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WP 2 – Teaching content development

D2.2 Collection of Module contents

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30/11/2019	3.0	Revision following mid-term review Language edits aligning with WP 1 deliverables and D3.2

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Table of Contents

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 overall structure of the TeacHy MSc course and how it is developed as well as the requirement for the collection of module content to be used as a starting point for the development of teaching material for Teachy.

1 Course modules

Based on the curriculum originally developed in TrainHy the full Master of Science course is split into a number of modules, covering logical parts of the curriculum needed in TeacHy.

1.1 Selection of course modules

The modules will be split into 3 groups.

Mandatory modules (compulsory modules)

Core modules: Covering the basic knowledge needed, such as thermodynamics and electrochemistry.

Introductory modules: Introduction to general concepts and specific technologies.

Applied module: Experimental Labwork (in local teaching laboratory or remotely managed), virtual labs.

Elected modules (optional modules, selected by the students, specialisation)

Fuel Cell and Hydrogen applications and Fuel Cell types, advanced characterisation etc.

Specialised and advanced topics.

The students will have the possibility to specialise within the field of Fuel Cells and Hydrogen (FCH), by selecting courses in this block.

Additional modules

Modules that cover more advanced topics, and topics that are peripheral to the main curriculum. Both can be used when additional ECTS point are needed, to adapt to different requirements for a MSc course, e.g. different lengths of study and especially courses with a duration of 18 to 24 months.

Each module in the course will generally carry 5 ECTS points

1.1.1 Mandatory modules

The following 7 mandatory modules have been defined as compulsory. Responsible partners are stated in brackets.

Thermodynamics, electrochemistry, chemistry (KIT)	Fuel Cell Technology (UBHAM)
Hydrogen (production, storage, handling), fuels (P2G, P2X) (UPB), electrolysers (UCTP, Grenoble INP)	Fuel cell modelling tools (POLITO, Grenoble INP) and control (TUD)
Characterisation methods (EPFL)	Labs (POLITO)
Hydrogen safety (UU)	

1.1.2 Optional modules

The following 11 optional modules have been defined as the 'optional' modules from which the students will have to choose 5 modules for a 60 credit (12 month) MSc course.

Environmental analysis, life cycle analysis (UBHAM)	Low temperature fuel cells (materials, stacks, thermodynamics, electrochemistry, chemistry) (Grenoble INP, UCTP, DTU)	High temperature fuel cells (materials, stacks, thermodynamics, electrochemistry, chemistry) (TUD, KPI)
Politics, markets, regulation, codes and standards (UBHAM, ULB)	Low temperature systems (DTU)	High temperature systems (UBHAM)
Advanced characterisation (EPFL)	Fuel cell electric vehicles (UBHAM)	High temperature chemistry for SOFCs/SOEs (TUD, KPI)
Energy systems and storage (UPB)	Advanced modelling (POLITO, Grenoble INP)	

1.1.3 Additional modules

Additional modules have been defined as well. These could possibly be shorter than 5 ECTS point.

These modules will be made available for courses running longer than 12 months (which is the standard at UBHAM) and/or that require more than 60 ECTS (120 UK credits) in taught modules.

Defect chemistry	Low temperature stack elements	Life time testing
Polymer chemistry (Grenoble INP)	High temperature stack elements	Accelerated testing (low temperature and high temperature fuel cells)
Catalysis (Grenoble INP)	Degradation	Presentation skills
Electrochemical impedance spectroscopy	Fuel quality	Project management
Power to Gas Technology (UBHAM)		

Currently only the Catalysis and P2G modules are being made available in the test phase.

2 Collecting Existing Teaching Material

As a starting point for the development of the MSc course itself (in WP3), all consortium partners as well as associate partners were encouraged to upload any available teaching material developed in other contexts that could fit within the TeacHy curriculum.

All uploads were accompanied by the short template form described below in order to organise the content into the 3 categories of modules, and to organise the content so that it could be identified and further developed.

The uploaded material was intended to form the starting point for the module development, and allow the consortium to have a head start.

Material included output from the previous educational EU projects (TrainHy, KnowHy etc.), and lecture slides, hand-outs, and scripts from modules run at the various universities. It also includes online material, software used to deliver simulations, videos, glossaries, and any other methodologies, materials, or description of equipment used in undergraduate and graduate university training.

A repository was arranged on the TeacHy web page internal pages and content uploaded there for review and further processing.

2.1 Collection template

For the collection of teaching material, a general template to be included with each upload was developed. This template made it easier to identify key aspects of the supplied material.

The template contains the following information:

Teachy - Teaching content upload

Please fill out the fields below and included this file with the uploaded material

(Put everything in a zipped archive and upload to the Teachy website)

Uploaded by

Where does it fit in the TeacHy curriculum

Type of content (slides, handout, booklet, video etc)

Audience, level (BSc, MSc, etc)

Extent (ECTS, duration, etc)

Language

Copyright

The template is available on the webpage for use when uploading content.

3 Content Repository

The teaching materials repository is organised into a structure where it is available to all project partners for further refinement and expansion in WP 3.

3.1 Repository setup

On the Teachy website (teachy.eu) a private area was set up by UU with access for the consortium partners to upload material.

3.2 Collected material

The consortium partners contributed a large amount of material, that has been organised on the TeacHy web page. This included modules run at universities for 4th year (MEng) or PhD training, from the Joint European Summer School on Fuel Cell, Electrolyser, and Battery Technologies (JESS) and various other sources.

A subset from the webpage is seen below.

List of Mandatory Modules

Uploaded By	Date Uploaded	Document Title	File
Emanuele Giglio	10 - 11 - 18 : 11 54 AM	Modelling material partial draft	Link
Emanuele Giglio	03 - 05 - 19 : 08 28 AM	FC Modelling (POLITO)	Link
Emanuele Giglio	10 - 06 - 19 : 09 11 AM	FC Modelling and control POLITO	Link
Florence Druart	25 - 09 - 18 : 14 56 PM	electrolysers_CDP_Grenoble_INP	Link
Iordache Ioan	31 - 10 - 18 : 12 13 PM	UPB Hydrogen introduction	Link
Iordache Ioan	31 - 10 - 18 : 12 16 PM	UPB Hydrogen from hydrocarbons part 1	Link
Iordache Ioan	31 - 10 - 18 : 12 18 PM	UPB Hydrogen from hydrocarbons part 2	Link
Iordache Ioan	31 - 10 - 18 : 12 19 PM	UPB	Link
Iordache Ioan	31 - 10 - 18 : 12 20 PM	Hydrogen production by the electrolysis of water at normal temperature -part 2	Link
Iordache Ioan	31 - 10 - 18 : 12 21 PM	UPB Hydrogen production using nuclear energy and thermo-chemical cycles	Link
Iordache Ioan	31 - 10 - 18 : 12 22 PM	UPB renewable non electrolysis hydrogen part 1	Link
Iordache Ioan	31 - 10 - 18 : 12 23 PM	UPB renewable non electrolysis hydrogen part 2	Link
Iordache Ioan	31 - 10 - 18 : 12 24 PM	UPB Hydrogen storage	Link
Iordache Ioan	31 - 10 - 18 : 12 25 PM	UPB on boart storage	Link
Iordache Ioan	31 - 10 - 18 : 12 26 PM	UPB Infrastructure	Link
Iordache Ioan	31 - 10 - 18 : 12 27 PM	UPB Power to Gas	Link
Iordache Ioan	31 - 10 - 18 : 12 28 PM	UPB Separation and purification	Link
Iordache Ioan	31 - 10 - 18 : 13 16 PM	UPB Hydrogen production by the electrolysis of water at normal temperature -part 1	Link
Iordache Ioan	31 - 10 - 18 : 13 30 PM	UPB High temperature water electrolysis	Link
Marian Chatenet	24 - 01 - 19 : 14 55 PM	Thermodynamics and Kinetics ow low-T WE	Link
Marian Chatenet	19 - 03 - 19 : 16 30 PM	Electrochemical-kinetics-1-equations	Link
Marian Chatenet	19 - 03 - 19 : 16 31 PM	Electrochemical-kinetics-2-stationary-regime	Link
Marian Chatenet	19 - 03 - 19 : 16 32 PM	Electrochemical-kinetics-3-stationary-regime(complex)	Link
Marian Chatenet	19 - 03 - 19 : 16 33 PM	Electrochemical-kinetics-4-faradaic-impedance	Link
Naser Al-Mufachi	17 - 08 - 18 : 10 40 AM	Introduction to Fuel Cells_UBHAM_V2.0_Part 3	Link
Naser Al-Mufachi	13 - 08 - 18 : 12 01 PM	Introduction to Fuel Cells_UBHAM_V1.0	Link
Naser Al-Mufachi	17 - 08 - 18 : 10 35 AM	Introduction to Fuel Cells_UBHAM_V2.0_Part 2	Link
V Shentsov	25 - 09 - 18 : 11 53 AM	Principles of Hydrogen Safety module	Link
Virgil DUMBRAVA - UPB	25 - 09 - 18 : 11 55 AM	Energy system and storage	Link
Virgil DUMBRAVA - UPB	25 - 09 - 18 : 12 02 PM	Hydrogen (production, storage, handling), fuels (P2G, P2X)	Link
Virgil DUMBRAVA - UPB	15 - 10 - 18 : 11 35 AM	1 week Timetable for the module Hydrogen (production, storage, handling), fuels (P2G, P2X)	Link
Yehor Brodnikovskyi	02 - 04 - 19 : 09 10 AM	Lectures_KPI_WP3	Link
Yehor Brodnikovskyi	14 - 05 - 19 : 08 37 AM	Lectures_1-2-3_KPI_WP3_	Link
Yehor Brodnikovskyi	14 - 05 - 19 : 09 49 AM	Video_Lectures_1-9_KPI_WP3_	Link
Yehor Brodnikovskyi	14 - 05 - 19 : 10 21 AM	Video_Lecture_#2_KPI_WP3_	Link
Yehor Brodnikovskyi	14 - 05 - 19 : 11 40 AM	Video_Lecture_#1_KPI_WP3_	Link
Yehor Brodnikovskyi	14 - 05 - 19 : 14 47 PM	Video_Lecture_#3-1_KPI_WP3_	Link
Yehor Brodnikovskyi	14 - 05 - 19 : 14 48 PM	Video_Lecture_#3-2_KPI_WP3_	Link
Yehor Brodnikovskyi	14 - 05 - 19 : 14 50 PM	Video_Lecture_#3-3_KPI_WP3	Link

The material collected consists for the most part of lecture slides used for previous teaching activities, but also videos of lectures as well as compendiums and other written material.

4 TeacHy Lecture content development

The layout, design and structural details of lecture and module development have been described in deliverable D2.1. This guidance will therefore concentrate on the content development from the point of view of an optimised student experience for online delivery. It is taken for granted that the face-to-face teaching is an established and well optimised routine at the participating universities.

Reference is only made here to the structure of content. The content itself, including learning outcomes and assessment definitions, are documented in deliverables D1.3 and D3.2.

4.1 Blended vs. face-to-face teaching

It has to be kept in mind, that a larger part of the course will be delivered via online pages and tools. Therefore a key element of interaction of teacher and student will not be available; that of asking questions in class. This works both ways

- lecturer asking students questions in order to make them think actively and develop immediate insight into the teaching content, and
- student asking lecturer for immediate clarification of any doubts.

In a context of online learning the latter is impossible to offer. Even if a blog or chat room were offered, an immediate answer at any time of day will be impossible. Contact times could be offered, but these would remove the freedom of the student to follow lectures at any time s/he chooses, thus returning to a timetabled learning experience. Beyond the mentioned options of Chat, Blog, or ‘office hours’, therefore, there will be no options for interaction outside of face-to-face lectures.

The first item, though, should receive some attention. Although it is not possible to directly interact with the student watching the online lecture, other ways of challenging thought have to be adopted. This can be the interruption of the lecture with

- a simple statement to rethink a problem,
- followed by resolving the problem.

or

- putting forward a problem to be solved in a given time (e.g. 5 to 10 minutes) with a corresponding blank sequence in the recording,
- followed by resolving and discussing the answer.

or

- referring the student to a quiz, class test, or other formative assessment via a link or referral to another item on the Learning Management System (LMS) lecture page.

It will be up to the content developer and the delivering lecturer as to which approach to choose. In any case, resorting to a ‘virtual’ question-and-answer setting will support the digestion of learning content by the students and will be vital for developing a deeper understanding of the teaching content.

4.2 Sequencing and modularity

As deliverable D2.1 pointed out, timing and length of online lectures will – at least initially – be oriented at conventional face-to-face teaching. After all, it is up to the student to interrupt watching a lecture any time and resuming whenever s/he chooses to. Therefore the length of sequences might appear as a minor problem, if at all.

Nevertheless, the accomplishment of having completed a lecture should be one offered to the student within reasonable effort. Therefore, similar timings as during university teaching seem appropriate since this corresponds to the recognised attention span of about 45 minutes – enriched by the previously discussed interruptions calling for student engagement.

With the adaption of the teaching material to other uses such as CPD, it might be adviseable to cut material into shorter sequences that can then be rearranged for other audiences. The more general introductory lecture parts could be selected over the more theoretical, equation supported ones, in order to assemble a MOOC or lectures and modules suitable for a CPD course. This, though, can also be achieved by 'cutting' longer lectures and re-assembling them by editing and manipulating the lecture videos. In an academic context and taking the requirements for graduate teaching into account, it appears sub-standard to deliver content in small snippets. A lecture of the level expected for graduate training would be one that develops a larger picture by taking reference to slides and statements made earlier in the lecture, thus building a complex piece of knowledge. It appears doubtful that this can be achieved by offering a larger number of shorter pieces that could theoretically be consumed at very different times, thus losing the context.

It is therefore probably the best approach to offer sequences within the lecture (e.g. by inserting cesuras with header slides) that allow later extraction rather than structuring the lectures such that they are made up of shorter sequences.

4.3 Additional material

Given that modules will be available over an extended period of time (see D2.1: two to three weeks) in order to allow students to work on the study projects, reports and coursework, this gives more opportunity than in classroom teaching to animate students to pursue additional reading, occupy themselves by watching related videos, or following relevant web links.

The 'Additional Resources' section of the lecture pages (cf. D2.1) should therefore be populated not only with a copy of the slide set and a reading list, but also web links, video material, PDF files with articles and further reading etc.

From the experience of the KnowHy project, 'serious games' such as laboratory handling of devices (relevant for module C6) can help in preparing for tasks such as a remote lab work session. Sufficient thought should therefore be given no only to the development and recording of the lecture but also to a set of accompanying material that will allow the students to build deepened knowledge – if they wish so.

Any humour and hints to unusual material will most probably be cherished by the students. Care should therefore be taken to supply a little more than simply a 'standard' delivery.