A Holistic and Scalable Solution for research, innovation and Education in Energy Transition

D4.5 Evaluation of ASSET educational proposition – final

Work Package	WP4 Programs delivery and piloting
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Executive Summary

ASSET - A holistic and scalable solution for research, innovation, and education in the energy transition - is an EU project funded under the Horizon 2020 programme.

This is the final evaluation deliverable of WP4 and it reports the assessment results of the delivery activities in all tasks of WP4 from M17 to M24 of the project. The evaluation of all main four components of the ASSET educational proposition including MOOCs, class-based courses, interdisciplinary courses and industry on-demand courses is therefore detailed in this deliverable.

In the second round of delivery, 10 class-based courses, 4 seminars, and 11 MOOCs have been delivered, and this deliverable particularly covers their comprehensive evaluation. The qualitative and quantitative findings for course-level assessment including self and peer assessment, and education level assessment through learning analytics are presented in detail.

Additionally, the design, development and delivery procedure of 5 interdisciplinary courses and 2 industry on-demand courses are also presented in this deliverable. The evaluation criteria for interdisciplinary and on-demand courses for both, course level and educational offer level assessment, along with the findings of the evaluation are also discussed in detail. Based on the experience of delivery and evaluation of interdisciplinary and industry on-demand courses, recommendations for the effective design, delivery and learning scheme of these novel programmes are covered. Lastly, the deliverable summarizes lessons learned from two years of ASSET educational programme delivery experience and draws a comprehensive set of guidelines for prospective educational programmes intended to achieve excellence in the energy transition.

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List of Acronyms

Abbreviation / acronym	**Description**
CROM	Centre for Research on Microgrids
KPIs	Key Performance Indicators
KSC	Knowledge Skills and Competencies
MOOCs	Massive Open Online Courses
SDGs	Sustainable Development Goals
SSH	Social Sciences and Humanities
STEM	Science, Technology, Engineering and Mathematics

1. Introduction

1.1. Purpose & Scope

WP4 is dedicated to the piloting and delivery of educational programmes developed under the ASSET platform. The purpose of this deliverable is to report the evaluation activities and the assessment results based on the evaluation activities for the ASSET educational proposition in the second round of the delivery, i.e. from. November 2020 to April 2021. All main four components of the ASSET educational proposition including MOOCs, class-based courses, interdisciplinary courses, and industry on-demand courses are covered within the scope of this deliverable.

The assessment strategy for the MOOCs, face-to-face and blended courses has been detailed in the previous version of the deliverable D4.4 [1]. In the second round of delivery, 10 class-based courses, 4 seminars, and 11 MOOCs have been delivered, so their comprehensive evaluation is covered in this deliverable. Additionally, the design, development, delivery, evaluation criteria, and assessment results for 5 interdisciplinary courses and 2 industry on-demand courses are also detailed in this deliverable.

The results from the assessment are analysed in detail for each course and MOOC. For the sake of deliverable timing, on a total number of 459 questionnaires (quali-quantitative), 434 have been elaborated, since MOOCs remain open, more questionnaires will be collected until the very last project days. The key results highlighting teachers' satisfaction, students' participation and engagement, their willingness to continue using the ASSET educational proposition, and trends for the adoption of ASSET educational proposition across Europe and worldwide are discussed in detail. Each course is monitored and analysed. Individual feedback to the corresponding instructors is provided for the enhancement of the quality of contents, engagement, and delivery. Based on the lessons learned from the two rounds of delivery, a comprehensive set of guidelines for excellence in energy transition through educational offers are derived and detailed in the last section of the deliverable.

1.2. Structure of the Deliverable

The deliverable report is organized into six sections as the main chapters. Section 1 introduces the document.

Section 2 details the findings of **course-level assessment for MOOCs and Class-based courses** for the second round of delivery. The findings from qualitative and quantitative analysis of self-assessment and peer-assessment are detailed in this section.

Section 3 provides an **overview of educational level assessment** in the second round of the delivery. This section presents the findings based on google analytics, EMMA analytics, and short assessment surveys **combinedly termed as learning analytics.** Base on the learning analytics, the assessment results per offering and feedback loop for the teacher's assessment and evaluation of the course are presented in this section.

Section 4 is dedicated to the **evaluation of interdisciplinary and on-demand courses**. The detailed evaluation criteria, questionnaires tailored for the interdisciplinary offerings, and industry perspective, and the findings based on the evaluation at the course level and educational level are detailed in this section.

Based on the experience of delivery and evaluation of interdisciplinary and on-demand courses, recommendations for future on-demand and interdisciplinary courses are highlighted in section 5. Additionally, based on the lessons learned during the complete project's educational offerings, a comprehensive set of guidelines for achieving excellence in energy transition education is also presented in this section.

Finally, Section 6 concludes the deliverable.

1.3. Relationships with other WPs and Tasks

This deliverable reports the results of the evaluation activities for the piloting and delivery of educational programmes developed under the ASSET platform for the second phase of delivery. Since this is the second and the last version of this deliverable, it encompasses the evaluation of all tasks of WP4 including MOOCs (Task 4.1), classroom-based and blended short programmes (Task 4.2), interdisciplinary courses (Task 4.3), and industry courses on-demand (Task 4.4). Therefore, this deliverable directly links with Task 4.1, Task 4.2, Task 4.3, and Task 4.4. Since most of the programmes that have been delivered are prepared in WP3, this deliverable has an indirect dependence on WP3, particularly with Task 3.1 'Learning graphs and modules designed for energy transition programmes' and Task 3.2 'Learning content preparation'. Moreover, the monitoring and evaluation tools prepared in WP2, under Task 2.4 'Monitoring Tools' have been employed for course-level assessment. These tools including questionnaires have been reported in D2.4 [2], so the deliverable has direct involvement with Tasks 2.4 and D2.4 as well [2]. The evaluation criteria for MOOCs and classroom-based and blended short programmes are detailed in D4.4, therefore, it also has the direct involvement of D4.4 [1].

2. Course Level Assessment

2.1. Assessment criteria used in the second phase

The ASSET educational offer is holistic and hybrid in its nature and approach. Therefore, its evaluation methodology consists of a mixed-method approach with a set of qualitative and quantitative questionnaires complemented with learning analytics and platform statistics. As in the pilot phase during the second run, we collected the assessment questionnaires and the criteria and methodology of them are already explained in Deliverable 4.4[1].

These tools are also connected with the system of indicators (KPIs) mentioned in section 1.3 of the DOA [2] and developed according to D2.4 Monitoring tools [3]. Table 1 reports the number of respondents to questionnaires according to the mentioned KPIs and their status:

KPI	Target	Total numbers		Status
6.1. Number of responses to ASSET questionnaires received from professors/tutors	30	Self-Assessment (11 MOOCs, 10 Other Courses,4 Seminars). Peer-Assessment (19 MOOCs, 10 Other Courses)	53	Achieved
6.2. Number of responses to ASSET questionnaires received from students/learners	400	54 Questionnaire for face to face courses and seminars; 230 MOOC Profile and expectations questionnaire; 60 Mini-survey for Quality Monitoring; 34 Exit questionnaires 19 Survey Course Blended Hydrogen as an energy vector; 9 On-demand courses survey	406	Achieved
6.5. Completion rate - Target (against an average value of 4-5% observed today [5])	>20%	Higher than the average value, but lower than the expected rate.	13,87%	Not achieved Still impressive increase (200%) compared to average value reported in the literature [5].

Table 1: Status of the number of respondents to questionnaires and MOOC completion

Self-assessment and peer-assessment tools have been developed to address the call for feedback at the individual and course levels. Moreover, in the following sections, the tools designed for course self-assessment and peer-assessment are reported, each one with a short explanation and data interpretation.

2.2. Self-Assessment

After four months from the launch of the second run, the teachers received a call to action for the self-assessment and received the instructions on how to use the online survey designed by UNINA and available on Survey Monkey. Only the teachers of the new courses of the second run had to fill the questionnaire. It was implemented in 11 MOOCs, 10 courses, and 4 seminars. In line with the Pilot Phase, the Self-assessment concerned two different sections:

- Qualitative part: questions about the process of the creation of the MOOC on the EMMA platform. The questions of this part were open and the respondent had at least 50 words to highlight positive and negative aspects.
- Quantitative part: questions about the expectations of teachers/tutors on the EMMA platform and their own experience with it. For the questions, we used the Likert scale.

2.2.1. Self-assessment: qualitative part

As we described in Deliverable 4.4 [1], this evaluation section concerns the qualitative self-assessment of course run. It consists of a set of questions aiming:

1. Self-Assessment form for Course development: This tool is intended to solicit a reflection process in teachers by inquiring about the level of involvement required by them in developing the course and detecting their coordination strategy.
2. Self-Assessment form for Course deployment: This form aims at understanding the level of comfort of teachers with the deployment plan. This experience was still affected by the Covid-19 lockdown. Aware of the difficulties created by lockdown, UNINA and AAU strengthened their effort in assisting teachers.
3. Self-Assessment form for Course running: The following form intends to assess the satisfaction of teachers and users against the platform functionalities and the course running. The EMMA platform staff at UNINA thanks to its analytics system can inform the individual teacher about the trend of his/her course to create a feedback loop.

The first part of the questionnaire contains a series of general questions about the mode of delivery of the course, the total of hours spent to organize the MOOC, the number of people involved during the MOOC construction, and finally the number of students in the class. **On average each course had 36 learners** and each of them involved more than one teacher/tutor and they spent over 5 hours per week for its organization.

For a brief overview, at the end of this section, there are two examples of self-assessment of MOOCs and class-based courses from the second-course run.

COURSE DEVELOPMENT **An Introduction to AC Microgrids for Energy Control and Management (MOOC)**	
Please specify the mode of delivery of your course (e.g. MOOC, class-based, etc.)	MOOC
How many people were involved in designing/adapting the course content?	4
How many hours per week do they spend on this task? What specific tasks do they do (e.g. write a blog entry, recommend further reading or video, monitor assignment results on the dashboard)?	person 1: Teacher- 5 hours per week for lecture slides and video preparation person 2: Organizer- 4 hours for organizing contents and coordinating among teachers for material preparation Person 3: Tutor Person 4: 10 hours- blog writing, videos editing, EMMA platform contents and description

	uploading, answers to the student's questions, engaging students
Did you provide overall feedback to the group about how the course was going? If so, what form did this take? (Video, mail, etc.?) How often did you do this?	Yes, email and in the final form as the MOOC report.
Have you or your co-teachers followed a course on EMMA?	Yes
COURSE DEPLOYMENT	
Were you able to cope with the timeframe set by the project management team for editing video lessons?	Yes, the time frame was reasonable
How were participants recruited?	The participants were recruited through email invitations to university students and industry collaborators. Also, we used the network of external lecturers and their students. Moreover, social media including Facebook and LinkedIn were also used to publicize the course offerings and invite participants to register.
Are you happy with the assistance received by the team involved in course deployment? If not, what were your expectations?	Yes, the team was very responsive to the various queries and assistance we needed to successfully deploy the course.
COURSE RUNNING	
How many teachers/facilitators/tutors have been involved in running the course?	4
Can you identify a baseline regarding user satisfaction of the platform used for delivery (please specify it)	Based on the comments from participants, participants were largely satisfied with the platform, the only problem they refer to was that the size of the slides seems to be small on the given platform sometimes.
Can you identify a baseline regarding user satisfaction concerning your course?	Active users were highly satisfied, some users requested more long videos and detailed content, which we will consider in our future offerings.
Are you happy with your course? What do you think can be improved?	I think the addition of embedded quizzes can be used to engage the students.
Did you take the chance to interact with learners? How was it?	From the analytics, it was observed that though the student enrolment was very high but very few students followed the course thoroughly and completed it to get the certificate. Next time we need to recruit more dedicated students, and also embed some effective engagement mechanisms, e.g. interactive quizzes, and group assignments, etc.

How did you use the feedback received from analytics?	Mostly, we interacted with the learners through comments on the blog, we noted their suggestions, following them some of the feedback incorporated, for instance, answers to the content related queries, other suggestions will be embedded in the future run.
Did your course receive the attention of unexpected users (i.e. from other countries, faculties, etc.)	Yes, it got a worldwide attention, but they are all from electrical engineering backgrounds, so it was not much unexpected, rather it was based on the publicity of individual course lecturers and their network of students scattered through different countries, for example, a very high ratio of students joined from South Asia (Pakistan), and most probably the reason being one of the active course organizers that work in Aalborg university but belongs to Pakistan, publicized it regularly using personal social networks, therefore many participants were recruited from there.

Table 2: Example of self-assessment: An Introduction to AC Microgrids for Energy Control and Management (MOOC)

COURSE DEVELOPMENT **Models, Methods and Optimization Tools for Energy Systems (class-based course)**	
Please specify the mode of delivery of your course (e.g. MOOC, class-based, etc.)	Class-based
How many people were involved in designing/adapting the course content?	9
How many hours per week do they spend on this task? What specific tasks do they do (e.g. write a blog entry, recommend further reading or video, monitor assignment results on the dashboard)?	2 main teachers devoted 10-12 hours per week for the preparation of materials including lecture PPTs and discussion slides. 1 Lab instructor took care of simulation exercises, prepared simulation exercises, few simulation models and codes as a design guide, and then exercises that will serve as the short case-based modules. They devoted around 8-10 hours per week. One course manager, who took charge of the communication with students, Moodle update, material dissemination, and in the end course evaluation. 3-4 hours per week.

Did you provide overall feedback to the group about how the course was going? If so, what form did this take? (Video, mail, etc.?) How often did you do this?	Since it was 3 days class-based course so most of the times teachers and lecturers all were present in the class, however, at the end of the course a detailed session with the evaluation of the course including the remarks of the student were drafted by the course manager and communicated it to all teachers and lab instructors involved in the course.
Have you or your co-teachers followed a course on EMMA?	No, that was a class-based course so EMMA was not involved
COURSE DEPLOYMENT	
Were you able to cope with the timeframe set by the project management team for editing video lessons?	Yes, as this was a class-based course planned according to the university specified timelines.
How have participants been recruited?	Through advertisement on the university website, Moodle, and centre for research on microgrids (CROM) website: www.crom.et.aau.dk
Are you happy with the assistance received by the team involved in course deployment? If not, what were your expectations?	The deployment team was not involved as it was purely a class-based course.
COURSE RUNNING	
How many teachers/facilitators/tutors have been involved in running the course?	5
Can you identify a baseline regarding user satisfaction of the platform used for delivery (please specify it)	The participants were highly satisfied with the delivery and course contents.
Can you identify a baseline regarding user satisfaction concerning your course?	The participants were highly satisfied with the delivery and course contents.
Are you happy with your course? What do you think can be improved?	The participants suggested that some prerequisite material may be added for a better understanding of the contents for the next time. Also, some simulation exercises may be updated for the next round of delivery. Based on these comments we intend to increase the duration and update the contents based on the students' expectations.
How did you use the feedback received from analytics?	Since it is a class-based course, so we did not use EMMA analytics.

Did you take the chance to interact with learners? How was it?	Yes, along with the interaction during the course sessions, there was a separate and dedicated closing section for the course to have the remarks and feedback from the participants. The participants were mostly satisfied with the contents and suggested some improvements.
Did your course receive the attention of unexpected users (i.e. from other countries, faculties, etc.)	It got a worldwide attention, most of them are from electrical engineering and industrial engineering backgrounds, so it was not much unexpected.

Table 3: Models, Methods and Optimization Tools for Energy Systems (class-based course)

2.2.2. Quantitative Self-Assessment of experience with the platform

This is a questionnaire aiming at quantifying how much the EMMA platform fits the expectations of teachers/tutors. The respondent could rate from "strongly agree" to "strongly disagree" (Likert scale) his/her reaction to the EMMA look & feel, the course effectiveness, the student behaviour. Questions have been organized into three clusters, i) The platform looks & feels, ii) The course effectiveness, and iii) The student's behaviour.

In table 4 of the quantitative part, a Likert scale is used to measure platform experience with questions about the general look, the functions, the logic, and architecture for the second round of the delivery.

Please rate from "strongly agree" to "strongly disagree" your reaction to the EMMA platform for providing your MOOC courses.	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
I like the general look and feel, including colours, font	36%	36%	28%		
The basic logic and architecture of the platform is functional	36%	40%	24%		
The basic logic and architecture of the platform is sufficiently flexible	16%	60%	24%		
The authoring environment is easy to navigate	20%	52%	28%		
It was easy to train staff to use EMMA	36%	24%	40%		
It was straightforward to transfer my course onto EMMA	20%	44%	36%		
My course fits/rides comfortably on EMMA	24%	48%	28%		
The personal blogs, conversation and wall offer me the range of communication tasks I need to run my course successfully	20%	28%	52%		
I/my co-teachers make full use of all the EMMA features in my course	4%	48%	44%	4%	

I/my teachers encourage learners to compare specific content in courses offered by other partners	4%	48%	44%		4%
I/my teachers encourage learners to compare different approaches to similar subjects by recommended specific study units in a variety of courses on EMMA	4%	48%	44%		4%
I encourage my students to follow the MOOC from start to finish	44%	20%	36%		
I/my teachers encourage participation in conversation from learners from other countries and language groups	36%	24%	32%	8%	

Table 4: Reaction to the platform Services

In Table 4 you can see how positive was the reaction of the teachers on the EMMA platform look and feel (72% strongly agree + agree). The majority of respondents showing appreciation for how it is easy for the trainer staff to use the platform (60%) and 64% of the teachers/tutors encourage their own learners to follow from start to finish the course. Finally, they encourage participation in conversation from learners from other countries and language groups (60%).

2.2.3. Self-Assessment of non-MOOC format

The same logic has been used to assess non-MOOC format courses. In this case, a set of closed questions with predefined answers (Likert Scale based) have been submitted to **teachers** to collect feedback. However, this offer has been created and provided for different situations. In some cases, it was possible to have class-based courses or seminars, in others they took the form of webinars, in others they took the form of blended classes depending on the Covid-19 context.

Please rate from "strongly agree" to "strongly disagree" your reaction to non-MOOC format courses. (Please select one option for each row.)	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Students are very interested in the topic	40%	36%	24%		
Students have no idea of the social implication of energy transition	20%	32%	12%	36%	
Students are interested in additional CFU/ECTS	24%	44%	28%	4%	
The course has been designed taking in mind the ASSET objectives	72%	16%	12%		
Teaching an Energy Transition class is challenging	32%	48%	20%		

Table 5: Self-assessment of non-MOOC format

Table 5 is quite clear: **the learners seem very interested in the topic (76%) while 52% of students have no idea of the social implications of the energy transition. However, 98% of the course has been designed taking in mind the ASSET objectives.**

2.3. Peer-Assessment (teachers only)

In line with the pilot phase, also this time the peer review of a course during the second run has been assigned to those MOOC providers who were not involved because their courses were assessed before.

The review was carried out on 19 MOOCs and 10 courses class-based and we have adopted a mixed method with both qualitative and quantitative aspects.

For the qualitative questionnaire, reviewers had to explain how the course looks from an external perspective highlighting both positive and negative aspects. Being the scientific content under the sole responsibility of teachers, they are not called to review the MOOC from a scientific perspective. Peers have been assigned to a MOOC by AAU, each one received a deadline and a list of questions to be answered.

For the qualitative part, information has been collected according to three dimensions of analysis:

1) Peer-Assessment form for Course Design: the peer instructors keeping the following questions and aspects in mind have evaluated the course design.
2) Peer-Assessment form for Course Material: the course material has been evaluated by the peer instructors keeping the following questions and aspects in the mind.
3) Peer-Assessment form for Course Activities: the course material has been evaluated by the peer instructors keeping the following questions and aspects in the mind.

For a brief overview, the following are a couple of examples of a peer-review as shown in Tables 6 and 7:

COURSE DESIGN **Example of Qualitative Peer-assessment: New Materials for Solar Cell Applications (MOOC)**	
Is there a clear pedagogical approach, and if so, what is it?	Yes, lessons are prepared in line with the learning outcomes; each lesson has videos, and lecture slides explaining the contents, moreover there is a quiz for each lesson for the evaluation of participants.
Are the syllabus and material logically structured and coherent (are terms explained, do sections follow each other?)	The syllabus is well defined, well structured, the materials are in line with the objectives and outcomes, and sections follow the proper sequence for the attainment of defined outcomes.
Are the learning outcomes clear and achievable?	Yes, the learning outcomes are clear and achievable.
Are active verbs used for the easily measurable learning outcomes?	Yes, for the learning outcomes for the whole course active verbs, e.g. recall, define, describe, etc. are used, however, these are missing for the individual lessons and units.
COURSE MATERIAL	
Are there any elements of multimedia (interactive materials, audio, video) included? If so, what are they? How do they look like?	Videos and slides are used as multimedia materials. The videos are very well prepared, easy to follow, and understandable. Also, the lecture slides are easy to follow and readable. The supplementary material is also prepared and attached with relevant lessons.
Are all materials open (are there any technological access issues)?	Yes, all the materials are open and accessible. No technological issue is found.
Do the external links work, if any?	Yes, they do work fine.
COURSE ACTIVITIES	
Are sections given clear timeframes?	The sections give proper and clear timeframes, including the time for videos, units, and slides.
Are there any communicative activities, if so, what are these?	Most of the communicative materials include videos, lesson slides, and more importantly, the assignment based on quizzes and short true-false questions.

Are there any collaborative activities, if so, what are these?	Collaborative activities are missing for the course.
Are there any assessment/assignment elements, and if so, what are they?	Yes, there are assignments and quizzes for each lesson and they are mostly true, false, and short multiple-choice questions for each of the lesson.
Are there any comments you wish to make about this course?	The individual lessons learning topics are well described, however learning outcomes for individual lessons are not defined, so these may be defined for each lesson, also few collaborative activities, including group discussions or group assignments may be included.

Table 6: Example of Qualitative Peer-assessment: New Materials for Solar Cell Applications (MOOC)

COURSE DESIGN Example of Qualitative Peer-assessment: DC Microgrids (Course)	
Is there a clear pedagogical approach, and if so, what is it?	The pedagogical approach is mostly a traditional teacher-centred approach, with lectures provided by the instructor to present the theoretical concepts based on the course. Theoretical lessons are complemented with research papers, from which the students can gain a more detailed insight on some aspects. Some student-cantered activities are in any case available, in form of laboratory sessions and exercises.
Are the syllabus and material logically structured and coherent (are terms explained, do sections follow each other?)	The materials and learning outcomes follow a clear structure, with starting lessons that are more oriented to the introduction of the main concepts and then a bigger focus on detailed aspects in the second part of the course. The main concepts and terminology are presented in the first learning materials. Overall, I think it is possible to find a clear logical structure behind the course.
Are the learning outcomes clear and achievable?	The learning outcomes are very clear and they sound to be aligned with the content and learning material of the course. Therefore, they sound to be of course achievable.
Are active verbs used for the easily measurable learning outcomes?	Active verbs are used for the definition of all the learning outcomes, such as "illustrate" and "design". Some of them may require some more in-depth verification process to measure if they have been fully achieved.
Are the activities consistent with the platform's functionality (i.e., discussion forum, feedback mechanisms)?	The course is mostly based on a traditional face-to-face teaching approach, but the theoretical part can be easily converted into a MOOC (as it was indeed done). The provided exercise sessions can be potentially introduced also in the platform and be used as a feedback mechanism or as a trigger for the forum discussion. Similarly, the papers provided as additional readings can be a further element of discussion in the forum.
COURSE MATERIAL	
Are there any elements of multimedia (interactive materials, audio, video) included? if so, what are they? How do they look like?	Some parts of the course have the associated videos, which were used as lesson units in the MOOC. Those videos look good and are well prepared.

Are all materials open (are there any technological access issues)?	The learning materials are all available in the internal repository, except the additional online readings. Access to those papers may require specific subscriptions (usually available internally to Universities).
Do the external links work, if any?	The provided external links work correctly.
COURSE ACTIVITIES	
Are sections given clear timeframes?	The timeframe for the course is the same as typical semester University courses. No more in-depth timeframe definition is provided for the different sections.
Are there any communicative activities, if so, what are these?	Some communication between students is implicitly encouraged in the laboratory sessions since the students are asked to work in groups.
Are there any collaborative activities, if so, what are these?	Collaborative activities are present in the laboratory sessions since students have to work in groups and prepare jointly a report of their laboratory activities and results.
Are there any assessment/assignment elements, and if so, what are they?	Exercises are provided within each laboratory session, which sounds a good approach to allow the students to self-evaluating their level of understanding of the topics.
Are there any comments you wish to make about this course?	Nothing particular, the course is on a modern topic and sounds to be well structured.

Table 7: Example of Qualitative Peer-assessment: DC Microgrids (Course)

The qualitative analysis shows very clear results on the syllabus and material because they are logically structured and coherent. Indeed, at the beginning of each lesson, there is an explanation about the objectives and the topics to be learned for each unit and the assignments have been designed, organized, and run. Also, the function and the activity of the EMMA platform have a positive response to the communication with the learners because also if the lessons are online there are several modes to discuss with them about the topics of the courses through the discussion forum and chat-box.

The quantitative peer-review analysis, instead, has been conducted with a short set of questions with predefined answers and each question has three different items (Table. 8). In this way, we could summarize the assessment of the most relevant features for a MOOC along six dimensions.

PEER ASSESSMENT (QUANTITATIVE)						
Please insert a signpost (X) into corresponding cells.		**x**		**x**		**X**
Use of multimedia	No multimedia, primarily text, and image-based		Some multimedia including audio, video, and interactive materials		A significant amount of multimedia, including audio, video, and interactive materials	

Degree of communication	Little or no communication included either between students or with tutors		Some communication, for example, some use of discussion forum		Significant communication across a variety of channels (forums, socials, blogs, webinars, etc.)	
Degree of collaboration	Little or no collaboration encouraged		Some collaboration		A significant amount of collaboration, and/or working in groups	
Amount of reflection	Little or no reflection encouraged		Some reflection encouraged		A significant amount of reflection encouraged throughout the course	
Learning pathway	No learning pathway provided		Some guidance provided, but a degree of student choice on the order of completing the materials and activities		A clearly articulated learning pathway is evident	
Formal learning	No link to formal learning		There is the option to link the course to a formal learning opportunity		The course is an integral part of a formal learning opportunity	
Learner autonomy Use	No learner autonomy		Some level of learner autonomy, for example in terms of choice of which materials and activities to complete in which order		Significant learner autonomy, with the opportunity for learners to personalize their courses and create their PLE	

Table 8: Components of Quantitative Peer-Review Analysis Questionnaire

The results of the quantitative assessment are **generally positive**. However, as we have already anticipated and as you can see in figures 1 and 2, the use of multimedia and communication in online courses is taken for granted, some cases would take advantage of increasing the degree of multimedia use and communication.

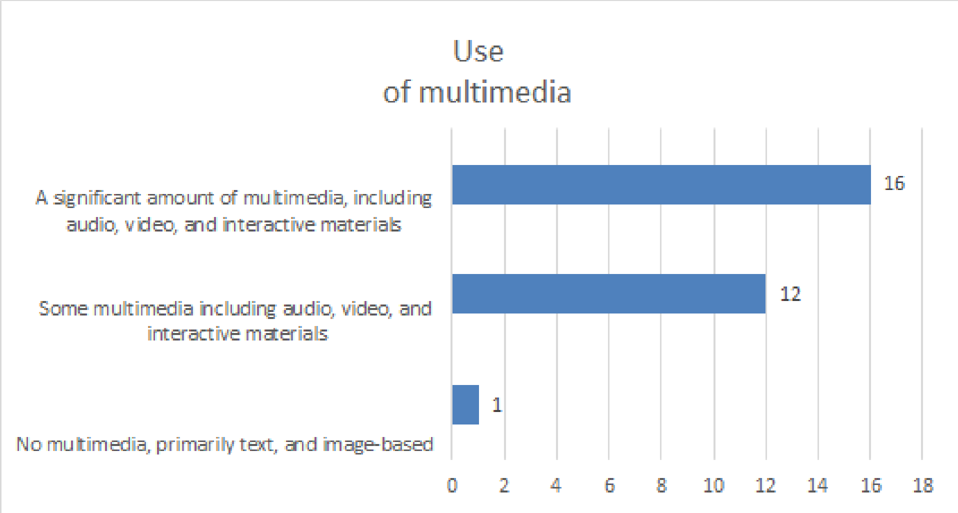


Figure 1: Peer-review: Use of multimedia

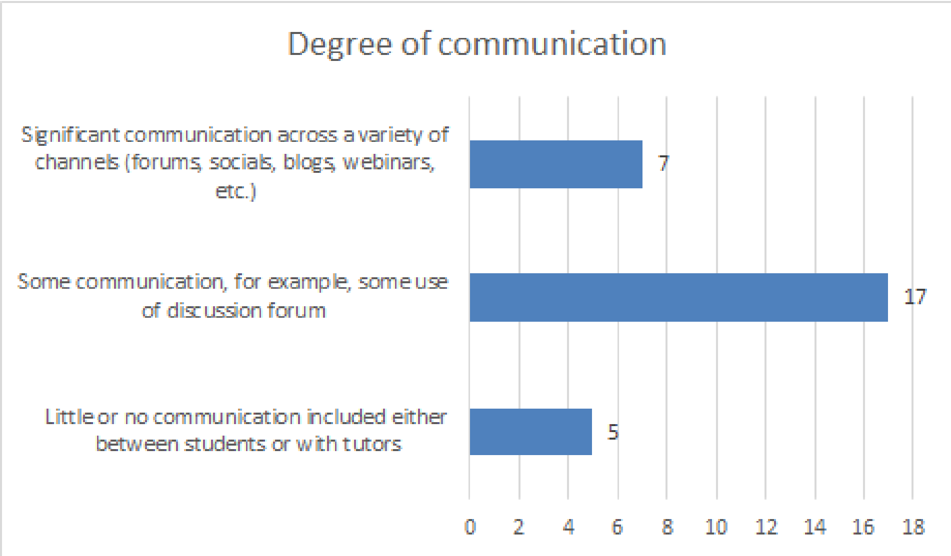


Figure 2: Peer-review: Degree of Communication

The basic structure of a MOOC is then in place, while the most advanced pedagogy based on some collaborations, reflections, and giving the sense of direction with a strategy to scaffold the course needs to be developed and used more, as shown in figures 3, 4, and 5.

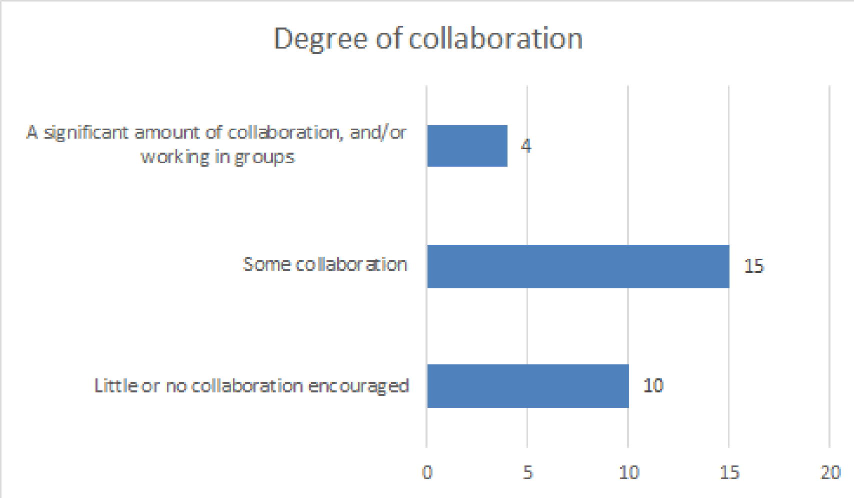


Figure 3: Peer-review: Degree of collaboration

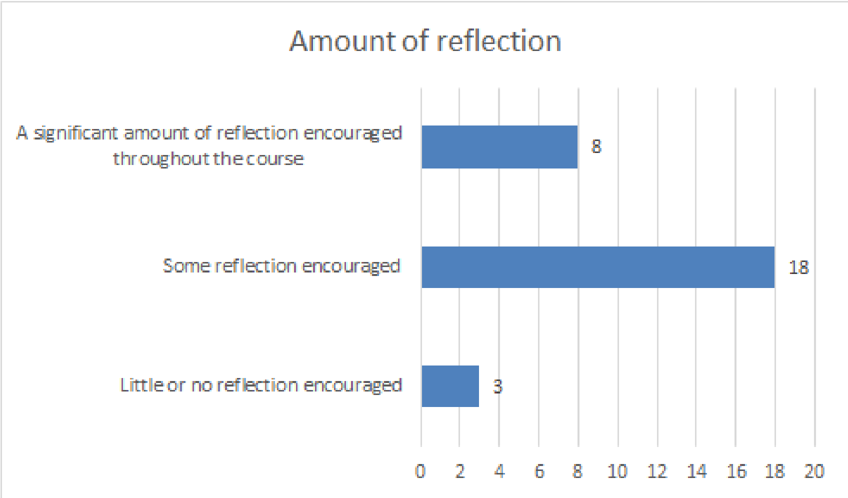


Figure 4: Peer-review: the amount of reflection

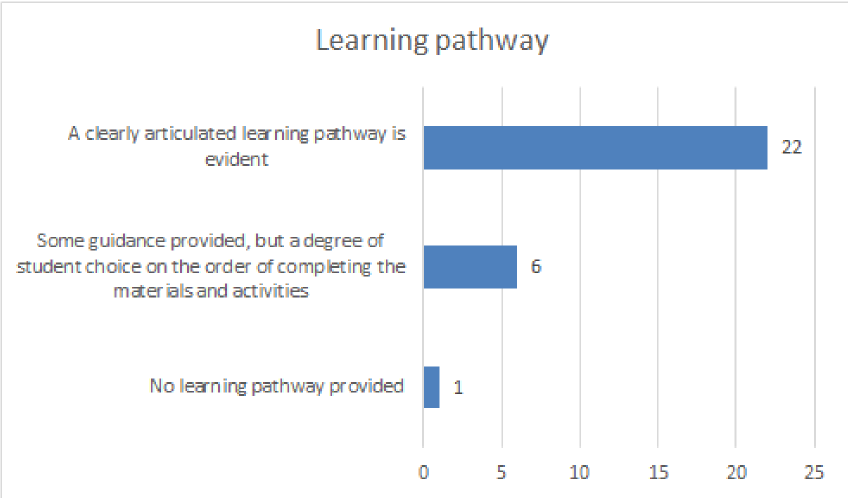


Figure 5: Peer-review: Learning pathway

The last two figures, i.e. Figures 6 and 7, shows that the students agreed about the independent nature of the courses, i.e. students can significantly learn the contents by themselves, with a greater degree of autonomous efforts, if they are provided with some instructional design and guidance.

However, these courses are also designed to become mostly an integral part of formal learning or to be linked to a formal course, in line with the ASSET's value proposition as shown in figure 6.

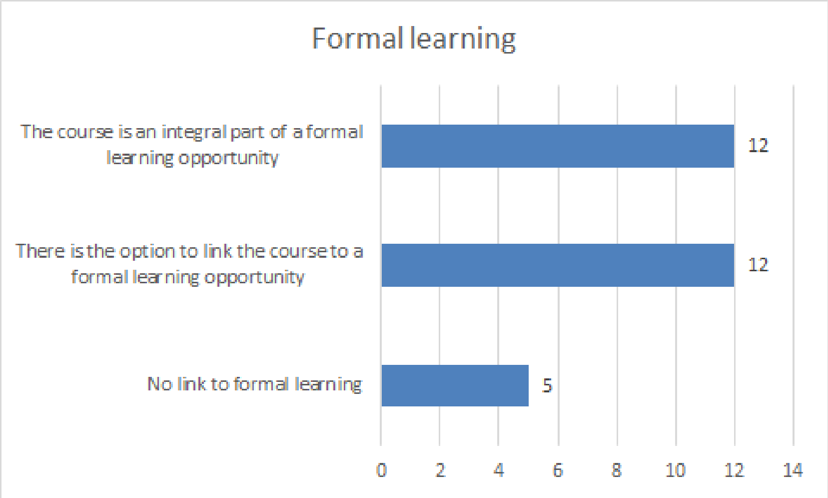


Figure 6: Peer-review: Formal Learning

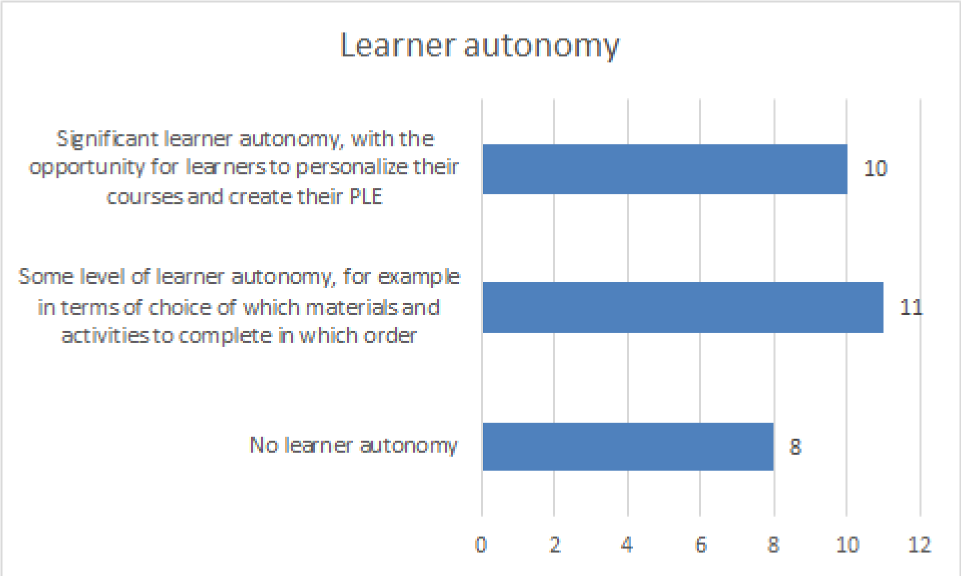


Figure 7: Peer-review: Learner Autonomy Use

3. Educational Offer Level Assessment

In this document, we will occasionally mention the data related to the first survey (pilot). To deepen the understanding, we recommend reading D4.4 - Evaluation of ASSET educational purposes [1].

The ASSET educational offer during the Pilot phase recruited **823 students** enrolled in a MOOC offered through the Emma platform while in the second run (02 November 2020 - 21 January 2021) recruited **1635 students.** Some of the students were enrolled in both runs, however, the total number of distinct recruitments is 2458. Of these 2458 enrolled learners, 68,42% were not able to follow any lesson, while 13,87% got a certificate of completion. This data is aligned to other similar offers in energy transition according to Romero-Rodriguez [4] but it is higher if compared to the completion rate in free online courses where fees are not required since the fee works as a relevant incentive for completing the course [5]. During a 2½ years study, scholars from various universities have tried to significantly improve completion rates [5]. Despite the fact that they tested different strategies, on 60.000 students, the completion rates in MOOCs were at most 29% for committed English-fluent students [5]. The data recorded by the aforementioned study shows that despite actions directly aimed at the increase in the completion rate the percentages of obtaining certificates for free online courses are quite low. Therefore, also in consideration of their heterogeneity and the innovative nature of the training offer, the 13,87% obtained from the ASSET courses can be considered an excellent achievement. In fact, at the time of writing, students continue to take courses. It is therefore likely that the completion rate will continue to rise in the coming weeks.

The following table describes the number of learners enrolled and the completion rate for each course. Obviously, the EMMA platform is still operational and the ASSET courses will remain online so we expect a significant increase in the completion rate. The dropout rate in this context is not meaningful, the offer is seen as a shopping model always there when needed.

Course	Provider	Enrolled	Completion rate
A holistic approach for Energy Transition: territory, networks, and sustainability	UNINA	108	7,40%
An Introduction to AC Microgrids for Energy Control and Management	AAU	148	11,48%
An Introduction to DC Microgrids for Energy Control and Management	AAU	162	16,04%
Maritime Microgrids: A Sustainable Solution for Green Sea Transportation	AAU	55	23,21%
Power Quality Challenges and Solutions for Microgrids	AAU	70	57,18%
Optimization Strategies and Energy Management Systems	AAU	116	16,37%
Electric heat pumps in the energy transition framework	UNINA	86	5,81%
Energy and environment	UWA	124	3,22%
Energy Efficient and Ecological Design of Products and Equipment	UWA	77	6,50%

Green professionalization and ethics	UNINA	50	22%
Hydrogen as an Energy Vector	UPV	579	9,84%
Innovation and Diversity in Engineering	RWTH	45	15,55%
New Materials for solar cells applications	UWA	112	26,78%
Renewable Energy Technologies	UNINA	153	11,11%
Train the Trainer	OTEA	227	22,9%
Corporate Communication and Corporate Social Responsibility	UNINA	145	9,45%
Challenges and solutions in Future Power Networks	RWTH	67	8,95%
Energy transition made simple for citizens	UWA	131	21,29%
Economics of energy sources and the optimal integration of renewables and energy conservation measures	Logical Soft	3	33,33%

Table 9: MOOCs offers, enrolments, and completion rates

These results reflect also the Covid-19 effect on online education when an enormous offer of online teaching came out from several educational and cultural institutions as well as from platforms, such as Edx and Coursera, offering free certificates for all. The impact of Covid-19 had an impact also on the availability of learners, mainly from university, to spend almost the whole day online in their university teaching with an overload impact. However, the percentage of learners who took the courses and who obtained the certificates has **more than doubled** compared to the pilot. The data seem to highlight a positive relationship between the slow return to normality and the increase in users of ASSET courses and certificates issued.

3.1. Learning Analytics for MOOCs

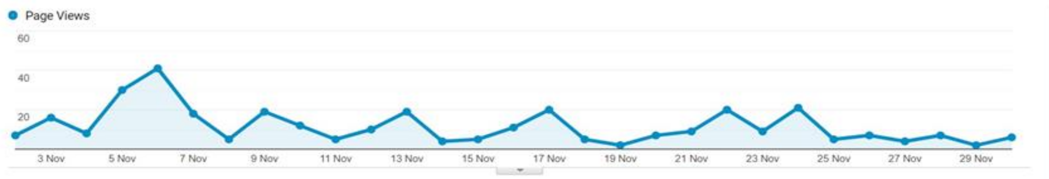
During the project, 2458 students registered for the ASSET courses. Information about the second run confirms the trends shown by courses during the pilot, so we have decided to not describe them again. The collected data highlights that users who have not gone beyond registration are the vast majority. However, we think that these learners probably believing they could get a certificate effortlessly and when they realized they had to take the tests they decided not to continue or to post-pone the activities for a better time. However, the quantitative data on learners who have gone beyond registration is encouraging.

3.1.1. Feedback Loop

As in the pilot phase, after the first month of the second run, only the professors of new courses received a PowerPoint presentation with the most relevant data concerning their course running to let them know the pattern of use and, in case, reacting to change it, offering more support to learners.

3.1.2. A case for the feedback loop of the second run: An Introduction to AC Microgrid for Energy Control and Management

The data were collected from November 2 to November 26 and came from Google analytics, EMMA platform, and Vimeo. The first section of the PowerPoint circulated to the relevant teachers contains the data from Google Analytics concerning the views and visitors. The MOOC has been visited 334 times: 53,9% are Returning Visitors against 46,11 % of New Visitors, as shown in Figure 1.



Primary Dimension: Page Other

Plot Rows | Secondary dimension: User Type | Sort Type: Default | advanced

	Page	User Type	Page Views	Unique Page Views	Avg. Time on Page	Entrances	Bounce Rate	% Exit	Page Value
			334 % of Total: 0.53% (62,918)	230 % of Total: 0.60% (38,114)	00:01:08 Avg for View: 00:01:31 (-25.55%)	112 % of Total: 0.94% (11,966)	59.82% Avg for View: 41.06% (45.68%)	28.44% Avg for View: 19.02% (49.56%)	US$0.00 % of Total: 0.00% (US$0.00)
1.	/course_an_introduction_to_ac_microgri	Returning Visitor	180 (53.89%)	118 (51.30%)	00:01:08	40 (35.71%)	45.00%	18.89%	US$0.00 (0.00%)
2.	/course_an_introduction_to_ac_microgri	New Visitor	154 (46.11%)	112 (48.70%)	00:01:08	72 (64.29%)	68.06%	39.61%	US$0.00 (0.00%)

Figure 8: Pageviews and number of visitors from Google Analytics

The MOOC received visits from several countries, in particular from Brazil 23,95% and Pakistan 9,58% but mainly also in Europe with 9,28% from Spain and France (Figure 9). A lot of interest for this course is also from the Americas (27,25%) and Asia 25,75%) as shown in Figure 10.

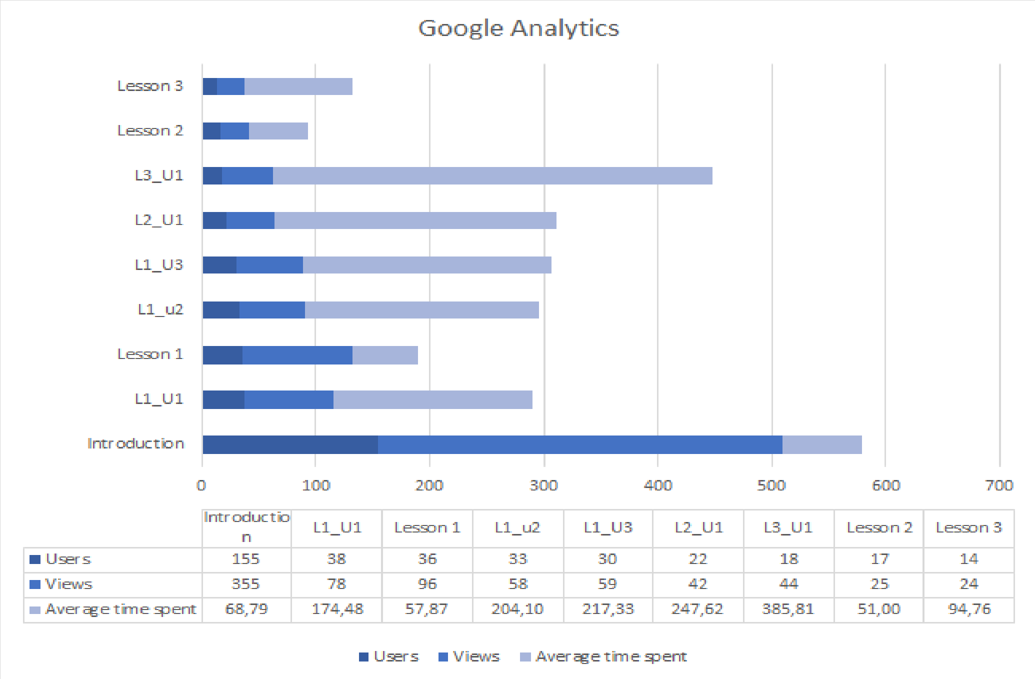
Country	Page Views	Page Views
	334 % of Total: 0.53% (62,918)	334 % of Total: 0.53% (62,918)
1. Brazil	80	23.95%
2. Pakistan	32	9.58%
3. Spain	31	9.28%
4. France	31	9.28%
5. Denmark	29	8.68%
6. Italy	24	7.19%
7. India	19	5.69%
8. Saudi Arabia	15	4.49%
9. Algeria	8	2.40%
10. Sri Lanka	7	2.10%

Figure 9: Countries reaching the course page. Google Analytics

Continent	Page Views	Page Views
	334 % of Total: 0.53% (62,918)	334 % of Total: 0.53% (62,918)
1. Europe	134	40.12%
2. Americas	91	27.25%
3. Asia	86	25.75%
4. Africa	22	6.59%
5. Oceania	1	0.30%

Figure 10: Course page visits per geographical area. Google Analytics

In Figure 11, there is a graph with data for Course Users, Views, and average time spent. Users of the course's introduction are 155 and Views 355. The course introduction was quietly interesting for the visitors of the platform but the data has a descending trend to the lessons. While the introduction can be visited also by people not enrolled to the course, only enrolled students can move forward explaining why data have a descending trend.



	Introduction	L1_U1	Lesson 1	L1_u2	L1_U3	L2_U1	L3_U1	Lesson 2	Lesson 3
Users	155	38	36	33	30	22	18	17	14
Views	355	78	96	58	59	42	44	25	24
Average time spent	68,79	174,48	57,87	204,10	217,33	247,62	385,81	51,00	94,76

Figure 11: Number of Users, views, and average time spent per course page. Google Analytics

In the second section, there are data from the EMMA platform and for *An Introduction to AC Microgrid for Energy Control and Managemen*t, 104 learners enrolled but few un-enrolled can be registered during the course lifetime (Figure 12).

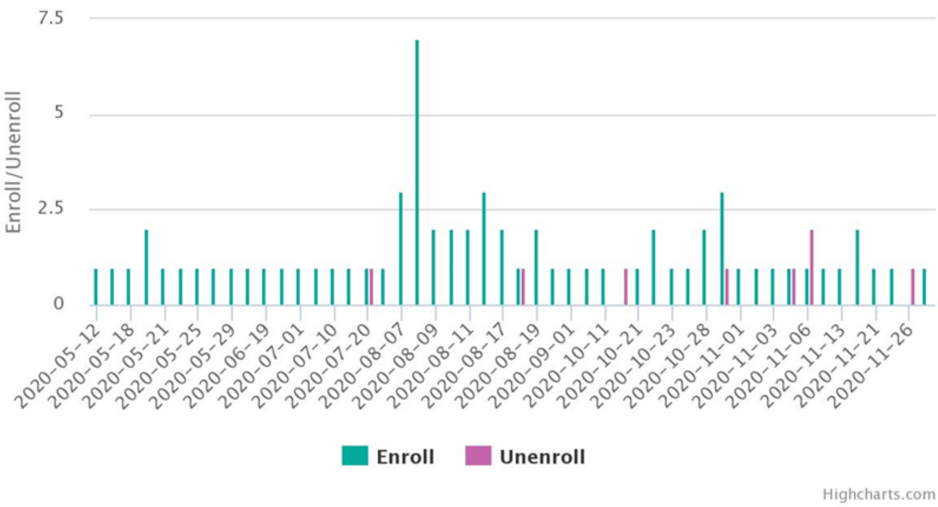


Figure 12: Number of enrolled people into the course. Emma Learning Analytics

In Figure 13, the number of interactions and the average time spent is reported, as shown, the MOOC has started quite well, but the number of interactions had a descending trend after the introduction of the course. This happens quite often in MOOC history, but the teacher can still try to engage their students by offering thoughts, personal messages, or can use the Emma interactive features (personal blog, conversation, assignment) to further involve the students.

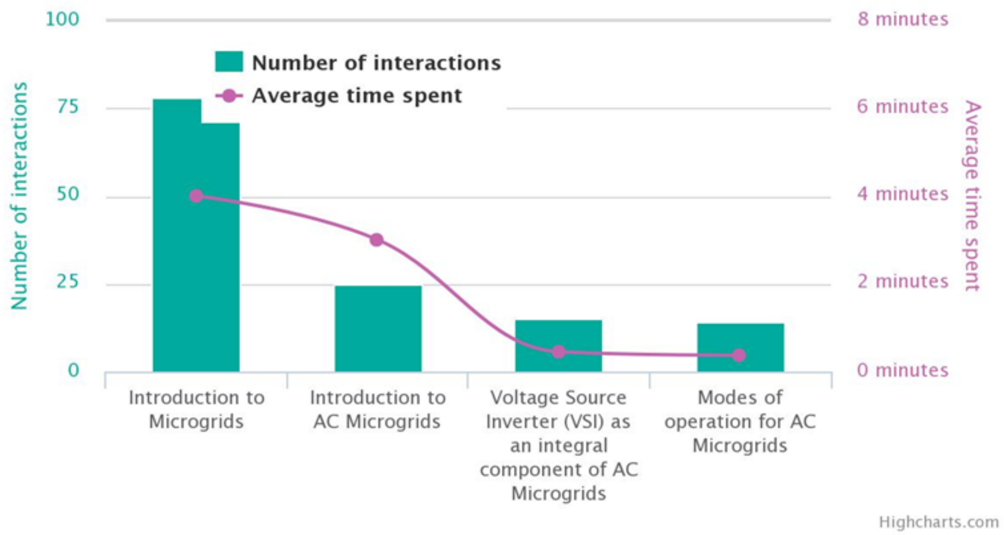
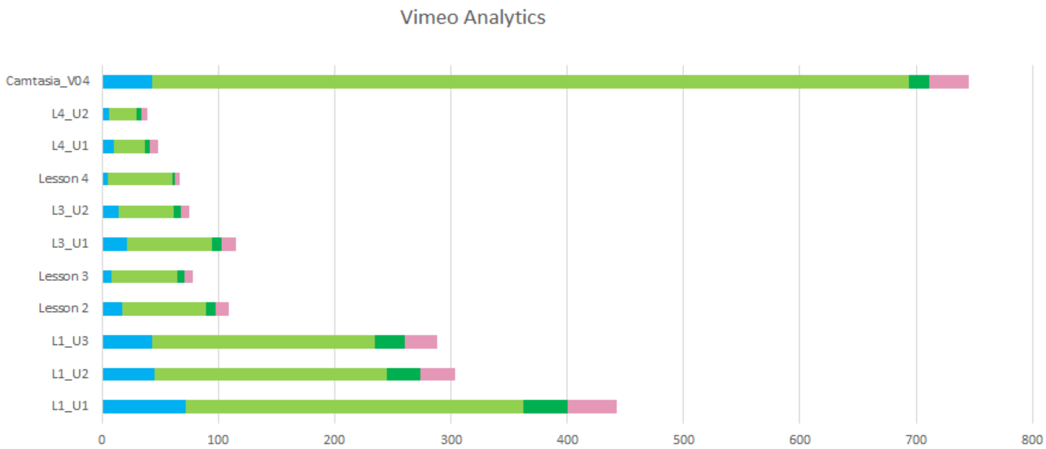


Figure 13: Number of interaction and Average time spent from EMMA platform

The third section of the report has the Vimeo data on the most important analytics of the video:

- **Views**: the number of times your video started "playing". Counts the number of sessions in which a person has hit the play button on a video or the video auto-played;
- **Unique viewers**: the number of people who have watched a video within a specified timeframe. Each user is tracked by a unique cookie based on their browser & device;
- **Impressions**: the number of times your video was "loaded" on a Vimeo clip page or on a website it's embedded on;
- **Finishes**: the number of sessions in which a video is played all the way to completion or within 2 seconds of the end of the video[1].

The Views of Lesson 1 Unit 1 are 72 and Unique viewers are 43 but in this category of the other lessons have a descending trend, only the lesson on Camtasia has 651 Impression. The missing videos have 0 in all categories (Figure 14).



	L1_U1	L1_U2	L1_U3	Lesson 2	Lesson 3	L3_U1	L3_U2	Lesson 4	L4_U1	L4_U2	Camtasia_V04
Views	72	45	43	17	8	21	14	5	10	6	43
Impressions	290	200	192	72	57	73	48	55	27	24	651
Finishes	38	29	25	9	6	9	6	3	4	4	17
Unique Views	43	30	28	11	7	12	7	4	7	5	34

Views Impressions Finishes Unique Views

Figure 14: Number of Views, Impressions, Finishes and Unique Views. Vimeo Analytics

[1] Vimeo. Video Manager Analytics Panel: https://vimeo.zendesk.com/hc/en-us/articles/115004386887-Video-Manager-analytics-panel

3.2. Learner expectations and evaluation for MOOCs

As we already explained in Deliverable 4.4 ASSET Educational Proposition [1] all learners enrolled in a MOOC have been invited to answer different questionnaires to express their opinions on the program, as well as on MOOC quality and platform usage. The questionnaires propose questions with a multiple choice of pre-coded reasons, but answering was not compulsory. Different from the pilot phase the answer rate is quite increased. For the questionnaire set please refer to D2.4 [3], and for the results of the pilot phase to D4.4 [1]. Here the most relevant results are reported.

3.2.1. User's profile and expectation

Profile and expectation questionnaire is a new survey and it is made by a mix of MOOC Registration and MOOC expectation questions, in this way the questionnaire is less redundant and simpler for the learners. It was added in the first lesson of each MOOC on the EMMA platform; the respondents, which increased from the previous questionnaire, are 215. The questionnaire is divided into two different sections: the first is about users' profiles, while the second section is about the course and the knowledge on Energy Transition.

The respondents of the ASSET courses questionnaire are 77,1% male and 22,8% female. As in the Pilot phase, the distribution per age shows the most numerous group 34,88% fit in the age class 25-34, but 32,09% are distributed in age-class 15-24 and 21,4% in age-class 35-44. While 10,7% falls in class 45-64 and that is the less numerous age-class. According to the previous deliverable, data shows a specific interest in young generations according to their educational path, 34,43% of them have a Master´s Degree while 16,51 have a Degree and Ph.D. 16,51%. Different from the pilot phase, during the second run, we found an increase of undergraduates 26,89%.

It is possible to define the interviewed users as trained or experts in Energy transition because a consistent part declared them knowledge "Fairly high" (48,37%) only 4,19% declare to have "Extremely low" knowledge. We need to point out that respondents identify themselves in two different and big clusters: the first about research & education (52,56%) and the second is about companies from the energy sector (32,56%).

Coherently with these answers, the Job sectors are in Education agency (27,46%), Energy production (20,42%) and Manufacturing industry (14,98%) but unlike the pilot phase there is an increase of Unemployed (18,41%), the other categories are Office Worker (16,92) Researcher (14,93%), Teacher and Lecturer and Middle Manager with the same percentage 9,45% as shown in Figure 15.

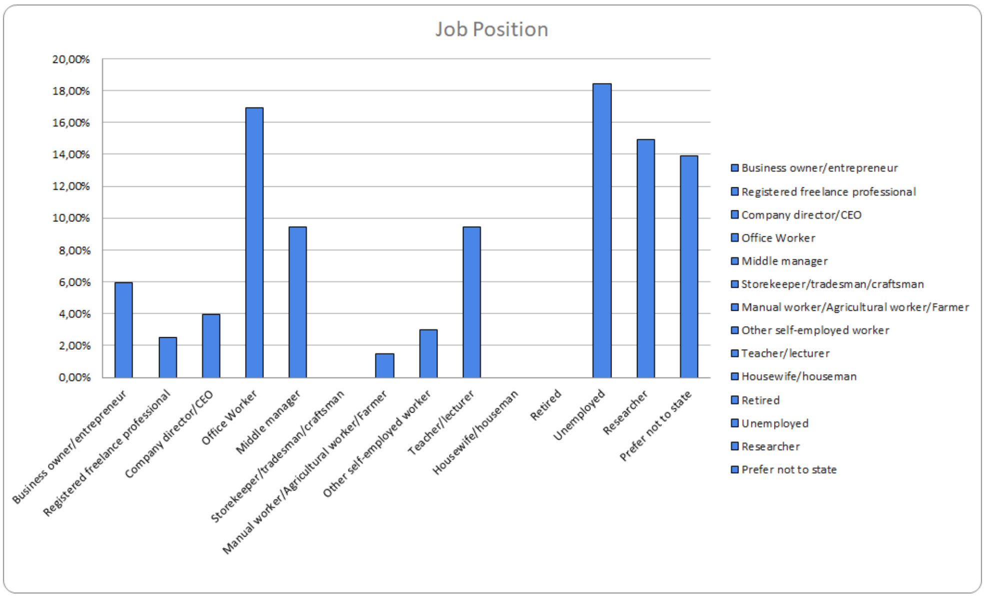


Figure 15: Job sectors of users

The second section of the questionnaire focused also on the interests of the users and ASSET offers. Regarding the reasons why they decided to register at ASSET MOOC offer, data highlights that the main reasons are **to get an idea on energy transition (40,47%), the necessity to gain advanced knowledge in energy transition (39,7%), to acquire new skills (32%).** The questionnaire showed that 43,7% of respondents intended to take a combination of ASSET courses on the EMMA platform.

Data showed that respondents would like to learn on Energy Transition preferably by watching the video, by discussing it with the teacher and tutor, doing quizzes or other assignments, and getting feedback. According to the pilot questionnaire, the less appreciated didactic tool seems to be reading learners' comments or discussing things online with other learners.

The respondents wished to enrol mainly in the following course:

- Renewable Energy Technologies (41,9%)
- Hydrogen as Energy Vector (33,5%)
- Optimization Strategies and Energy Management Systems (28,84%)
- Energy and environment (28,37%)

As for the hard skills, the users of the ASSET offer intended to increase, we mainly find highly sector-specific skills, management, language, and software knowledge. The following graph is quite illustrative of users' expectations in terms of hard skills to be acquired, as shown in Figure 16.

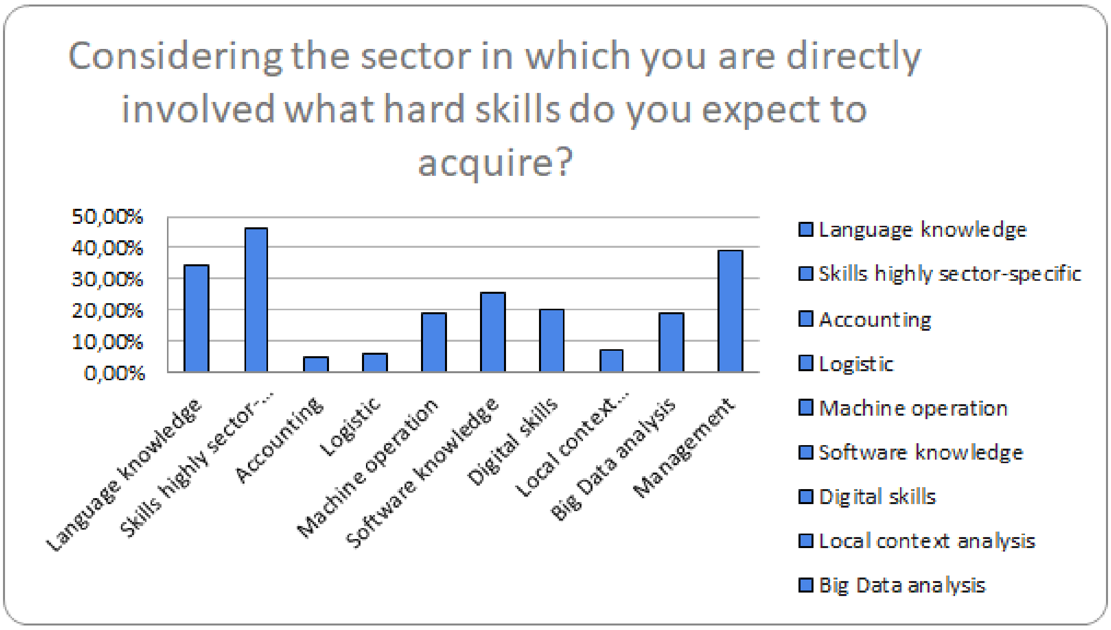


Figure 16: Hard skills to expect to acquire

The interviewees expected to acquire mainly the following soft skills: problem-solving, communication skills, adaptability, and decision making (figure 17). However, as the graph below demonstrates, the picture of the answers is decidedly more homogeneous than that seen for hard skills.

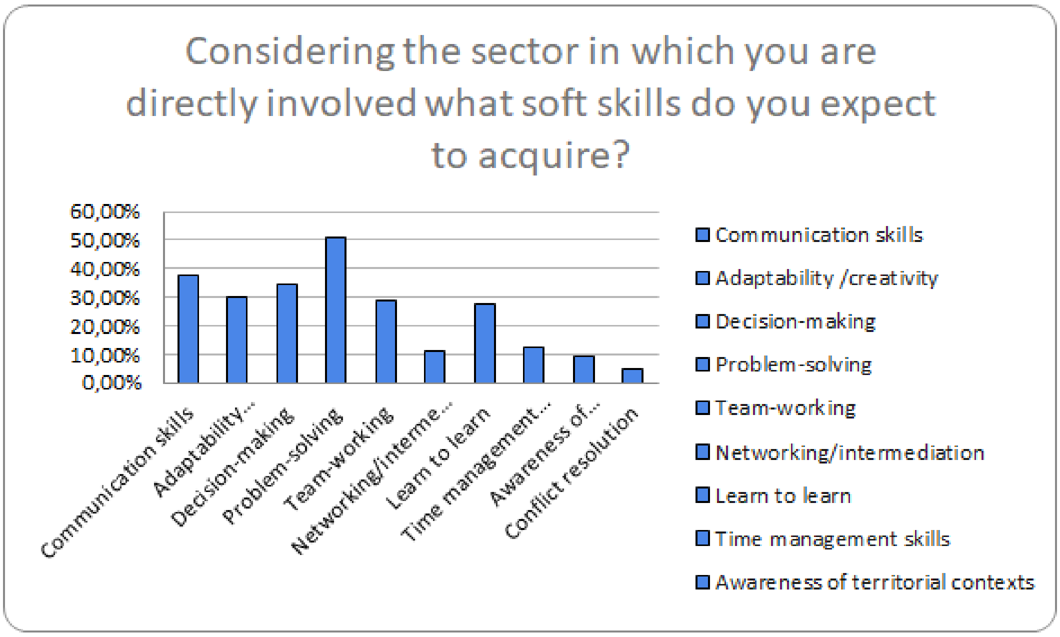


Figure 17: Soft skills expected to acquire

3.2.2. MiniSurvey for Course Quality Monitoring

The MiniSurvey for Course Quality Monitoring is a short questionnaire on the quality of the courses that enrolled learners have been invited to answer and 55 questionnaires have been filled correctly. In particular, we asked the users the strongest and the weakest aspects of the MOOCs, in this way it may modify the future courses.

Since we are still in the pandemic period of Covid-19, learners appreciated studying free on the EMMA platform because it offered the opportunity to learn about energy transition concepts with a clear structure of the courses, concise lessons, basic concepts, and research-based aspects. There is an answer of a student that represented quite well the opinion of a consistent part of the course users:

- **Clear**: all explanations are clear regarding the information given, the slides provided are also very useful to understand the topic.
- **Well explained**: as said before, the slides are very helpful to keep in mind the important information above all that the videos say.
- **Interesting**: topic with a future in the energy sector.

The answers related to the weakest aspect of ASSET courses show a general appreciation of the courses even though the respondents highlighted critical issues but reporting them as relative. In general, the weaknesses of the ASSET courses are the absence of subtitles, pronunciation not always correct, video lessons not always simple and clear.

For respondents, the courses are a good method to improve their own knowledge. In fact, with a Likert scale used to measure the level of learning over 60% think they have learned “much” by the following courses and only 3,64% “Very Little”, as it is possible to see in the following table.

Very Little	Not Much	Neutral	Much	Very Much
3,64%	1,82%	16,36%	61,82%	16,36%

Table 10: Rating from “very little” to “very much”, how much do you think you have learned from the course

Those data are significant also concerning the experience with MOOCs because over 50% of the respondents to the questionnaire answered positively by ASSET courses, while 32,73% expressed “Strongly Like” and 12,73% have a neutral opinion. In conclusion, **over 83% of the interviewees would recommend the courses followed to a friend.**

3.2.3. Exit Questionnaire

Exit questionnaire is a short questionnaire to inquire about user satisfaction concerning ASSET courses. The questionnaire was completed by 33 users. The first data to be detected concerns the high percentage of completion of their courses (90.9%) and the willingness to complete it for those who have not yet achieved certification. Regarding the reasons for not completing the course, the lack of time and the topic that doesn't meet expectations seem to be the main ones for the interviewees. Over 75% of respondents defined the courses they attended as useful, engaging, and multidisciplinary while only 3% defined them as non-exhaustive. Over 65% of respondents defined the course materials as up-to-date and adequate to expectations while tasks and assignments were defined as of the right amount from 60,6% of respondents. Tasks and assignments are a good opportunity for self-assessment for 72,72% of the interviewees. These quantitative findings are illustrated in Figure 18.

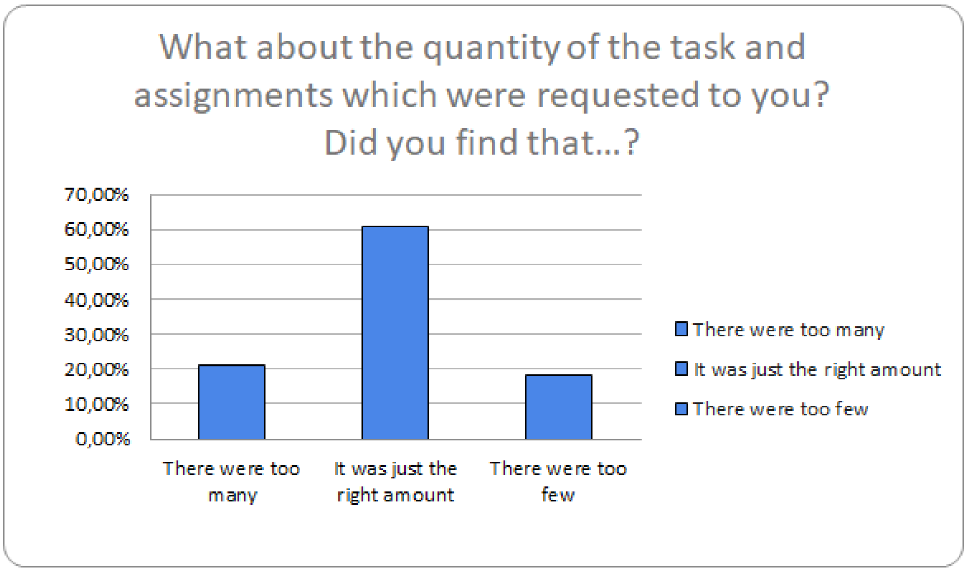


Figure 18: Opinion on tasks and assignments

For the majority of respondents, the interactive functions (conversation, chat, blog) available for the MOOC on EMMA were little used but when they were used their use was effective. Video content was judged by over 70% of respondents positively or neutrally both in terms of format and in terms of quality and effectiveness. Over 84% of respondents rated their experience with ASSET MOOCs as extremely good or fairly good. Finally, concerning the whole ASSET program on ENERGY TRANSITION offered on EMMA, the interviewees stated that the offer should be more focused on environmental issues and societal challenges.

3.3. Learners' expectation and evaluation for face-to-face courses

Unlike the Pilot phase, as we mentioned before, this questionnaire has been filled by the webinars’ students. For this reason, we have fewer respondents than in the first phase. The total number of respondents were 54 but, for the completeness of the answers, it was chosen to take in the analysis 42 of them.

Regarding gender, the sample under examination showed a clear prevalence of men (81,48%). These data confirm the results of D4.4 [1], where it seems clear that the areas related to education in engineering are still preferred by male students. Most of the interviewees are among three different age classes 15-24 with 29,63%, 55,56% in class 25-34 and the last class is 35-44 with 11,11%.

As we could imagine, most of the respondents come from Denmark 29,63%, Spain 24,07%, Greece 20,37%, and Germany 16,67%. The questionnaires filled in by users from other countries are a residual share and have low statistical significance.

Regarding the education level, the questionnaire highlighted that a clear majority of users have a Master (38,89%) and a Ph.D. (29,63%). Furthermore, it is evident that the partners of the ASSET project are mostly universities and therefore undergraduate learners were a privileged target (31,48%).

Data also shows those specific fields of the energy transition that are considered most interesting. For the users of the ASSET courses, they were renewable energy, energy storage, energy efficiency, climate change, smart and flexible energy systems as shown in Figure 19. **Aspects linked to the Policy/regulatory aspects and Carbon capture, utilization, and storage (CCUS) do not arouse the deserved interest yet.**

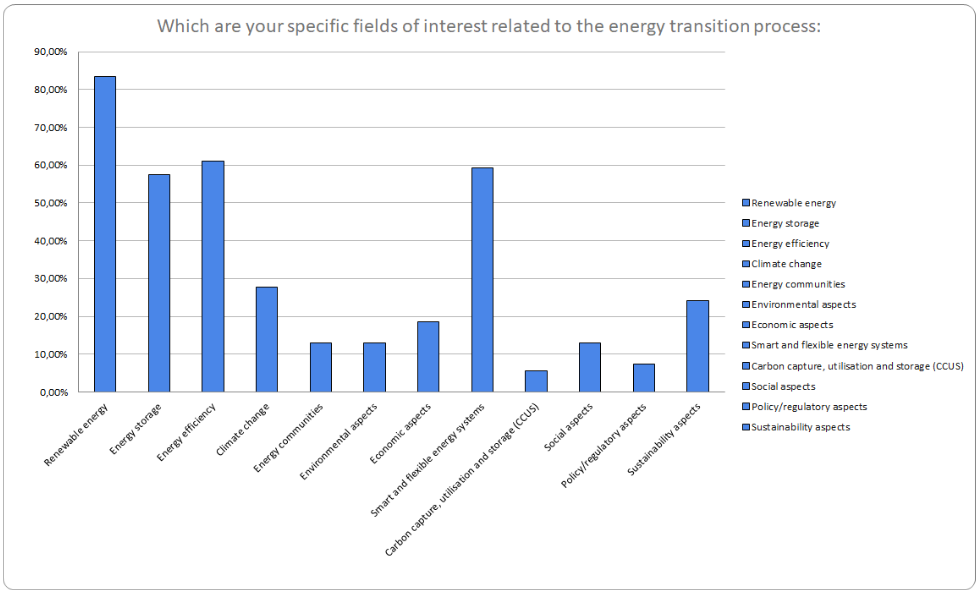


Figure 19: Specific field of interest related to the energy transition process

Respondents would like to learn about Energy Transition preferably by watching the video and by discussing things online with the teacher/tutor. The least appreciated didactic tool seems to be reading learners' comments or doing assignments. The data were collected using the Likert scale (-2, -1, 0, +1, +2), and the results obtained are in the following Table 11.

How you would like to learn on Energy Transition					
	Strongly dislike	Dislike	Neutral	Like	Strongly like
By reading text	3,70%	7,41%	29,63%	44,44%	14,81%
By watching videos	1,85%	1,85%	1,85%	57,41%	37,04%
By reading comments posted by other learners	3,70%	7,41%	42,59%	33,33%	12,96%
By discussing things online with other learners	1,85%	9,26%	25,93%	44,44%	18,52%
By discussing things online with teacher/tutor	1,85%	1,85%	18,52%	42,59%	35,19%
By doing quizzes or other assignments and getting feedback	7,41%	5,56%	22,22%	37,04%	27,78%

Table 11: How you would like to learn about Energy Transition

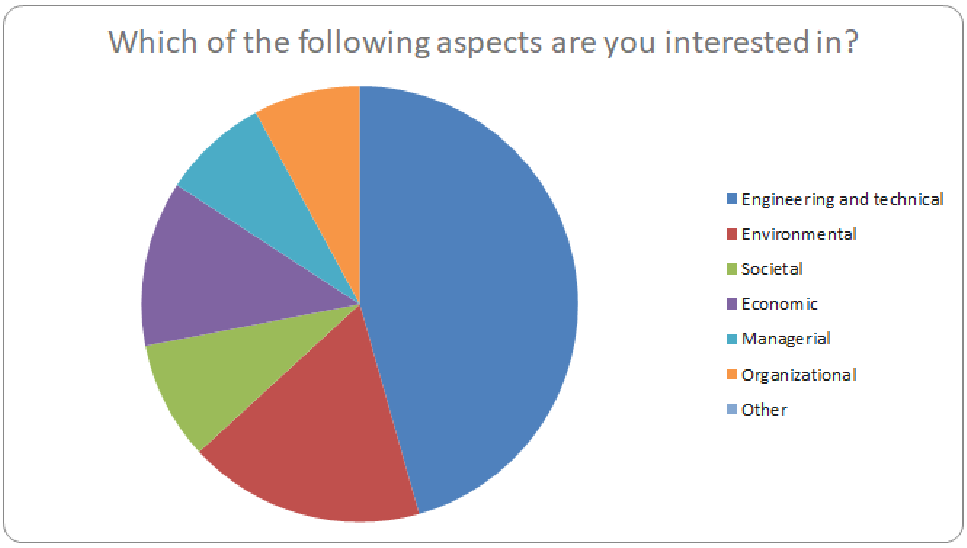


Figure 20: Aspects of interests

Figure 20 highlights how engineering and technology are mainly associated with the energy transition as well as for Environmental aspects with 17,5%. The other spheres seem to be residual. However, in this graph societal aspects are less relevant than environmental and engineering aspects because the respondents come from technical webinars and courses.

What has just been said seems to be confirmed by the answers to the question "Which of the following ASSET Courses would be interesting for you?" In fact, the most "interesting" courses were once again those related to technical and engineering issues (Figure 21).

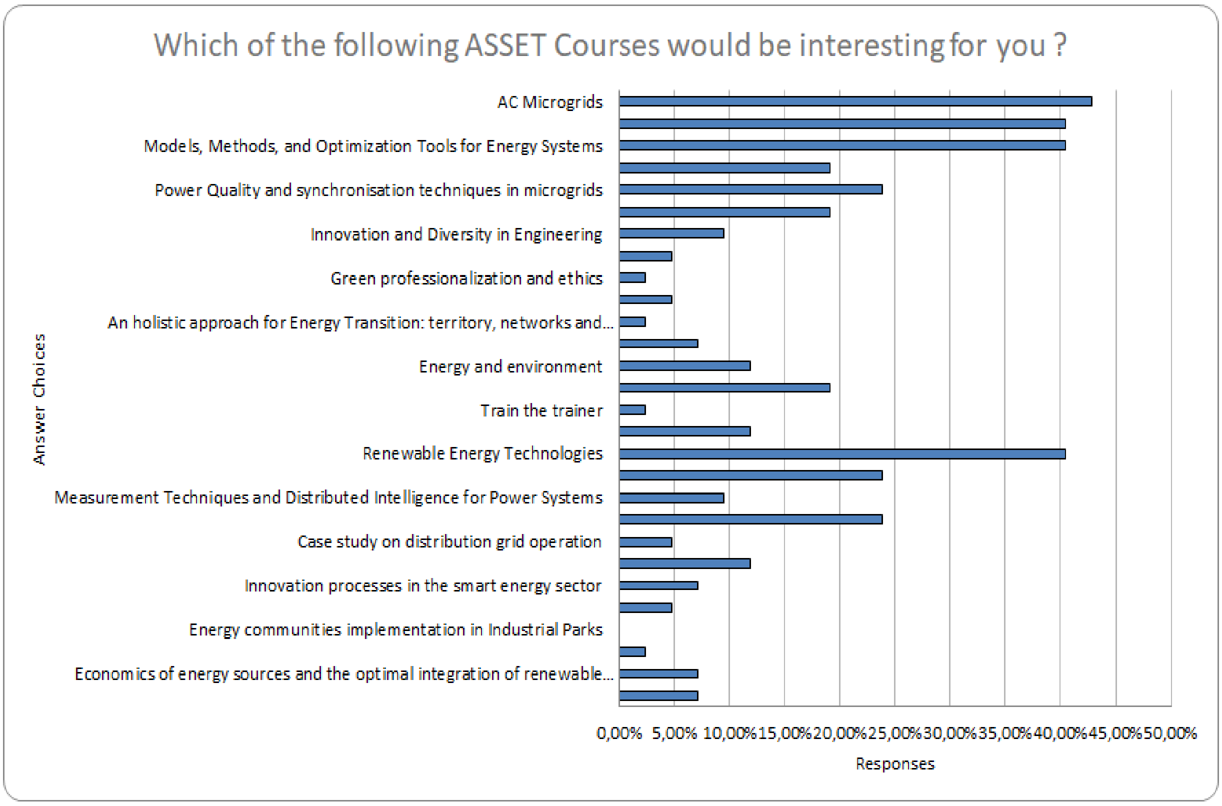


Figure 21: Users interest in Energy transition courses

These students consider their own knowledge in the field “neither high nor low” (64,29%) and “fairly high” (23,81%) against 4,76% which consider it ‘Extremely high’ or ‘Fairly low’ (7,17%). (see Table 12)

	Extremely high	Fairly high	Neither high nor low	Fairly low	Extremely low	Total
1	4,76%	23,81%	64,29%	7,14%	0,00%	100%

Table 12: How would you consider your knowledge in the Energy Transition field?

The Likert Scale was also used to measure some specific characteristics of course students followed in the face-to-face mode as shown in Table 13, so to have a broad evaluation of the face-to-face offer. The results are quite encouraging, as it is possible to see in the following table. Courses are considered engaging, innovative, multidisciplinary, flexible, useful, integrative, and preparing for in-depth education.

	Completely agree	Fairly agree	Neither agree nor disagree	Disagree	Fairly disagree	Completely disagree
It's engaging	26,19%	54,76%	19,05%	0,00%	0,00%	0,00%
It's comprehensive	21,43%	61,90%	11,90%	4,76%	0,00%	0,00%
It's exhaustive	11,90%	52,38%	23,81%	7,14%	0,00%	4,76%
It offers a multidisciplinary perspective	19,05%	52,38%	21,43%	7,14%	0,00%	0,00%
It offers flexibility in learning paths	26,19%	45,24%	21,43%	4,76%	2,38%	0,00%
It's innovative	40,48%	35,71%	16,67%	4,76%	2,38%	0,00%
It's useful	47,62%	52,38%	0,00%	0,00%	0,00%	0,00%
It's complementary to acquired knowledge	40,48%	42,86%	16,67%	0,00%	0,00%	0,00%
It's preparatory for an in-depth education	40,48%	47,62%	9,52%	2,38%	0,00%	0,00%

Table 13: How much would you agree with the following statements about the course you have followed?

Question number 13 is a series of claims concerning the courses followed and the respondents had to agree or disagree with certain statements. A shown in Figure 22, 35,71% said that the course was well organized and it helps me to complement my previous knowledge into the field. 33,33% enjoyed the experience and for them, it was something new from the previous learning experience. Interestingly, however, 30,95% of the respondents found the course "Truly formative" and it was up to my overall expectations. During the lessons, to deepen the topics studied, learners were provided with various teaching materials that the respondents found updated (54,76%), of right quality (38,10%), and matching the expectations (23,81%).

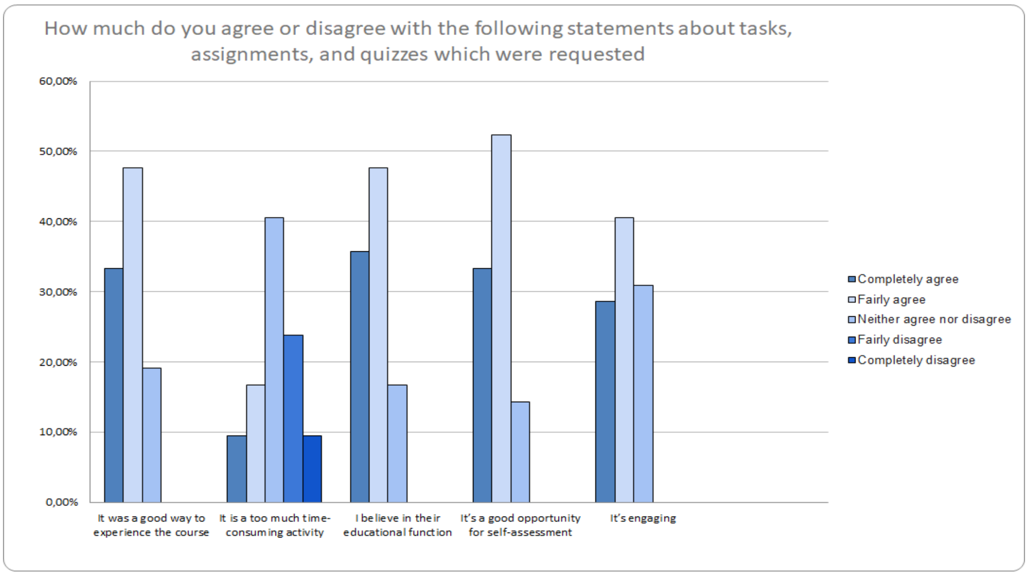


Figure 22: Agree or disagree about tasks, assignments, and quizzes

The answers probably mean that the student feels the need to rework the knowledge acquired through quizzes and homework because they see their educational importance to be involved in the lesson, also these give the opportunity both to self-assess and to receive feedback from the teacher.

Finally, as we can see in Figure 23, the respondents assessed their experience with the program as good. It emerges that the courses are of high quality according to their expectation.

Figure 23: how would you rate your experience with this short programme?

The last questionnaire for the face-to-face course was filled by UPV learners and it is useful to test the quality of the course “Hydrogen as Energy Vector”.
The data were collected using the Likert scale (from 1 to 5) and the total number of questions are 4 with 19 respondents. The course has quite positive responses because 68,4% said that the teacher or tutor met their expectations according to the mastery of the subject, resolution of doubts, and attention to the student. As shown, in Figure 24 the general organization of the course was good. 63,2% said “Totally agree” with the materials, content, and material or technological infrastructure.

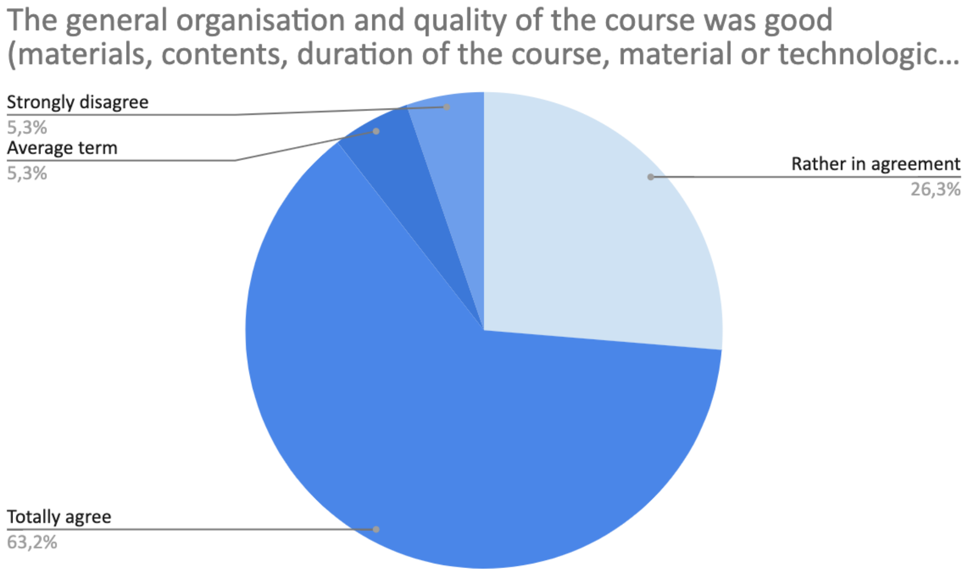


Figure 24: General organisation and quality of the course Hydrogen as energy vector

4. Evaluation of Interdisciplinary and On-demand Courses

4.1. Interdisciplinary Courses development

A total of five interdisciplinary courses were delivered with four of them being created by integrating SSH-relevant learning outcomes in curricula of running technical courses and one of them being designed from the beginning as an interdisciplinary course.

As this was the first time of delivering an interdisciplinary course for all four professors involved in this endeavour, we decided to: a) collect feedback mainly through focus groups rather than questionnaires so that we capture better the impact of this combination on our students; and b) attempt this combination in class with few tens of students (instead of a course with a large number of attendees).

An additional interdisciplinary programme was designed by RWTH Aachen University. This course will be offered to RWTH students as a seminar after the end of the project. Also in this case, the use of the learning graph tool significantly facilitated the creation of the course, since it allowed to easily combine learning outcomes associated to different domains (electrical engineering and SSH). For the course preparation, some interactions between the professors responsible for the starting programmes were necessary. This is because it was decided to use the existing learning materials only as starting point, but to refine most of them to have a better integration and to stress even more the interdisciplinary perspective. Even if some interactions and additional work was needed to update the materials, the learning graph tool has been extremely important to identify the possible connections between two courses originally intended for different purposes.

The details of the interdisciplinary courses, along with the updated time plan, is shown in the following Table 14.

No	Course title	Creator	Involved Disciplines	Re-using learning materials (D3.2)	Target audience	Delivery
1	Software Defined Networks	UNIWA, P. Karkazis	ICT and Innovation processes in the energy sector	YES	Postgraduate UNIWA students	Spring 2020
2	Mobile app development	UNIWA, N. Leligou	ICT and Innovation and Diversity in engineering	YES	Undergraduate UNIWA students	Winter 2020
3	New Materials for solar cell applications	UNIWA, T. Ganetsos	Material and Responsible Research	YES	Undergraduate/ post graduate UNIWA, and Democritean University of Thrace	Winter 2020
4	Energy Efficient and Ecological Design of Products and Equipment	UNIWA, C.S. Psomopoulos	Ecological and Energy Efficient approach and Corporate communication and responsibility	YES	Undergraduate and post graduate UNIWA students	Winter 2020

No	Course title	Creator	Involved Disciplines	Re-using learning materials (D3.2)	Target audience	Delivery
5	Understanding Responsibility in the Energy Transition	RWTH, F. Ponci, and A. De La Varga	Electrical Engineering & SSH	Only partial	Undergraduate/ postgraduate students	Design only

Table 14: Details of ASSET Interdisciplinary course offers

For the four courses offered during the project, two different approaches were followed for the course delivery:

- For courses 1, 3, and 4, the professors delivered the learning materials associated with the SSH-relevant topic after careful study and communication with the creators.
- For course 2, the students were prompted to follow the materials of the SSH course that were prepared for its MOOC version and in the end, the professors that created them (prof. Carmen Leicht-Scholten and Julia Berg from RWTH) gave a dedicated lecture which was structured interactively so that the students were provided the opportunity to place questions and receive answers.

4.2. On-Demand Courses Development

4.2.1. Growth Mindset for AI services in the energy sector

For the preparation of this on-demand course, we were contacted and enquired by PowerOps, an SME residing in the United Kingdom. The inquiry was as follows:

“We are an SME interested with strong competencies in artificial intelligence for the energy sector. We are interested in defining our services in a way that we can bring them to market. We have been inspired by the ASSET course "innovation processes in the energy sector" and we would like to explore the opportunity to attend a tailored course.”

The request was initially received from OTE Academy, which contacted the representative of the company for more information. Based on the outcomes of the discussion, they agreed to an **inter-disciplinary programme** that would be delivered in **blended** mode to accommodate the tight time schedules of the employees of the company.

For the development of the programme, OTE Academy contacted the University of West Attica to co-design this interdisciplinary course and tailor it to the blended style. We used the learning graph model to design the course and organize our work, which also allowed us to give a more structured vision to the employees as well.

To address the needs of the company, the learning graph shown in Table 15 was created, which was also inserted in the ASSET learning graph tool (as shown in Figure 25). Next, the relevant materials were developed. The following graph shares the first three learning outcomes with the programme “innovation processes in the energy sector”.

Educational Programme Title	**Growth Mindset for AI services in the energy sector**
SET Area	New technologies and services for consumers
EQF level	7

Learning outcomes	• Understand Innovation Processes • To familiarise with Growth Mindset • To develop Design Thinking • To develop MVP based on artificial intelligence in energy system planning • To develop MVP based on artificial intelligence in real-time energy grid operation
Other relevant keywords	• Innovation Structure • Innovation Processes • Growth Mindset • Design Thinking • Minimum viable product • AI-based energy services
Course Description	This course explains essential methods and tools of Innovation Management, targeted in the field of the energy sector. Additionally, it guides the trainees to apply these methods to artificial intelligence-based services for the energy sector focusing on solutions for system planning and real-time system operations.

Table 15: Program Overview: Growth Mindset for AI services in the energy sector

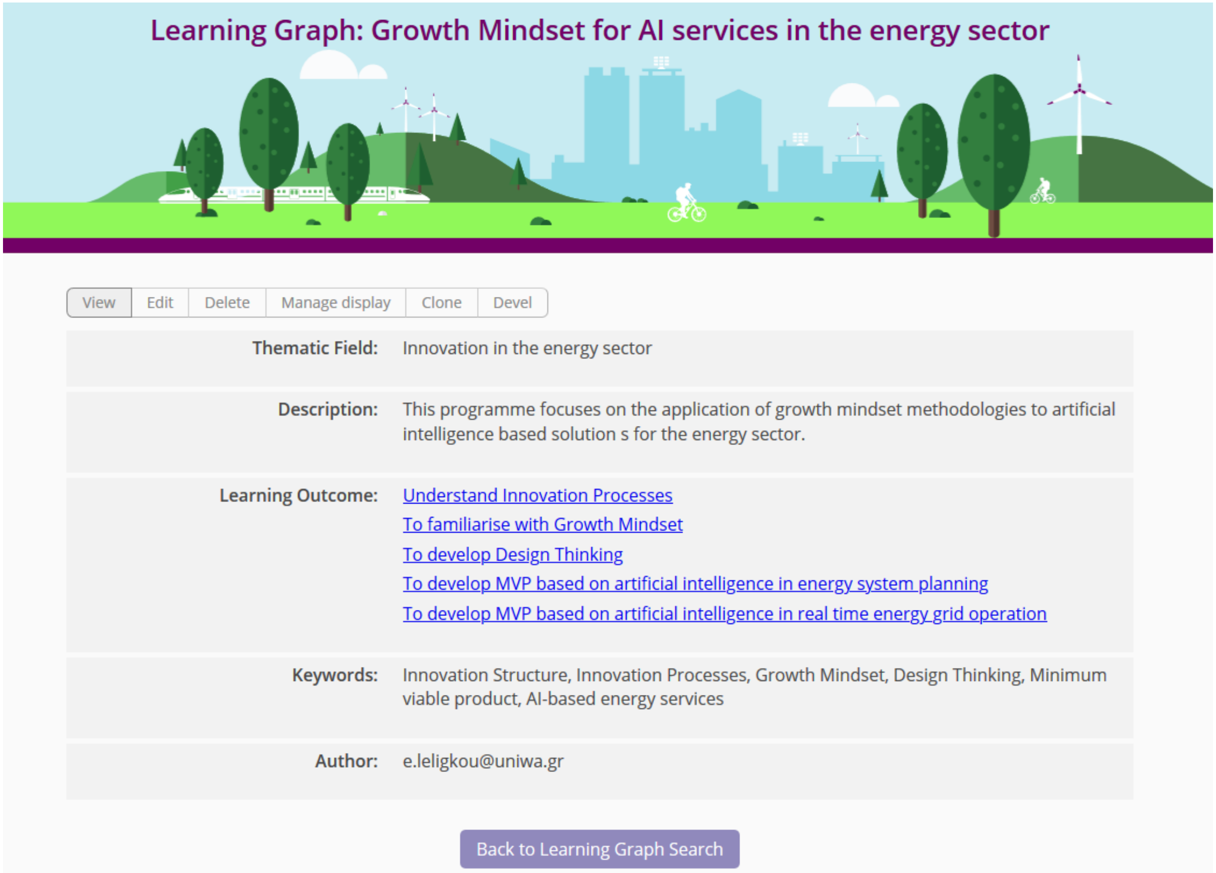


Figure 25: The learning graph of the developed course as shown in the learning graph tool

The materials were delivered to the company in January 2021 and two web-based meetings/courses were organized using Microsoft teams: one on 9/2/2021 to present the material and the main outcomes targeted and another one on 12/3/2021 for final discussion. Figures 26 and 27 show the five employees of the company attending the course (on 12/3/2021).

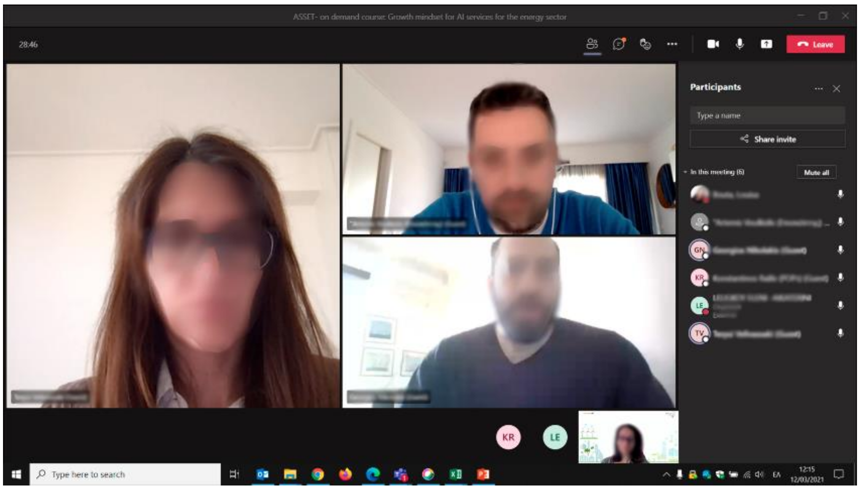


Figure 26: Screenshot from the web-based course (12/3/2021)

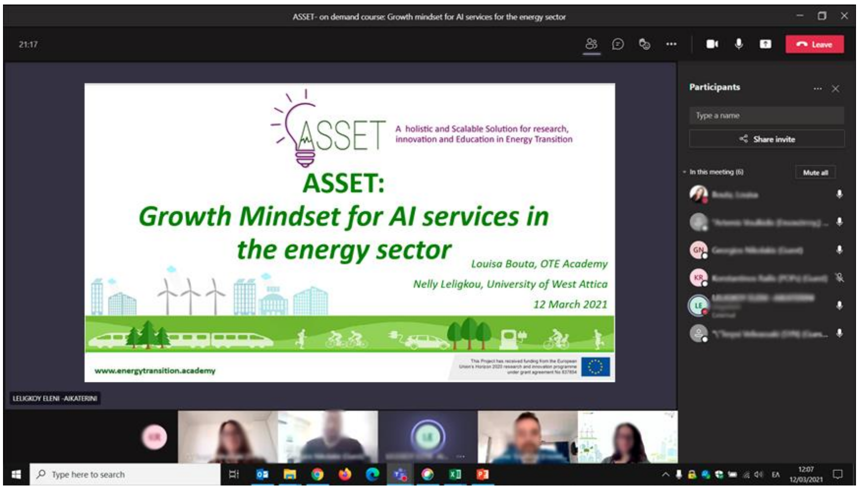


Figure 27: Screenshot from the web-based course (12/3/2021)

4.2.2. Emerging Technologies for the Future Smart Grid

The second on-demand course was created and delivered to the Italian company Unareti, which is a large utility responsible for the distribution of gas and electricity above all in the north of Italy. The company has close collaborations with RWTH and therefore it was well aware of the activities and developments in the ASSET project. After some meetings and discussions about the project, they showed their interest in receiving a small course on some topics potentially relevant for them. In particular, the company representatives underlined that course on last generation technologies are very interesting and important for them, both to upgrade the skills of the employees and to follow more easily and promptly the last technological trends.

Based on their interest, a series of dedicated meetings was organized with some company representatives to show more in detail the educational offer developed in ASSET and the tools created to explore learning outcomes and materials. For this purpose, both the marketplace and the learning graph tool were shown. The company then asked some time to check the available topics and to identify a shortlist of subjects of their interest. Following their indications, the programme indicated below (with the learning graph shown in Table 16) was eventually created. Figure 28 shows the screenshot of the corresponding learning graph introduced in the learning graph tool of the ASSET website. It is worth noting that the programme includes three learning outcomes taken from different existing courses. This emphasizes the benefit and simplicity of exploiting the learning graph models for the design of new courses with mixed learning outcomes.

Educational Programme Title	Growth Mindset for AI services in the energy sector
SET Area	Integrating renewable technologies in the energy systems; resilience and security of energy systems; renewable fuels and bioenergy
EQF level	7
Learning outcomes	• Examine various techniques for power quality improvement • Describe cyber threats for power systems and possible cybersecurity solutions • Describe fuel cells working principles as well as associated applications
Other relevant keywords	Power Quality, Total Harmonic Distortion, Voltage Dip, Unbalance Supply, Voltage Regulation, Cybersecurity, Resilience, Cyber-attacks, Grid Security, Hydrogen, Electrolysis, Fuel Cells, Energy Storage
Course Description	This course provides the technical details behind some topics particularly important for future smart grids, namely power quality, cybersecurity and fuel cells.

Table 16: Program Overview: Emerging Technologies for the Future Smart Grid

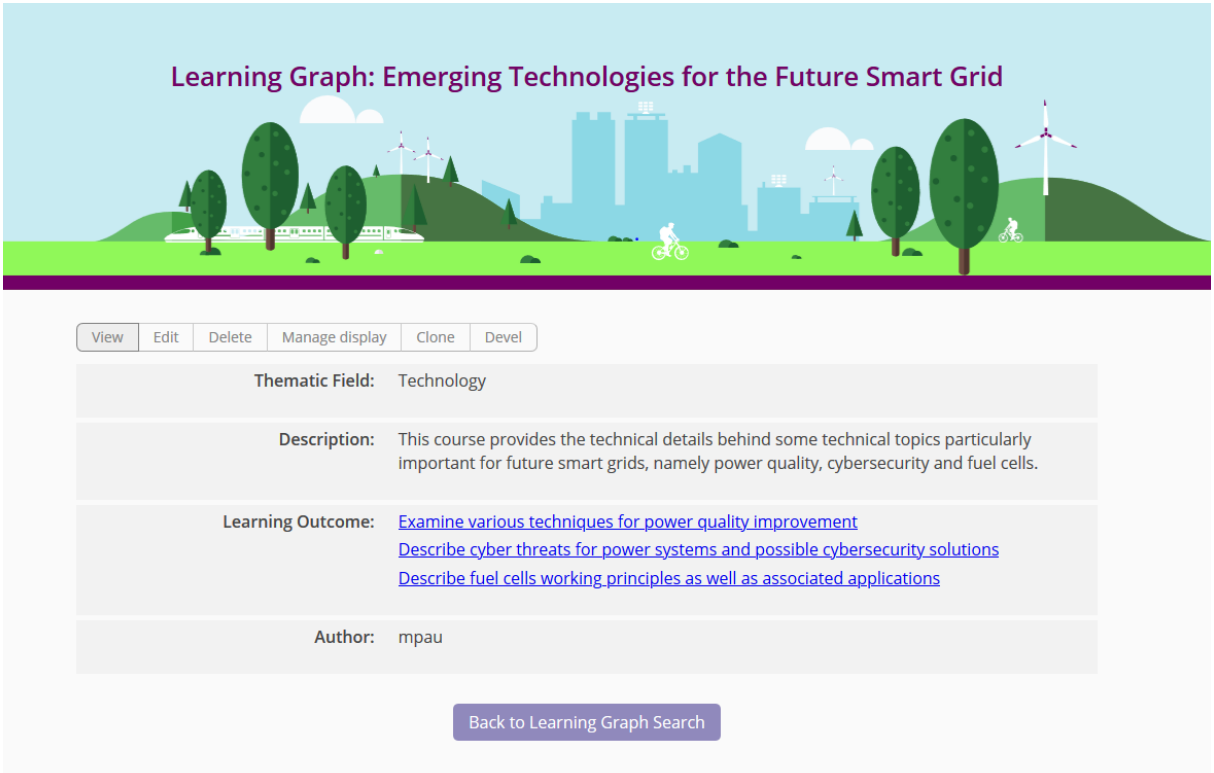


Figure 28: The learning graph of the developed course as shown in the learning graph tool

Their interest towards the selected learning outcomes was motivated as follows:

- *Examine various techniques for power quality improvement*: the problem of power quality is already relevant today in electrical distribution grids, but it will be even more important in the next future due to the increasing number of new technologies being connected to the low

voltage grids (renewable energy sources, electric vehicles, etc.). Having an overview of the impact of the power quality issues and of novel solutions to mitigate this impact is thus key for the company.
- *Describe cyber threats for power systems and possible cybersecurity solutions*: with the digitalization of the grids and the associated intelligence, it is clear that cybersecurity is the main requirement for critical infrastructures like electricity and gas networks. This is also a topic in the continued evolution and, hence, keeping an eye on recent solutions and ideas is of vital importance for the company.
- *Describe fuel cells working principles as well as associated applications*: hydrogen is an energy vector that is gaining more and more attention. The company employees are not familiar with this topic, as it is not a technology that is part of their daily activities. Consequently, we are highly interested in getting some insight into the concepts and applications associated with it.

For the delivery of the course, the company asked to possibly receive video material as this was the most flexible way to allow multiple employees to follow the course. They clearly indicated that having the possibility to flexibly decide when and where to follow the course was important for allocating the due time to it. The learning material was provided in December 2020 and the company employees were given two months for following the course, raise possible questions and provide feedback.

4.3. Evaluation Criteria

The evaluation criteria for the **interdisciplinary courses** have been based on:

- The self-assessment by the professors involved in the creation and delivery of the programme;
- The assessment of the course by the students.

The self-assessment focused on the easiness of the process for the interdisciplinary course creation and on whether the professors intend to follow this approach again in the future.

Concerning the students' assessment, we focused on their interest and satisfaction in the combination of technical and non-technical topics and the impact on their engagement and modification (widening) of their attitudes. For this purpose, for three out of the four delivered courses (courses 1, 3, and 4) we established focus groups to discuss and gather detailed feedback. For the other course (course 2), the students were asked to fill in a questionnaire composed of the following questions:

- Do you consider that it is of value to tackle and integrate non-technical units in selected courses in the curricula?
- Do you consider that the non-technical part was sufficiently covered given that it was not the central point of the course?
- Evaluate the quality of this part of the course.
- Did the lecture given by the expert help you understand better the topics?
- How likely is it for you to attend the same MOOC through EMMA?
- Have you ever enrolled in any MOOC in the past?

Similarly, the evaluation criteria for the **on-demand courses** was based on:

- The self-assessment by the programs' creators;
- The assessment of the program by the company employees who followed the course.

The self-assessment focused on the easiness of the process to create the course, on the value of the tools (marketplace and learning graph tool) developed within ASSET for the program preparation, and on the other learnings coming from the interaction with the industrial partners.

The industry assessment was instead collected via a dedicated questionnaire, which aimed at collecting information and feedback about the following aspects:

- Demographic information (gender, age, education of the course attendee);
- Feedback on the quality of the programme, of the materials, and general level of satisfaction;
- Strong and weak aspects of the course;
- Relevance of the course topic for the company.

4.4. Assessment Results

4.4.1. Interdisciplinary courses

Concerning the **self-assessment**, the professors found it easy and very interesting to integrate other topics in their courses. They also reported that this contributed to the engagement of their students as their feeling was that the professor is not a narrow-minded technology-oriented scientist but has a more global view of life, society, and market. As a result, they reported that they will continue offering the modified curricula and they plan to include other SSH elements in other courses as well.

For the course where an expert from another university was invited to give a lecture, the whole process of inviting the students to attend the MOOC and then arrange the lecture was very interesting and smooth and allowed the professors to e-meet each other.

For the **students' assessment**, for three out of the four courses, we established focus groups and for course 2 we additionally asked the students to fill in a questionnaire. When the professors met to report and study the results, they concluded that the questionnaire's results reflect also what happened in the rest of the courses. For this reason, we provide in the sequel these results, which were gathered through the e-class platform (the platform widely used in Greece by the university as LMS).

All questions were asking the students to answer using a 5-point Likert scale.

Results:

In the question "Do you consider that it is of value to tackle and integrate non-technical units in selected courses in the curricula?" All students answered positively which the majority indicating that they agree (4 on a scale from 1-5). These quantitative findings are shown in Figure 29 below:

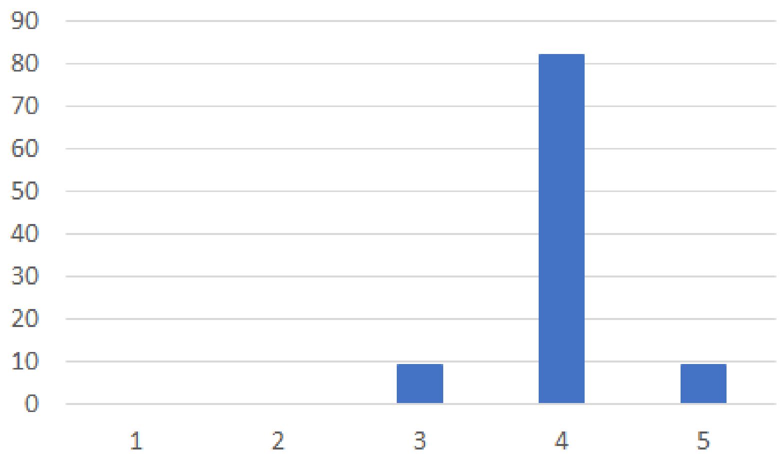


Figure 29: Students' response to the value added by integrating non-technical interdisciplinary units in the course

In the question "Do you consider that the non-technical part was sufficiently covered given that it was not the central point of the course?", the feelings of the students here were almost uniformly distributed as shown in the following figure 30 on the next page.

In the question "Evaluate the quality of this part of the course", the feelings of the students here in principle are good. Those that did not give a high score at the quality said in the free text space we provided that their issue was that they would like to have more practical examples which is perfectly in line with the attitude of engineers. These quantitative findings are shown in Figure 31 on the next page:

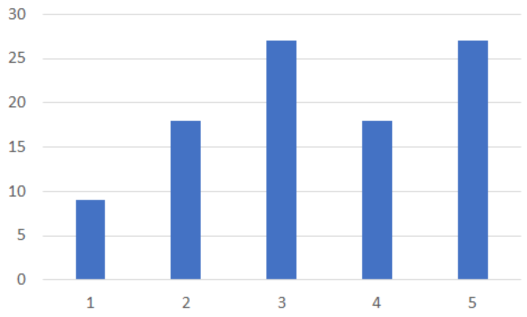


Figure 30: Students' response to the non-technical interdisciplinary contents covered in the course

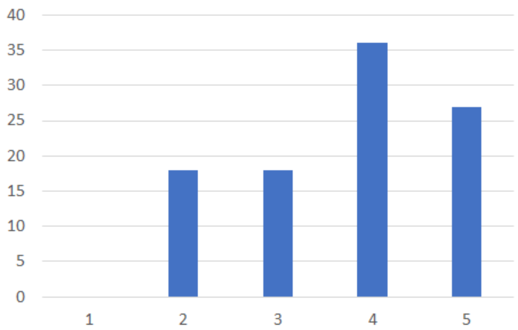


Figure 31: Students' response to the quality of non-technical interdisciplinary contents covered in the course

In the question "Did the lecture given by the expert help you understand better the topics?", there was a strong positive feeling as shown in the following figure 32.

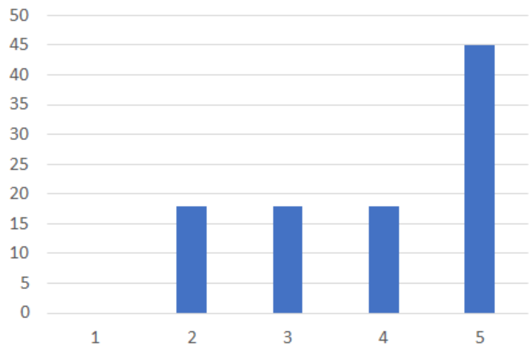


Figure 32: Students' response to the understanding of the topic by integration of non-technical interdisciplinary contents

For the question "how likely it is for you to attend the same MOOC through EMMA?", the answers are shown in the following figure. The result is considered very positive, given that they had already received the first elements. In the discussion that followed the questionnaire, they said that they are going to follow other MOOCs to explore other topics as well.

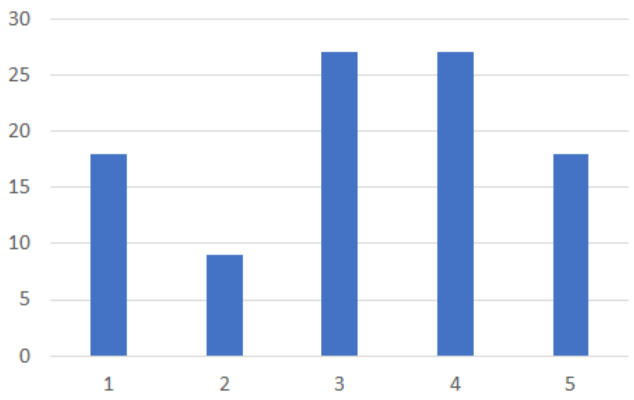


Figure 33: Students' willingness to attend the interdisciplinary courses as a MOOC through EMMA

In the question "have you enrolled in any other MOOC in the past?", 80% answered NO, which was a surprise for the professor but at the same time a very encouraging result as now they know they can find additional knowledge outside their university.

The questionnaire prompted the students to point out three positive and three negative elements of the process. Only one comment was negative, referring to the inclusion of a non-technical part in the course. All the rest of the comments showed the students were engaged and they would like an additional invited lecturer. The negative points they raised were around the inclusion of more practical examples and going deeper into the topic and have more contents related to practical aspects.

4.4.2. On-demand courses

The **self-assessment** mainly focused on the easiness of the process to create the course, on the value of the tools (marketplace and learning graph tool) developed within ASSET for the programme preparation, and on the other acquirements coming from the interaction with the industrial partners. The main findings and considerations are summarized below.

Easiness of the process to create the course:

- During the creation of the new course, the re-use of material from already existing programmes accelerated the creation of the new course by at least 40%.
- At an early stage, it was possible to also involve the industrial partners in the programme definition, thanks to the availability of already existing courses with a clear structure in terms of learning outcomes and materials.
- Having a pool with a variety of learning materials prepared according to different learning styles allowed to easily meet the requirements of the industrial partners, in particular in terms of flexibility in the fruition of the course.

Value of the ASSET tools:

- The marketplace gave the organizations involved in the course the opportunity to reach industrial partners located in other countries, thus leading to international reach.
- The learning graph tool allowed the industrial partners to get a clear idea of the available learning outcomes, materials, and associated delivery modes.
- The clear structure of existing programmes created via the learning graph model allowed to easily combine learning outcomes originally associated to different topics and materials created by different institutions.

Other findings/learnings:

- While the course "Growth Mindset for AI services in the energy sector" was initially addressed to OTE Academy, both OTE Academy and the University of West Attica collaborated for the creation of the course; this experience showed that this collaboration was necessary and brought benefits for both organizations.

- While the course "Emerging technologies for the future smart grid" was addressed to RWTH Aachen University, the created programme included learning outcomes and materials coming from different universities, namely Aalborg University and Universitat Politecnica de Valencia; this showed the value of the created ecosystem to enlarge the educational offer and the portfolio of available options.

For the **industry assessment,** we used an online questionnaire with several questions in addition to some further discussion with companies' representatives after the end of the course. Figure 34 shows the demographic information about the companies' employees who attended the two on-demand courses. The graph shows that the course had a majority of male attendees and that participants were equally distributed in the age intervals 25-34 and 35-44. Moreover, most of the attendees hold a Ph.D. title, which underlines that they already have a high education level.

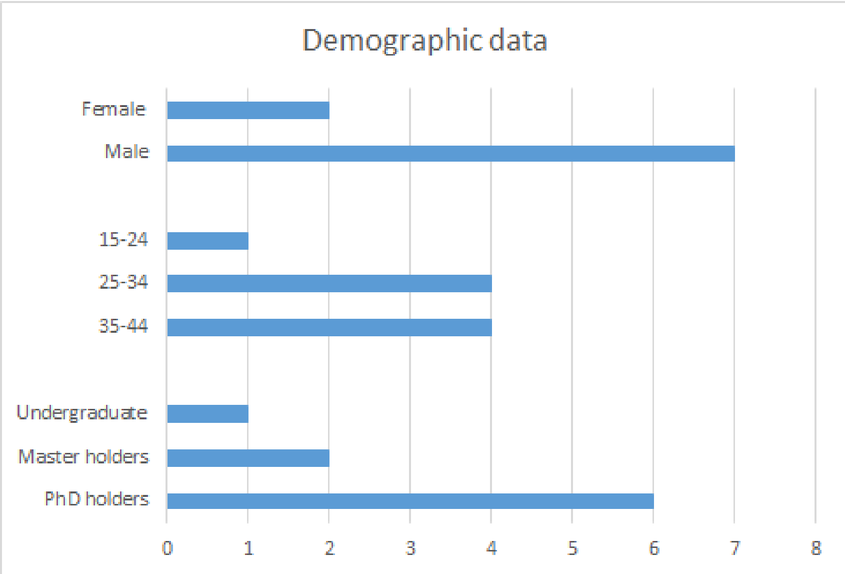


Figure 34: Demographic information about the on-demand courses' attendees

Figure 35 shows the main aspects around energy transition that the course attendees were interested in (note that there was the possibility to indicate multiple interests for each course participant).

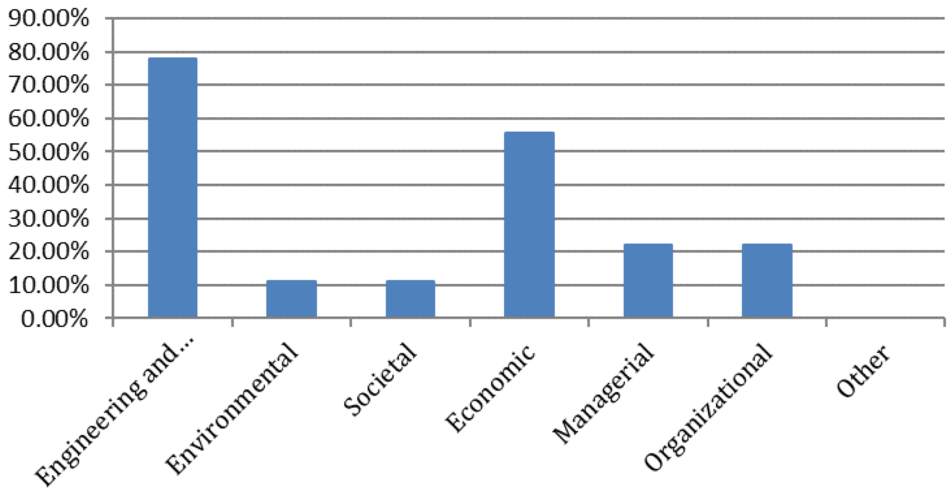


Figure 35: Energy transition-related interests for on-demand courses' attendees

Table 17 indicates the general assessment of the delivered programmes. In general, all the participants evaluated positively the delivered course. The multi-disciplinary aspect of the courses was one of the most appreciated aspects, together with the fact that the covered topics were complementary to the already acquired knowledge of the companies' employees. This underlines two important factors for the design of the on-demand courses, namely being able to embrace different topics potentially relevant for the company (multidisciplinary approach) and to provide fresh content and ideas, which can be seen as valuable by the company.

Please rate from "strongly agree" to "strongly disagree" the following statements on the overall programme	**Strongly agree**	**Agree**	**Neutral**	**Disagree**	**Strongly disagree**
It is engaging	44.4%	55.6%	0%	0%	0%
It is comprehensive	44.4%	55.6%	0%	0%	0%
It is exhaustive	33.3%	33.3%	33.3%	0%	0%
It offers a multi-disciplinary perspective	77.8%	11.1%	11.1%	0%	0%
It offers flexibility in the learning path	55.6%	44.4%	0%	0%	0%
It is innovative	33.3%	66.7%	0%	0%	0%
It is useful	88.9%	11.1%	0%	0%	0%
It is complementary to already acquired knowledge	88.9%	11.1%	0%	0%	0%
It is preparatory for in depth education	33.3%	33.3%	22.2%	11.1%	0%

Table 17: Industry assessment of the overall courses

Tale 18 shows the evaluation results for the questions more specifically related to the delivered learning materials. The obtained results show that the course participants were satisfied with the quality level of the materials and they considered them up to date, which is an important factor in a very dynamic scenario with quickly evolving technologies. Also, all the attendees were happy with the style with which the course and materials were provided, even if, in some of the open questions, it was explicitly highlighted how some of them would have loved having closer interactions and discussions with the course instructors.

Please rate from "strongly agree" to "strongly disagree" the following statements on the learning materials of the course	**Strongly agree**	**Agree**	**Neutral**	**Disagree**	**Strongly disagree**
They were up to date	66.7%	33.3%	0%	0%	0%
They were offered in the right quantity	44.4%	55.6%	0%	0%	0%
They were quite poor in quality	0%	0%	0%	55.6%	44.4%
They were not appropriate for a MOOC-style course	0%	11.1%	22.2%	33.3%	33.3%
Their style matched my expectations	44.4%	55.6%	0%	0%	0%

Please rate from "strongly agree" to "strongly disagree" the following statements on the learning materials of the course	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
They were difficult to understand	0%	22.2%	11.1%	55.6%	11.1%

Table 18: Industry assessment of the provided learning materials

Table 19 provides the overall evaluation of the experience in attending the on-demand course. In general, course participants declared to have enjoyed the experience and that they felt engaged. Also, they underlined that the courses were something new for the previous learning experience and that they provided important complementary knowledge.

Please rate from "strongly agree" to "strongly disagree" the following statements on the course experience	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
It was up to my overall expectations	**55.6%**	44.4%	0%	0%	0%
I enjoyed the experience	**77.8%**	22.2%	0%	0%	0%
I felt engaged	**55.6%**	44.4%	0%	0%	0%
I felt challenged	33.3%	**44.4%**	22.2%	0%	0%
It was easy to follow	33.3%	**66.7%**	0%	0%	0%
It was something new with respect to previous learning experience I have had	**77.8%**	22.2%	0%	0%	0%
It was well organized	**66.7%**	33.3%	0%	0%	0%
It was truly formative	**44.4%**	44.4%	11.1%	0%	0%
It helps me to complement my previous knowledge in the field	**66.7%**	33.3%	0%	0%	0%

Table 19: Industry assessment of the overall experience

The overall satisfaction is further confirmed by the answers to the question "All in all, how would you rate your experience with this short programme?", whose results are shown in the following Figure 36.

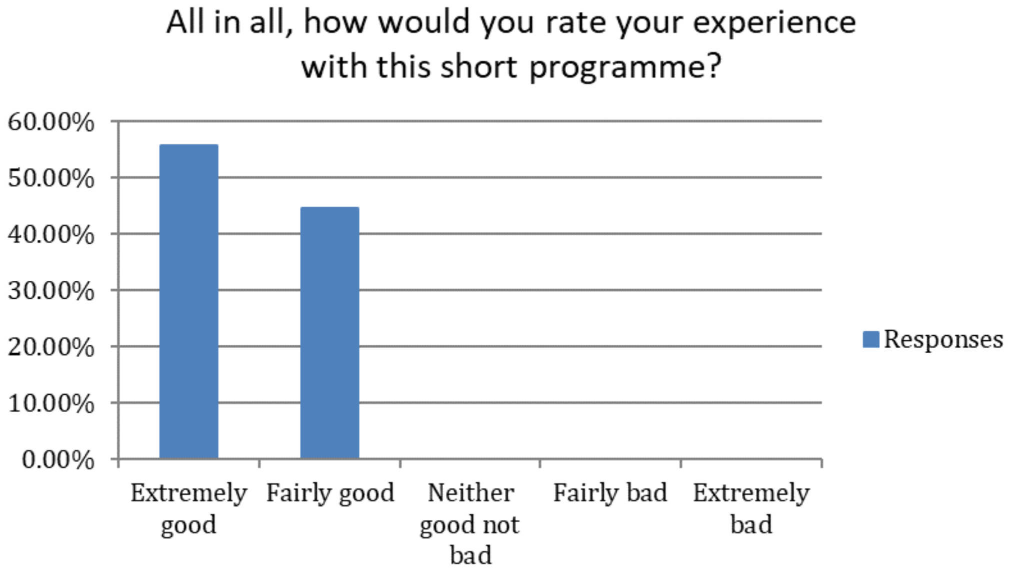


Figure 36: Overall evaluation of on-demand course attendees

Finally, Figure 37 shows the feeling of the course attendees regarding how much knowledge they gained by following the on-demand course. while Figure 38 indicates their intentions to recommend the offered courses to other colleagues.

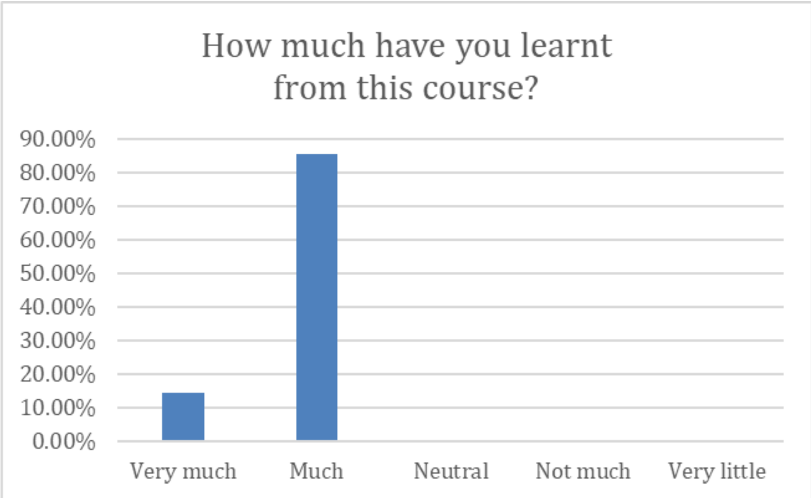


Figure 37: Level of knowledge acquired through the course

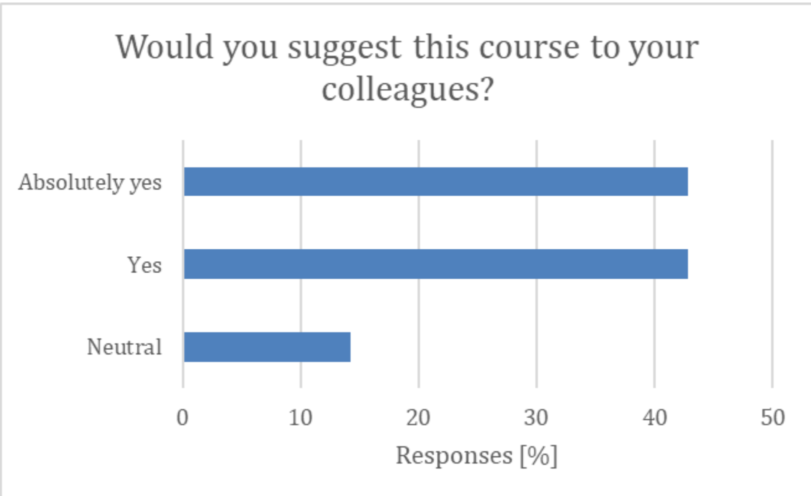


Figure 38: Results on potential recommendation of on-demand courses

The obtained results suggest that the designed courses were effective in transmitting new knowledge and upgrade the skills of the companies' employees, which was indicated as one of the main needs by the industrial partners at the moment of the course request and preparation. The respondents not only think they have learned a lot through the offered courses, but they indicate that it would be beneficial also for their colleagues to attend the course.

5. Recommendations for Excellence in Energy Transition

The lessons learned from the project as a whole are highlighted in this chapter to be used for its scalability, consolidating project networks, collaboration, and value proposition. As described, the Covid-19 situation has largely affected the project activities and the delivery of the courses. In most cases, forcing us to re-scheduling, re-designing, scaffolding, changing the mode of delivery, used formats and learning experiences. Guidelines for effective engagement of class participants in online synchronous and asynchronous modes of delivery have been described in D2.4 and D4.4 [1] [3], therefore, there is no need to reproduce them since the second run has taken into account the mentioned suggestions to increase both face-to-face programmes and MOOCs results and assessment. In the previous version of the deliverable, i.e. D4.4 we presented the comprehensive guidelines for future MOOCs, face-to-face and blended course. Since interdisciplinary and on-demand courses were not were in the phase of preparation and we completed their delivery in the second run, therefore we present below the comprehensive guidelines for interdisciplinary and on-demand courses for industries to be taken into consideration for future deliveries.

5.1. Recommendations for Interdisciplinary Courses

5.1.1. Course Design

While the learning graph method allows a quite easy “mix and match” approach in the design of the course, attention has to be paid to ensure that the topics related to different domains are well integrated and that they both get the right level of detail in the program. A potential risk when having a dominating topic and a second one covered more shortly, is that the students could feel to have acquired just a high-level idea of the topic, but without gaining good knowledge about it.

5.1.2. Course Delivery

The professors involved in the ideation of the interdisciplinary courses all agree that the design of the course and the integration of multidisciplinary aspects is significantly facilitated by the use of the learning graph model; course creators should therefore structure their learning outcomes and materials accordingly so that these opportunities can be easily grasped by other instructors.

5.1.3. Student engagement in Interdisciplinary Courses

In the experience made with our interdisciplinary courses, students highly appreciated having a broader view of the topic, which was not only focused on strict technical details, but offering a wider picture from different perspectives and domains. Also, they liked having external instructors bringing their expertise and this helped to engage them even more. Course designers can take these aspects into account to enrich and expand their education offer. Moreover, they can now exploit modern technologies to facilitate the delivery of the interdisciplinary material (MOOCs, remote teaching, etc.).

5.1.4. Content refinement for interdisciplinary courses

While an interdisciplinary approach was generally very well received, obtained feedback showed that some efforts may be required to slightly adapt the learning materials for meeting the expectations of the students. In general, the attitude and expectations of the students may vary depending on their field of studies, and this implies that the educational content may need to be revised for making it more attractive to the target students.

5.2. Recommendations for on-demand courses

With respect to the on-demand course, the following conclusions and recommendations can be drawn from the experience made in the project.

5.2.1. On-demand Course design

Similar to what already expressed for the interdisciplinary programmes, also in the case of on-demand programmes, the design of the courses has been extremely simple thanks to the use of the learning graphs and the possibility to retrieve the most appropriate learning outcomes and materials from the available education offer to meet the industrial requests. Therefore, the use of the learning graph's structure is highly recommended for the ease of creation scalability and multiplication potential.

5.2.2. Employees' interest

Our on-demand course attendees highlighted the importance for them of receiving high-quality content complementary to their experience and background for remaining updated with the last technological trends, but not only. This is particularly important in the energy transition domain where technologies, standards, markets, processes, etc. change and evolve very rapidly. From the employees' perspective, this type, of course, is not only welcomed but is actually necessary for the further development and upgrade of their skills.

5.2.3. Company policies

One of the main obstacles for the delivery of the courses to industrial partners is the possible limitations and constraints associated with the very different policies and attention paid by the companies concerning the topic of further education. This implies that the courses should be generally designed to provide as much flexibility as possible in the course fruition and learning path.

5.2.4. Learning style

In close relation to the previous point, our on-demand course attendees enjoyed the experience and positively evaluated the flexibility provided by e-learning approaches. At the same time, however, they also pointed out the importance to still have close interactions with the instructor. The educational offer should be therefore tailored to accommodate the flexibility needs of company employees, also keeping into account remote learning options, but still without disregarding the central role of the instructor and the direct interactions (between instructor and learner) for the learning process.

5.3. ASSET's Comprehensive Recommendations for Excellence in Energy Transition

With the completion of the second run, the whole project's analytics increased a lot, thanks to the experience gained and the correction implemented. Enrolments in courses satisfied the project expectations. Although the completion rate did not reach the expected KPI, it represents a meaningful result of the ASSET project as a wide and hybrid programme now available for all coming projects and academic programme innovations to meet the Sustainable Development Goals (SDGs). Without such an effort, generously funded by the European Commission, there would not be space for education in the Energy Transition. Moreover, the ASSET program has been accompanied by SSH research which has detected and clarified the missing Knowledge, Skills and Competences in the field. The triangulation among SSH and assessment results is a valuable possibility to be explored to offer a comprehensive framework to Energy Transition stakeholders and lessons learned:

1. **The ASSET educational offer was a niche – but largely exploitable – offer**
   The ASSET offer has been launched at the same time the transition was launched throughout communication and policy actions. We do not have any doubt that it was just in time to encounter the growing interest of energy companies and policymakers so placing the ASSET project in the best possible place. With the experiences achieved in running course diverse for pedagogy, format,

topic, and technology, ASSET paves the way for further projects and initiatives, for example, the ERIGRID H2020 projects asking for hosting new MOOCs on Emma so as to stay where an offer in the field is already available. This demonstrated the reputation of both ASSET and the EMMA platform and the exploitability of the programme soon.

2. **Openness is not enough. Incentives are better**
In the previous deliverable D4.4 [1] , we stated that pedagogy and success of MOOCs are not a standardized practice or specific formula but a combination of factors. A TEACHING MIX where the appeal of any MOOC seems to depend as much on the topic, teacher engagement/presence, user motivation, and MOOC design. We have detected several combinations and realized that the most effective one in the Energy Transition field is where teacher presence and motivation come together. On teacher presence we have already elaborated in D2.4 [2], about motivation it is worth noting that many learners came from universities outside the European Union, many of them claiming certification from EU universities. They were committed to complete the courses. Following this idea, no doubt introducing a form of incentive such as a fee to gain a certificate from the university offering the course would represent a strong incentive to increase the completion rate as demonstrated by MOOC literature.
3. **Open conversations do not work for STEM disciplines and Energy Transition**
The instructional design of technical courses needs to take into account how difficult it is to engage learners in an open conversation. This does not mean that they do not have an interest in peer-to-peer learning activities, but that they require lab-based learning applications where interaction is strongly focussed on the learning activities through simulations and case-based learning.
4. **Skill gaps, as well as gender inequalities in STEM education**
Skill gaps, as well as gender inequalities in science, technology, engineering, and mathematics (STEM) education, have been highlighted throughout data from several sources. To take them into account, new education programmes should create courses in engineering with a broader range of arguments spanning from technical topics to management, logistics, and communication with an open perspective on the new fields such as big data, artificial intelligence, and algorithms. Gathered data seem to suggest that such formats would fit better gender and cultural diversity opening up STEM education to a new way of thinking.
5. **Transformation to student-centred learning through learners' engagement**
In the delivery activities of the second phase, an emphasis on enhanced student engagement, using various tools, and strategies enabled us to achieve an enhanced learning experience as discussed in the survey results. Based on experience with the delivery, it is highly recommended to effectively transform the conventional teacher-cantered approach majorly adopted in the face-to-face mode of delivery into student-centred learning encouraging students to participate and create bottom-up knowledge in the field of the energy transition with a focus on interdisciplinarity.
6. **Adoption of flexible teaching and assessment**
Face-to-face, MOOCs, and blending modes with co-teaching approaches can be intelligently mixed for effective delivery, particularly based on the ASSET experience for energy transition programmes, it enabled a reinforced learning experience with interdisciplinary skills development and expertise among the participants. Similarly, the right blend of summative and formative assessment is necessary not to just create the depth of knowledge for energy transition but also to allow student engagement, and active participation in the class for bottom-up knowledge creation.
7. **Interdisciplinary courses engage the students and trainees**
The interdisciplinary courses were well accepted by the students and the trainees which shows that not only the market feels this need but also the audience accepts it very well.
8. **On-demand courses match the expectations of the companies and their trainees**

The companies feel they need tailored training. This was the main outcome from various interactions we had with companies' communities and with the companies that requested the on-demand courses. So, there is space for boosting the use of the marketplace.

9. **ASSET learning graph tool facilitates the creation of interdisciplinary and on-demand courses**
During the design and delivery of the five interdisciplinary courses and the two on-demand courses, we realized that it is now significantly easier to prepare such courses because the learning graph tool provides us with a) inspiration of topics to integrate into our running courses, b) access to introductory materials that can easily be reused and c) contacts to the creators of the materials relevant to interesting topics that come from other disciplines than those of our own.

6. Conclusions

This deliverable presents the outcomes of the evaluation of the ASSET educational programmes for the second phase of the delivery activities, i.e. from November 2020 to April 2021. The assessment strategy for the MOOCs, face-to-face, and blended courses has been detailed in the previous version of the deliverable. In the first phase, 5 class-based courses, 7 seminars and 9 MOOCs were delivered and their detailed evaluation is covered in D4.4. In the second round of delivery, 10 class-based courses, 4 seminars, and 11 MOOCs have been delivered, so their comprehensive evaluation is covered in this deliverable. Additionally, the design, development, and delivery of 5 interdisciplinary courses and 2 industry on-demand courses are also detailed in this deliverable. Due to their hybrid nature, the evaluation criteria for interdisciplinary and on-demand courses are different from the criteria used for regular courses and MOOCs. Therefore, the evaluation criteria, various layers of evaluations, questionnaires, and respondents' details are discussed in this deliverable. Based on the presented criteria, a detailed evaluation of interdisciplinary courses is covered. Recommendations for the interdisciplinary and on-demand courses are also covered in the deliverable. Last but not least, based on the lessons learned after two years of ASSET educational programme delivery, a comprehensive set of detailed guidelines for excellence in the energy transition is presented for future educational programmes in the energy transition.

Overall ASSET educational offers reached more than 5000 people across the globe through the EMMA platform, MOOCs, class-based courses, and workshops. The assessment and evaluation surveys are completed by more than 400 students and more than 30 instructors. The detailed analysis of evaluation **confirms the satisfaction of instructors and participants** with the quality of the delivery in the field of the Energy Transition. The successful integration of interdisciplinarity in educational offers, market needs assessment and resultant on-demand courses will open up new dimensions for synching up the synergies of industries academia, training actors and policymaking institutes. The overall evaluation document serves as a baseline to collect feedback and draw comprehensive guidelines for future educational programmes. Future offerings based on the recommendations laid out in this deliverable will contribute in terms of their quality enhancement, value addition, expandability, scalability, and sustainability. Thereby, they will catalyse an exponential growth in the achievement of required Knowledge, Skills and Competencies to tackle the grand challenge of the Energy Transition.

7. References

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