fits the characteristics of flexible, open, interconnected spaces that foster environmental situations that favor active-collaborative work.

Characteristics of the spaces

Visual permeability

Visual permeability is the ability to see the interior and exterior of a place from different positions. Furthermore, it is key to achieving a sense of community and connectivity between spaces. That is why it is one of the main characteristics of innovative teaching-learning spaces.

Figure 5.1: Glassed teaching rooms

https://ethazi.tknika.eus/es/caracteristicas-de-los-espacios-ethazi/

The main proposal is that of open spaces with the majority of glass walls, open and transparent. The visibility between the interior and exterior of the places is total and the preferred color in the classroom must tend to clarity. At first, it may be uncomfortable for teaching teams and students to change from a traditional classroom model to one with visually permeable spaces since they have become accustomed to working in a type of classroom in which the door is closed and nobody knows what goes on inside it. That is why, taking into account the general idea of generating open spaces, we must also design spaces to respect the privacy of people, whether they are teachers or students. There they can be alone with their thoughts, for independent study, silent reading, the use of a laptop or simply to relax.

Figure 5.2: Working in Groups in a glassed room

Flexible furniture

As a physical space, the classroom must be flexible to the new needs of the students. This flexibility must manifest itself in two fundamental aspects:

- The furniture and physical elements that the classroom has, going from the classic desks to the tables that facilitate teamwork and collaboration.
- The arrangement of the elements, seeking adaptation to the different needs of the students and allowing the teacher to have different modalities for the class without the need to make physical adjustments to it.

The classroom furniture must allow the possibility of configuring the space differently, always concerning the moment of the learning process. It can be configured in different ways: for individual work, in groups of 2 to 4 students, in a large group, etc.

Figure 5.3: Working in groups with flexible tables

There must be no teacher's table as such. The teaching team must experience the same type of physical space as the students. With an open flow to the classroom, the teaching team must be able to better facilitate and listen to the students' conversation and thinking.

Figure 5.4: Free movable chairs for sitting together in groups

360˚ paintable walls

This is another characteristic that is related to the flexibility of the spaces. The main idea is to turn every wall of the learning spaces into blackboards. Instead of having a single point of visual support for the teaching staff and the students as in traditional classrooms, all the walls would be used as blackboards, facilitating new spaces for teaching and learning.

Figure 5.5: Paintable glass wall

There are special paints on the market that, applied to smooth walls, turn them directly into slates. Another more economical option is to apply a vinyl coating to the smooth wall.

Figure 5.6: Adding notes to a presentation on a paintable wall

Ease of use of Information and Communication Technologies

Integrating the use of ICTs is a demand of the labor market, therefore the school must also educate in the use of ICTs: teach the responsible use of information and transform it into knowledge. Due to the current technological demand, the learning spaces must allow the connection of fast and efficient wireless networks. They must allow the use of various devices (laptops, smartphones, tablets) with greater connectivity and ease of use. Even so, some teaching modules may need to use special graphic or industrial design programs that require special devices.

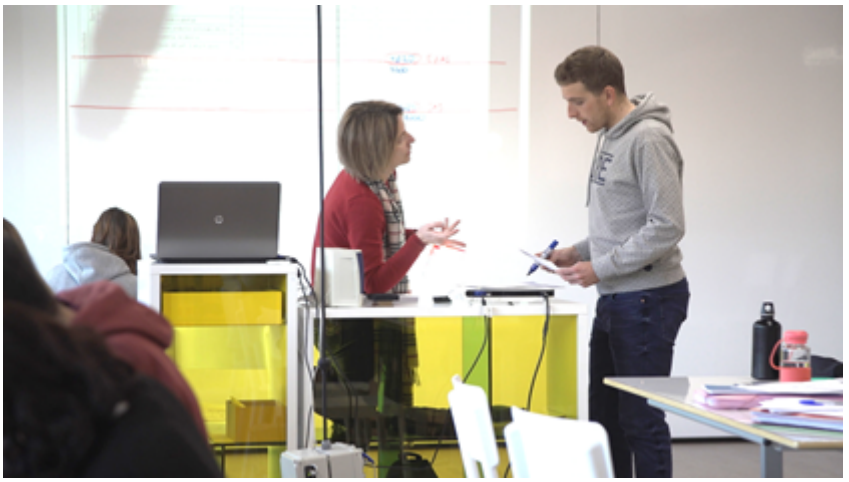

Figure 5.7: Consultation situation in a technically well-equipped class

Also interesting is the proposal for the use of interactive whiteboards, with which several students can work together or independently on the board, using their fingers or a marker. Every inch of the surface works as a collaborative workspace: multiple students and multiple actions.

Flexible connections

It is interesting that, having as reference the connectivity of digital instruments and devices, the electrical and digital connections to the network are as flexible as possible. Conveniently, these connection points can be adapted to the different combinations of use of these learning spaces.

Figure 5.8: Freely movable sockets on the ceiling

As an example, we can suggest electrified rails, columns, or minicolumns of electrical connections, raised technical floors, etc.

Figure 5.9: Adjustable columns with electrical connections

Acoustic comfort

The most important thing in a classroom is acoustic comfort, both in traditional and collaborative teaching. If a classroom has poor acoustics:

- Low-frequency sounds distort speech,
- sound bounces off walls and ceiling and echoes are created,
- noise levels intensify,
- students and teachers have to raise their voices to be heard.

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This will make both teachers and students feel tired and lose concentration. Therefore, the main objectives of acoustic comfort in spaces are:

- Reduce sound levels,
- minimize low-frequency background noise,
- guarantee the clarity of speech and the comfort of speaker and listener,
- and avoid the echoes.

The solutions to be adopted in these spaces could be based on:

- Install an acoustic ceiling with exceptional absorption qualities for all speech frequencies, specifically the lowest,
- install panels on the back wall for traditional teaching and group teaching,
- enable a reflective area on the ceiling above the teacher for situations related to traditional teaching.

Figure 5.10: Group work situation under movable socket

Proposals for an initial adaptation of spaces

At first, the change or modification of spaces and furniture is very attractive, but making these modifications does not imply a change in the mentality of the learning model change. This adaptation is still the last part or final touch of the transformation of the environment of the educational center, although it is one of the most visible and detectable parts by external agents.

Still, from the moment we begin to be aware of the need for a change in the teaching-learning model until we finally see the results of the change in our students and the spaces, it can take a relatively long time (approximately 5-6 years).

During that time, we can make small changes in the learning spaces that can be useful during the process. We will quote them briefly:

1. **The teacher's table.** A work table will be needed for when the teacher is not making some important explanation or some master class but when entering the classroom, but this table should not be the main reference of the classroom.

   The teacher's work is together with his students and everyone must use the same means of work. Normally, the classroom projector is usually connected to the teacher's computer. Teachers can use laptops and connect when necessary using a flexible cable or via Bluetooth from any table in the classroom.

2. **Blackboards and paintable walls.** In traditional classrooms, a general whiteboard is normally used for everyone. All the students are looking at the blackboard and the teachers dictate their lesson from a preferred place on it.

   Smaller individual blackboards distributed in the classroom can be enabled so that the student teams can use them or if the teaching team considers it appropriate to clarify any doubts to the students of a specific team.

   If you want to build paintable walls, an economical option is to modify the existing brick walls. Simply by attaching an addition of plasterboard and then covering this wall with transparent vinyl we would already have one paintable wall.

3. **Student tables.** In a teamwork environment, the furniture must facilitate at any given moment a reconfiguration of the classroom. For example, if you take an individual test, if you want to have a debate or if you have to expose some important topic.

   In either case, these changes should be done relatively quickly, in a couple of minutes at most. If the furniture was very heavy or the tables are anchored to the floor or other tables, this would make this agile modification impossible.

   Tables and chairs must be light and can be individual because it is the individual who adapts to the table. We suggest tables with tables measuring 70x70 cm for

example, in which a laptop and a notebook fit perfectly at the same time. It is also important that the tables and chairs in the classroom are stackable and, if possible, folding chairs.

These tables are not the property of the student throughout the course but will change according to the situations created in the classroom. That is why it is important to have lockers or spaces where the student can deposit their belongings (notebooks, books, and such).

4. **Flexible connections.** A good wireless internet network is very important, especially if students use laptops for classroom work. Without a powerful wireless network, teachers and students cannot work well.

   If this wireless network is not available, it is not convenient to locate computers as the preferred center of the classroom. We propose to place them in the corners, glued to the walls of the classroom to free the central part of it. If the electrical wiring and internet connection are placed on the walls, the cables will not crush.

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Chapter: The new role of teachers and students

Context

Current and future circumstances (as we are experiencing an era of constant changes) force us to prepare future workers, future people for situations of uncertainty that will come.

We don't know what kind of job profiles are going to be needed, neither the technologies that will come in a few years nor the jobs that our current students will perform in the future. Given this new learning scenario that we want to create, we will see how the role of the actors acquires new nuances since both teachers and students will carry out a change of roles.

That is why the school and the places and methods of learning are changing. The traditional roles of student and teacher will tend to disappear in the sense that the former will cease to be passive subjects of their learning (dependent solely on the teacher and what he or she transmits) and the latter will become guides or mentors of the learning process of the students, and not mere transmitters of knowledge and skills.

The role of the student

The objective pursued with active methodologies is that students feel motivated to learn and not just to pass, it means, to get a good grade. For this purpose, Project-Based learning is to empower students in their learning process, acquiring a leading role. The student has to go from being a stone guest (passive element) to becoming someone who takes responsibility for his learning process and for collaborating in having his or her classmates also involved in learning. In the beginning, when we start using different active learning processes, we can listen to phrases like these:

Frequent sentences among students:

- "I don’t know how to do that."
- "I prefer to study the day before sitting the exams."
- "Here you have to work hard."
- "I can’t or don’t want to work in this group”
- "I am not learning anything"

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Or making excuses:

- "You (the teacher) do this so you don't have to work and teach."
- "You have to explain it to me, that's what they pay you for."

It is important to assume that students must be encouraged to accept this change of role, which will have a positive influence on the development of personal and social skills established in the curriculum.

These skills are closely linked to experiences and lifelong learning, so they will evolve throughout life. The bases must be strengthened so that they are acquired and never taken for granted that they are settled.

We can reflect the change in the student's role and compare it in the following chart:

Changes in student's mentality	
Traditional role	**New role**
The student shifts from…	**To…**
…considering that a teaching material exclusively in the written text that the teacher offers.	…being prepared to handle multiple and varied sources of information including assessing the reliability of sources.
…waiting for the teacher to turn the information into knowledge for him/her.	…performing active work to convert information into knowledge, creating elaborations.
…considering the classroom as the only place where they can learn.	…considering the educational context as something that does not end in the classroom or the faculty.
…considering the teacher exclusively as the figure from which one will learn.	…considering his/her classmates as people, one can also learn from and whom he/she can also teach.
…considering that the result of learning is based on knowledge.	…considering that the result of his/her learning is not only based on knowledge but also based on skills and competence (attitudes, methods, information search skills).
…thinking that they learn only to pass the exam.	…understanding that the learning will never end and that developing the ability to learn will condition their capacity to adapt to future situations.

Table 6.1: Reflection of the learners

The role of the teacher

A project-based learning methodology will not work if all the parts do not adequately interpret their role. The role of the teacher will always play a fundamental role as a

facilitator of learning, sometimes to redirect students to the resolution of technical issues (the vocational education teacher is usually a specialist in different technical fields) and sometimes as a guide or mentor.

This change of role must be carried out little by little because the human being learns by imitation, and we have also been students. Our teachers (some with better luck and others with worse luck) had mostly taught us in the old style until a few years ago. Because we have seen traditional teaching for a long period of our life (from first class until the end of studying) this behavior is anchored in us. So, teachers should be aware that they have to change and move forward in that direction.

The most important skills that teachers will have to work on are:

- Turn to the interests and needs of the students. This will allow us to know, inspire and involve them.
- Listen actively. Not only what the person is expressing directly, but also the feelings, ideas, or thoughts that underlie what he/she is trying to express. Inactive listening, empathy is important.
- Be intuitive. Understand or perceive something clearly and immediately about what may be happening at any given time. The role of teachers as an observer acquires great importance daily. You will have the opportunity to notice many nuances in the interactions and performance of students that allow you to act in one way or another.
- Identify the student as the protagonist in the learning process. The important thing is not what you know, but how she/you can learn it.
- Be aware of the achievements that students will acquire. The small steps that you will observe in daily evolution will claim all your attention.
- Be the guide, tutor, or mentor who is waiting for the proposed objectives to be achieved. It will help students to think critically and orient their reflections through questions that will stimulate the search for information and so, enable them to overcome their difficulties.
- Be patient. Let them fight to learn, and accept that the construction of individual and collective learning is a process. Be aware that they cannot be left alone and must be accompanied, and that sometimes, retaining the solution will be the most convenient for students.
- Focus our work on the student learning and not on what we teach as teachers based on a static and usually uncompromising schedule. The schedules must be

adapted in each moment and situation while continuing to work on the learning outcomes, but deepening the agenda according to the student profile.

- Be part of a team of teachers in which all have a clear and consistent understanding of the whole process and their role in it.
- Give and receive feedback (round trip). Have feedback between teachers and students throughout the learning process. The students must have an accompaniment that allows them to self-regulate, receive improvement guidelines, and so, perceive their progress.

At the same time, the teaching team will need information on the evolution of students, to guide them in their learning process. The feedback, therefore, allows exchanging impressions between the teaching team and the student about their learning process. On the other hand, if we want students to take responsibility for their learning process, it is essential not to try to impose our impression as teachers over theirs.

We must reach an agreement with them on the real progression of the student. If there is no agreement, measures must be adapted to achieve it, either by encouraging the student to demonstrate his or her point of view or by recognizing the impression of the teaching team by the student.

There is a comparison between the traditional role of the teacher and the new role to be acquired in the following table:

Changes in teacher mentality	
Traditional role	**New role**
The Teacher shifts from…	**To…**
…being the only source of the information.	…being a source in the ones available by the student.
…being the one who interprets the information and turns it into knowledge for the student.	…being a facilitator or guide, to let the student perform the same process that he or she used to perform before.
…considering the classroom as the only possible context for the transfer of knowledge to the student.	…organizing new educational contexts that help students build knowledge and develop skills.
…consider him/herself as the only model from which you can learn.	…taking into account the relevance of peer learning, and providing opportunities for this to happen.
…teach and evaluate content from an academic perspective.	…teaching and evaluating competencies (knowledge, skills, and attitudes) from an academic-professional perspective.

…teach what is needed to learn.	…teaching how to learn. That is, teach the student to learn knowledge, skills, and attitudes that help him/her to continue learning.

Table 6.2: Reflection of the teacher

Interdependence between both roles

The active role of students requires that the teacher will be the guide or facilitator of the learning process, understanding that the timing of the learning process can be different each time. Each activity can take longer than expected, and this must be assumed.

Due to this change of roles, we have just talked about, students and teaching staff often have problems with the organization of schedules. For students, it will be necessary to start giving guidelines at the beginning, always trying to acquire more and more autonomy.

It is not that the role of the teacher passes from "all" to "nothing" giving up all the management, but that the students are gradually able to self-manage. For this, different instruments can be used, such as team schedules, group or individual learning journals, portfolio of evidence of learning achievements, intermediate tasks, or essays of the final evidence of the challenge.

In this change of roles, there is also the need to work in teams. Students often have difficulties in coordinating and taking responsibility for their learning and that of their team. We can help them in the process through tools such as team contracts, tutorials with each team, self-assessment, evaluation, etc.

As you can see, teamwork is fundamental in this process. It is important to remember that, if several teachers work in solving the problem, it will be necessary that they also coordinate their activities, as they ask to collaborate with students, and so develop the same teamwork skills as the students. Doing so will be an example for them.

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Chapter: Defining the teams

Context

The collaboration consists of working together, helping, supporting, encouraging, caring for each other, being attentive to the needs of each team member, to achieve common goals. Success is sought not only for oneself but for all team members. Needless to say, we are all good at something; no one is good at everything.

Collaborative learning is a didactic technique based on learning in small teams, where each member collaborates to maximize both their learning and that of each of their peers.

That is why it is essential to provide teaching teams with different tools for creating student teams, but above all, once created, to activate them properly. In this chapter, we will try to explain and define the different steps to follow.

Even so, before starting to create the teams we must ask some questions:

1. Should student teams be homogeneous or heterogeneous?
2. How many members are the teams going to be?
3. Will these teams be maintained throughout the course or will we change them every so often (every quarter, every challenge, etc.)?
4. What team roles are we going to distribute in the teams?

The answer to these questions often depends on the characteristics of the students. Sometimes it is convenient to force situations if possible related to the work environment for which they are studying.

Different theories suggest that teams should be heterogeneous in their personality so that each one contributes their part to the team and this is as compact as possible. But real classroom situations lead us to not have a general rule to create these teams.

It is up to the group of students to become a good team to achieve the objectives of both the collective and the individual. Following the theory, the number of members of the groups should range between 3-5, making 4 the ideal number. But there are times when teams of 4 students cannot be generated (due to the number of students who have enrolled in the training cycle) and other times, the equipment available in the classrooms (practical classrooms and theoretical classrooms), makes it difficult to optimize these teams, sometimes reaching teams of i.e. 2 or 6 students.

Team building techniques

Using group formation techniques or work teams is not as difficult as it might seem a priori, nor is it totally easy. Of course, although it requires more effort on the part of teachers, the result is usually more satisfactory and lasting; and above all, if it has not been previously implemented in the classroom, a very attractive precedent will be created for the future. There are several moments in the life of a group or team that require the application of some type of technique, although the planning, development, and evaluation of the techniques require some effort, in the medium and long term the saving in time is noticed and greater ease to perform joint tasks or obtain better results (in the shortest possible time). It is important to note that it will be the personal skill of the group dynamizer (usually one of the teachers of the training cycle). And while this skill can be learned, a technique is not effective in itself, because it has no life of its own, and requires not only certain skills, but a lot of patience because changes are often necessary. To introduce and implement group techniques, it is necessary to be a flexible person with a great capacity for adaptation.

Although there are multiple techniques and dynamics for team building, in our case we propose to use two techniques:

- Color Technique
- FAIRY

Color Technique

This technique is easy to dynamize and produces results in a relatively short time. It consists in having the learners each choose for themselves one of the colors that can be seen in the following graphic:

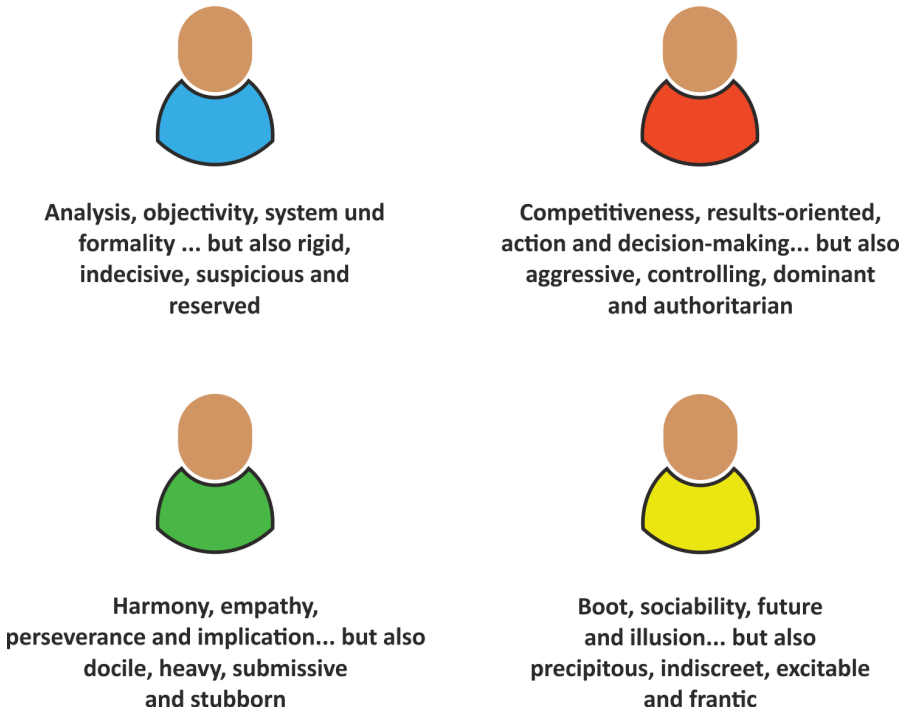

Figure 7.1: Properties of the colors in the color game:

Four fundamental types of energies are classified, each associated with a color, which can define the behavior of people. Everyone has four types of energy, it is the combination of the four energies that creates a single individual.

The energies are represented by the following colors:

- Sea Blue: Cold and analytical,
- Fire Red: Energetic and impulsive,
- Yellow Sun: Cheerful and spontaneous,
- Green Earth: Social and empathic.

Every being has some of the four energies, but normally some of the energies (or colors) are more dominant than the others and mark one's character and behavior more than the others. There are no better or worse "colors", each one has its characteristics that can be better or worse depending on what.

Identification of profiles by colors

It is about performing a game with the students to make the teams according to their personality traits and their role in the teams.

The game is as follows:

1. The group is shown the document with the adjectives that correspond to the different colors (red, yellow, blue, and green).
2. After verifying that they understand the meaning of the words, the teacher invites them to choose the color that best suits each of them. The colored cards are on the table.
3. The teacher asks everyone to write their name on their card and, just in case, a second color (the one that identifies them the most after the first).
4. The teacher collects all the cards and takes time to sort the students into teams taking into account the following criteria:
    - All colors are represented in each team,
    - If it is not possible with the first color card, the second color that the students have chosen comes into account, to compensate for the profiles and personalities in the teams,
    - The students will be informed in which team they were sorted.

HADA – Team Composition Analysis

Any team has its strengths and weaknesses, which are improvable aspects. But what strengths does each team have and what aspects are improvable? How are strengths and weaknesses created in a team? Strengths arise when team members have mutual trust and when each team member brings their strengths to the team. Therefore, it is required to know in advance what are the strengths of each of the team members. Weaknesses arise when members of a team block each other and/or when certain skills are lacking: e.g a team consisting only of creative people will produce many ideas. However, they will have difficulties in their application. Next, a method is proposed to find out a student's strengths that he/she transmits to the team and which strengths are missing. This technique can be used either before the creation of the teams or afterward, to identify the different profiles of each student, since the color technique may not be very objective. In any case, it is a very simple technique that consists of each student filling out a form in which they must choose between different affirmations of their personality and number them from 1 to 4. Once the check is done, the sum of the numbers must be done vertically. In the end, the results should be presented in the graph of the following sheet. The teaching team analyzes the results and distributes the students in different teams trying to maintain heterogeneity.

Team Roles

Although different roles can be assumed and distributed among student teams, we will take the profiles or roles obtained with the HADA technique, which are the following:

Managers: They like to take the initiative and, therefore, sometimes they seem to be dominant. The managers pay attention to the progress of the team and assume responsibilities. They are oriented to conclusions and objectives and do not like when time is wasted or when people relax too much.

Collaborators: They like to work together with others and are compromising. It is important for them that a good climate prevails in the team, so they prefer to avoid confrontations and debates. Sometimes they give the impression of being shy.

Developers: They like to develop new ideas and are willing to discover new paths. They have the facility to elaborate proposals and, therefore, sometimes they are a little restless. They don't like routine or boredom. They are creative and give importance to diversity in the team.

Analysts: They work in a perfectionist and organized way, and they expect others to work carefully, so they don't like confusing or convulsive situations. They are compliant and try to evaluate things objectively.

We can also choose other roles, depending on the characteristics of each team: spokesperson, secretary, finalizer, motivator, etc. Ideally, in each team all these profiles are present. After doing the HADA analysis it may turn out that there is some imbalance in the profiles. One way to compensate is to set certain functions. For example, if there is no analyst in the team, then it would make sense to make sure someone fulfills the function of quality manager. In addition, certain formal functions (such as the coordinator, team spokesperson, presenter, time controller) should be agreed upon so that competencies and responsibilities are clear and balanced. A function does not have to be assumed for the entire duration of the project. A change of function avoids monotony and promotes understanding (for example, if team members do not concentrate on work, being responsible for controlling time becomes quite difficult). In addition, role changes are also useful for each team member to do what they are good at, and they can also try to learn what they still do not handle well.

Set team standards or activate team

In each team, there are rules of operation and relationship, even if they are not explicitly formulated. If the rules are not previously agreed upon, attitudes can infiltrate (for example: "We never arrive on time anyway."), which can make teamwork

unnecessarily difficult. That is why to write the rules and translate them into a document we will use the following format, and to fill it out we will follow the dynamics described below:

1. Ask the group to hold a brainstorming session and think about:
    - What can prevent teamwork, and take note of the elements that can damage collaboration (i.e. only favoring own interests, not offering help)?
    - How do they want your team to do joint work: what rules should be valid for everyone on the team?
    - What standards should be applied concerning cooperative work with other teams?
    - Which striking name could be chosen?
2. Then, ask them to write the rules down in a document and present their conclusions (in summary form, 3-5 minutes).

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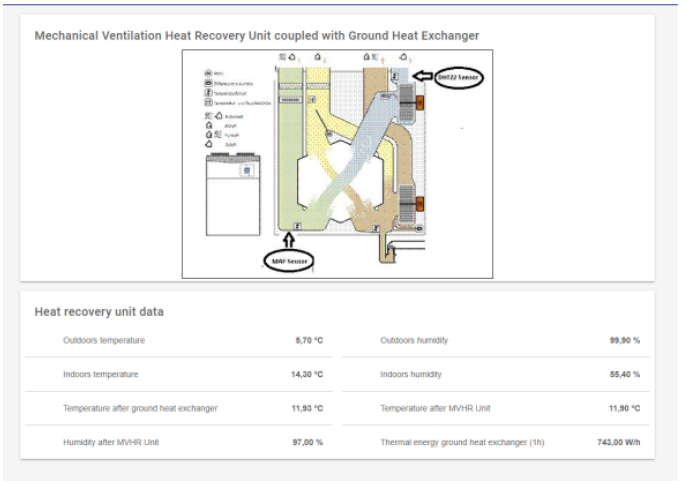
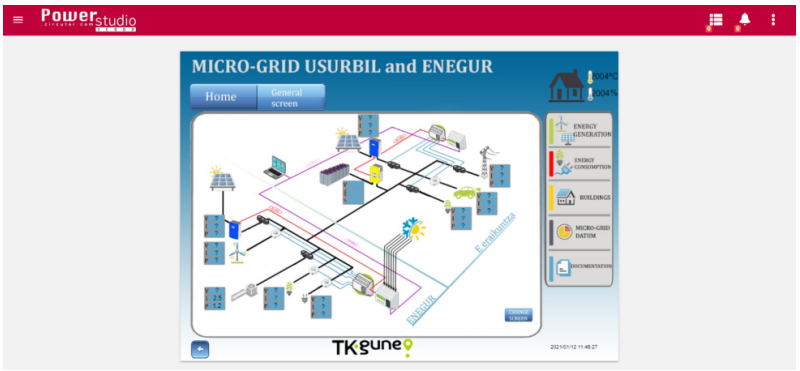
Case Studies

Case Study from CIFP Usurbil LHII (Basque Country, Spain)

Aspect 1	**Toolkit on „Smart Energy Management"- Training Modules Piloting**	
Specific Modules	M1: Introduction to Smart Energy Management M2. Energy Efficiency: Thermal Installations	
Piloting group's qualification	Higher Technician in „Smart Efficiency and Solar Thermal Systems"	
SQF Level	4	
SEM qualification: *Aggregated Unit of LOs (Learning Outcomes)*	U1- Introduction to Smart Energy Management	LO1. Climate change and the need to save energy LO2. Basics of Smart Energy Management LO3. Smart Energy Management Experts
	U2 – Design and Analysis of Smart Energy Measurement Systems	LO1. Identification of measurement points and parameters LO2. Implementation of energy measurement sensors and grid analyzers (thermal/electric) LO3. Implementation of monitoring platforms LO4. Analysis of energy balance and efficiency rates LO5. Analysis of consumer behavior related energy consumption patterns
Aspect 2	**Definition of the project Task**	

General Task	Thermal and Electrical efficiency analysis of the F building of School 
Specific tasks which cover LOs of Training Modules	– Thermal Analysis of existing Air recovery system through free hardware and software-based monitoring system. 

<table>
<tr><td></td><td>


– Electrical self-sufficiency analysis of the F building through a proprietary monitoring system.


</td></tr>
<tr><td>Aspect 3</td><td>Time arrangements</td></tr>
<tr><td>Teachers</td><td>The teaching team (teachers who deliver classes to the group) has been set up to have their workload concentrated, as much as possible, with the same group. That way there is the possibility to be flexible in terms of the specialist teacher taking charge of the group as the project progresses and the need for guidance changes (in terms of subject been covered by the project at that time) for students. The team did work as a self-managed one.</td></tr>
<tr><td>Students</td><td>The student’s timetable changes radically while they are carrying out the project so there is no division in terms of the subject taught but a continuous time during the day devoted to the project.</td></tr>
<tr><td>Aspect 4</td><td>Adaptation of spaces and infrastructure</td></tr>
<tr><td>Furniture</td><td>There was used flexible furniture so it was easy to change the layout of the room. When “traditional classes” were held out it was possible to arrange tables in a typical rectangular way whereas while working in teams they</td></tr>
</table>

	could be moved and grouped as wanted. The blackboard is a traditional one and, even if it would be much appreciated, there are no paintable walls. 
ICT connections	Each student has a portable computer so it is easy for him to move and work on a team basis or individual basis. There is wifi coverage to work on the internet. 
Aspect 5	**Process management: Teacher role/Student role**
Teacher role	The role of the teacher has been more guiding students through the complexities of the Project rather than delivering just content. It has been

	very important to establish some checkpoints through the project development so students don't lose the objective and cope with such a long work without getting lost or frustrated. This new role is not easy at first and pedagogically requires a change for the teacher who feels sometimes more comfortable delivering content and not forcing students to get the results on their own.
Student role	The toolkit was a really helpful tool for them as it enabled them to have the knowledge related to the learning outcomes in a way (online) much more flexible. This means each group could have access to the different concepts needed throughout the development of the project in a synchronized way. The teacher was there, of course, to give support while doing the tasks and for any query related to the online course itself.
Aspect 6	**Teambuilding**
Techniques	In our piloting experience, we did not use any technique for building up the teams since our group was a second-year group so we knew how each student was in terms of character and profile. We did try to mix up people in groups of 2-3 people in which their characters (creative, manager, hard worker...) did have a balanced structure to have a better experience. Nevertheless, sometimes it is better to mix up homogeneous character students to force them to take up roles they are not used to. Still, the use of any technique or dynamic should be envisaged in case students from the group are new and there is not any experience with them by the group of teachers.
Aspect 7	**Assessment / Qualitative experience**
Assessment	Students were assessed both in technical and transversal skills. Technical aspects were corrected by each corresponding teacher and the transversal skills were assessed by the group of teachers together. These late ones were based on evidence taken about initiative and responsibility, team working, and communication skills.

Technical Competence (60%)	**Transversal competence (40%)**			
Design and Analysis of Smart Energy Measurement Systems	Teamwork	Report, presentation, and ICTs	Individual work (implication and autonomy)	Oral communication
60%	10%	10%	10%	10%

Table 22: Competencies

U04: DESIGN AND ANALYSES OF SMART ENERGY MEASUREMENT SYSTEMS

Assessment criteria	**1**	**2**	**3**	**4**
Learning outcome 1: Can define energy measurement parameters in the system				
● He/She does not know which are the parameters (electrical energy in generation and consumption) to measure to analyze self-sufficiency and neither how to measure thermal efficiency rate for MVHR unit and ground-air heat exchanger.	**1**			
● He/She does know which are the parameters to measure but is not able to identify where to measure them.		**2**		
● He/She knows which are the parameters to measure and, even if not all the sensors are located, he knows where to locate them.			**3**	
● He/She knows which energy parameters to measure are and where to locate them with its sensors.				**4**
Average				
Learning outcome 2: Implementation of measurement sensors and grid analyzers (thermal/electric)				

• He/She has no idea about the kind of sensor to place into the installation.	**1**			
• He/She knows what kind of sensor to place but is not able to accomplish the connection and register of data.		**2**		
• He/She knows what kind of sensor to place, can acquire data but not the registering of it in a database.			**3**	
• He/She can select the right kind of sensor and even register data in time intervals.				**4**
Average				
Learning outcome 3: Can identify and implement which platform to use for integration of monitored data				
• He/she is not able to identify a current existing monitoring platform.	1			
• He can identify a current monitoring platform but is not able to implement new measurement data in it.		2		
• He can identify and implement new measurement data but is not able to show it in UI.			3	
• He can identify and implement new measurement data as well as integrate it into a UI.				4
Average				
Learning outcome 4: Can identify energy balance and efficiency rates				
• Is not able to determine the energy balance in the system and the efficiency rate.	1			
• Can carry out a yearly balance of energy identifying energy surplus and shortage periods but the parameters have not been correctly chosen and he does not assess efficiency rate correctly even if he applies the formula.		2		

• Can carry out energy balance analysis and efficiency rates calculation but does not interpret the results.			3	
• Can determine both energy balance and efficiency rates and justification.				4
Average				
Learning outcome 5: Can identify consumer behavior-related patterns and their accordance with estimated use.				
• He/She can generate the electrical energy profile of the installation.	1			
• He/She can generate the electrical energy profile but not analyze the pattern.		2		
• He/She can generate the electrical energy profile and analyze it but the interpretation is wrong.			3	
• He/She can generate the electrical energy profile and correctly analyze and interpret it.				4
Average				

Table 23

- The transversal competencies to assess in this challenge will be teamwork, communication (in written support), individual performance, and oral communication and they will be assessed individually.
- The ponderation of the transversal competencies will be as shown below.
- The way to assess these will be done in different ways: teachers, auto-assessment by students, and evaluation among them. Finally, we will calculate the average of all the marks.

Competence	Who will assess			
	Teacher (via Google Forms)	Teammate	Auto-assessment	**Average**
Teamwork (10 %)				
Report, presentation, and ICT (10 %)				

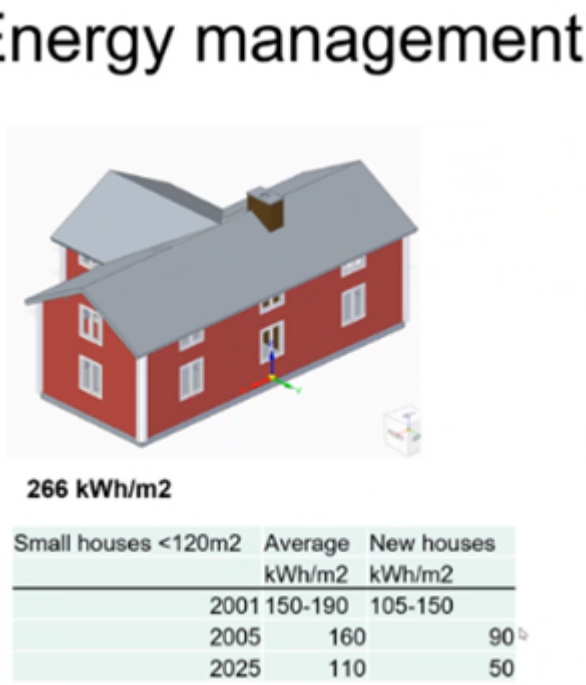
Individual work and autonomy (implication) (10 %)				
Oral communication (10 %)				

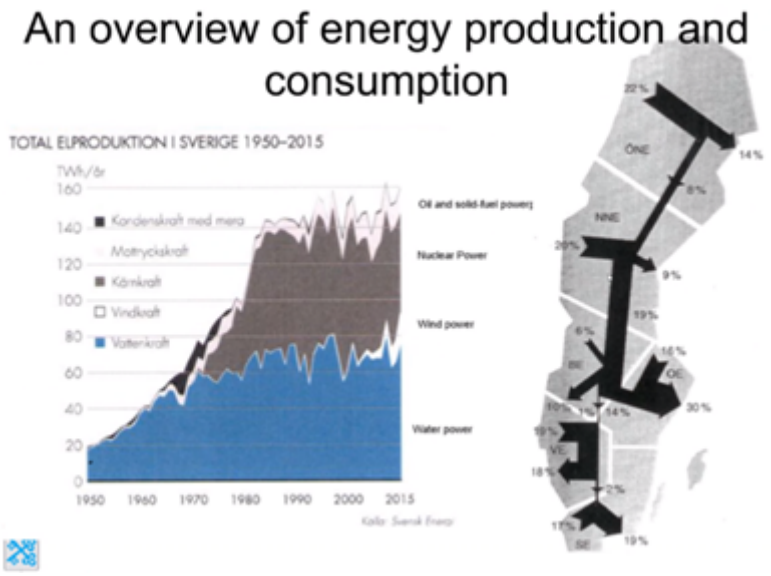
Table 24

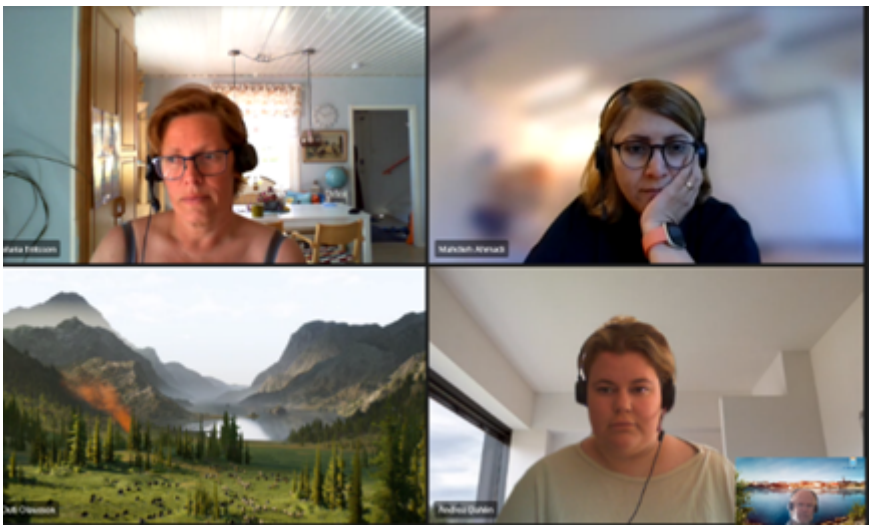
Qualitative experience	The experience was interesting for both students and teachers since it enabled them to practice a blended learning experience taking as a base a MOOC course. Students judged the implemented material very useful for the project development since it was possible for them to access the needed knowledge in a very livable manner (the majority of it is based on teacher recorded videos with online assessment material to prove the student has reached the minimum target). Until then, it has been required to deliver group lessons to the whole group while implementing the project. This has the disadvantage that the development pace is different for each group and it is difficult to uniformize it.

Case study about Energy Mapping

Aspect 1	**Toolkit on "Smart Energy Management" – Training Modules Piloting**	
Specific Modules	M 3: Energy mapping	
Piloting group's qualification	Higher education in Electric and VVS engineering	
SQF Level	5	
SEM qualification: Aggregated unit of Los (Learning outcomes)	U1- Energy management	LO1. Identify a buildings use, heating-, cooling-, and ventilation systems LO2. Write an energy policy for a building/company LO3. Create an energy mapping of a building

		LO4. Suggest energy improvements and make calculations on them.
Aspect 2	**Definition of the Project Task**	
General task	Make an energy mapping on a certain facility  Small houses <120m2 / Average kWh/m2 / New houses kWh/m2 2001: 150-190 / 105-150 2005: 160 / 90 2025: 110 / 50	
Specific tasks which cover Los of Training Modules.	Analyze of what kind building does your organization has? ● What kind of building does your organization have? ● How is the building heated? ● Is there any cooling system? ● What type of ventilation does it use? ● What can be the main users of electricity? ● What kind of lighting is there? ● Are there any specific runtimes?	

	
Aspect 3	**Time arrangements**
Teachers	The teaching team (teachers who deliver classes to the group) has been set up to have their workload concentrated, as much as possible, with the same group. That way there is the possibility to be flexible in terms of the specialist teacher taking charge of the group as the project progresses and the need for guidance changes (in terms of subject covered by the project at that time) for students. The team did work as a self-managed one.
Students	The student's timetable changes radically while they are carrying out the project so there is no division in terms of the subject taught but a continuous time during the day devoted to the project.
Aspect 4	**Adaption of spaces and infrastructure**
Furniture	Due to the Sars-Cov-2 pandemic, all lessons were available through Microsoft Teams and the students were divided into study groups. In every group there discussed and answered the questions

ICT connections	 The students worked together to discuss the issues. **Work instructions:** Discuss and answer the following questions in your energy group – What kind of building does your organization have? – How is the building heated? – Is there a cooling system? – What kind of ventilation does it use? – What can be the main users of electricity? – What kind of lighting is there? – Are there any specific runtimes?
Aspect 5	**Process management: Teacher role/student role**
Teacher role	In the beginning, the role of the teacher has been more guiding students through the complexities of the project rather than delivering just content. It has been very important to establish some checkpoints through the project development so students don't lose the objective and cope with such a long work without getting lost or frustrated. This new role is not easy at first and pedagogically requires a change for the teacher who sometimes feels more comfortable delivering content and not forcing students to get the results on their own. During the Sars-Cov-2 pandemic lockdown, the role of the teacher became, even more, that of an organizer, supporter, and facilitator.
Student role	Especially during the lockdown, the Toolkit was a really helpful tool for them as it enabled them to have the knowledge related to the learning outcomes in a way (online) much more flexible. This means each group could have access to the different concepts needed throughout the

	development of the project in their own time. The teacher was online, of course, to give support while doing the tasks and for any query related to the online course itself. But it was a shame that the practical tasks could not be carried out. Students told us they learned a lot but are not sure if they can apply the lessons learned. They were happy with the online content in an uncertain time but they missed the execution of the tasks.
Aspect 6	**Team building**
Techniques	In our piloting experience, we did not use any technique for building up the teams since our group was a second-year group so we knew how each student was in terms of character and profile. We did try to mix up people in groups of 2-3 people in which their characters (creative, manager, hard worker…) did have a balanced structure to have a better experience. Nevertheless, sometimes it is better to mix up homogeneous character students to force them to take up roles they are not used to. After all, the use of any technique or dynamic should be envisaged in case students from the group are new and there is not any experience with them by the group of teachers.
Aspect 7	**Assessment / Qualitative experience**
Assessment	Students were assessed both in technical and transversal skills. Technical aspects were corrected by each corresponding teacher and the transversal skills were assessed by the group of teachers together. These late ones were based on evidence taken about initiative and responsibility, team working, and communication skills. Implementation was not assessed due to modifications done in lockdown.

Technical Competence (60%)	**Transversal competence (40%)**			
Energy mapping	Teamwork	Report and presentation	Individual work (implication and autonomy)	Advisory skills
60%	10%	10%	10%	10%

Table 25

U04: DESIGN AND ANALYSIS OF SMART ENERGY MEASUREMENT SYSTEMS

Assessment criteria	**1**	**2**	**3**	**4**
Learning outcome 1: Identify a buildings use, heating-, cooling-, and ventilation systems				
• He/She is not able to identify a building's use, heating-, cooling-, and ventilation systems.	**1**			
• He/She is able to identify a rough overview of a building's use, heating-, cooling-, and ventilation systems.		**2**		
• He/She is able to identify an overview of a building's use, heating-, cooling-, and ventilation systems.			**3**	
• He/She is able to identify a detailed analysis of a building's use, heating-, cooling-, and ventilation systems.				**4**
Average				
Learning outcome 2: Write an energy policy for a building/company				
• He/She is not able to write an energy policy for a building/company.	**1**			
• He/She is able to write an energy policy for a building/company.		**2**		
• He/She is able to write an energy policy for a building/company and relate it to other companies' energy policies.			**3**	
• He/She is able to independently find similar representative buildings their energy consumption.				**4**

Average				
Learning outcome 3: Create an energy mapping of a building				
● He/She does not know the key parameters of an energy mapping.	1			
● He/She does know which are the key parameters to analyze energy mapping.		2		
● He/She knows which are the ket parameters to analyze and, is able to calculate a basic energy mapping.			3	
● He/she knows which key parameters are to analyze and is able to calculate an energy mapping.				4
Average				
Learning outcome 4: Suggest energy improvements and make calculations on them.				
● He/She can not use the data to reduce energy consumption and influence the users.	**1**			
● He/She can use data thereby he/she can gather data but can not reduce the energy consumption.		**2**		
● He/She can use data to reduce energy consumption but he/she can not influence the users.			**3**	
● He/She can use the data to reduce energy consumption and influence the users.				**4**
Average				

Table 25

1. The transversal competencies to assess in this challenge will be teamwork, communication (in written support), individual performance, and advisory skills and they will be assessed individually.
2. The ponderation of the transversal competencies will be as shown below.

3. The way to assess these will be done in different ways: teachers, auto-assessment by students, and evaluation among them. Finally, we will do an average of all the marks.

Competence	Who will assess			
	Teachers (via Google Forms)	Teammate	Auto-assessment	**Average**
Teamwork (10%)				
Report, presentation (10%)				
Individual work and autonomy (implication) (10%)				
Advisory Skills (10%)				

Table 26

Qualitative experience	The experience was interesting for both students and teachers since after lockdown it was real piloting of distance learning. Students judged the implemented material very useful for the project development since it was possible for them to access the needed knowledge in a moment of their choosing within limits. Because teachers choose to give weekly deadlines to retain some control in these first weeks of online learning. In the last three weeks of the project students only got the last deadline and a weekly progress interview.

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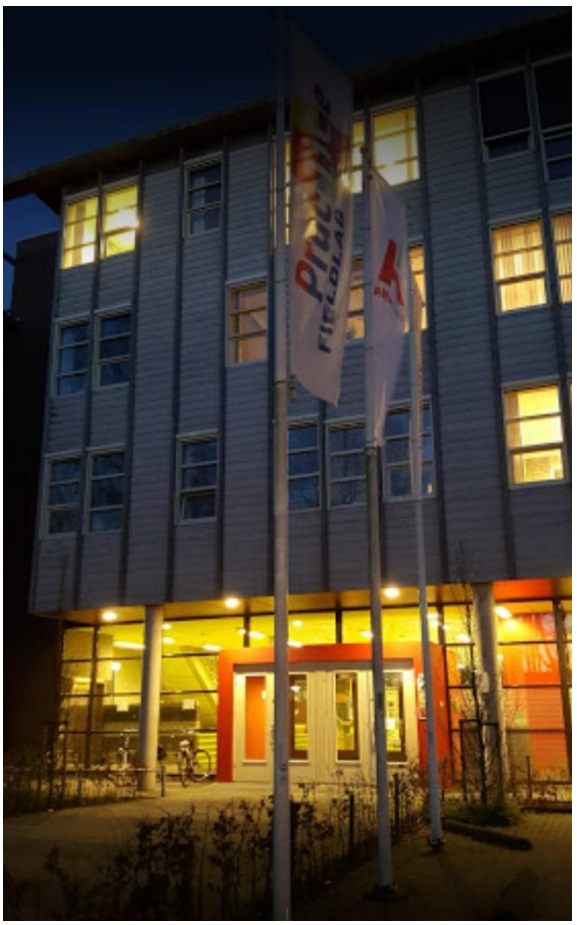
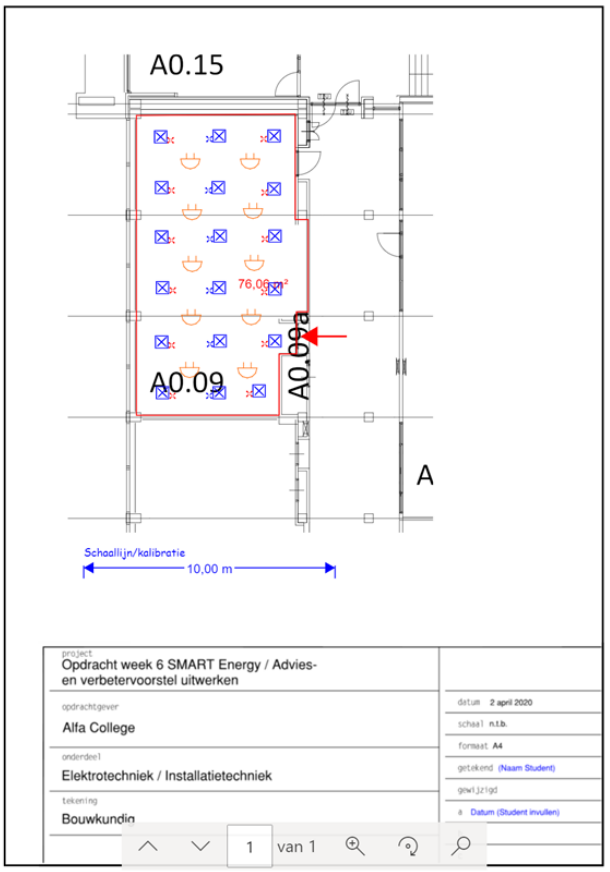
Case study on Smart Lightning

Aspect 1	**Toolkit on „Smart Energy Management" – Training Modules Piloting**	
Specific Modules	M4: Smart Lightning	
Piloting group's qualification	Higher Technician in Installations and Electrics	
SQF Level	4	
SEM qualification: *Aggregated Unit of LOs (Learning outcomes)*	U1 – Designing and implementation of Smart Lighting	LO1. Identification of different types of lighting LO2. Implementation of smart lighting systems, including devices and control systems LO3. Designing lighting systems to reduce energy consumption
Aspect 2	**Definition of the Project Task**	
General task	Designing and implementation a Smart Lighting System in a classroom in a school.	

	
Specific tasks which cover LOs of Training Modules	Analysis of existing lighting systems in the classroom, designing new lighting systems to reduce energy consumption, implementing new lighting systems. The task was changed after the Sars-Cov-2 pandemic lockdown: implementing the lighting system could not take place.

	
Aspect 3	**Time arrangements**
Teachers	The teaching team (teachers who deliver classes to the group) has been set up to have their workload concentrated, as much as possible with the same group. That way there is the possibility to be flexible in terms of the specialist teacher taking charge of the group as the project progresses and the need for guidance changes (in terms of subject covered by project that time) for students. The team did work as a self-managed one.
Students	The student's timetable changes radically while they are carrying out the project so there is no division in terms of the subject taught but a continuous time during the day devoted to the project.
Aspect 4	**Adaption of spaces and infrastructure**
Furniture	There were different kinds of classrooms. One classroom specifically had block-out blinds so that measurements on lighting could be carried out independently in the sunshine. There was a digital board available.

	 Due to the Sars-Cov-2 pandemic lessons were moved exclusively to online lessons after three weeks. For several days there were no lessons at all as everyone had to download Microsoft Teams and had to adapt.
ICT connections	 Each student has a portable computer so it is easy for him to move and work on a team basis or individual basis. There is wifi coverage to work on the internet. During the Sars-Cov-2 pandemic lockdown, it was more difficult. All students had laptops and the internet coverage in the Netherlands is good but some students had no camera on their laptops or had difficulties adopting new digital skills. It took some time to help everyone online but after approximately a week a new online working environment was established.

Aspect 5	Process management: Teacher role/Student role
Teacher role	In the beginning, the role of the teacher has mostly been guiding students through the complexities of the project rather than delivering just content. It has been very important to establish some checkpoints through the project development so students would not lose the objective and cope with such a long work without getting lost or frustrated. This new role is not easy at first and pedagogically requires a change for the teacher who feels sometimes more comfortable delivering content and not forcing students to get the results on their own. During the Sars-Cov-2 pandemic lockdown, the role of the teacher became, even more, that of an organizer, supporter, and facilitator.
Student role	Especially during the Sars-Cov-2 pandemic lockdown, the Toolkit was a really helpful tool for them as it enabled them to have the knowledge related to the learning outcomes in a way (online) much more flexible. This means each group could have access to the different concepts needed throughout the development of the project in their own time. The teacher was online, to give support while doing the tasks and for any query related to the online course itself. Sadly, the practical tasks could not be carried out. Students told us they learned a lot but are not sure if they can apply a lesson's content. They were happy with the online content in an uncertain time but they missed the execution of the tasks.
Aspect 6	**Team building**
Techniques	In our piloting experience, we did not use any technique for building up the teams since our group was a second-year group so we knew how each student was in terms of character and profile. We did try to mix up people in groups of 2-3 people in which their characters (creative, manager, hard worker…) did have a balanced structure to have a better experience. Nevertheless, sometimes it is better to mix up homogeneous character students to force them to take up roles they are not used to. Still, the use of any technique or dynamic should be considered in case students from the group neither know their classmates nor do they know the teachers.
Aspect 7	**Assessment / Qualitative experience**
Assessment	Students were assessed both in technical and transversal skills. Technical aspects were corrected by each corresponding teacher and the transversal skills were assessed by the group of teachers together. These late ones

	were based on evidence taken about initiative and responsibility, team working, and communication skills. Implementation was not assessed due to modifications done in lockdown.

Technical Competency (60%)	**Transversal competence (40%)**			
Design and Analysis of Smart Energy Lightning Systems	Teamwork	Report and presentation	Individual work (implication and autonomy)	Advisory skills
60%	10%	10%	10%	10%

Table 27

U04: DESIGN AND ANALYSIS OF SMART ENERGY MEASUREMENT SYSTEMS

Assessment criteria	**1**	**2**	**3**	**4**
Learning outcome 1: Is able to identify different types of lighting in the system				
● He/She does not know which are the parameters (different types of light, standards for lighting, standards for light calculations) to analyze light and neither how to calculate lighting plans.	**1**			
● He/She does know which are the parameters to analyze but is not able to calculate lighting plans.		**2**		
● He/She knows which are the parameters to analyze and, is able to calculate a basic lighting plan.			**3**	
● He/she knows which parameters are to analyze and is able to calculate an elaborate lighting plan.				**4**
Average				

Learning outcome 2: Implementation of smart lighting systems, including devices and control systems				
• He/She does not know which smart lighting device to place in the smart lighting system and does not know how to gather and analyze the data.	**1**			
• He/She does know which smart lighting device to place in the smart lighting system but does not know how to gather and analyze the data.		**2**		
• He/She does know which smart lighting device to place in the smart lighting system and does know how to gather the data yet the analysis is very basic.			**3**	
• He/She does know which smart lighting device to place in the smart lighting system and does know how to gather and analyze the data.				**4**
Average				
Learning outcome 3: Designing lighting systems to reduce energy consumption				
• He/She can not use the sensors nor the actuators in a smart lighting system to reduce energy consumption and influence the users.	1			
• He/She can use the sensors but not the actuators in a smart lighting system whereby he/she can gather data but can not reduce the energy consumption.		2		
• He/She can use the sensors and actuators in a smart lighting system to reduce energy consumption but he/she can not influence the users.			3	
• He/She can use the sensors and actuators in a smart lighting system to reduce energy consumption and influence the users.				4

Average	

Table 28

1. The transversal competencies to assess in this challenge will be teamwork, communication (in written support), individual performance, and advisory skills and they will be assessed individually.
2. The ponderation of the transversal competencies will be as shown below.
3. The way to assess these will be done in different ways: teachers, auto-assessment by students, and evaluation among them. Finally, we will do an average of all the marks.

Competence	Who will assess			
	Teachers (via Google Forms)	Teammate	Auto-assessment	**Average**
Teamwork (10 %)				
Report, presentation (10 %)				
Individual work and autonomy (implication) (10 %)				
Advisory skills (10 %)				

Table 29

Qualitative experience	The experience was interesting for both students and teachers since after the Sars-Cov-2 pandemic lockdown it was real piloting of distance learning. Students judged the implemented material very useful for the project development since it was possible for them to access the needed knowledge in a moment of their choosing within limits. Because teachers choose to give weekly deadlines to retain some control in these first weeks of online learning. In the last three weeks of the project students only got the last deadline and a weekly progress interview.

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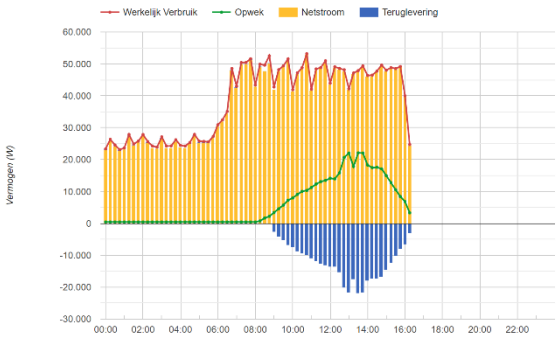
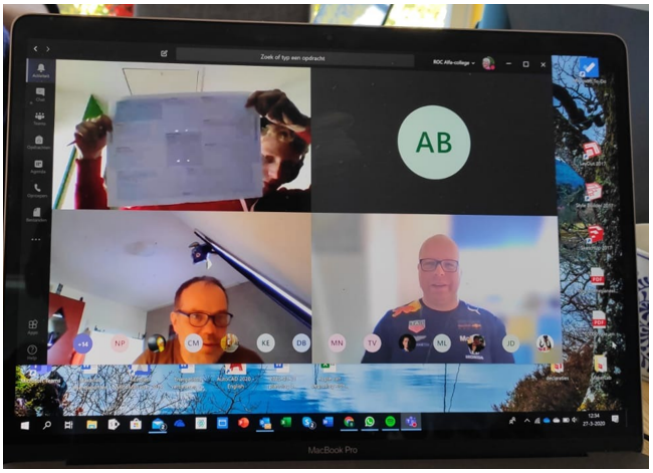
Case study on User Experience Design (Alfa College)

Aspect 1	**Toolkit on "Smart Energy Management" – Training Modules Piloting**	
Specific Modules	M5: UX Design	
Piloting group's qualification	Human Technology	
SQF Level	4	
SEM qualification: *Aggregated Unit of LOs*	U1 – UX Design of User Interface of Smart Energy System	LO1. Designing a paper prototype LO2. Designing a digital prototype LO3. Testing and finalizing the User Interface
Aspect 2	**Definition of the Project Task**	
General task	Design and testing of a user interface for the smart energy system in school 	
Specific tasks which cover Los of Training Modules	Analysis of existing energy system interface, designing and testing user interface	

	
Aspect 3	**Time arrangements**
Teachers	The teaching team (teachers who deliver classes to the group) has been set up to have their workload concentrated, as much as possible, with the same group. That way there is the possibility to be flexible in terms of the specialist teacher taking charge of the group as the project progresses and the need for guidance changes (in terms of subject covered by project that time) for students. The team did work as a self-managed one.
Students	The student's timetable changes radically while they are carrying out the project so there is no division in terms of the subject taught but a continuous time during the day devoted to the project.
Aspect 4	**Adaption of spaces and infrastructure**
Furniture	There was one classroom with a digital board available where students could work in groups. 

	Due to the Sars-Cov-2 pandemic, lessons were moved exclusively to online lessons after three weeks. For several days there were no lessons at all as everyone had to download MicrosoftTeams and had to adapt.
ICT connections	Each student has a portable computer so it is easy for him to move and work on a team basis or individual basis. There is wifi coverage to work on the Internet. During the lockdown, it was more difficult. All lessons were moved to Microsoft Teams. All students had laptops and the internet coverage in the Netherlands is good but some students had no camera on the laptop or had difficulties adopting new digital skills. It took some time to help everyone online but after approximately a week a new online working environment was established. 
Aspect 5	**Process management: Teacher role/student role**
Teacher role	In the beginning, the role of the teacher has been more guiding students through the complexities of the project rather than delivering just content. It has been very important to establish some check-points through the project development so students don't lose the objective and cope with such a long work without getting lost or frustrated. This new role is not easy at first and pedagogically requires a change for the teacher who feels sometimes more comfortable delivering content and not forcing students to get the results on their own.

	During the Sars-Cov-2 pandemic lockdown, the role of the teacher became, even more, that of an organizer, supporter, and facilitator.
Student role	Especially during the Sars-Cov-2 pandemic lockdown, the Toolkit was a really helpful tool for them as it enabled them to have the knowledge related to the learning outcomes in a way (online) much more flexible. This means each group could have access to the different concepts needed throughout the development of the project in their own time. The teacher was online, of course, to give support while doing the tasks and for any query related to the online course itself. But it was a shame that the practical tasks could not be carried out. Students told us they learned a lot but are not sure if they can apply the lessons learned. They were happy with the online content in an uncertain time but they missed the execution of the tasks.
Aspect 6	**Team building**
Techniques	In our piloting experience, we did not use any technique for building up the teams since our group was a second-year group so we knew how each student was in terms of character and profile. We did try to mix up people in groups of 2-3 people in which their characters (creative, manager, hard worker…) did have a balanced structure to have a better experience. Nevertheless, sometimes it is better to mix up homogeneous character students to force them to take up roles they are not used to. Regardless, the use of any technique or dynamic should be envisaged in case students from the group are new and there is not any experience with them by the group of teachers.
Aspect 7	**Assessment / qualitative experience**
Assessment	Students were assessed both in technical and transversal skills. Technical aspects were corrected by each corresponding teacher and the transversal skills were assessed by the group of teachers together. These late ones were based on evidence taken about initiative and responsibility, team working, and communication skills. Implementation was not assessed due to modifications done in lockdown.

Technical Competency (60%)	**Transversal competence (40%)**			
Analysis of old user interfaces and designing and testing of new interfaces	Teamwork	Report and presentation	Individual work (implication and autonomy)	Advisory skills
60%	10%	10%	10%	10%

Table 30

U04: UX Designing and testing of a user interface for smart management system

Assessment criteria	**1**	**2**	**3**	**4**
Learning outcome 1: designing a paper prototype				
• He/She does not know the character and goal of the user interface, can not create user flow charts, and can not create a paper prototype.	**1**			
• He/She knows the character and goal of the user interface, but can not create user flow charts or a paper prototype.		**2**		
• He/She knows the character and goal of the user interface, creates user flow charts but can not create a paper prototype.			**3**	
• He/She knows the character and goal of the user interface, creates user flow charts, and creates a paper prototype.				**4**
Average				
Learning outcome 2: Designing a digital prototype				

• He/She is not able to define logical groups, can not identify the most logical symbols and artwork, and can not design a digital prototype.	**1**			
• He/She is able to define logical groups, can not identify the most logical symbols and artwork, and can not design a digital prototype.		**2**		
• He/She is able to define logical groups, can identify the most logical symbols and artwork but can not design a digital prototype.			**3**	
• He/She is able to define logical groups, can identify the most logical symbols and artwork, and can design a digital prototype.				**4**
Average				
Learning outcome 3: Testing and finalizing the user interface				
• He/She can not set up user tests or analyze the data, is not using an iterative design process, and can not deliver and explain the final user interface.	1			
• He/She can set up user tests and analyze the data, does not use an iterative design process, and can not deliver and explain the final user interface.		2		
• He/She can set up user tests and analyze the data, using an iterative design process but can not deliver and explain the final user interface.			3	
• He/She can set up user tests and analyze the data, using an iterative design process and, can deliver and explain the final user interface.				4
Average				

Table 31

1. The transversal competencies to assess in this challenge will be teamwork, communication (in written support), individual performance, and advisory skills and they will be assessed individually.
2. The ponderation of the transversal competencies will be as shown below.
3. The way to assess these will be done in different ways: teachers, auto-assessment by students, and evaluation among them. Finally, we will calculate the average of all the marks.

Competence	Who will assess			
	Teachers (via Google Forms)	Teammate	Auto-assessment	**Average**
Teamwork (10 %)				
Report and presentation (10 %)				
Individual work and autonomy (implication) (10 %)				
Advisory skills (10 %)				

Table 32

Qualitative experience	The experience was interesting for both students and teachers since after lockdown it was real piloting of distance learning. Students judged the implemented material very useful for the project development since it was possible for them to access the needed knowledge in a moment of their choosing within limits. Because teachers choose to give weekly deadlines to retain some control in these first weeks of online learning. In the last three weeks of the project students only got the last deadline and a weekly progress interview.

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