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ANNETTE PROJECT

Advanced Networking for Nuclear Education and Training and Transfer of Expertise

DELIVERABLE D 5.3

Practical Implementation of courses on Nuclear Safety Culture

Nature of the deliverable		
R	Report	X
P	Prototype	
D	Demonstration	
O	Other	

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ABSTRACT:

This report describes the actions performed during the ANNETTE pilot course delivery in the frame of WP5 summarising the results obtained so far. The courses run or being run in the frame of WP5 are described. Reference is made to the Deliverable D2.4 for the common actions made in the frame of the ANNETTE project in order to advertise the courses of the master for Continuous Professional Development to be established at the end of the project.

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GENERAL LIST OF ABBREVIATIONS

ACTP	Accredited Coach Training Program
ANNETTE	Advanced Networking for Nuclear Education and Training and Transfer of Expertise
ASME	American Society of Mechanical Engineers
BelV	Subsidiary of the Belgian Federal Agency for Nuclear Control
BSc	Bachelor of Science
BWR	Boiling Water Reactor
CCS	Carbon Capture and Storage
CEA	Commissariat à l'Énergie Atomique et aux Énergies Alternatives
CEMAV	Audiovisual Media Center
CIRTEN	Consorzio Interuniversitario per la Ricerca Tecnologica Nucleare
CITON	Centre of Technology and Engineering for Nuclear Projects
CLP4NET	Cyber Learning Platform for Network Education and Training
CMET	Competence Maintenance, Education and Training (Working Group in IGD-TP)
CNAT	Association of Almaraz and Trillo Nuclear Power Plants
CPD	Continuous Professional Development
DoW	Description of Work
EC	European Commission
ECTS	European Credit Transfer System
ECVET	European Credit system for Vocational Education and Training
EdF	Electricité de France
EFTS	European Fission Training Schemes
EHRO-N	European Human Resource Observatory - Nuclear
EMSNE	European Master of Science in Nuclear Engineering
ENEF	European Nuclear Energy Forum
ENEN	European Nuclear Education Network
ENS	European Nuclear Society
ENSTTI	European Nuclear Safety Training and Tutoring Institute
ENSREG	European Nuclear Safety Regulators Group
EQF	European Qualifications Framework

ESARDA	European Safeguards Research & Development Association
ETI	Education and Training and Information (also E&T&I)
EU	European Union
EUTERP	European Training and Education in Radiation Protection Foundation
E&T	Education and Training
FORATOM	European Atomic Forum
FORTUM	Energy company for the Nordic and Baltic countries, Poland, Russia and India
Fusenet	European Fusion Education Network
GENTLE	Graduate and Executive Nuclear Training and Lifelong Education
HERCA	Heads of Radiation Protection Competent Authorities
HMI	Human-Machine Interface
IAEA	International Atomic Energy Agency
ICTS	Singular Scientific and Technical Infrastructures
IGD-TP	Implementation of Geological Disposal Technology Platform
INMA	International Nuclear Management Academy
INOOC	Innovative Nuclear Open Online Culture
INPO	Institute of Nuclear Power Operations
INSAG	International Nuclear Safety Group
INSTN	Institut national des sciences et techniques nucléaires
IRPA	International radiation protection association
ITCE	Information Technology Communication Electronics
IUED	University Institute of Distance Education
I&C	Instrumentation and Control
JRC	Joint Research Centre
KIT	Karlsruhe Institute of Technology
KSA	Knowledge, Skills and Attitude
KSC	Knowledge, Skills and Competences
KSR/A	Knowledge, Skills at appropriate Responsibility Autonomy level
LIDAR	Light Detection and Ranging
LMS	Learning Management System

LO	Learning Outcome
LTO	Long Term Operation
MELODI	Multidisciplinary European Low Dose Initiative
MEPhI	Moscow Engineering Physics Institute
MIT	Massachusetts Institute of Technology
MOOC	Massive Open Online Course
MS	Member State
MSc	Master of Science
MTO	Man-Technology-Organisation
NCfN	National College for Nuclear
NOOC	Nano Open Online Course
NSC	Nuclear Safety Culture
OCW	Open Course Ware
ODL	Open and Distance Learning
OER	Open Educational Resources
PhD	Philosophy Doctorate (Research Doctorate in general)
RWM	Radioactive Waste Management
R&D	Research and Development
SAG	Senior Advisory Group
SCK•CEN	Belgian Nuclear Research Centre
SET	Strategic Energy Technology
SMR	Small and Medium sized Reactors
SNE-TP	Sustainable Nuclear Energy Technology Platform
SSS	Safety, Security and Safeguards
STEM	Science Technology Engineering and Mathematics
TACIS	Technical Assistance to the Commonwealth of Independent States
TSO	Technical Supporting Organisation
UCL	Université Catholique de Louvain
UMAN	University of Manchester
UNED	Universidad Nacional de Educación a Distancia

UNESCO	United Nations Educational, Scientific and Cultural Organization
UPM	Universidad Politécnica de Madrid
VET	Vocational Education and Training
WANO	World Association of Nuclear Operators
WFSJ	World Federation of Science Journalists
WNA	World Nuclear Association
WNU	World Nuclear University
WPn	Work Package (n = 1, 2, …)

1. INTRODUCTION

As remarked in Deliverable 5.2 [1], the ANNETTE Project (Advanced Networking for Nuclear Education and Training and Transfer of Expertise) is aiming at a major coordination of nuclear Education and Training (E&T) in Europe, with a long lasting impact through a sustainable structure of courses delivered by different course providers. This aspect was discussed in detail in the deliverables issued in the frame of Work Package 2 [2-4] which, together with WP5 and WP6, envisages relevant actions in view of establishing a "master" programme for Continuous Professional Development (CPD) and of delivering a Summer School, planned in the period from June 2018 to July 2019. Actually, this period needed to be extended to a longer time owing to delays in course delivery. This is one of the reasons of this report appearing in turn with some delay.

In this context a "master" is intended as a one-year higher education programme suited for people mainly having already a MSc and wishing to start, deepen or extend their competences in the nuclear fields. The master to be established under the ANNETTE Project is presently intended to be based on a collection of courses, partly set up in the frame of ANNETTE and partly contributed at the end of the project also by external course providers, to be achieved incrementally by learners during their lifelong learning path. The role of ENEN will be to stimulate discussions among the different Course Providers and Stakeholders about the offer to be established each year and to release intermediate and final certifications of the master studies.

As discussed in Deliverable 2.4 [4], the "vision" of ANNETTE in relation to courses to be delivered is reported in Figure 1. The initial core of Course Providers is envisaged to catalyse efforts from additional external Course Providers and the long-term goal is to keep within ENEN a permanent Steering Committee that should continue to propose each year courses for CPD, in similarity with what proposed during the ANNETTE project. Certifications will be released by the different course providers and by ENEN as described in Deliverable D2.4 [4], reporting in an Annex the bylaws of proposed for the certifications.

In the following subsections, the conclusions reached in the two previous deliverables D5.1 [5] and D5.2 [1] detailing the proposed offer and the contribution of WP5 to the "master" are summarised. The final choices made for running the courses and their timing of release will be discussed in view of the final assessment to be presented in Deliverable D5.4.

Figure 1. The "vision" of ANNETTE as presented to the Stakeholders

1.1. Why MOOCs in ANNETTE project?

As it has been stated before, ANNETTE Project has the main objective to set up a major coordination of nuclear Education and Training (E&T) in Europe, with a long-lasting impact through a sustainable structure of courses delivered by different course providers.

As it was stated in D5.2, during the design phases of the project, there was a strong willingness to include all the issues related to Nuclear Safety Culture (NSC). For the nuclear industry, all these issues are in fact, obligations or "must" in the education of personnel working in the nuclear field at any level in management. Once again, as it was mentioned in D5.2: "*Awareness of their importance was firstly pointed out by IAEA through the International Nuclear Safety Group [6] in the aftermath of the Chernobyl accident and later. INSAG-4 and INSAG-15 reports, for instance, clarified the views of the Agency concerning the organizational requirements and the personal attitudes to be developed in order to establish nuclear safety culture at an appropriate level in organizations working in the nuclear field.*"

Also, another important institution such as the Institute of Nuclear Power Operations (INPO) [7], focused on these ideas and concepts, in order to link all of them to an industrial environment, matching at a very large extent the ones of IAEA, by its inspiring report on the "Traits of a Healthy Nuclear Safety Culture". [8]

Also, it is important to mention, that the European Nuclear Education Network, conducted the NUSHARE project [9], aiming to revive and share the attention for nuclear safety culture. *"Its main objective [was] to develop and implement education, training and information programs strengthening competences required for achieving excellence in nuclear safety culture. Particular attention [was] paid to lessons learned from stress tests conducted on all EU nuclear Power Plants in response to the Fukushima accident and to sharing best practices at the European level."*

Probably, the most daring challenge covered in that project, was to explain in a clear and effective way to all the key-players, from decision makers to opinion amplifiers (as journalists) what are the foundations and main concepts around nuclear safety culture, especially making sure they understand why nuclear power generation is different from others. A good success was achieved in this frame by involving the World Federation of Science Journalists (WFSJ) [10], who developed in cooperation with the project partners one of its "educational media" specifically on nuclear energy and "nuclear safety culture" [11]. This resulted in worldwide accessible documentation, for science journalists but also for decision makers, which constitutes an interesting reference for those willing to understand the concepts at the basis of nuclear safety culture.

Moreover, ENEN also participated in the TRASNUSAFE project [12], related to Nuclear Safety Culture for a different target group. In particular, the TRASNUSAFE project was funded by the European Commission to design, develop and validate training schemes on nuclear safety culture for professionals operating at a high level of managerial responsibility in the industrial and medical sectors; the Université Catholique de Louvain (UCL) was the Coordinator and the European Nuclear Education Network (ENEN) was one of the 18 partners; the outcome of the project was the delivery of 5 Eurocourses addressing the following subjects:

- **EuroCourse 1**: Managerial Competences and Leadership For Safety Culture: A course for managers in the nuclear sector;
- **EuroCourse 2:** Setting Up A Management System, A course for managers in the radiological sector;
- **EuroCourse 3:** Economic Relevance Of Safety Culture In Medical Applications, A course for managers in the radiological sector;
- **EuroCourse 4:** Observation Techniques, A course for managers in the nuclear sector;

- **EuroCourse 5:** Compliance Of Contractors With Safety Systems, A course for managers in the nuclear sector.

The attention to the aspects of Nuclear Safety Culture is now continuing in the ANNETTE project, with a specific Work Package (WP5), devoted to inherit and continue proposing the courses developed in the previous European Fission Training Schemes (EFTS), as TRASNUSAFE and NUSHARE, building on their experience in order to prepare new material and courses in the frame of a master for Continuous Professional Development (CPD).

Finally, as it was stated in D5.2, internal reflections and exchanges had with stakeholders on the nature of the Master for CPD to be set up in the frame of ANNETTE led to conclude that an "incremental" master for Life Long Learning, made of short and targeted modules (one or two weeks) or of courses delivered by e-learning techniques, would be the best choice to attract professionals in the present context.

However, there was a blind spot in all the efforts related to safety culture courses that were achieved in the previous deliverables. Even when the e-learning was being considered and used as a resource or backup tool in D5.2, it was never applied as the main training way. During the end of XX century, the education has been changing from face-to-face learning to blended learning and e-learning. E-learning started with Internet, basically at the end of the 90´s, but its great expansion is taking place during XXI century. Educational and training needs are not the same now than they were before; thus, many platforms and companies have started to focus on e-learning education with great success, especially regarding life-long learning necessities. In addition, the world-wide movement for the development of Open Educational Resources (OER) has led since 2002 to the development of open online learning resources by the most prestigious universities, among many other contributors. This has been even more evident since 2012, the year in which the MOOCs (Massive Open Online Courses) emerged as a highly disruptive educational development and big online learning platforms started to be launched such as Coursera, Edx.org or Udacity, where many important Universities, being the Massachusetts Institute of Technology (MIT) and Harvard University their flagships, joined in the offer of MOOCs being attended by millions of people all over the world. All these new ventures are having great success, in both number of students and prestige, and open and online education is being required by

international organisms, such as the European Commission or UNESCO, among other relevant ones, to give answer to the millennium goals.

As such, at the beginning of the design, it was considered to explore the possibility to develop a whole MOOC course in Nuclear Safety Culture, aiming to reach younger participants, and to reach the maximum number of people with a single course. When thinking of Nuclear Safety Culture, as one of the main roots for the IAEA and INPO safety models, it is recognized that it is a “must” concerning very different concepts, from culture, safety itself, to nuclear power generation features or characteristics, to leadership, as a whole. In spite of this, the most interesting issues relating all the aforementioned concepts have sufficient meaning per se to be treated and understood individually, allowing them to be addressed under an innovative MOOC approach. Regarding the different existent types of MOOCs, short MOOCs, named NOOCs (Nano Open Online Courses), could lead to address different relevant issues and topics independently or, finally, as a whole, if participants enrolled all the courses being offered. Thus, the decision was to design of a group of independent NOOCs covering the main aspects involved in Nuclear Safety Culture, as it will be described later.

MOOCs instructional design is mainly based on short video lectures as the main learning resources, also including other different learning resources, such as complementary materials (external videos, readings, simulations, etc.). Regarding learning activities, besides the personal work with the learning materials, MOOCs promote individual participation and contributions in the communication area of the platform and collaborative work, as well, going from simple to more complex team working possibilities. Self-evaluation opportunities are offered (multiple-choice online tests being the most common one). Formal evaluation may range from online quizzes, reports and problems resolution to more participative possibilities such as peer-to-peer or forum participation assessment. Thanks to this, it is possible to have, on the one hand, a great interaction between all the participants, both the students and the trainers, and on the other hand, a formal final qualification. Optional accreditations are usually being offered at the end of each course, many times requiring a final online exam.

1.2. The context: Other Nuclear engineering MOOCs

As explained before, MOOCs are a powerful tool to connect with students all over the world, making the learning of a given subject easier, and more accessible to anyone interested on it. Despite of the great number of MOOCs now available and the millions of people enrolled in them all over the world, the quantity of MOOCs related to the Nuclear Industry are scarce. Some Universities have developed some MOOCs in OCs in well-recognized platforms like Edx. There, it is easy to find the work done mainly by the MEPhI (The National Research Nuclear University from Russia), the MIT (Massachusetts Institute of Technology) or the Delft University. Covering from technical aspects to some managerial and sociological courses. But nothing is said about Nuclear Safety Culture.

Looking for Safety Culture MOOCs in any given platform, the number of them is even lower. This is an odd issue and concern, because Safety Culture can be applied to many other high-risk industries covering from health care, aviation, oil and gas and others, not just the nuclear industry, being then a relevant issue to address.

So, it seemed obvious, that there was not any MOOC focused on safety culture field nor in nuclear safety culture. When facing how to fill the gap, this D5.3 was developed and designed in order to cover not just the nuclear field, but to include a more general description, in order to attract more participants, and to make them to get interested in the nuclear aspects of safety culture.

2. SUMMARY OF NEEDS AND PLANNED OFFER

- **Uppsala University - course Human-Technology-Organization/Human Factors for nuclear safety including virtual reality**

University of Uppsala with the support of the Institute for Energy Technology (IFE) in Halden, has been successful in preparing a curriculum and course plan for the course *Human-Technology-Organization/Human Factors for nuclear safety including virtual reality.*

The pilot course was offered to professionals within industry during autumn 2018 and conducted during December 2018 for a limited number of course participants from Sweden and the U.K.

Considering the rather specialized content of the course it was planned to offer the course for professionals within nuclear industry and authorities as contract education. Initially the plan is to offer one course opportunity per year.

Although there was a need within industry and other organisations for competence within the field is covered by the course it has turned out to be difficult to identify individual prospective course participants that can be targeted with promotional materials. As discussed in Section 3 of Deliverable 2.4 [4] the pilot courses were primarily advertised through the ENEN website pages about the ANNETTE courses, the ANNETTE bulletins and the Uppsala University portal for nuclear contract education [13]. Though the participation in the course, held from November 5 to December 21 was limited (only 4 participants), preparing it and having it in place represented an achieved goal valuable for its contribution to the overall offer of ANNETTE and to be considered for future delivery.

- **MOOCs on Nuclear Safety Culture by TECNATOM-UNED**

2.1 Objectives of the MOOCs

2.1.1. The strategic objectives of the MOOC

When the nuclear industry faces its 21st century challenges face to face, one of them is the little attraction it exerts on new professionals, who often prefer other industries. The reasons for this are many, but among them is the false perception of nuclear as being an outdated industry, with a public opinion against it.

One way to reach these new professionals, as well as those who remain active through the internet, is to use that same means of communication. Therefore, as mentioned elsewhere in the ANNETTE project documents, it has been decided to develop a MOOC on nuclear safety culture. The strategic objectives are the following:

- **Show what safety culture is to a public not expert in the field**. Safety culture is essential in multiple high-risk industries, from Oil & Gas, through aviation, and others. Therefore, the idea of addressing the first part of the course in a general way is to show with modern methods that safety culture is necessary in many industries.
- **Explain that the nuclear industry, like other high-risk industries, understands its particularities.** Identifying risks and facing their reduction embraces a healthy safety culture, making nuclear being a pioneer industry in the development of safety culture.
- **Connect a concept as important as leadership, with the culture of organizations, and their relationship between the leader and co-workers**. Recognise that leaders shape the culture of organizations, and through their influence, they can modify the safety culture of an industry.
- **Reach as many participants as possible, both in geographical distribution and in professional profiles.** MOOCs are a very useful tool. Since the participants, they always have a friendly face, which reminds them of the figure of the traditional instructor.
- **Reach a younger audience**, who is more familiar with the use of new technologies when it comes to improving their learning and being able to be more selective in the content they want to learn.
- **Improve the image of the nuclear industry, demonstrating that we use the most modern techniques and tools at our disposal.** Trying to banish the idea that it is an obsolete industry, being a sector capable of adapting to the modern world.
- **Learn to develop MOOCs,** getting essential knowledge for the development of future similar courses, in different subjects related to the nuclear world. Being able to make the knowledge necessary to enter the nuclear industry more accessible to everyone.

2.1.2. The research objectives of the MOOC

Regarding the research on education envisaged with this learning experience, some hypotheses have been made, guiding the design of the initial and final surveys of each NOOC composing the MOOC. The results from these surveys, as well as the learning analytics from the MOOC platform will allow us to gather interesting research results.

As stated in the questionnaires made available in the MOOCs, after the validation by experts of the initial and final surveys of the courses, a scientific research on education will be conducted. For this purpose, we have made initial hypotheses of the impact of the MOOCs and the running of the course will allow to draw conclusions on these items:

1 The MOOCs will attract master students and professionals from the nuclear sector and other industries.

2 The MOOCs will increase the interest, multidisciplinary interactions and knowledge about Nuclear Safety Culture.

More specifically:

On STEM Bachelor and Master students, the MOOCs will:

- Encourage a feel for nuclear safety culture by experiencing its meaning (learning by experience).
- Enable an enjoyable experience.
- Facilitate networking with other target groups, and possible job opportunities.
- Foster the interest to enrol in further courses in the nuclear field, such as ANNETTE courses.

On professionals from the nuclear sector, the MOOCs will:

- Allow to go further in understanding and applying nuclear safety culture.
- Enable interaction with professionals from other industrial sectors, and master students.
- Motivate on the use of innovative educational tools and open contents for teaching and learning.

On professionals from other industries interested in the nuclear sector, especially high-risk industries, the MOOCs will:

- Allow understanding safety culture in the context of the nuclear sector.
- Enable interaction with professionals from the nuclear sector.

2.1.3. An attempt to gather students from two initiatives in WP5: a link with Uppsala University and the course on Human Factor.

During the development of the courses, it was considered the possibility of using the MOOCs as course 0 (i.e., preparatory) or even as part of the course taught by the university of Uppsala. Also, there was the idea to use the ANNETTE Summer School on nuclear technology as a test of the MOOCs and at the same time offer the possibility of taking the three NOOCs privately by the students.

With this option, the students could have access to transversal subjects prior to their specific training and Tecnatom and UNED could have firsthand opinions to adapt or improve in the final implementation of the MOOC.

Finally, due to the longer time and development needs required by the NOOCs, it was not possible to adjust them to the start dates of the face-to-face courses: so it was decided not to enroll the students until we could offer the product in a verified version.

2.2. Background

2.2.1. Tecnatom previous experience in NSC training: the content experts

Tecnatom has developed training and awareness programmes on nuclear safety culture in recent years in different projects at both national and international level.

- Training for licensed and non-licensed personnel in NSC for Cofrentes Nuclear Power Plant: two different modules provide theoretical training based on basic safety principles and operating experience. Licensed personnel must pass the course and theoretical examinations in order to join the staff. The same training, with a narrower scope, is provided for the rest of the staff.

- Participation in the development of leadership programs for the safety and professional development of commanders at Spanish nuclear power plants
- Participation in the project Corona I and Corona II where a training academy of technical character as well as of safety and leadership was created for VVER type plants [14]
- Facilitation of the Nuclear Safety Fair in Barakah NPP (UAE) where the main characteristics of the nuclear safety culture were presented to a public both expert and novice [15]

2.2.2. UNED background

UNED is one of the largest universities in Europe, with 48 years of experience in Distance Education, in general, and online and blended learning in particular since 2000.

The UNED has a long experience in Open Educational Resources (OER) and MOOC developments, as well. Regarding this, the UNED has its own MOOC platform development, being internationally recognized for its expertise in MOOC design and production, usually participating in national and international projects in this field. As such, the UNED was one of the first universities in Europe launching MOOCs in 2012. UNED Abierta [16] portal is devoted to UNED open educational resources, including its MOOCs offer. Actually, UNED MOOC platform has been developed from opensource EdX.

Regarding UNED personnel participating in ANNETTE project, the UNED INOOC team is integrated by experts in Open and Distance Learning (ODL), in general, and in Innovation in the Nuclear Education and Training field, in particular. On one side, INOOC Team has been involved in studying and designing open and online courses in nuclear engineering, including MOOCs and, on the other side, Ángeles Sánchez Elvira delivers her expertise in quality and innovation in Open and Distance Education, in general, and MOOC design and development, in particular.

As well, Mercedes Alonso and Javier Sanz have been for long time teaching nuclear engineering subjects in bachelor and master's degrees, offering, in this way, the link between Tecnatom content experts and UNED ODL experts.

2.3. Preliminary design

2.3.1. The first design: the templates

As a first step, UNED developed templates in order to guide the course design. In the following the templates are shown.

Information and Basic Structure of a MOOC based on a NOOC format

TECNATOM-UNED

Proposal of a MOOC on Nuclear Safety Culture based on the offer of three NOOCs (Nano-Online-Open Course), that may be taken and certified independently or taken step by step, as a whole program, as well, if participants finally enrolled in each one. All courses have been available on UNED Abierta Platform.

The designers and developers of TECNATOM-UNED in the project had many face-to-face and online meetings all along the process until NOOCs implementation.

Basic information of the courses

Instructional Design of the MOOC Structure, sequence and didactic elements of each NOOC

An initial common instructional design template was developed for each NOOC, as it is showed in (Table 1), taking the first NOOC as an example

1st NOOC template

Presentation of the NOOC in the external website	
Presentation of the course before enrolment	° **An engaging presentation: introduction video to the NOOC (justification), target, general learning outcomes, contents)** ° **Information about the curators** ° **Information about NOOC length, badges*, certification and formal accreditation requirements (if available), etc.** ° **Formal dates**
Welcome and introduction to the NOOC in the beginning of the course, once registered	
Welcome/Introduction	° **Welcome video** ° **General Information of the course, structure, guidelines, facilitation, chronogram/calendar and participation rules (video and/or pdf)** ° **Use of the platform (video UNED Abierta and link to a guide in pdf)** ° **Self-assessment of knowledge/ competences in the field (may be optional)** ° **Initial survey (participants characteristics, expectations, etc)**
Unit/Module 1. **Didactic element to be prepared**	
Information and Unit guidelines	**Introduction, specific unit learning outcomes, list of contents and guidelines of the unit presented as follows:** ° **Short video of presentation; and/or** ° **Text visible in the platform**
Multimedia material aligned with learning outcomes and contents	° **One or more explanatory videos (no more than 10 minutes).** ° **Videos may include exercises to be done while watching the video, and these exercises may be used as formative assessment or summative one**
Complementary material	**Downloadable documents, Links, Notes .ppt, etc.**
Learning activities	° **Learning activities to be done by participants to achieve the expected learning outcomes (e.g., watching videos, answering questions, participating, debating, solving problems, etc)** ° **Clear instructions for each activity**

Assessment aligned with learning outcomes	° **Quizzes (all units should have at least one quiz or more per video); quizzes shall offer a proper feedback** ° **Other types of assessment that may be getting more complex along the course:** • **Exercises/ problems with feedback** • **Tasks that could be evaluated in a peer-to-peer format (rubrics for assessment have to be included)** ° **Clear instructions for each type of assessment and criteria of evaluation have to be offered, including deadlines** ° **Requirements to overcome each unit (eg, percentage of correct assessment)**
Interaction	° **Forum** ° **Some synchronous session may be offered**
Final Badge after unit or NOOC completion	° **Units may be presented as a list of challenges and badget participants can win if they manage to achieve**

*A badge in a MOOC is achieved for free by those who successfully finish it. They don´t have an official recognition, but can be shared and used to give notice of the course completion

Table 1. Example of a template

A final assessment was also included for each NOOC, and a formal certification of the whole MOOC, also.

2.3.2. Courses main features and the Course Guide

From the very beginning, future participants and interested parties could have access to prior information, informing them of the main characteristics of the MOOC. In the UNED blog [17] all the information was reflected.

Regarding the Course Guide, participants were informed that the courses were conceived as a first contact with the safety culture in all areas to continue, then, deepening in more specific concepts in the nuclear field. In order to establish a good safety culture and nuclear safety culture, aligned leadership is necessary. They also were informed that all these aspects would be worked out in a dynamic, different and participative way, in which collaborative learning will be a key aspect.

Regarding each of the courses, the following related information was included in the Course Guide of each NOOC:

NOOC I. What is safety culture?

1. Learning Objectives

- Identify the main features of the safety culture
- Analyze the risks associated with jobs and situations
- Apply the lessons learned from the case study on safety
- Know the main models of safety culture
- Evaluate the importance of organizational culture in safety
- Observe the evolution of the safety

2. Contents

- Introduction
- Risks management
- Safety culture concepts.
- Organizational Culture for safety
- Safety I to Safety II.

3. Pre-requisites/participant background

- No specific requirements are needed

Figure 2: Table of contents of NOOC I

NOOC II. Understanding Nuclear Safety Culture

1. Learning Objectives

- List the differentiating characteristics of nuclear energy
- Describe the type of safety analysis that serves as a basis for safety requirements and their limitations
- Know the concept of defence-in-depth
- Explain how your work affects safety in all levels.

2. Contents

- Presentation
- Nuclear Energy differentiating characteristics.
- Basic Philosophy.
- How my work affects safety.
- Defence-in-Depth evolution.

3. Pre-requisites/participant background

- Basic knowledge about nuclear technology, that may be attained using the glossary of nuclear terms available in the three NOOCs

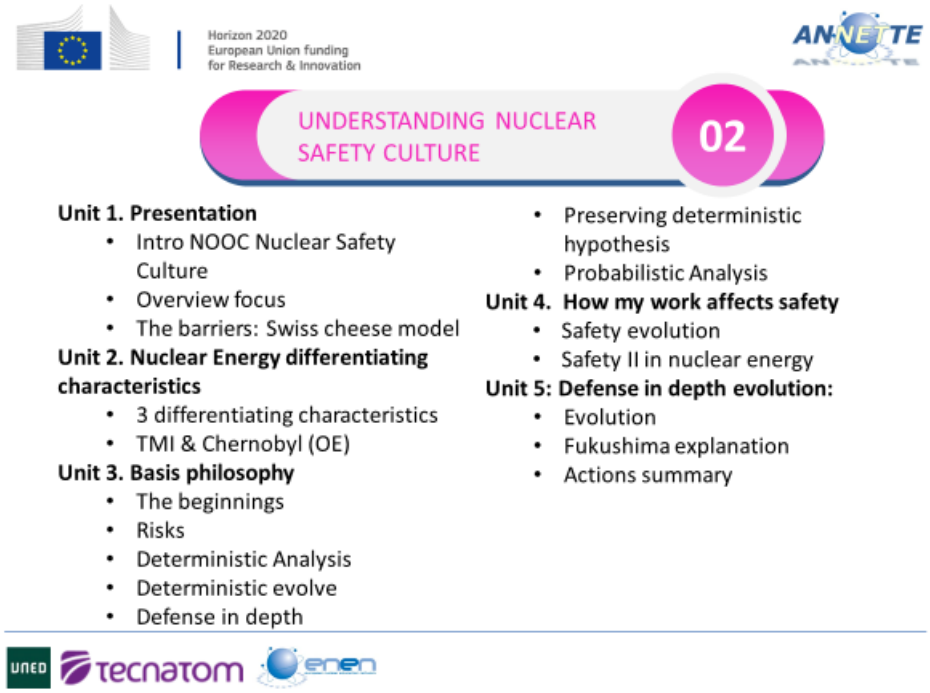


Figure 3: Table of contents for NOOC II

NOOC III. Developing leadership for safety

1. Learning Objectives

- Knowing the main theories of leadership and how they have evolved until today
- Acquire the skills to maintain effective leadership in emergency situations
- Apply those leadership skills for the development of teams or partners

2. Contents

- Introduction.
- Evolution and types of leadership.
- Leadership for safety.
- Leadership for nuclear safety.

3. <u>Pre-requisites/participant background</u>

- No specific requirements are needed

Figure 4: Table of contents for NOOC III

3. COURSE IMPLEMENTATION AND DELIVERY

➢ Uppsala University - course Human-Technology-Organization/Human Factors for nuclear safety including virtual reality

The course *Human-Technology-Organization/Human Factors for nuclear safety including virtual reality* was advertised through the ANNETE web site and additionally Uppsala U. and IFE used their own channels to distributing information about the course opportunity directly to contacts within industry and authorities in Sweden and Norway.

The course consisted of four main parts;

1. A preparatory home-study assignment.
2. One week of on-site lectures and laboratory work at the IFE facilities in Halden Norway.

3. Home asignments consisting of case studies, provided by the course management and reported upon in a written essay.
4. An individual, on-line oral examination with dual examiners from Uppsala U.

The Course Content is detailed in the following items:

- Design of Human-Machine Interface (HMI) in nuclear power plants, demonstration.
- The Man-Technology-Organisation perspective (MTO).
- Comparison of the MTO perspective with alternative perspectives and approaches.
- Human factors in modern technical system design and operations.
- Technological perspectives on unwanted events, including central concepts like barriers, human error, and how organisational factors affect human performance.
- Methods for analysing events. HF tools and how to use these in industry application of HF methods to increase safety in control-room work.
- Principles of user-centered design, verification & validation, and human performance.
- The user-centred design process, supporting human factors needs.
- Safety and human performance (organisational factors in design).
- Operating models and capabilities (organisational factors in design).
- Interaction design: designing high performance, safety-oriented displays.
- Control room design and ergonomics.
- Verification and validation processes and tools.

Learning outcomes

After passing the course, participants are able to:

- Select and apply tools, methods and techniques to improve safety and productivity in work systems;
- Explain and analyse the complexities of interaction between technology, humans and organisational processes;
- Integrate complex human and organisational aspects in the design and operation of engineering systems;
- Conduct critical reviews of work systems in terms of human factors and organisational aspects;

- Explain design processes and account for defined activities in different phases of a design project;
- Assess risks associated with the negligence of critical man-technology-organisation interfaces;
- Explain and discuss human factors (HF) design-work methods including the use of virtual reality tools.

Assessment

The course assessment consisted of hand in exercises and an oral presentation where the content of the exercise reports was examined by the teachers in charge of the course.

Course evaluation

As previously reported, the participants were asked to give their feedback on the course via a digital evaluation survey that was sent to them on the last day of the course. According to the course evaluation, the participants expressed that the course led to the learning outcomes and felt it relevant to them in the workplace. They also stated that the set-up, with the 5 consecutive days in Halden, was efficient and served the learning purpose well.

The course management concluded that the course can be conducted as is, without any major adjustments.

- **MOOCs on Nuclear Safety Culture by TECNATOM-UNED**

3.1. Profiles that have participated in the work:

3.1.1. Content experts (Tecnatom)

- **Fernando González González. Co-Director**

Education and training: Industrial Engineer. (ETSII Universidad Politécnica of Madrid, Spain). Executive Coach (ACTP and AECOP training), Performance Management Basic Certificated Instructor (by ADI international). The Extraordinary Leader, The Coach Extraordinary and the Inspiring Leader (by Zenger&Folkman). Management Training Program (IESE, Universidad de Navarra) BWR SRO Simulator Certificate (1.984).

International experience**:** Participation in several EC projects (ESPRIT program); Participation in several TACIS Projects. Participation in recent projects CORONA, TRASNUSAFE, NUSHARE. Leader of the task group of the Spanish Society of Radiological Protection on radiological Protection Culture, in cooperation with IRPA.

- **David Abarca Ahijado**

Education and training: Bachelor's degree, Mechanical Industrial Engineer, Master's degree, Renewable Energy. INPO First-Line Leadership Essentials-2019 promotion.

Experience**:** Ten years of experience in high-risk sectors such as nuclear or oil&gas, focused on safety management and leadership.

- Project manager in analysis and methodological design of the implementation of actions and training related to cultural change, safety culture, soft skills and leadership: CORONA Academy (EU), Safety process cultural reinforce development (Repsol)
- Consultancy and training projects for managers, supervisors and workers in high-risk industrial facilities: Human Performance Instructor at the Barakah NPP Safety Fair (UAE), Spanish NPP training member.
- Simulation engineer: Development, implementation and maintenance of simulation models for the electricity generation, distribution and transport industry: Liaison engineer with technical office in China for the development of generic training simulator (IAEA), Development of the nuclear power plant full-scope simulator (NA-SA)

- **Alvaro Pablo Muñoz Rodrigo**

Education and training: Master degree, Physics; AP1000 Senior Reactor Operator Simulator Instructor – Westinghouse Electric Company

Experience**:** Twelve years of experience in power generation sectors including concentrating solar generation, nuclear. Focus on power plant operation and training.

- Project manager in e-learning projects, for several clients from nuclear power plants, to cybersecurity courses.
- E-learning instructional designer: Development and design e-learning courses, through e-learning tools, gamification and others.

- SRO Simulation Instructor: Development, and delivery of simulator and classroom training for Reactor Operators and Senior Reactor Operators in USA, China and Spain. Simulator common-logic and non-common logic developer and tester.
- Research and Development Engineer: Development, delivery and testing of electric power generation forecast for concentrating solar power plants. Liaison with Solucar management and operators. Atmospheric models for Road Weather Information Systems for Alberta DOT (Canada). Ceilometer (Cloud base height meter) design, and LIDAR development.

3.1.2. UNED experts and technical support

MOOC design and implementation requires the participation of a multidisciplinary team. The expertise of the individuals and a right coordination as well, are key aspects for the success for a MOOC. The different profiles that have participated in the MOOCs design and implementation from UNED´s side, coordinated by Mercedes Alonso, are shown below in Table 2, and the profile of the main academic participants are stated, as well:

M.Sc. Mercedes Alonso Ramos – M. Sc. in Power Engineering at UPM, Research Competence on advanced models for inventory calculations in fusion installations in 2001.20 years of experience teaching Nuclear Engineering, 17 using the distant teaching methodology at UNED. Currently, assistant lecturer at the Power Engineering Department of UNED Industrial Engineering School and involved in her PhD Thesis on new tools and methodologies for Education, Training and Information applied in the nuclear field. She took part in FP7 ENEN-III Project, coordinating the design and implementation in UNED aLF virtual platform of an International Distance Course on ADS for Transmutation, and later she was involved in the redesign of this course for a MOOC format, and in the evaluation of the available open courses in nuclear engineering worldwide. She attended the last course from TRASNUSAFE 8 (April 28-30 2014). She is also participating in other European projects linked to education: ENEN+ AND in CLOUD

Dr. Ángeles Sánchez-Elvira Paniagua – PhD in Psychology and professor at the Faculty of Psychology of UNED since 1991. IUED (University Institute of Distance Education) Director May 2019-; 2004- 2013; Training Director of the IUED 2001-2004. Vice-Dean and Coordinator of Methodology and Innovation, Faculty of Psychology, May 2018-. She has developed different lines of research and implementation

of methodological innovation and quality assessment of UNED methodology. She has been the director of the annual editions of the Iberoamerican Course for Distance Education (2004-2012). As specialist in OER (Open Educational Resources) she and her team awarded a runner-up prize at the first Prize of Universia-OCW,and she was the coordinator of the first Latin-American MOOC (Ibervirtual UNED COMA: Basic Digital Competences), also participating in the design and implementation of the MOOC "ICTs for teaching and learning"

Prof. Javier Sanz – PhD in Nuclear Engineering at Universidad Politecnica de Madrid (UPM) and full professor in Nuclear Engineering at UNED since 2002. He is head of the Nuclear Power Engineering Unit of the Department of Power Engineering at UNED Industrial Engineering School, and head of the Nuclear Analysis Engineering Research Group (TECF3IR [18]) at UNED. He is also Deputy Vice-Rector for Research at UNED and sub-director of the Nuclear Fusion Institute at UPM. He has published around 90 papers (covered in JCR database) devoted to computer developments and applications for nuclear analysis, activation analysis and applications to safety, waste management and radioprotection analyses in the nuclear field. He has been main researcher of UNED participation in over 40 national and international projects and responsible of the development of ACAB activation code. Currently he is leading several activities within Fusion for Energy, ITER IO, and EUROfusion (Euratom/Horizon 2020), some in the frame of the Safety Program for DEMO.

The Table 2 summarizes the different UNED professional profiles that have participated in the NOOCs´ development.

UNED Academic Experts
• Experts in innovative education in engineering
• Experts in innovation in education in nuclear education
• Research department in the nuclear field
ODL Experts (Open and Distance Learning)
• Experts in research in education
• Experts in MOOCs production
• Experts for MOOCs dissemination
• Experts for the validation of the surveys
UNED experts in digital multimedia production
• Audiovisual producer
• Audiovisual manager
• Subtitling expert
UNED Technical support for MOOC Development
• Technical support for UNED Abierta platform
• Platform developers
UNED research section for the support in European Projects

Table 2: Profiles that have participated in the work

3.2. The design of the quality control and coordination UNED-Tecnatom

The complexity of the work to be done, and the different professional roles to participate in its design and development, advised to make use of a coordination tool. For this coordination, a Microsoft 365 TEAMS was created to work in parallel and ensure the traceability of every document (Figure 5).

Thus, for each NOOC a folder was created with:

- Units in ppt (contents of each video).
- Flowpath.
- Video Subtitles.

This format of collaborative folders between organizations and the use of chat, as well, allowed the team to keep track of the revisions, since the methodology involved several interventions on the preparation of each video

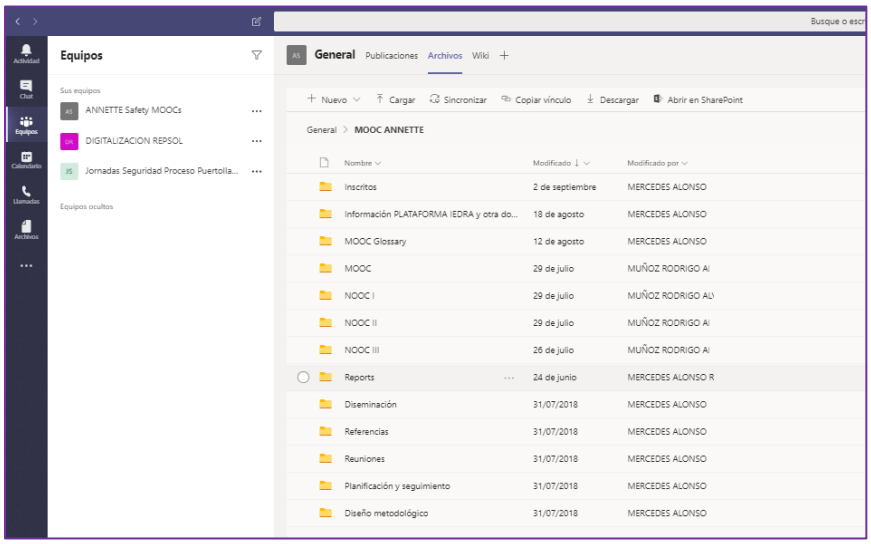


Figure 5: Use of Microsoft 365 Teams

During all the production process templates were used to keep trace of all pending items as a quality check of the different course contents and structure (Figure 6).

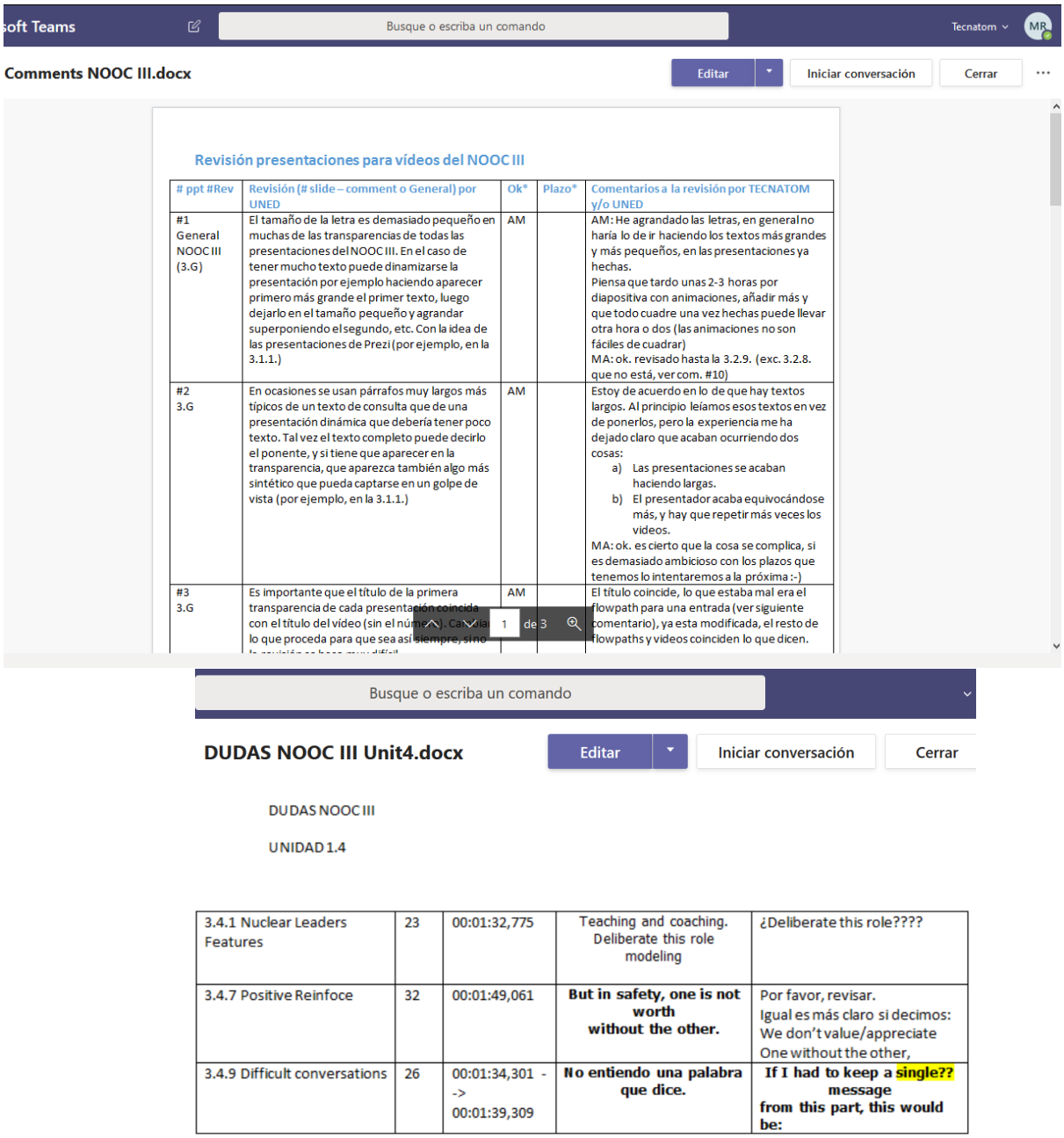


Figure 6: Use of templates as a quality check

3.3. The MOOCs production process I: the flowpath:

As already said, long before developing the video lectures scripts and presentations, it was needed to design the whole structure of the course, with all the contents. To speed up the development process, and to clarify to all the members of both Tecnatom and the UNED the architecture of the courses, the chosen way was to write down a flow path document. Figure 7 is an example of flowpath shared in Team.

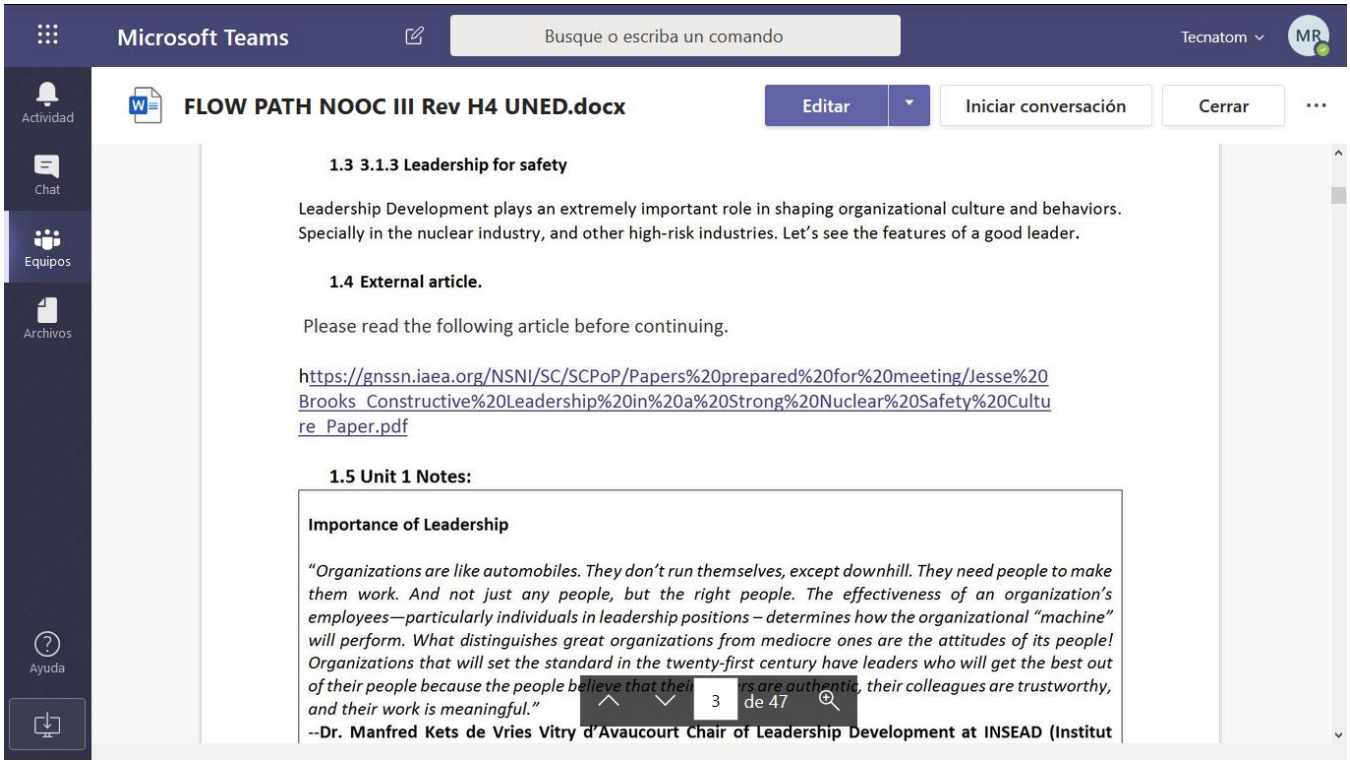


Figure 7: A look of NOOC III flowpath in Teams

Although it is tempting to think of the flow path document as a blueprint, the true nature of it was more vivid, modifying its parts as the development group improved their knowledge in the development of the MOOC. Therefore, the flow path document represents the learning path that the participants in the different MOOCs would follow. Including the video lectures with brief descriptions, activities, test, peer-to-peer activities, lecture notes, external articles, and videos, and the exam question bank at the end of them, also. By using it, both, the UNED team and Tecnatom could coordinate, and be on the same page when developing or changing the different contents. As it was

mentioned before, there were 3 small or Nano-MOOCs (NOOCs), and all of them had their own flow path. Due to the long-time invested in developing the 3 NOOCs, there were slight differences between the different flow paths. As the group learned how to make the MOOC gentler, and more friendly to the participants.

Moreover, the flow path documents were used by the UNED, as MOOC pedagogical experts, to give some tips to improve the training material. It can be understood as a way of communication between Tecnatom as the developers of the training material, and the UNED as MOOC guides. Based on it, the group of UNED Abierta uploaded the three different NOOCs into the MOOC learning platform, and strength and upgraded the different activities, to make them fit better in what a MOOC should be.

3.4. The MOOCs production process II: the video-lectures

3.4.1. The choice of the contents of the videos based in the context of the course flow path, and on the expertise and training materials by Tecnatom.

As the principal nuclear training provider in Spain, and thanks to the participation as INPO member, Tecnatom has been providing Nuclear Safety Culture in Spain for many years. Therefore, all the expertise gain in the nuclear power plants was transferred to the online course. Obviously, there were some challenges when the template is a classroom class which needs to become an online course.

Unlike the systems training for nuclear power plant personnel, Safety Culture classroom training is very participative; thus, many different activities are used, where all the students must participate, and in doing so, increase their performance when speaking of safety culture subjects.

One of the most successful courses, which help the company to improve, is the safety culture classes that Tecnatom teaches to all the personnel at Cofrentes Nuclear Power plant, in Spain.

Also, that course and the experience gained with it were the fundamental foundations for the participation in the CORONA Project. Under the umbrella of those key courses, a way of “showing” the content of them should be developed. In a MOOC, the most important learning tool are the video lectures and they can be used as the link between the students and the lecturers.

For that reason, it was decided to think of developing the flow of the course, as if the students were in a face-to-face classroom training, following the same path that Cofrentes personnel do and developing video lectures that, step by step, cover all the knowledge and contents from Cofrentes Safety Culture

courses and the CORONA project. Based on this, the need to transform the presentations into something dynamic, to catch up the attention of the participant was a must.

3.4.2. UNED experts training to Tecnatom for MOOC content developers and video lectures recording in Polymedia studios

Based on UNED expertise in MOOC development, the UNED team worked closely with the Tecnatom Team to train the content developers into the basis of the instructional design of MOOCs, not only in terms of the learning sequence to be followed (e.g., participant guide elements, orientations, type of learning materials and activities available within MOOCs, types of assessment, etc.), but also on how to present the contents to be viewed in short and lively video presentation and how to proceed with the video-recordings in the Polymedia studios of UNED. Several training sessions on video-lectures recording took place before, until all the team was satisfied with the final results.

The recording of short video-lectures in the UNED Polymedia studios required then what is described in the next sections.

3.4.3. The production of the PowerPoint presentation with the presenter notes in each slide by Tecnatom.

As it has been stated before, UNED recommendation was to transform the classroom presentations into something more engaging and dynamic. Thus, the Tecnatom team used their knowledge in the development of several e-learning courses, to make the presentations more attractive, trying to balance what the lecturer says with the information provided.

Although most of the lecturers in MOOCs do not use scripts, during the design phase it was clear that due to the amount of information, and, also due to the fact the lecturers were not native English speakers, it could be worthy to make scripts for both the video lecturer and the subtitles. Obviously, there was still room for improvisation, but the main concepts and the way to introduce them should be in the notes.

Thanks to the lecture notes from any power point presentation, it was possible to customize the configuration of the recording studio, or Polymedia Studios, and back up the lecturer with all the information needed.

3.4.4. The revision of content ppts by UNED for quality assurance:

Once the power point presentations were uploaded to Teams, UNED took care of their revision, looking mainly at the course methodology, the relation to other course subjects, the graphical readability and dynamics of the slides, and a language revision.

3.4.5. Request and control sequence for Video lectures recording in UNED CEMAV Polymedia studio, according to UNED CEMAV administrative and technical procedures

In order to have all recorded videos in CanalUNED and UNED YouTube channels, metadata needed to be given (name, authors, synopsis, keywords, etc).
Series for the MOOCs video were created in both CanalUNED and UNED YouTube channel, as it will be described below.

3.4.6. The recording of the video-lectures

Recording of the video lectures was taken in UNED Polymedia Studio, where the presenter and the presentation were synchronized and merged in a single screen in order to have a more user-friendly recording.

Figure 8: The MOOCs teaching team in UNED Polymedia Studio

Figure 9: The recording of a video lecture in UNED Polymedia Studio

Table 3 show the number of videos and the number of recording hours.

No videos recorded	NOOC I	35	por tectatom	4	por UNED	31		Recording hours	NOOC I	2:38:08	por tecnatom	0:07:35	por UNED	2:30:33
	NOOC II	30		1		29			NOOC II	1:55:47		0:01:21		1:54:26
	NOOC III	33		0		33			NOOC III	1:58:00		0		1:58:00
total		98		5		93		total		6:31:55		0:08:56		6:22:59

Table 3: The videos recorded for the MOOCs: some numbers

Apart from the videos recorded in UNED Polymedia Studio, a few videos were recorded by Tecnatom in their headquarters. They were also uploaded in UNED multimedia repository in order to have them available in the same way for the course virtualization.

3.4.7. The upload and testing of the video lectures in CanalUNED multimedia repository and the migration to UNED YouTube channel

A series was created (Figure 10) in UNED institutional repository of multimedia contents: CanalUNED [19-20-21]. After the videos were uploaded in CanalUNED, the link was sent in order to review the videos, and give the ok in order to proceed with the migration to UNED YouTube Channel, where playlists were created for each NOOC (Figure 11) in order to place the corresponding video lectures [22-23-24]

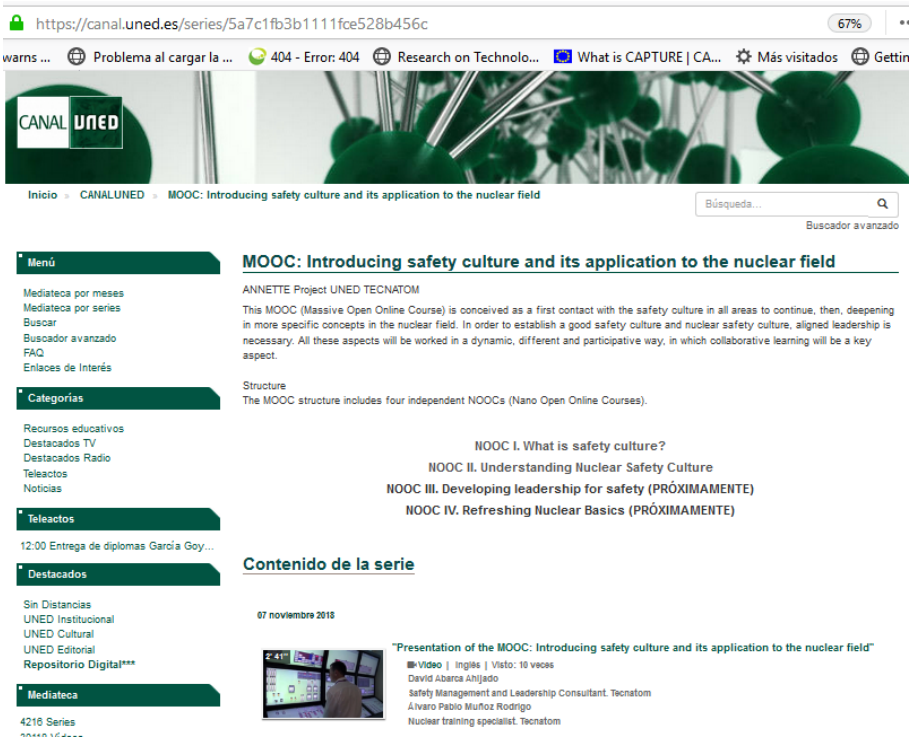


Figure 10: NOOCs´ video lectures in CanalUNED

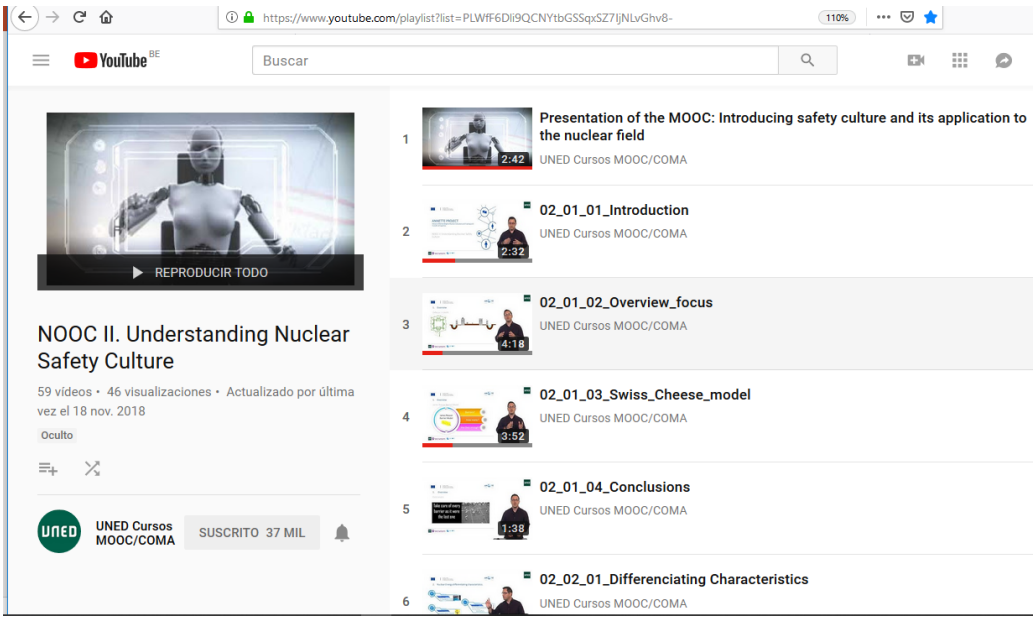


Figure 11: The appearance of UNED YouTube NOOC II playlist

3.4.8. The subtitling of the videos

Accessibility and user-friendly requirements suggested to have all the videos subtitled. This represented an extensive work to be done, as well as it was extensive the transcription of the videos that can be visualized in the platform. This is aimed to help following the course in a more self-paced way.

3.4.9. The links in the flowpath for the course virtualization in UNED Abierta platform

Once the subtitled videos were available for use, the link was used in the MOOCs platform in order to have the videos embedded in the course.

3.5. The MOOCs production process III: The choice of other learning materials

Other Learning materials (Table 4) were chosen to enrich the learning experience: external videos and external articles were linked inside the courses, and as well lecture notes were prepared at the end of each course unit in order to resume its main features.

External videos		External articles	
NOOC I	2	NOOC I	4
NOOC II	5	NOOC II	4
NOOC III	1	NOOC III	5
total	8	total	13

Table 4: Number of external videos and external articles in each NOOC

3.6. The MOOCs production process IV: The design of the course activities

To test and challenge the participants, a ser of questions were prepared, and other learning tools which can be used in a MOOC, as well (Table 5). The questions were made to make the course more dynamic and to increase participation.

A total of 28 activities where developed in all the MOOCs, including final exam questions, multiple choice, drag and drop and peer review questions.

Activities	activity forum	self-evaluation	P2P	final exam	total activities
NOOC I	3	4	1	1	9
NOOC II	1	6	0	1	8
NOOC III	4	4	2	1	11
total	8	14	3	3	28

Table 5: The learning activities, the numbers

Designing fair and challenging questions is not an obvious task. Although, the MOOC platform used by UNED allows to have a wide set of questions to used, during the MOOC development the design team focused on four different set of activities:

- **Multiple-choice questions.** Multiple choice questions are a good way to evaluate the understanding of participants, consisting in the correct answer and three distractors, which have to be fair and challenging at the same time. In the flow path they were indicated with a correct answer and a feedback, but the answer was "random" when shown in the platform.
- **Drag-and-drop:** Very visual, and fun for the students, in general. Help to remember things in a more visual way, and to deepen the knowledge.
- **Peer-to-peer questions and assessment.** When trying to have students more active and make them participate in an online course, the peer-to-peer questions are a "must". Students should give a short answer to the questions asked, based on an example made by the lecturers. But the most important issue, is the feedback. After writing down the answer, each participant has to evaluate other students, giving feedback and providing a grade for the answers. For this purpose, participants used a rubric protocol that was developed by the instructors.
- **Forums:** A MOOC contains multiple forums, they are used to rise concerns, answer general questions and generate debate and talk to other participants (even lecturers and instructors), this is the highest participating activity.

3.6.1. Non graded exercises (self- evaluation)

Although all the questions in the MOOC could be graded, it is needed to have a set of self-evaluation questions, after some videos, as a way of delivery formative feedback to participants. A common practice in other MOOCs is to have at least one question after each video and grade them; however, when having a high number of short videos, this is impractical. As mentioned in the previous section, a question needs to be challenging. On one hand, as the development process progressed, it was obvious that short videos, ranging from 2 to 5 minutes long videos, made them easier to record and gentler for the students. On the other hand, those short videos, increased its number, but also made them to focus more on an important topic, and the students would not face a challenging question, because they would have cleared the concept of that video.

In order to solve this, the questions were set after a number of videos were visualized, and then it was easier to test the new knowledge acquired by the participants when needed; nevertheless, most of the questions were non graded exercises, giving the participants the opportunity to test themselves.

Hereafter, we can see some of those self-evaluation exercises, which were drag and drop (Figure 14), multiple choice (Figure 13) and forum participation (Figure 12):

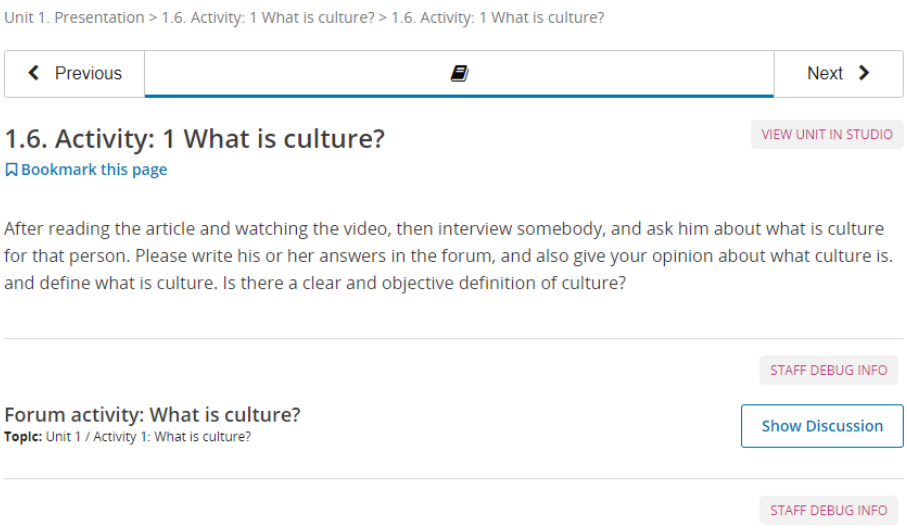


Figure 12: Example of Forum Activity, NOOC I.

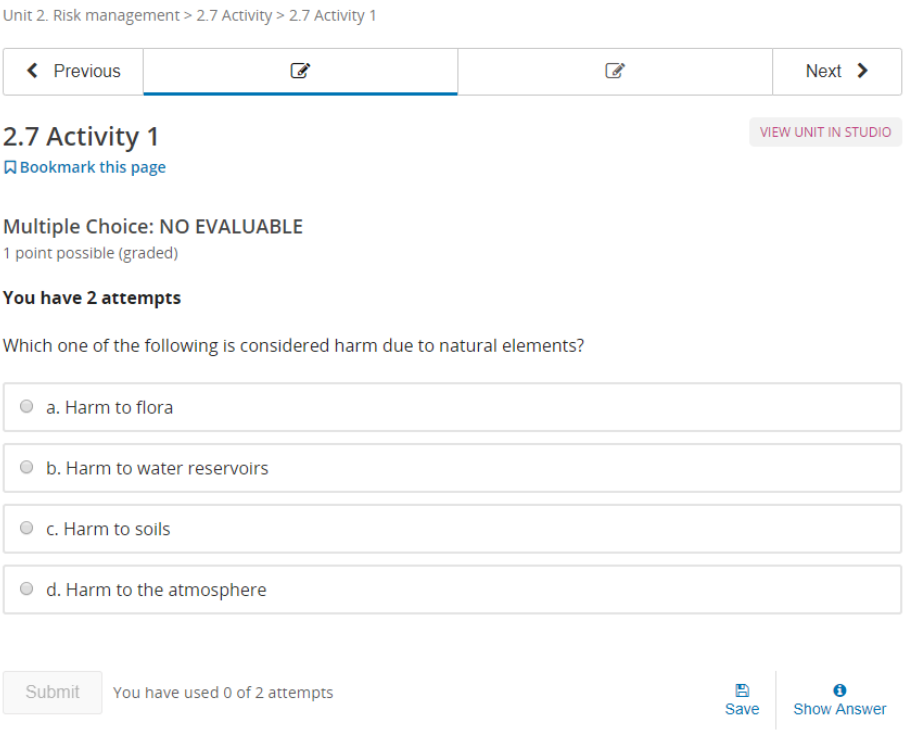


Figure 13: Example of multiple choice

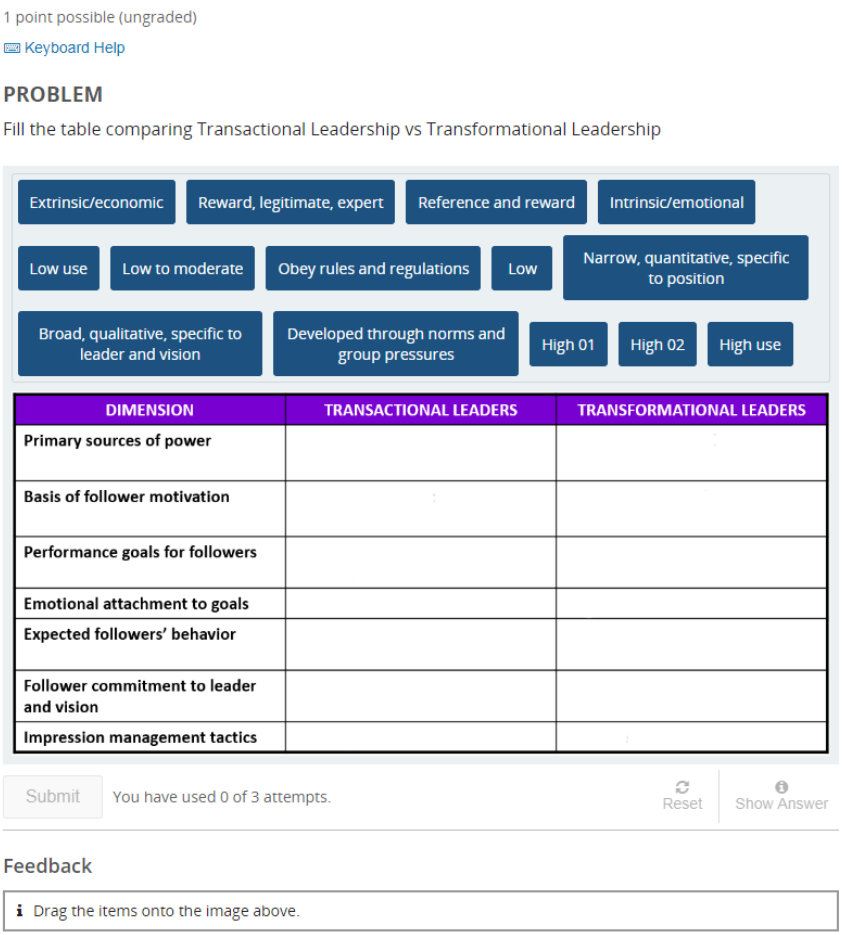


Figure 14: Example of drag and drop activity.

3.6.2. Peer to peer activities

A peer-to-peer (P2P) activity is based on the premise of a peer student who corrects the work of other peer/s assigned to him as part of the learning process, by providing grades and feedback.

By putting on the site of an author and an evaluator, it is intended that the student is better aware of all aspects of his/her learning and assimilates knowledge more critically.

When choosing a given way of evaluation, it is a "must" to know its pros and cons, which must be considered when using them as an evaluation method. The main advantages of using a peer-to-peer (P2P) evaluation are the following:

- The human component of the P2P evaluation allows a deeper and more critical analysis, allowing the correction of significantly more complex tasks without increasing the technical difficulty of their design.
- It increases the human factor in the MOOC, which, being a purely online environment, is blamed, as usual in these areas, for a very high abandonment rate due to a prevailing feeling of loneliness (or isolation).
- It allows the student to be involved in the revision work, in addition to the writing work, which makes him/her a participant in all aspects of the training, being a more active agent in his/her learning and making him/her more aware of all the facets of the same.
- Peer-to-peer assessment is related to the development of relevant soft skills such as critical judgement.

However, there are several fundamental disadvantages of the inclusion of a P2P task:

- The inclusion of a P2P task can influence the abandonment rate of the MOOC in a significant way, as it will be discussed in detail below.
- The human component introduced must be controlled by very precise rubrics to avoid arbitrariness in evaluations.
- The system must have some way of detecting and discarding outliers in the evaluation.

It is necessary to inform very clearly of the times of accomplishment of the task and evaluation of the same, as well as to raise awareness of the importance of the rubric to maintain homogeneous objectivity in the corrections. The P2P implies a tacit pact of all those involved to work towards a common good, which can be utopian if the task seems too ambitious or the rubric is too difficult to follow.

However, the aforementioned factors are not trivial and should be considered both when designing tasks and when writing rubrics.

Finally, the students do not choose their peers when grading others' exercises; thus, there could be the possibility of students not been graded for many different factors. When this occurs and there is a correction pending or maybe it is incorrectly graded, the instructors need to do the correction themselves.

3.6.3. Design of Final exams

One of the most important challenges in a MOOC is the completion of the final exam. In the present case, if a participant finishes successfully all the three NOOCs that make up the entire program, it is possible to obtain a certification, but more importantly 1 ECTS. For all this, it was necessary to make an evaluation as complete as possible of the knowledge acquired by the participants. The instructional design team, based on its experience in other European projects such as CORONA, developed a series of question banks. From these question banks, at the end of each NOOC, 10 questions related to the content taught are chosen and evaluated according to them.

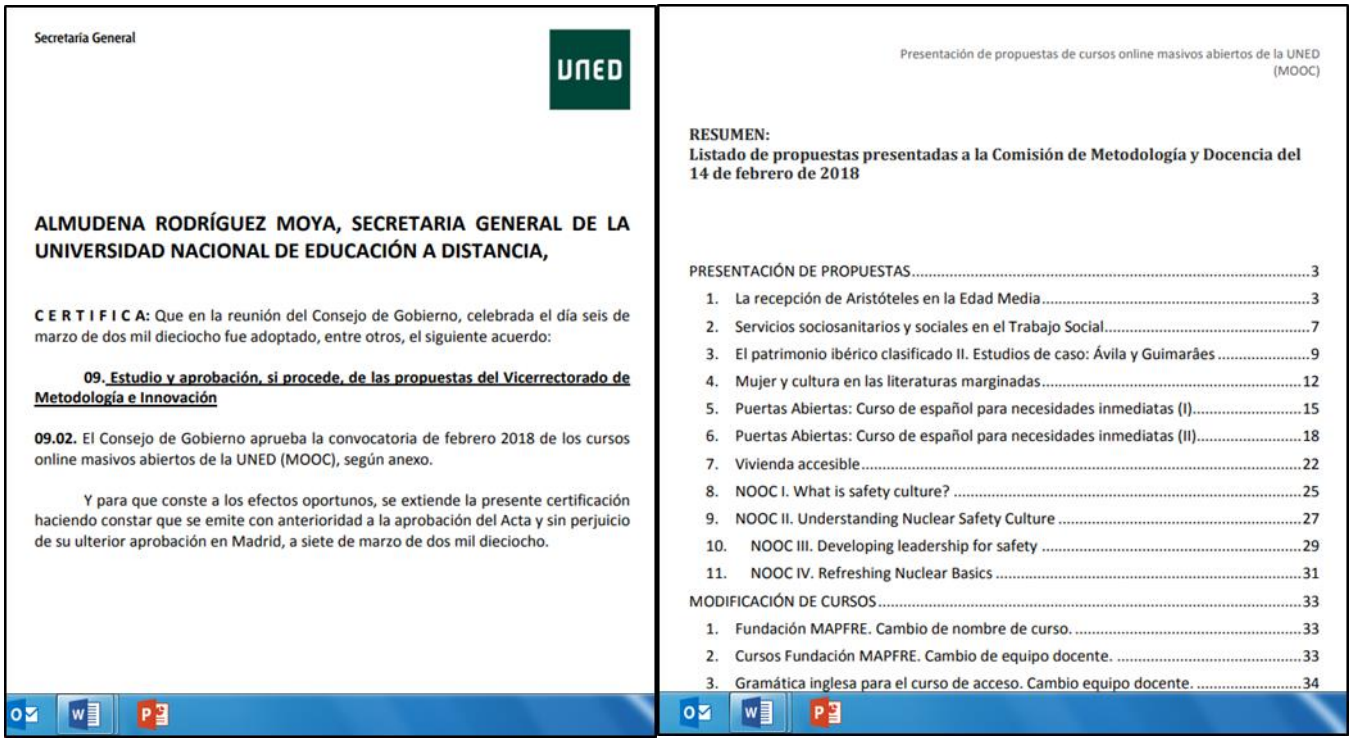
It should be noted that the exams are not the entire NOOC grade, there are a series of exercises that can be assessed throughout the courses, which have a specific weight within the NOOC in question, and therefore are used in the evaluation of the final grade.

For simplicity, and to avoid misunderstandings, the final exam questions were mainly multiple-choice and drag-and-drop.

3.7. The MOOCs production process V: the virtualization of the course contents in UNED Abierta platform

3.7.1. UNED approval of the MOOCs production

The first step to create a MOOC in UNED MOOC platform goes through an administrative path of filling a detailed description of the course (Figure 16) in order to be approved within UNED Governing Board (Figure 15).



Secretaría General

UNED

ALMUDENA RODRÍGUEZ MOYA, SECRETARIA GENERAL DE LA UNIVERSIDAD NACIONAL DE EDUCACIÓN A DISTANCIA,

C E R T I F I C A: Que en la reunión del Consejo de Gobierno, celebrada el día seis de marzo de dos mil dieciocho fue adoptado, entre otros, el siguiente acuerdo:

09. Estudio y aprobación, si procede, de las propuestas del Vicerrectorado de Metodología e Innovación

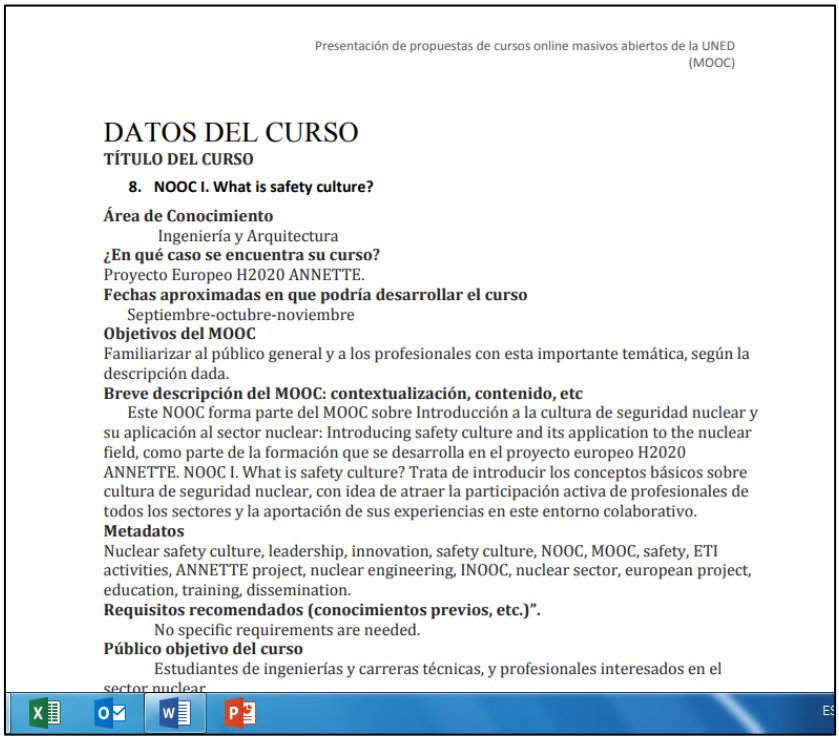
09.02. El Consejo de Gobierno aprueba la convocatoria de febrero 2018 de los cursos online masivos abiertos de la UNED (MOOC), según anexo.

Y para que conste a los efectos oportunos, se extiende la presente certificación haciendo constar que se emite con anterioridad a la aprobación del Acta y sin perjuicio de su ulterior aprobación en Madrid, a siete de marzo de dos mil dieciocho.

Presentación de propuestas de cursos online masivos abiertos de la UNED (MOOC)

RESUMEN:
Listado de propuestas presentadas a la Comisión de Metodología y Docencia del 14 de febrero de 2018

Figure 15: approbation of the Noocs by the Governing Board



DATOS DEL CURSO

TÍTULO DEL CURSO

8. NOOC I. What is safety culture?

Área de Conocimiento
Ingeniería y Arquitectura

¿En qué caso se encuentra su curso?
Proyecto Europeo H2020 ANNETTE.

Fechas aproximadas en que podría desarrollar el curso
Septiembre-octubre-noviembre

Objetivos del MOOC
Familiarizar al público general y a los profesionales con esta importante temática, según la descripción dada.

Breve descripción del MOOC: contextualización, contenido, etc
Este NOOC forma parte del MOOC sobre Introducción a la cultura de seguridad nuclear y su aplicación al sector nuclear: Introducing safety culture and its application to the nuclear field, como parte de la formación que se desarrolla en el proyecto europeo H2020 ANNETTE. NOOC I. What is safety culture? Trata de introducir los conceptos básicos sobre cultura de seguridad nuclear, con idea de atraer la participación activa de profesionales de todos los sectores y la aportación de sus experiencias en este entorno colaborativo.

Metadatos
Nuclear safety culture, leadership, innovation, safety culture, NOOC, MOOC, safety, ETI activities, ANNETTE project, nuclear engineering, INOOC, nuclear sector, european project, education, training, dissemination.

Requisitos recomendados (conocimientos previos, etc.)".
No specific requirements are needed.

Público objetivo del curso
Estudiantes de ingenierías y carreras técnicas, y profesionales interesados en el sector nuclear

Figure 16: Nooc I description for approval

3.7.2. The initial course announcement in UNED MOOCs page

Long before the start of the courses, and after the authorization from UNED Governing Board, each course space is created in UNED Abierta platform, and the course page with the course title, course image, course starting date and main course characteristics is available in UNED MOOCs page [15] for dissemination purposes, and as well enrolment of future participants is available. That was the also the case for ANNETTE MOOCs (Figure 17).

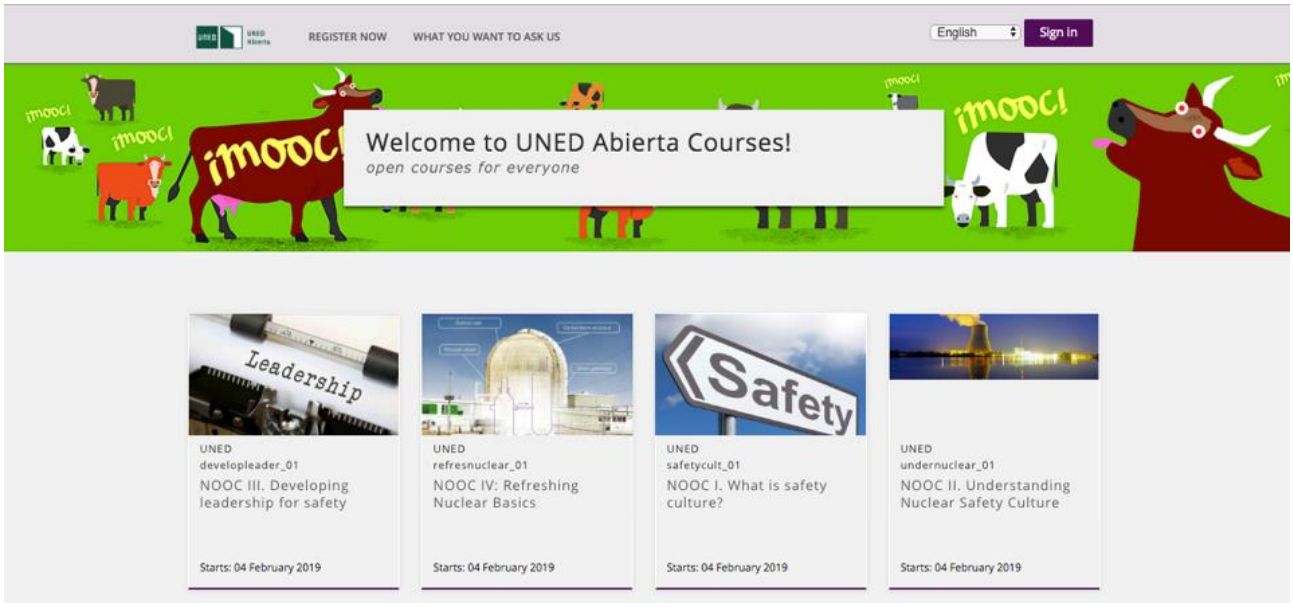


Figure 17: NOOCs in UNED Abierta Portal

Initially, 4 NOOCs were proposed, but later the 4th NOOC was deleted and a complete glossary of 704 nuclear terms (Figure 18) was developed to be part of each of the other 3 NOOCs.

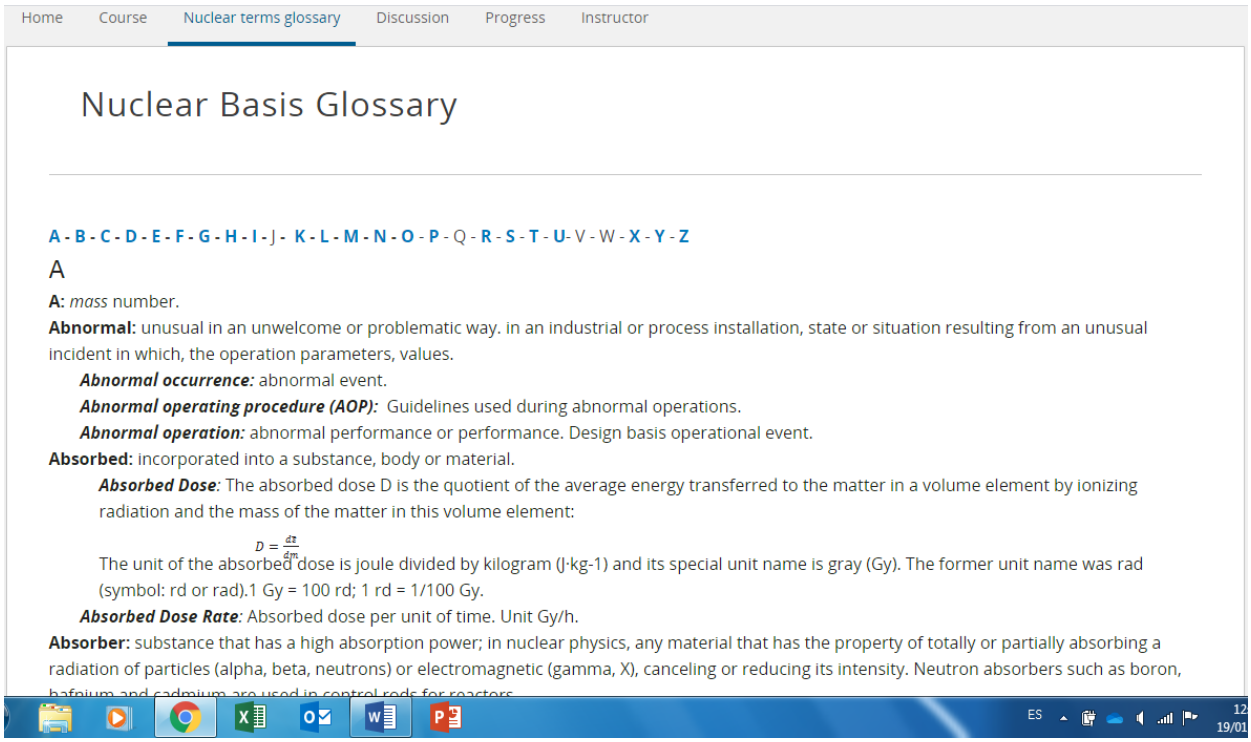


Figure 18: A look of glossary in 3 Noocs

3.7.3. The use of Studio developer area for MOOCs edition

At this stage of the NOOCs creation in UNED Abierta platform, availability for the edition of the courses was made to the teaching team as well as to possible beta testers of the course, making use of Studio developer area, as shown in Figure 19.

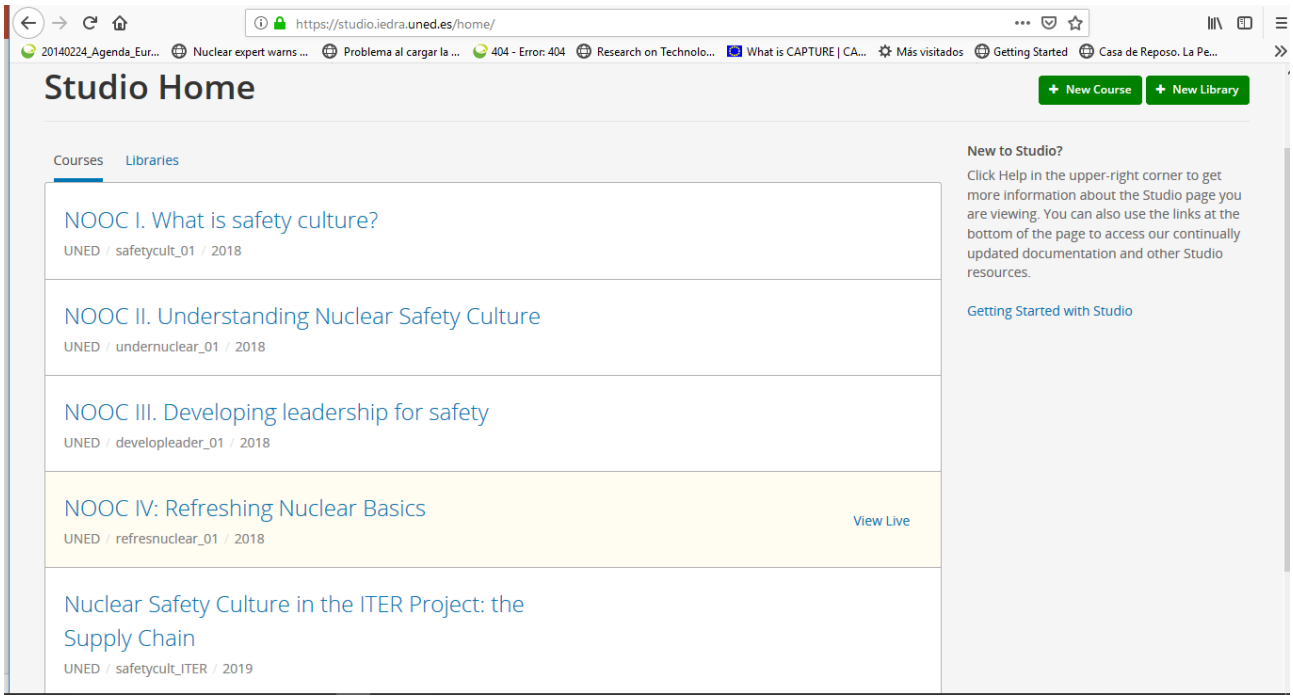


Figure 19: Studio developer area for the MOOCs and ITER SPOC Teaching team

3.7.4. The virtualization of the course by UNED Abierta technical team

After all the videos were produced, all the other external materials chosen or designed, and all the learning activities had been designed, the flowpath could be finalised and all the information needed was available for the virtualization of the courses. The UNED Abierta technical team took care of the inclusion of all the course contents within the desired course structure. In Figure 20, a view of the course, once virtualized in UNED MOOCs platform, can be seen.

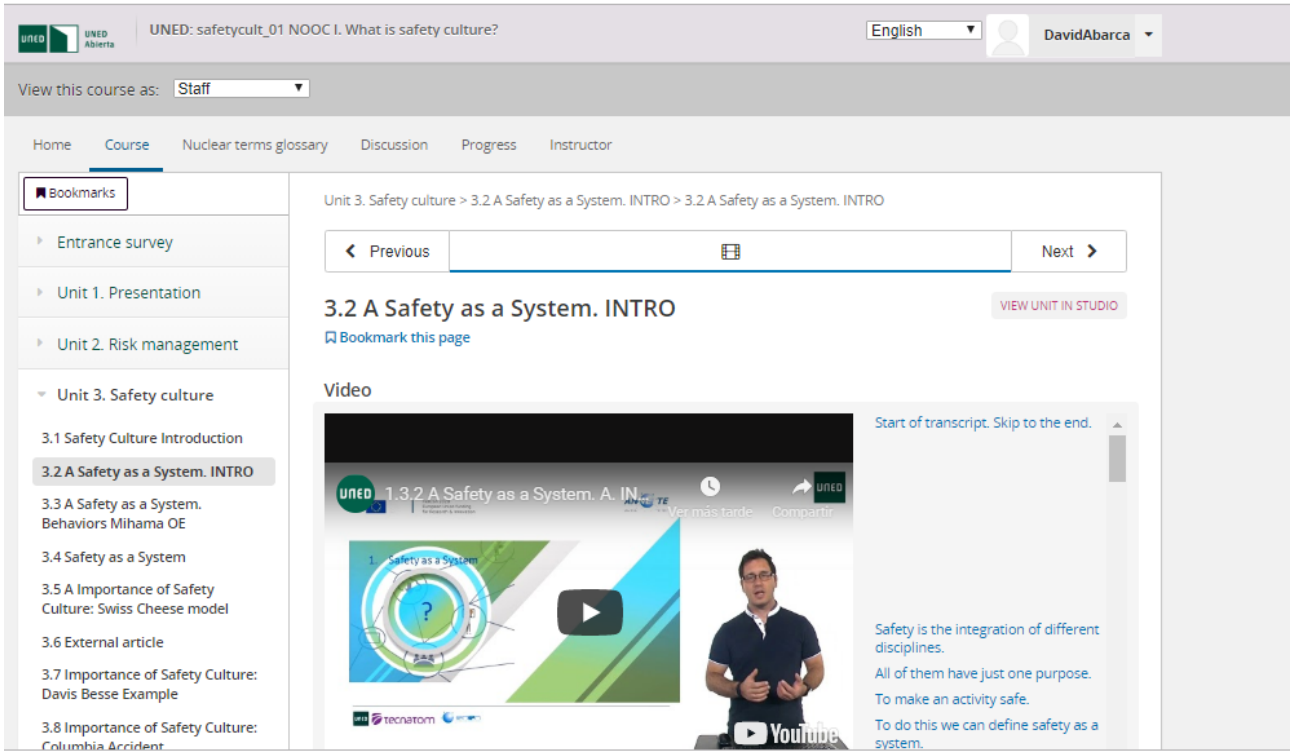


Figure 20: A look of the course once virtualized in UNED MOOCs platform

Regarding the visualization of the videos, it is possible to show or hide the subtitles, and as well show or hide the video transcription, where the text said by the presenter is highlighted. Also, the video may be put in full screen. The courses can be followed in different types of devices, such as computers, tablets or smartphones.

3.7.5. The final check by UNED teaching team and UNED Abierta Technical support

Once all the course contents had been virtualised on the platform, and before the courses started, a thorough revision took place. A close collaboration between UNED Abierta technical team and UNED teaching team was necessary to make sure that no errors were left, taking into account the numerous videos, activities, units and subsections involved.

3.8. The design and the validation by experts of the initial and final surveys

An initial and final survey was designed for each NOOC taking into account the research objectives, and they were validated by experts, both in education and e-learning, as well as in Nuclear Safety Culture, and nuclear engineering in general.

3.8.1. The objectives of the surveys

The research objectives, as stated in the corresponding section of this report, guided the preliminary design of the initial and a final survey for each NOOC.

3.8.2. The preliminary design of the surveys and their validation by experts

For the validation of the surveys of the courses, experts were gathered who contributed in kind to the quality assurance of this research instrument. For this purpose, a questionnaire was designed in Google Forms in order to:

- Inform the experts on the characteristics of the course and the objectives of the scientific research in education.
- Gather their feedback on the pertinence and adequacy of each item in the surveys, and possible personal comments.

You can see in Figure 21 how the questionnaire looked like, as well as a view of the experts' responses in Google forms in Figure 22.

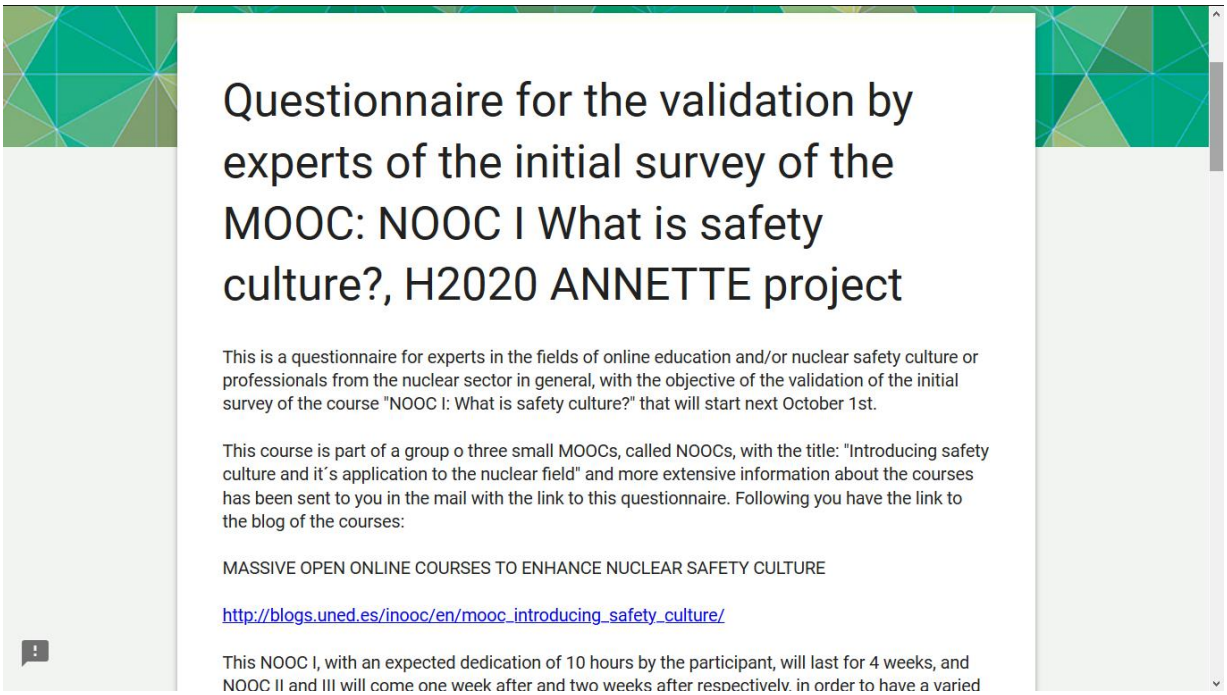


Figure 21: The questionnaire for the expert validation of the initial survey of NOOC I in Google Forms

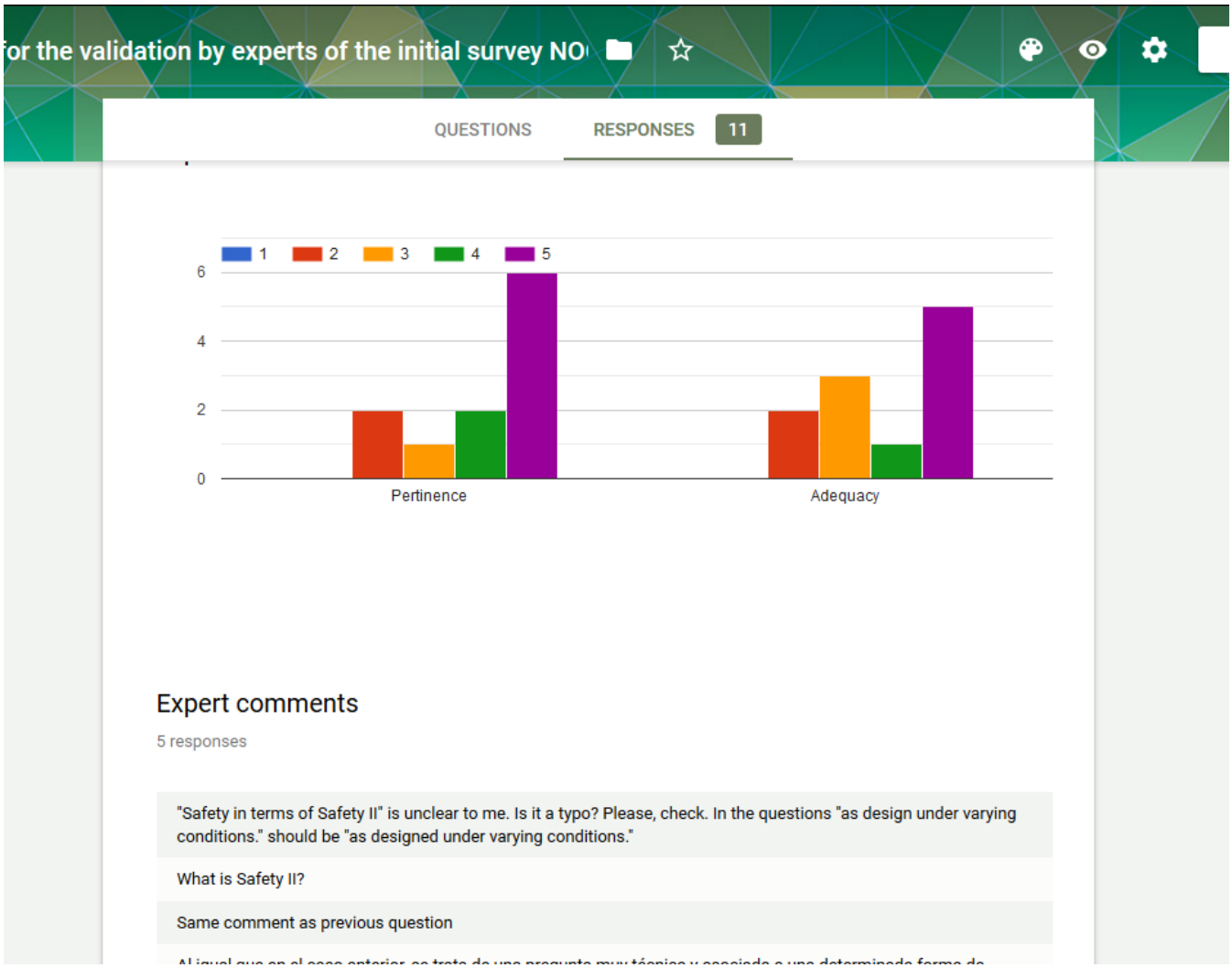


Figure 22: Responses to the questionnaire for the validation of experts of the initial survey of NOOC

3.8.3. The initial and final surveys of the 3 NOOCs

After the feedback of the experts regarding the questionnaires, changes were made in the surveys taking into account their comments, and the final version of the surveys was implemented to be used in the NOOCs. You can see below screenshots of both a survey (Figure 23) and a survey response (Figure 24).

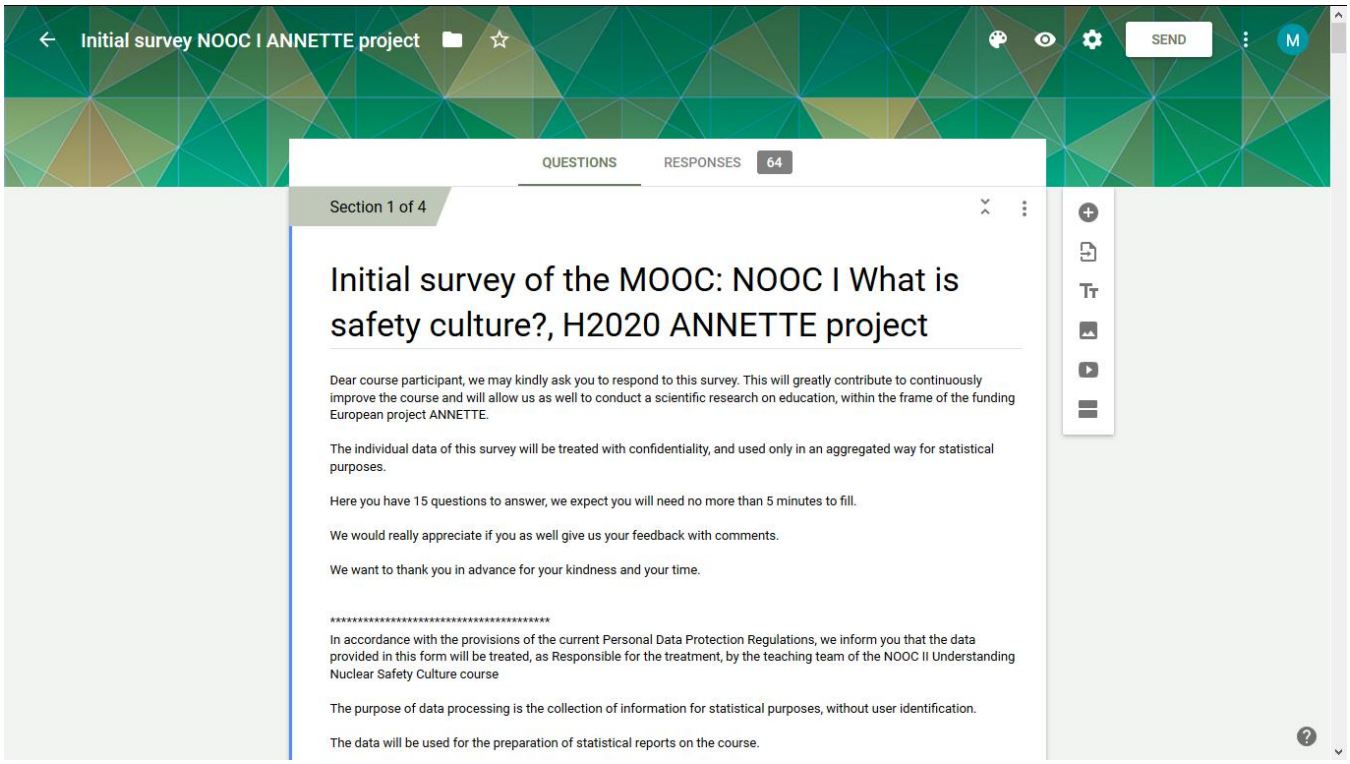


Figure 23: Screenshot of the initial survey for NOOC I

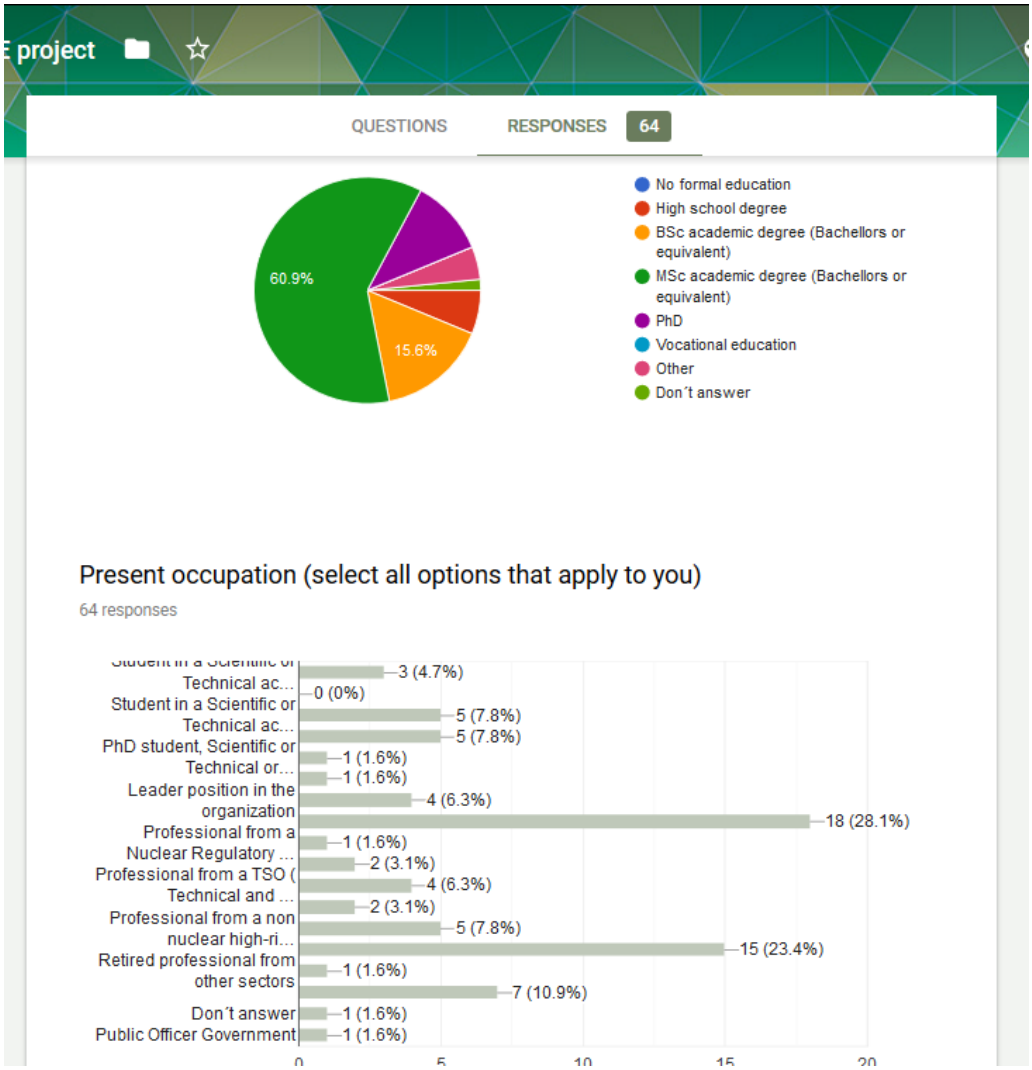


Figure 24: Screenshot of the responses to the initial survey of NOOC I

Each survey was built on the experience of the previous one, as the courses were starting with one week of difference from the other, and each survey was validated by experts after having the experience of the validation of the previous NOOC III. Then all questionnaires and surveys were different from each other, 6 questionnaires and 6 surveys.

In the Table 6, a look at the number of learners that answered the surveys, and the number and profile of the experts that validated them, is shown.

		LEARNERS	EXPERTS		
NOOC I	Initial survey	64	11	Education	7
				elearning	4
				Safety culture	1
				Nuclear safety culture	3
				Organization of the nuclear sector	3
	Final survey	29	10	Education	6
				elearning	5
				Safety culture	1
				Nuclear safety culture	3
				Organization of the nuclear sector	2
NOOC II	Initial survey	26	14	Education	10
				elearning	6
				Safety culture	2
				Nuclear safety culture	4
				Organization of the nuclear sector	4
	Final survey	17	12	Education	8
				elearning	6
				Safety culture	2
				Nuclear safety culture	3
				Organization of the nuclear sector	4
NOOC III	Initial survey	35	8	Education	5
				elearning	3
				Leadership for safety	1
				Safety culture	2
				Nuclear safety culture	2
				Organization of the nuclear sector	1
	Final survey	37	8	Education	5
				elearning	3
				Safety culture	2
				Nuclear safety culture	2
				Organization of the nuclear sector	1

Table 6: Number of learners answering the MOOCs surveys, and number and profile of the experts validating the surveys

3.8.4. Embedding the surveys for anonymized follow up of the participants path

The surveys were embedded in the courses in such a way that they remained anonymized, only a number would be assigned to each participant answering it, nevertheless allowing to track the

responses. This way we could follow the activity and survey response of the anonymous participants, allowing an interesting research study on education.

3.8.5. The follow up authorization

A follow-up authorization was designed in order to have the permission to contact the attendees in order to gather a longer-term feedback, as envisaged during the research design.

3.9. Dissemination activities

3.9.1. Dissemination of the work

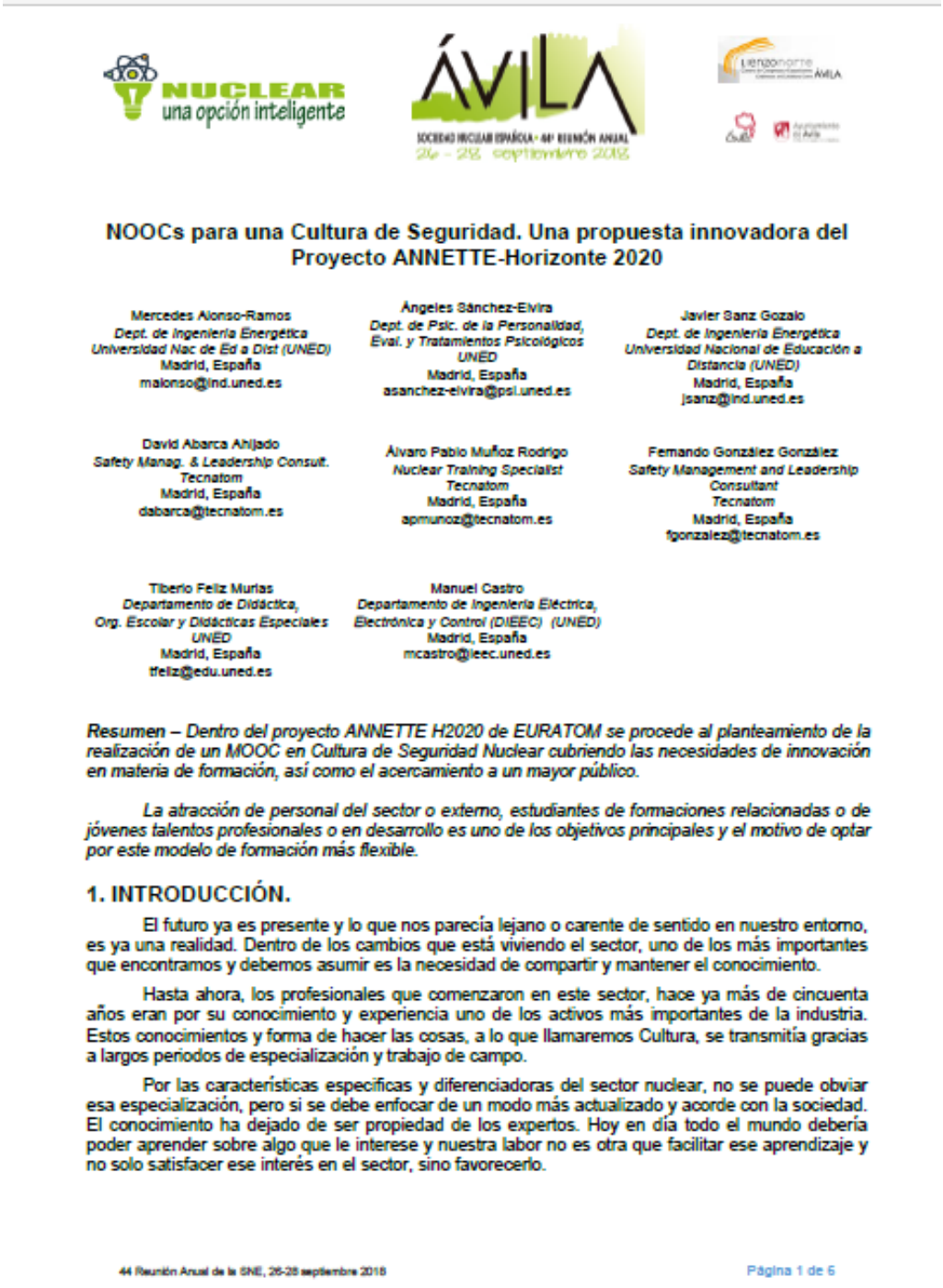
A very broad previous dissemination campaign was developed about the development of the work involved for the MOOCs. Mainly as follows:

- Learning with MOOCs V congress [25] This is one of the most important international congresses on MOOCs. See reference for details. Figure 25 is a picture of the presentation in the congress.

— Presentario of ANNETTE MOOC on Nuclear Safety Culture in the "Regional, Technical and Culture on MOOCs" Session

Figure 25: The presentation of the MOOCs in LWMOOCS V congress

- Annual Meeting of the Spanish Nuclear Society [26] The MOOCs were presented by David Abarca in Spanish in this conference. See a picture of the presentation in Figure 26.



NOOCs para una Cultura de Seguridad. Una propuesta innovadora del Proyecto ANNETTE-Horizonte 2020

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Resumen – Dentro del proyecto ANNETTE H2020 de EURATOM se procede al planteamiento de la realización de un MOOC en Cultura de Seguridad Nuclear cubriendo las necesidades de innovación en materia de formación, así como el acercamiento a un mayor público.

La atracción de personal del sector o externo, estudiantes de formaciones relacionadas o de jóvenes talentos profesionales o en desarrollo es uno de los objetivos principales y el motivo de optar por este modelo de formación más flexible.

1. INTRODUCCIÓN.

El futuro ya es presente y lo que nos parecía lejano o carente de sentido en nuestro entorno, es ya una realidad. Dentro de los cambios que está viviendo el sector, uno de los más importantes que encontramos y debemos asumir es la necesidad de compartir y mantener el conocimiento.

Hasta ahora, los profesionales que comenzaron en este sector, hace ya más de cincuenta años eran por su conocimiento y experiencia uno de los activos más importantes de la industria. Estos conocimientos y forma de hacer las cosas, a lo que llamaremos Cultura, se transmitía gracias a largos periodos de especialización y trabajo de campo.

Por las características especificas y diferenciadoras del sector nuclear, no se puede obviar esa especialización, pero si se debe enfocar de un modo más actualizado y acorde con la sociedad. El conocimiento ha dejado de ser propiedad de los expertos. Hoy en día todo el mundo debería poder aprender sobre algo que le interese y nuestra labor no es otra que facilitar ese aprendizaje y no solo satisfacer ese interés en el sector, sino favorecerlo.

Figure 26: The paper presented to the Annual meeting of the Spanish Nuclear Society

EADTU OOFHEC2018 congress [27]. (Figure 27)

Figure 27: Presentation of the MOOCs in EADTU OOFHEC2018 conference

- Presentation given by Mercedes Alonso Ramos on the ANNETTE MOOCs UNED-TECNATOM during the space for "news and initiatives from members" of the «3rd ENEN aisbl General Assembly », organized by ENEN in Brussels, 1 mar 2019.
- ANNETTE Bulletin. See Deliverable 2.4 for information on this Bulletin.
- Course page and other information in INOOC blog [28].

  INOOC stands for Innovative Nuclear Open Online Culture. INOOC blog (Figure 28) was created in order to gather interesting information on the activity of the team coordinated by Mercedes Alonso Ramos.

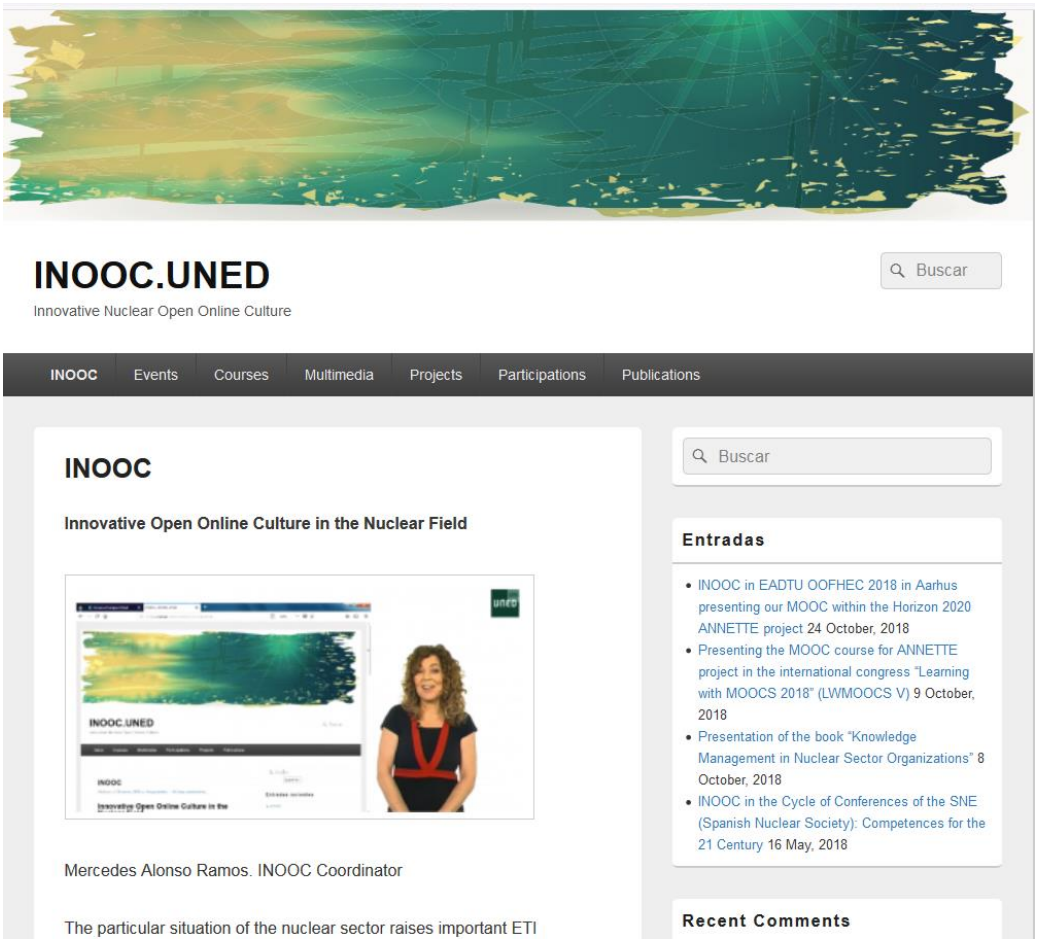

Figure 28: INOOC blog home page

A special page for the course information was created in INOOC blog [17], and as well other relevant information was published in the blog. (Figure 29)

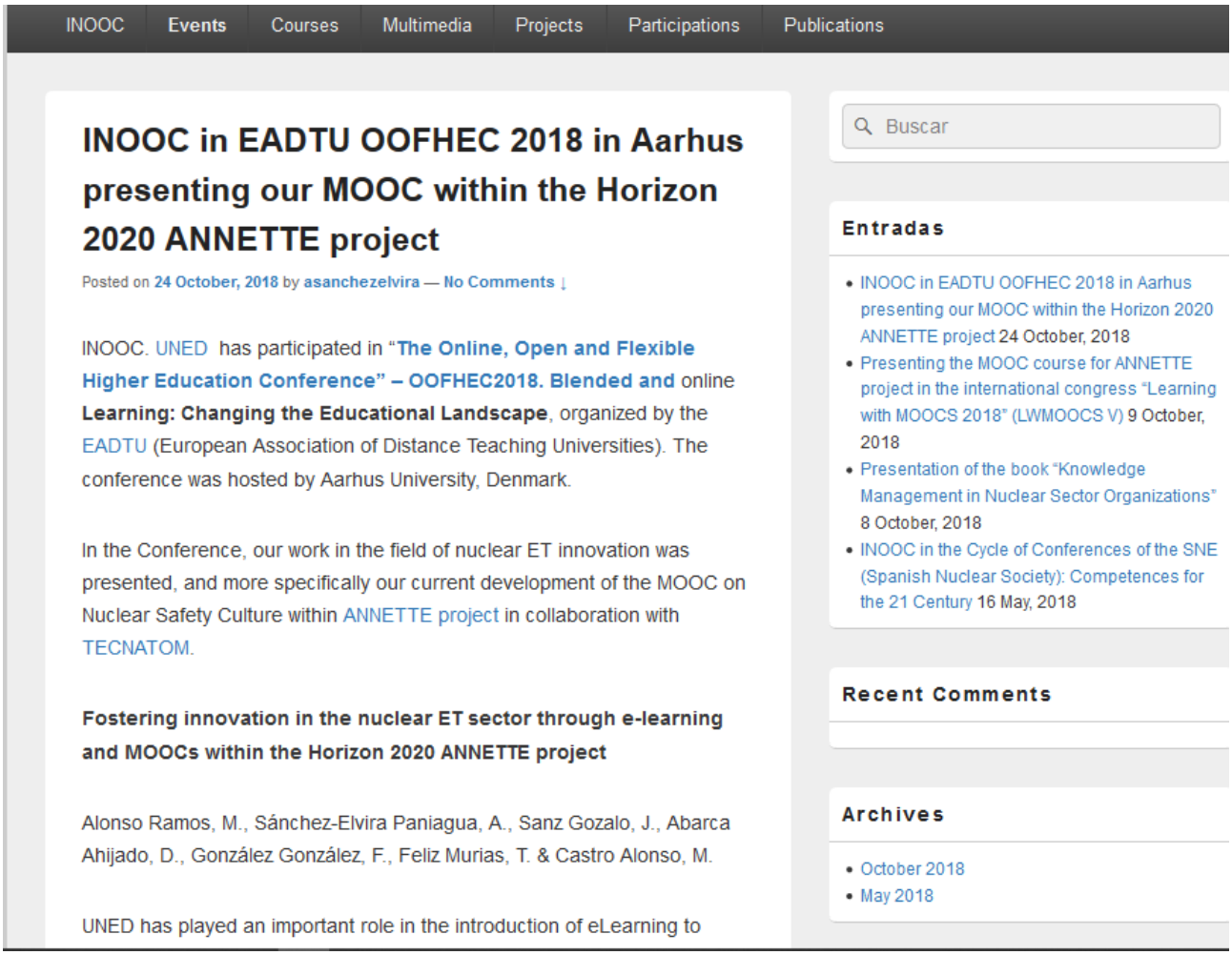

Figure 29: An example of an event published in INOOC blog for the dissemination about the development of the MOOCs

3.9.2. Dissemination to gather participants

As well an extensive dissemination has been developed in order to attain a big number or attendees.

Mainly as follows:

- The recording of a promo video by UNED Audiovisual Department [29]. (Figure 30)

Figure 30: A promo video image

- INOOC-UNED blog and INOOC information form (Figure 31)

INOOC blog kept track of the information on the courses and had as well the links to enrol in the courses. Moreover, a possibility for those who wanted to be informed about the progress of the courses design and development was available by filling the required data in a questionnaire.

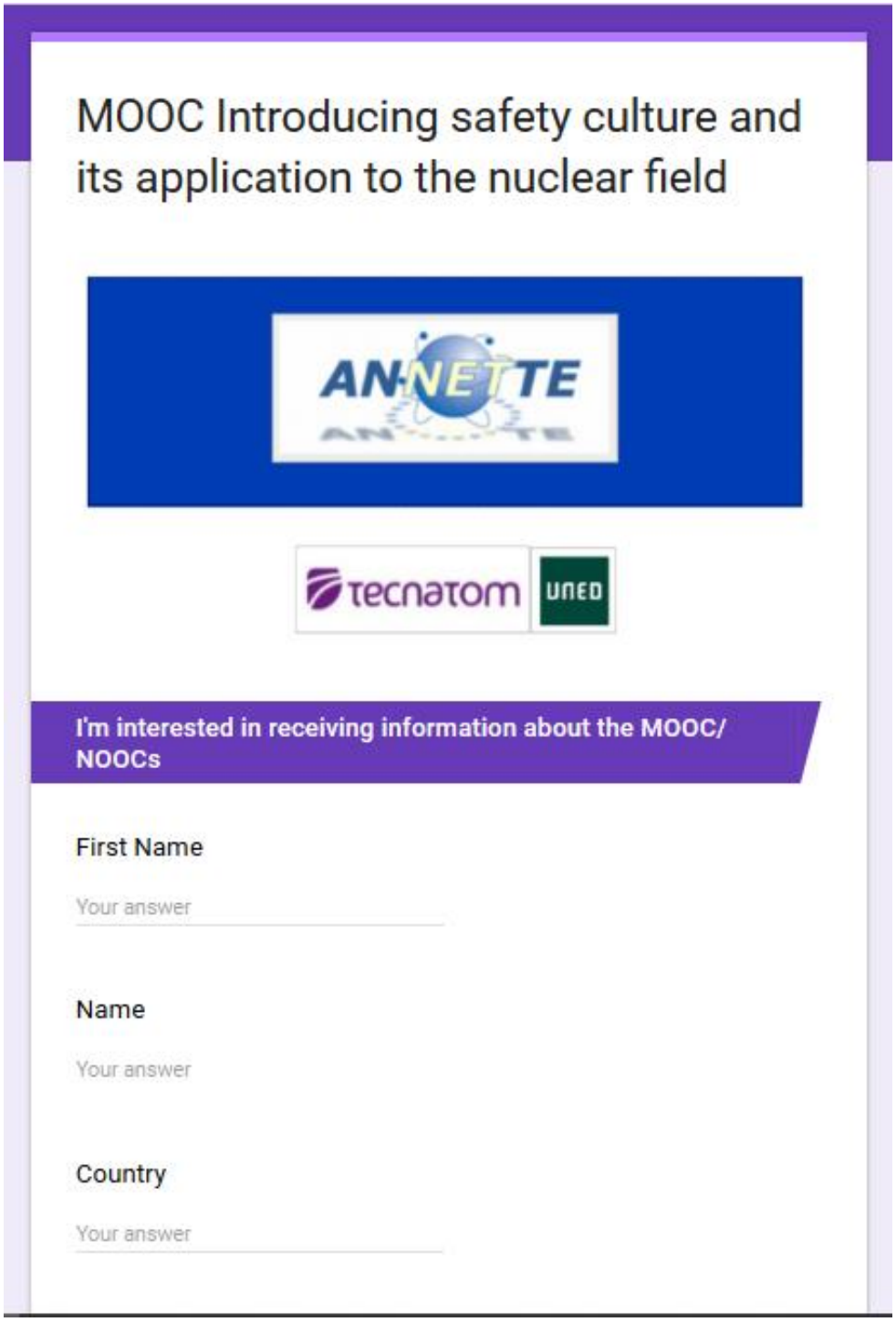

Figure 31: INOOC information form

- Dissemination work by UNED Abierta staff.

  UNED Abierta is involved in the dissemination of the MOOCs as well as in their production and implementation. Specialised staff is dedicated to MOOCs dissemination in social networks, taking care of the dissemination of the MOOCs on Nuclear Safety Culture as well.
- The in-kind collaboration of experts in the dissemination.

  Here we would like to thank César de la Cal Losada, former Director of Human Resources of CNAT (Association of Almaraz and Trillo Nuclear Power Plants), who kindly contributed to disseminate internationally about the course to professionals from the nuclear sector and to other high risk industries.
- The INOOC twitter account.

  A Twitter account was created in INOOC-UNED blog in order to disseminate about the MOOCs.
- ANNETTE Bulletin.

  Dissemination in ANNETTE Bulletin, as explained in Deliverable 2.4., has been crucial to gather participants for the course.
- Other dissemination work.

  Personal mails have been as well sent by members from the MOOCs academic team as well as by other close contacts.

3.10. Difficulties encountered

3.10.1. Causes for the delay of the MOOCs run

The greatest weakness of the program was the lack of previous experience in the development of MOOCs on the side of the team. In the first phase, a complete program of 4 complete NOOCs was designed, and it was offered in that way on the UNED platform.

As the group progressed several challenges appeared, namely:

- **Need to learn**. Despite having e-learning knowledge, this was the first MOOC type course developed by the group, although based on experiences as students, the idea was to develop a quality teaching material, overcoming the weaknesses that the teaching staff found in other MOOCs when participating as students. Including, not using static, and visually boring

presentations. The use of short videos of 2-5 minutes to explain concepts, avoiding losing the attention of the participants, was the format selected for the NOOCs.

- **The number of videos and activities was very large.** A large number of hours was needed to be reserved for the recording rooms of the UNED. Unfortunately, UNED's daily academic activities required the use of the same room so that UNED could develop its courses for UNED students.
- **Need to edit and review the technical data on the material and content, and the revision of English**. Most of the didactic material has been developed exclusively for this course. Like any process of creating documentation, it has taken a great amount of time correcting and improving the material itself, to have a high-quality material, which could meet the most rigorous standard.
- **Redefine the scope of NOOC 4**. Under the premise of reaching as many participants as possible, the MOOC contains two quite general NOOCs, namely NOOC I and NOOC III, which can be followed by people without specific knowledge in the nuclear industry. Under this idea, in the first phases of the design and development of the MOOC, it was considered necessary to have a fourth course, explaining the basic concepts of the nuclear industry. A course that includes parts of reactor physics but also of the description of technologies used in the nuclear industry, so that participants without prior knowledge of the nuclear sector could follow the MOOC in full. As the modules progressed, it became obvious that developing a complete NOOC would take too much time, but it was also not necessary to be able to follow the other NOOCs. Anyone without a technical background could be interested in safety and leadership culture issues, so doing a NOOC to introduce them to technology could discourage them from doing the other NOOCs. It was then decided to develop a glossary of nuclear terms, covering everything necessary to complete the three NOOCs that make up the course. The development of a glossary also allowed more flexibility, being able to access its contents from any of the NOOCs simply by selecting the appropriate tab. This solution was taken as the most appropriate and a glossary was developed with approximately 700 terms of generic fundamentals and nuclear technology itself.

3.10.2. Dissemination needs

Dissemination for MOOCs is essential to gather a wide audience. And in the case of more technical and specific MOOCs, like the ones developed in this project, more specific dissemination actions. We made a very broad dissemination campaign, but further dissemination efforts would have been interesting. In the case of MOOCs, it is ideal to have all the partners involved in the project participating in a broad dissemination campaign as well as having a multidisciplinary team of dissemination experts in the area to give advice on the design of the dissemination strategy and assisting in the coordination of the dissemination campaign.

3.11. Running the courses

3.11.1. The course announcements to the course participants in the course platform and duration of the courses.

After all the contents of the course were already in the platform, dissemination work took place in order to announce the course participants the coming soon opening of the courses. Attention was given to reminding the importance of filling the initial and final surveys of the courses as well as helping with the course dissemination in order to gather a wider audience. The platform allows sending massive emails to all participants of the course, as well as to the course teaching team, in order to do this dissemination work within the MOOC platform. A first mail was sent a few days before each course started, and another one the starting day in order to favour having the participants taking the course at the same time (**¡Error! No se encuentra el origen de la referencia.**). Also, an announcement mail was sent when a course was reaching its end announcing the date, and as well in the case of a delayed end of the course.

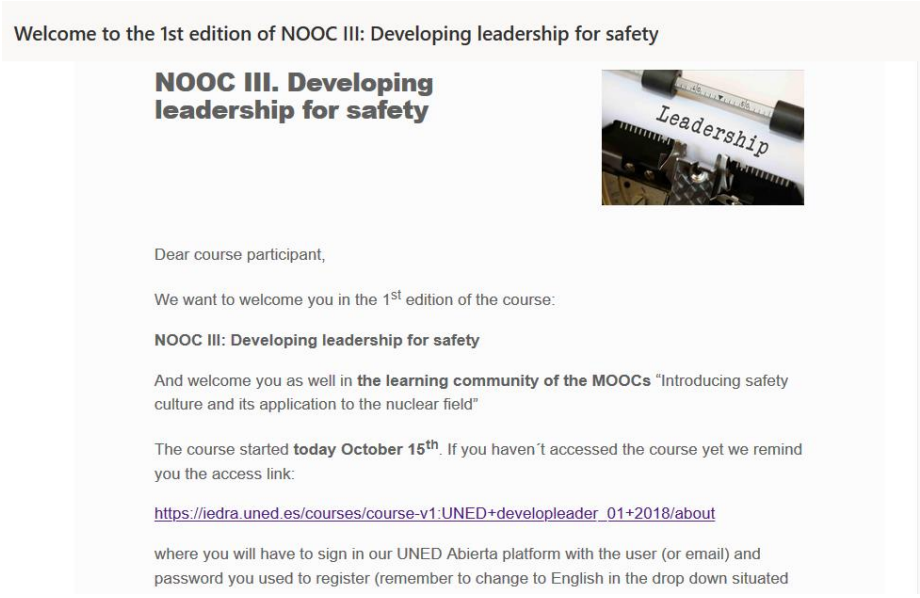

Figure 32: Mail sent by the platform to NOOC III course participants to announce the course start

Although the initial plan for the duration of the courses was quite short, we could finally delay them in order to gather a wider audience, as the subscriptions were rising every day and we didn´t want to miss participants with an early course end. This fact and the late start of courses delayed more the preparation of the corresponding reports, but hopefully the results will justify this decision.

As we can see in the Table 7: NOOC I was initially announced from October 1st 2019 till October 21st, NOOC II started from October 8th 2019 till October 21st, and NOOC III from October 15th 2019 till October 28th. NOOC I and II were first delayed to finish October 28th, and later a further delay was announced for all courses till November 12th 2019, when all the courses finally ended.

	Start date	Announced end date	First delayed end date	Final delayed end date
NOOC I	October 1st 2019	October 21st 2019	October 28th 2019	November 12th 2019
NOOC II	October 8th 2019	October 21st 2019	October 28th 2019	November 12th 2019
NOOC III	October 15th 2019	October 28th 2019		November 12th 2019

Table 7: Courses start date and end date

3.11.2. The use of the platform for the follow up of the courses

UNED MOOCs platform has a space for instructors, where interesting follow up of the courses can take place. In Figure 33, a screenshot of the page with the information on the enrolment in the course is shown and then Figure 34 on the learning analytics page with the different information available.

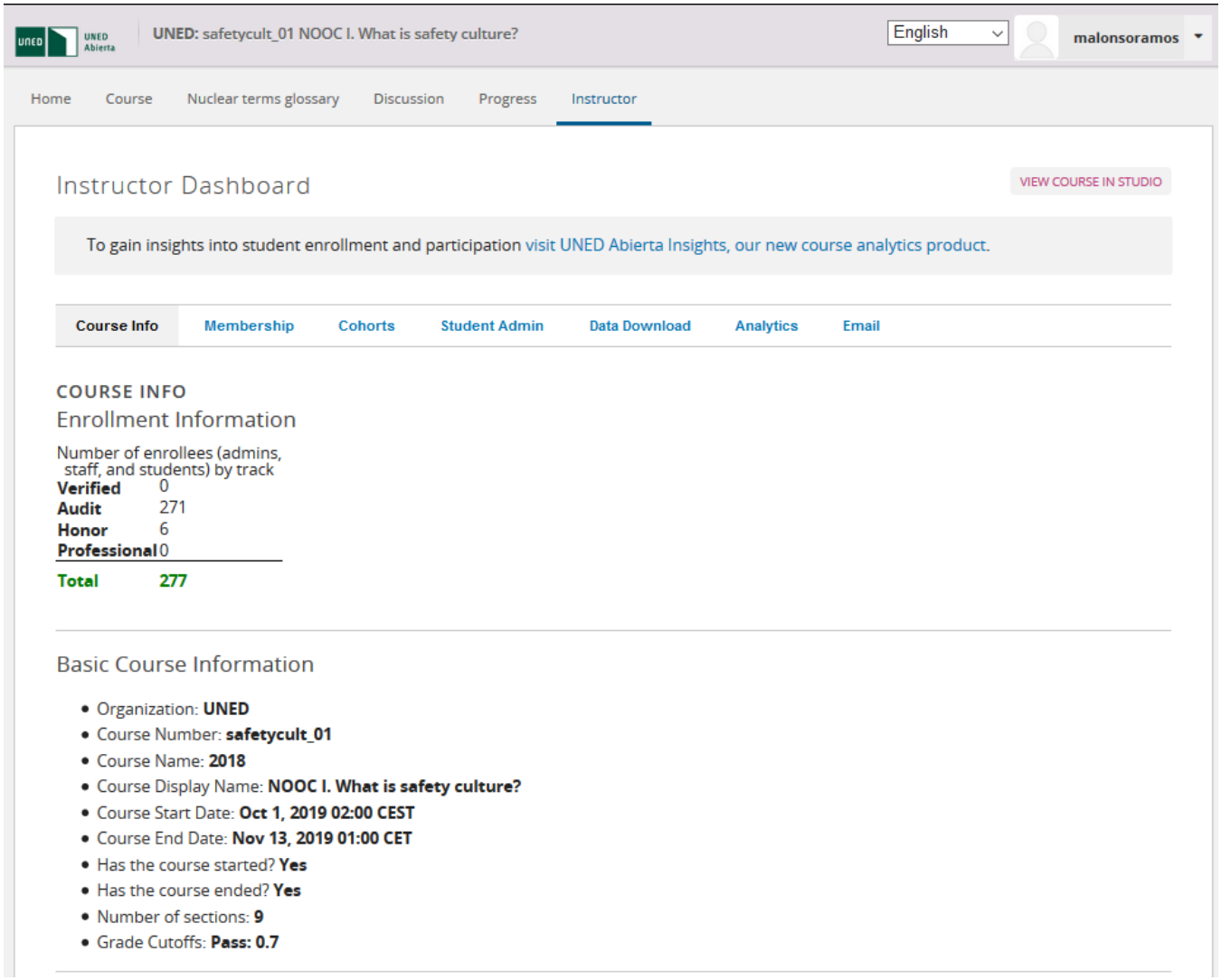

Figure 33: A screenshot of the instructor dashboard in UNED MOOCs platform

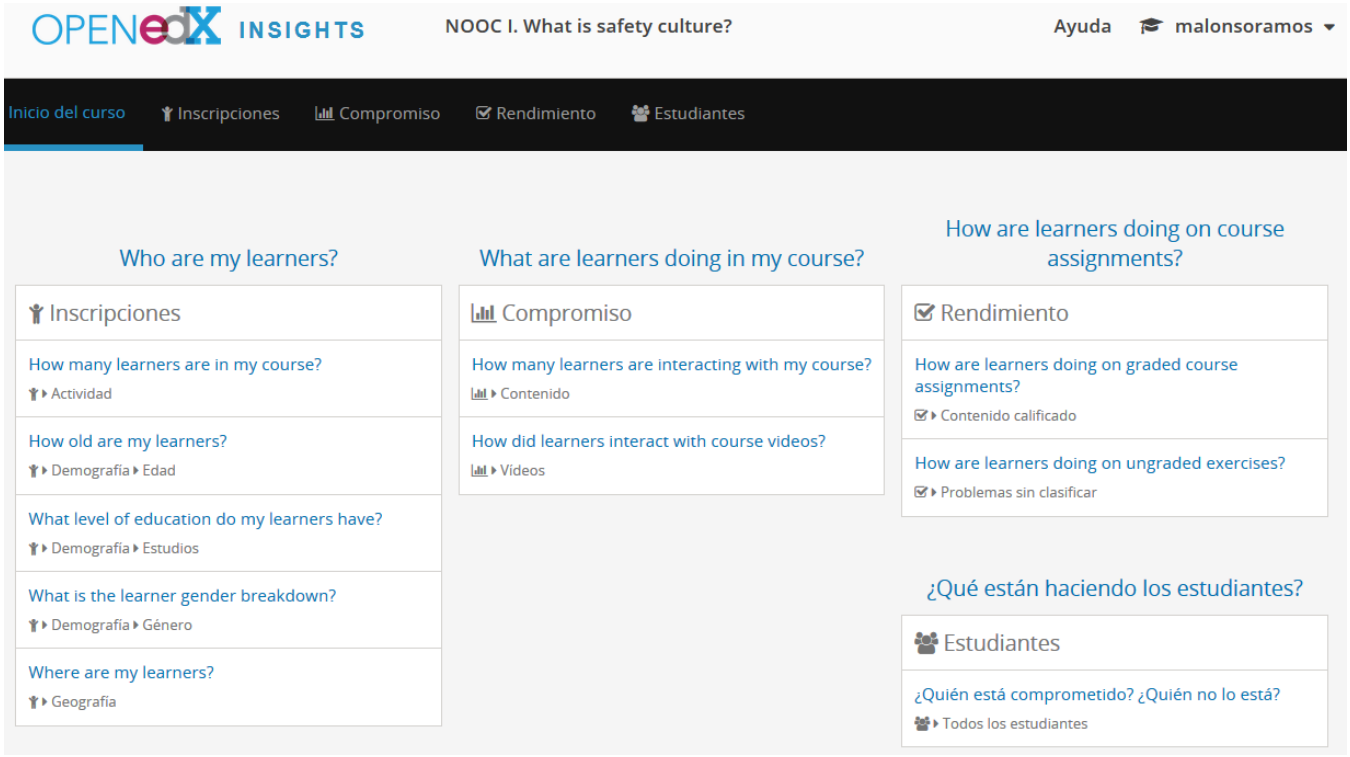

Figure 34: Data acquisition in the platform: The MOOCs learning analytics

In Deliverable 5.4, extensive information on the data gathered in the courses will be made available.

3.11.3. Some numbers on the course run

Here we give some numbers on the course run. More detailed data on the course run will be presented and analysed in Deliverable 5.4.

The total number of participants in the courses is shown in Table 8:

NOOC I	277 participants
NOOC II	199 participants
NOOC III	283 participants

Table 8: Participants in each course.

As in any other MOOC, the actual attendees, those who follow the course and participate in activities, are a small percentage of the total enrolled participants. Nevertheless, the number of visualizations of

the videos gives an idea of the large impact of the courses and their video lectures. As an example, it is shown in theTable 9 for NOOC I a total of 956 visualizations.

NOOC I	Complete views	Partial views	% complete views
UNIT 1			
1.1. NOOC I Introduction	66	16	80,50%
1.3. Focusing on culture	50	14	78,10%
1.7. What is safety: The importance of interactions	47	6	88,70%
1.8. What is safety: The ANNETTE tower	43	7	86,00%
1.10. ANNETTE tower solution	39	2	95,10%
total	245	45	total views 290
UNIT 2			
total	218	23	total views 241
UNIT 3			
total	163	38	total views 201
UNIT 4			
total	62	36	total views 98
UNIT 5			
total	97	29	total views 126
TOTAL VIEWS NOOC I	785	171	**956**

Table 9: Number of video visualizations of course NOOC I

3.11.4. Feedback from participants

Feedback from participants was given either by responses in the initial and final survey, or by posts in the forums, or else by personal emails to the teaching team. In general, the feedback was very positive, but as well some “bugs” were reported in the course, guiding the teaching team to revise and check the course structure and contents for the present edition of for future ones. Some hints on the feedback will be highlighted in Deliverable 5.4

As an example of feedback responses to the anonymous voluntary final survey on the participants is shown.

Overall rating of the course:

- NOOC I 48,3% answered with 5 (maximum grade was 5). Shown in Figure 35.
- NOOC II 88.2% answered with grades between 8 and 10 (10 maximum)
- NOOC III 52,8% answered with grades between 8 and 10 (10 maximum)

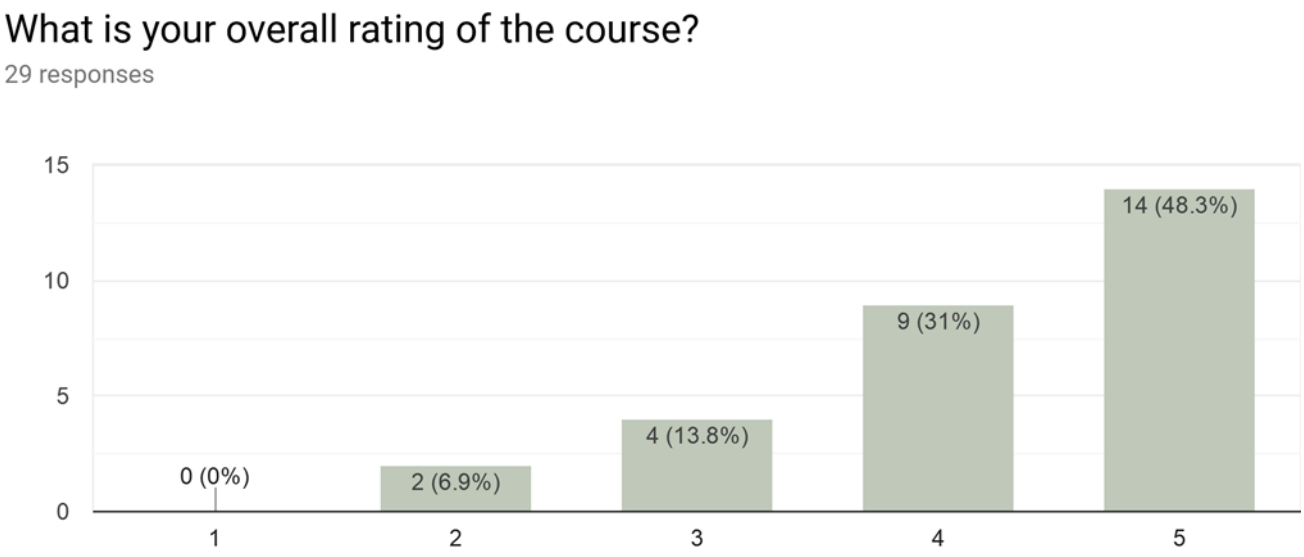

Figure 35: Overall rating of NOOC I by the NOOC participants in the final survey

4. CONCLUSIONS

As shown in the previous sections, the effort spent in WP5, after the withdrawal of CEA-INSTN, was concentrated on the two courses delivered by Uppsala University and by UNED and Tecnatom. As a matter of fact, following the suggestions of EC at the time of approval of the ANNETTE proposal, the greatest emphasis was devoted to the production of the MOOC. This objective resulted definitely challenging for the novelty of the subject and the need to adapt and upgrade previous experience on similar subjects in the new format. This justified the greater effort devoted by UNED and Tecnatom in particular to the work performed in WP5.

The Course on MTO by Uppsala University had a relatively reduced attendance, though this was comparable to the one of other courses run in the frame of ANNETTE which, collectively, produced relatively large numbers of attendances. So, the preparation of the course material and its first run can be considered anyway a sound achievement.

Regarding the Nuclear Safety Culture MOOCs some conclusions are presented below.

The NSC MOOCs represent a very innovative educational offer in the nuclear sector, gathering participants also from other sectors, as well as students, favouring talent capture for the new generation of professionals in the nuclear sector. Very few MOOCs have been available for the nuclear sector and the NSC MOOCs are probably the ones having a more innovative instructional design.

The experience of developing the MOOC courses has been a very enriching experience for both UNED and Tecnatom, and a close collaboration and interaction has been needed to attain the quality of the courses.

The initially planned work has become much more extensive and difficult due to offering 3 complete courses with a numerous number of videos (rounding 100) and activities, as well as the complete glossary of nuclear terms. Close coordination between UNED and Tecnatom has involved as well a great effort, and the redesign of the available contents and learning activities to be suitable for a MOOC has also required an added effort and coordination with experts in methodology in UNED. Also subtitling of all the video lectures has been necessary for accessibility purposes, increasing the production effort.

The courses had very good feedback by the course participants. Deliverable 5.4. will cover this issue in greater detail.

The sustainability of the courses will be attained by a permanent availability of the MOOCs in UNED Abierta platform in a SECOND EDITION, with no teacher assistance. These courses have already been created in the platform, and a final quality check is being done; they will be opened to participants on February 4th 2020. Now the courses are available in UNED Abierta portal and it is possible to enrol for future participation when the courses are opened. More extensive information on this permanent edition will be given in Deliverable 5.4.

Regarding dissemination activities an extensive activity has been developed both for the dissemination of the work involved in the production of the courses as well as for gathering participants. Nevertheless a more extensive, dedicated and coordinated effort would have been beneficial for increasing the participation in the courses. As well, a publication for a JCR scientific journal will be prepared and hopefully published in the next months.

The extensive information, analysis and conclusions from the data analytics, the initial and final surveys and other feedback from the participants will be presented in Deliverable 5.4.

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