Grant agreement number: 779730

WP 5 – Integration onto online e-learning platform

D5.3 MOOC and demo course development

Due date: 31/07/2018

Lead participant name: DTU

List of contributors: DTU, KIT

Status: F (final, revised)

Dissemination level: PU

Last updated: 07/07/2019
(revision 31/10/2022)

Document History

Issue Date	Version	Changes Made/Comments
03-07-2019	1.0	Final draft
04-07-2019	2.0	edits
07-07-2019	3.0	edits
19/07/2021	3.1	funding statement update (RSW)
31/10/2022	3.2	revision following review

Disclaimer and Acknowledgment:

This project has received funding from the Fuel Cells and Hydrogen 2 Joint Undertaking under grant agreement No 779730. This Joint Undertaking receives support from the European Union's Horizon 2020 research and innovation programme, Hydrogen Europe and Hydrogen Europe research.

Any opinions expressed in this report are solely those of the authors and neither of the FCH 2 JU, nor the European Commission or its representatives.

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About TeacHy

As the FCHT industry gradually emerges into the markets, the need for trained staff becomes more pressing. TeacHy2020, or short TeacHy, specifically addresses the supply of undergraduate and graduate education (BEng/BSc, MEng/MSc, PhD etc.) in fuel cell and hydrogen technologies (FCHT) across Europe.

TeacHy2020 will take a lead in building a repository of university grade educational material, and design and run an MSc course in FCHT, accessible to students from all parts of Europe. To achieve this, the project has assembled a core group of highly experienced institutions working with a network of associate partners (universities, vocational training bodies, industry, and networks). TeacHy offers these partners access to its educational material and the use of the MSc course modules available on the TeacHy site. Any university being able to offer 20 to 30% of the course content locally, can draw on the other 80 to 70% to be supplied by the project (and its successor entity that will support the platform post-project).

This will allow any institution to participate in this European initiative with a minimised local investment. TeacHy will be developing solutions to accreditation and quality control of courses, and support student and industry staff mobility by giving access to placements. Schemes of Continuous Professional Development (CPD) will be integrated into the project activities. We expect a considerable leverage effect which will specifically enable countries with a notable lack of expertise, not only in Eastern Europe, to quickly be able to form a national body of experts.

TeacHy will offer some educational material for the general public (e.g. MOOC's), build a business model to continue operations post-project, and as such act as a single-stop shop and representative for all matters of European university and vocational training in FCHT. The project partnership covers the prevalent languages and educational systems in Europe. The associated network has over 70 partners, including two IPHE countries, and a strong link to IPHE activities in education.

Deliverables Abstract

The deliverable describes the development of the MOOC demo as well as a trial run of the first MOOC module.

1 Demo modules development

1.1 Demo modules – MOOC capabilities

For the demonstration of capabilities of the MOOC platform a number of smaller modules were developed.

These showed off the general principle of how to build a MOOC module/course and what is technically possible to include in a module.

The developed modules have been used internally to show off the MOOC platform and have been developed in close collaboration with the Net-Tools consortium.

1.2 How to build a MOOC module

A 'How to build a MOOC' module was developed. The module contains an introduction to the following basic concepts used on the Net-Tools platform

- Module layout and division into lectures
  - Options for how to progress from lecture to another. Possibility for choosing lectures freely or in sequence.
  - Progression based on passing of quizzes or just watching the lecture.
- Multimedia capabilities
  - Video of lectures, and best practices for making these.
  - Visualisation and animations
- Student evaluation, in the form of automatic quizzes that test the understanding of the topic.
- MOOC constraints; recommendation for video length.
- The demonstration course developed by DTU deals with the development of potential

MOOCs "how to develop a MOOC course" and gives detailed instructions to the developers (Fig.1).

Fig.1: Demo Course available at NET-Tools LMS dealing with instructions on how to develop MOOCs.

1.3 Smaller trial modules

Based on the “How to” MOOC some smaller modules were made, with examples of videos and quizzes and on Fuel Cell and Hydrogen related topics.

Once enrolled as a learner the reader will get forwarded to the specific entry page of the MOOC and gets instructed more detailed about the main content included (fig.2.0).

The main content became further subdivided as it is demonstrated by the content to the demo course. The content itself spreads over the major parts which must get taught to instruct potential MOOC developers to the basics. Demonstration of several opportunities which could get used for the development of a MOOC is included in subchapters. The general overview of this demo MOOC is:

- Introduction to online learning
  - Introduction to this course
  - Teaching online
- How to plan and structure a course
  - Course structure
- Examples of course module
  - Fuel Cells
  - Introduction to Solid Oxide Fuel Cells
- How to create course content
  - Introduction to content
  - Quizzes
  - Video
- Creating videos for online courses
  - Example of Videos recording approaches

Fig.2: Entry page of the Demonstration MOOC on the NET-Tools platform.

1.4 Introduction to online learning via the NET-Tools MOOC concept

1.4.1 Aims of the course

The aim of this section is to show an example of a course as it could be delivered on the OpenEDx platform in the shape of a MOOC structure. The sample discussed will contain snippets of a course on fuel cells as a specific example of how courses hosted on the NET-Tools platform can look. Further, the course contains lists of quizzes and other material for inspiration. There will be technical information on how to create content throughout the course.

At the end of the course learners will be able to:

- Describe what element comprise a good MOOC course
- Plan a MOOC course
- Design course content for the OpenEDx platform
- Create quizzes in the OpenEDx platform
- Choose methods and procedures for video production

1.4.2 Video examples

Making an online course presents unique opportunities for us if we choose to use them. In this page you will see examples of how we can use videos to bring students to places they do not normally go. The examples include expert interviews, lab tours, hands-on tutorials, and real life demonstrations, Fig.3.1 to 3.4.

The video are just some examples of the kinds of videos that can be implemented in a course. The important takeaway point is that we should not limit ourselves to trying to capture a conventional university lecture. Rather we should use the video media to its fullest. Later in this course we will look into how we can optimize video production for lecture type videos and also how we go about recording video material

Expert's interviews

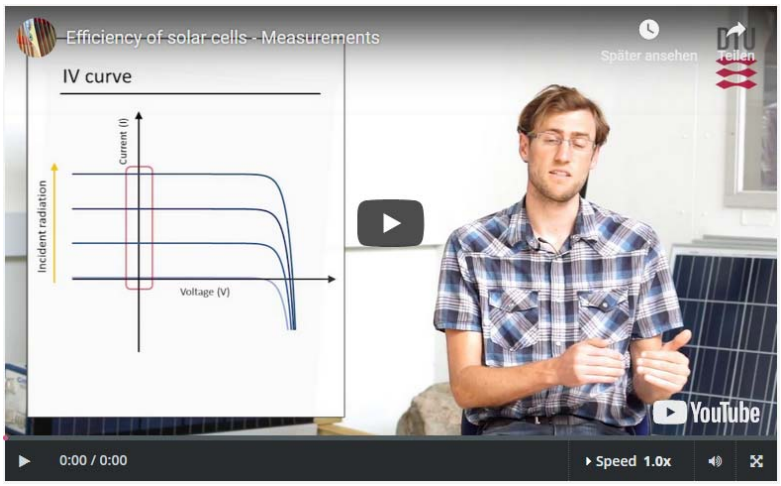


Fig.3.1: Example to incorporate different videos into e-learning e.g. "expert's video".

Fig.3.2: Example to incorporate different videos into e-learning e.g. “labour tour”.

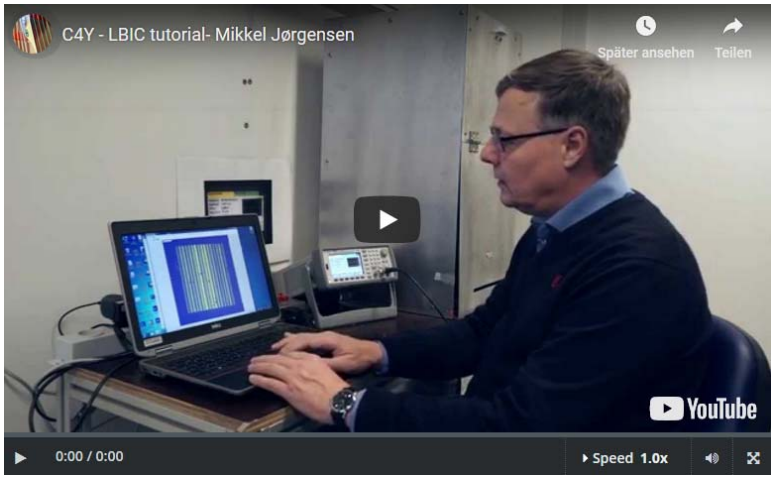


Fig.3.3: Example to incorporate different videos into e-learning e.g. “hands on tutorial”.

Fig.3.4: Example to incorporate different videos into e-learning e.g. “real world example”.

1.4.3 NET-Tools e-learning module storyboard template

Learning objectives

1. Module Learning Objective (MLO) 1
    1. List parent Course Learning Objectives (CLO) this MLO contributes to
2. MLO 2
    1. CLO X, CLO Y etc.
3. MLO 3 etc.

Module introductions

1. Plain text document (PDF / HTML)
2. Sets the context for the current module in terms of previous modules and perhaps other courses
3. States the pre-requisites needed to complete the module
4. Explains how the module prepares the participant for the next module.
5. Summarises the teaching activities (TA) and the content for each of the concepts in the module
6. Lists further reading

Concepts

Modules should contain 3-10 concepts depending on the complexity. Two concepts described more detailed in the following subchapter.

Concept 1

Content

1. Background reading: 1-5 pages of plain text document (PDF / HTML, compulsory for each concept unless contained in module intro document). All information needed to complete the module/concept quiz is contained in the document. Directly supports all MLO's
2. Presentation: 3-10 Slides (PDF / PowerPoint, compulsory if no video content included in the concept but highly recommended in addition to video content). Slides should present the key concepts of the concept that will be quizzed. The slides should summarise the background reading but not duplicate. Directly supports all/majority MLO's
3. Video: max 5 mins. At least 1 video is recommended in the module. As in slides the video should be a concentrated version of the supporting/background reading covering all key points. Directly supports all/majority MLO's
    1. Recommended that presenters face appears at least shortly
    2. Good to include dynamic illustrations of plots, derivations of formulae, show real objects, show how experiments/demonstrations done in real life
    3. Optional to include supplementary longer videos containing detailed information presented e.g. by an expert
4. Exercises / TA's: Optional, but recommended. Ideally should create a sandbox for the participant to play/practice with the knowledge gained. Exercise should align with the MLO's and MQQ's

5. Formative Assessment Quiz: Optional. Quiz questions should be few in number, brief and relatively simple to test if the key concepts are understood to a minimum degree. An example can be fact checking to test if the background reading has been read / video watched / exercise completed.

Concept 2

Module quiz, compulsory to have at least one question that tests each MLO, preferably 2-3 or even more. Multiple choice questions should provide correct and incorrect answers that can be arrived due to a reasonable logical mistake or misunderstanding.

- Highly recommended that quiz contains several quiz type questions (e.g. multiple choice, select correct answers, identify feature in diagram, make a calculation and enter numeric value…
- All quiz questions must give feedback on why incorrect answer is incorrect, optionally giving a hint
- Recommended that module contains 2-3 x number of questions that each participant is asked such that majority of participants are not identically quizzed and that if the participant re-takes the quiz they are not asked the same questions again
- Question weighting????
- Formative Assessment Quiz questions should not be repeated

1) Module Quiz Question (MQQ) 1
    a) State which MLO the MQQ tests
2) MQQ 2
    a) MLO tested
3) MQQ 3 etc.

1.4.4 Real world example: What are fuel cells

In the following, a real world example of a course module for a fuel cell course will be demonstrated.

Introduction to fuel cells

A fuel cell is an electrochemical cell that converts the chemical energy from a fuel into electricity through an electrochemical reaction of hydrogen fuel with oxygen or another oxidising agent. Fuel cells differ from batteries in that they require a continuous source of fuel and oxygen (usually from air) to sustain the chemical reaction. In a battery the chemical energy comes from chemicals already present in the battery. This means that fuel cells can produce electricity continuously for as long as fuel and oxygen are supplied.

Figure 1 Examples of applications of fuel cells

1.4.5 Multiple Choice with Hints and Feedback

1/1 point (ungraded)

How do fuel cells generate electricity?

You can add an optional tip or note related to the prompt like this.

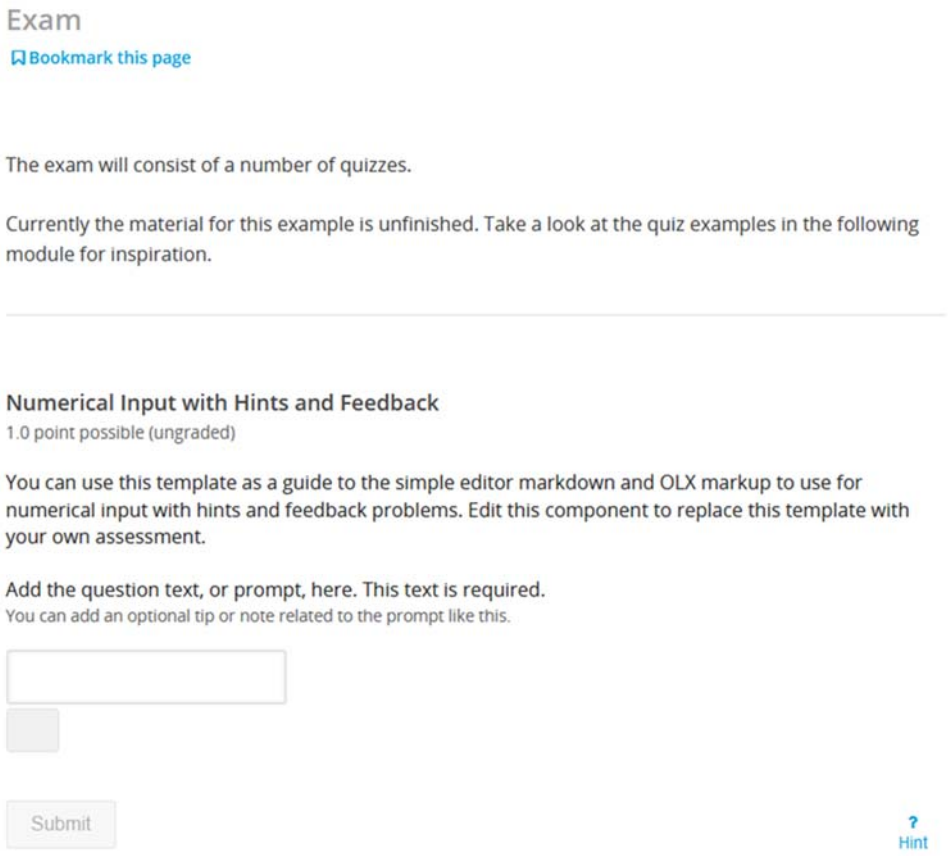
- ☐ Combustion
- ☉ Electrochemical reaction correct
- ☐ Fission

Answer

Correct:

Much like a battery, a fuel cell produces electricity through an electrochemical reaction, which generates electricity without any combustion.

1.4.6 Exam (example)



1.4.7 How to create a course content

Introduction to course content

A described earlier in the course, course content includes video lectures, but there are a wide variety of possibilities for including content. These include:

- Video lectures
- Reading material
- Formative quizzes
- Summative quizzes
- Interactive elements
- Discussion forums
- ...

In this module we will go through each type of course content with examples.

1.4.8 Example quizzes

In Open-edX you can create a wide variety of quizzes. In this section we will showcase a number of quiz examples to illustrate the scope of quizzes that can be made. Before you move on, however, we will spend a few words on good use of quizzes in online learning.

Practice and exam quizzes

An essential concept when talking about quizzes is formative and summative assessment or put in other words practice and exam quizzes. When creating e-learning it is easy to forget

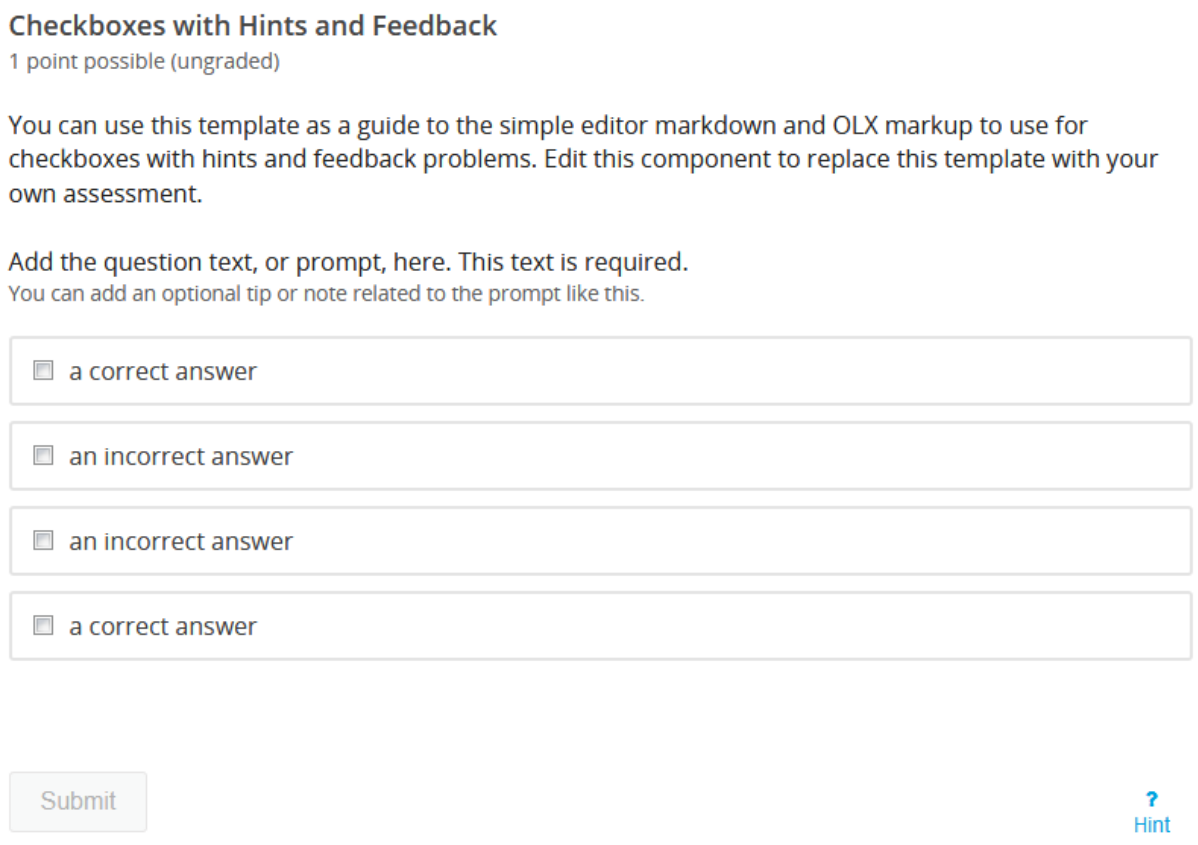
the difference between the two. In conventional education the use of formative evaluation is typically widely used. When you ask questions during a lecture you are doing formative assessment. In these circumstances students can answer more freely than they would do at an exam. We also give them thorough feedback on their answers. In an example like this it is clear that the aim is learning and not probing which grade a particular student deserves.

In online teaching this type of interaction does not come as naturally, but we must remember the aim of making formative assessment, namely to further learning. Therefore we will include formative assessments during the course to facilitate learning. What makes a particular quiz formative is that we tell the student that they are working on a practise quiz. Further we give them feedback on their answers. When they are wrong we tell them why they were wrong and likewise when they are correct we tell them so, and why.

Summative quizzes we use for exam purposes and therefore the nature of the feedback will be different. For exam questions we cannot give the students the answers, but we can give those hints.

Quiz examples

With the above lesson in mind, you can take a look at the quizzes below and think about what distinguishes formative and summative quizzes.



Dropdown with Hints and Feedback

1 point possible (ungraded)

You can use this template as a guide to the simple editor markdown and OLX markup to use for dropdown with hints and feedback problems. Edit this component to replace this template with your own assessment.

Add the question text, or prompt, here. This text is required.

You can add an optional tip or note related to the prompt like this.

Select an option

Submit

? Hint

Multiple Choice with Hints and Feedback

1 point possible (ungraded)

You can use this template as a guide to the simple editor markdown and OLX markup to use for multiple choice with hints and feedback problems. Edit this component to replace this template with your own assessment.

Add the question text, or prompt, here. This text is required.

You can add an optional tip or note related to the prompt like this.

- an incorrect answer
- the correct answer
- an incorrect answer

Submit

? Hint

Numerical Input with Hints and Feedback

1 point possible (ungraded)

You can use this template as a guide to the simple editor markdown and OLX markup to use for numerical input with hints and feedback problems. Edit this component to replace this template with your own assessment.

Add the question text, or prompt, here. This text is required.
You can add an optional tip or note related to the prompt like this.

Submit

? Hint

Text Input with Hints and Feedback

1 point possible (ungraded)

You can use this template as a guide to the simple editor markdown and OLX markup to use for text input with hints and feedback problems. Edit this component to replace this template with your own assessment.

Add the question text, or prompt, here. This text is required.
You can add an optional tip or note related to the prompt like this.

Submit

? Hint

Math Expression Input

1 point possible (ungraded)

You can use this template as a guide to the OLX markup to use for math expression problems. Edit this component to replace the example with your own assessment.

Add the question text, or prompt, here. This text is required. Example: Write an expression for the product of R_1, R_2, and the inverse of R_3.
You can add an optional tip or note related to the prompt like this. Example: To test this example, the correct answer is R_1*R_2/R_3

Submit

Image Mapped Input

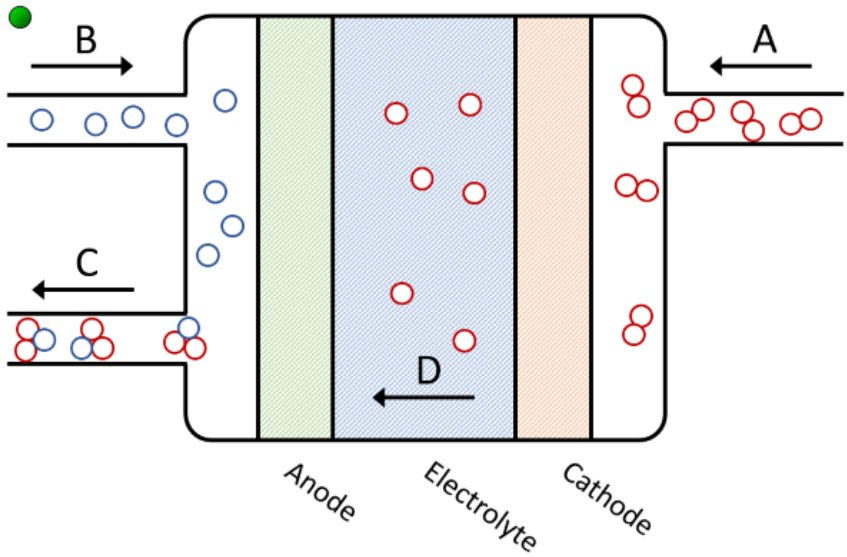
1 point possible (ungraded)

In an image mapped input problem, also known as a "pointing on a picture" problem, students click inside a defined region in an image. You define this region by including coordinates in the body of the problem. You can define one rectangular region, multiple rectangular regions, or one non-rectangular region. For more information, see Image Mapped Input Problem in *Building and Running an edx Course*.

When you add the problem, be sure to select **Settings** to specify a **Display Name** and other values that apply.

You can use the following example problem as a model.

What country is home to the Great Pyramid of Giza as well as the cities of Cairo and Memphis? Click the country on the map below.



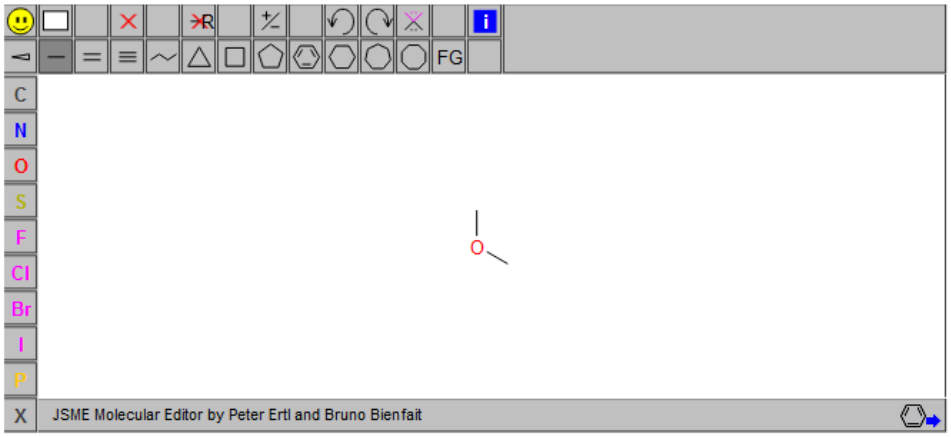
Submit

Molecular Structure

1 point possible (ungraded)

A molecular structure problem lets the user use the JSME editor component to draw a new molecule or update an existing drawing and then submit their work. Answers are specified as SMILES strings.

Can you draw the benzene?



Submit

1.4.9 Examples of video content

It is possible to create a variety of video content for online courses. Below you will see an example of a typical video lecture for an online course.

Types of video content

It is important to note that video content can take a variaty of forms as was discussed in the "Introduction to online learning" module. In the module on creating videos for online learning we will look at different models for creating video lectures and include examples of simple video creation.

1.4.10 Studio recording with multiple cameras

At DTU we use a studio to record videos and we use multiple cameras to enhance the possibilities of the presenter. Please take a look at the video example below.

This video was recorded in a studio with fixed studio lights and fixed camera positions. This ensures that it is easy to go into the studio and record videos whenever it suits the presenter. This is a great advantage when creating a course. While you may find the example here too ambitious, we encourages you to consider using the idea of a fixed studio as it simplifies video recording independent of the complexity of the setup.

Equipment used

Cameras: Two Sony A6000 and iPhone SE for insert video

Sound: Sennheisser G3 + ZOOM H5

Lights

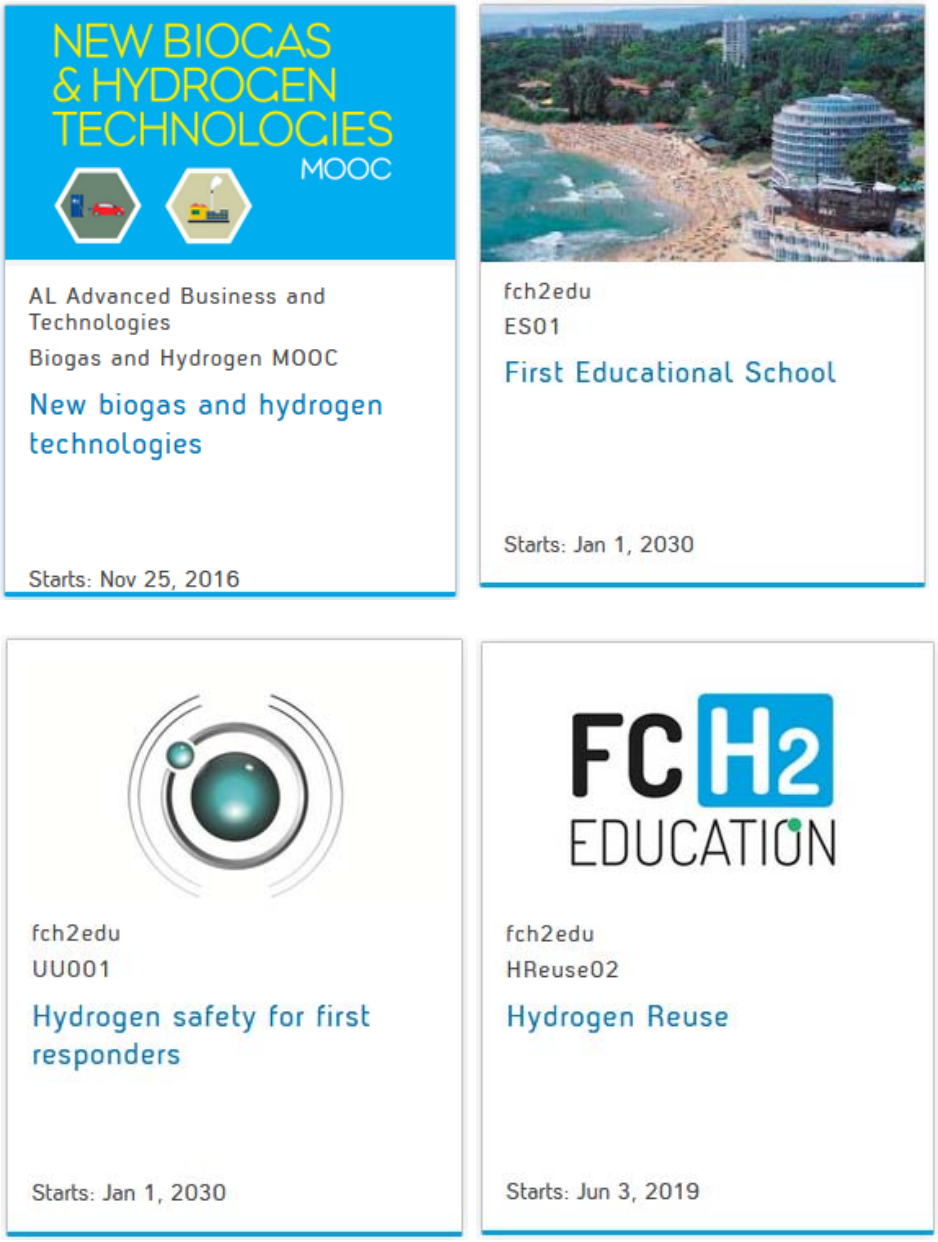
Tablet: Microsoft Surface Pro 4

Screen recording: Techsmith Camtasia

Editing: Premiere Pro

1.5 Further NET-Tools trial MOOC's

Meanwhile further MOOCs available at LMS NET-Tools e-platform for demonstration on the general possibilities how to create a MOOC (content) and also implemented technical features which can get used within each single MOOC.



Due to open access, everybody can enroll to the demonstration courses. Therefore you need to register as "learner" at:

https://elearning.fch2edu.eu/register

2 Trial Module 1 – Principles of Hydrogen Safety

The content for the module “Principles of Hydrogen Safety” developed by UU was chosen as the basis for a trial module.

This module is delivered fully online or face-to-face as a block-release and focuses on the fundamentals of hydrogen safety science and engineering. This module combines a variety of topics relevant to the safety engineering framework including relevant RCS. The module enables a student to understand the phenomena associated with modern hydrogen technologies and scientific foundation behind relevant hydrogen safety engineering methods and models. The considered phenomena include unscheduled releases and dispersion of expanded and under-expanded jets, ignition mechanisms, microflames, hydrogen jet fires and associated hazard distances, etc. The case studies are the part of the module to reinforce the best practice in hydrogen safety. The module consists of 12 lectures:

1. Introduction to hydrogen safety
2. Hydrogen properties and hazards, comparison with other fuels
3. Regulations, Codes and Standards (RCS) and hydrogen safety engineering
4. Unignited releases
5. Ignition of hydrogen mixtures
6. Microflames
7. Jet fires - Part 1
8. Jet fires - Part 2
9. Hydrogen permeation
10. Compatibility of metallic materials with hydrogen
11. Materials for hydrogen technologies
12. Case studies

Each lecture is concluded by an online self-assessment quiz. The online self-assessment quizzes are formative assessment but do not count towards the module mark. Successful completion of the quiz of a lecture enables access to a subsequent lecture.

The module assessment consists of two pieces of coursework - one in the first half, and one in the second half of the semester. Each piece of coursework contributes 50% to the overall module mark. Each piece of the coursework contains mix of problem-based solutions requiring answer as a numerical value and qualitative questions requiring essay-style answer. The coursework may incorporate tests of factual knowledge, problem solving.

A student trial was run on this course with 16 students from EPSRC doctoral training course (CDT) at Birmingham University and 8 students from Grenoble INP, who were taking the pilot delivery of the module. The provided feedback is summarised as follows:

- Students from Grenoble felt that the Hydrogen Safety module was very detailed. They suggested, as an improvement, to use less text and more video content. Students recommend that the lectures should be more balanced in length and contain less text. Students reported that the Hydrogen Safety module is like an online textbook and perhaps reduce text to around 70% text with the balance including more images, video, etc.

- CDT Birmingham students were evaluating the e-Laboratory of safety engineering part in particular every single tool and the list of improvements have been reported and sent to programmers for further development.
- Internal evaluation has further improved the module based on suggestions from students and also cross checking of the materials quizzes and course works.

3 Communalities and Transferability to CANVAS

As explained in Deliverable 5.2, the NET-Tools platform was in the end not considered useful to the TeacHy project when thinking of course delivery.

Nevertheless, the delivery of sample lectures and 'teasers' will be further considered to broaden the public outreach of TeacHy and address potential students by posting these on the NET-Tools MOOC section.

The structure of the Open EdX Learning Management System (LMS) is different to CANVAS. Course content can be transferred, but will require some adaptation work. Open EdX is somewhat similar to Moodle, an LMS used at many institutions.

As the main contact person in the TeacHy project in charge of the MOOC development at DTU, who was also involved in the NET-Tools project, left DTU, the activities came to a halt.

Other MOOC content from DTU could have been adapted for use in TeacHy but this was not further pursued as it would have not interlaced with TeacHy project content in any way, and would simply have been a re-labelling exercise.

Further details on the LMS implementation on CANVAS will be reported in Deliverable 5.4.

4 Summary

The MOOC section of NET-Tools was considered for delivering modules for university use and Continuous Professional Development (CPD) courses, and even MOOCs addressing the general public.

As the NET-Tools platform was not considered suitable for university teaching, the transfer was considered of low priority and activities did not continue at the pace planned.