



E-learning Programmes and Courses Evaluation Report

Virtual Campus Hub D3.4

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DTU Wind Energy E-0035, July 2013

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By

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Virtual Campus Hub D3.4

Preface

The research infrastructure project Virtual Campus Hub¹ (VCH) runs from October 1, 2011 to September 30, 2013. Four technical universities in Europe, who are all active in the field of sustainable energy, form the project consortium: the Technical University of Denmark, The Royal Institute of Technology in Sweden, Politecnico di Torino in Italy, and Eindhoven University of Technology in the Netherlands. The project is partially funded by the European Commission under the 7th Framework Programme (project no. RI-283746).

The VCH project follows two main work streams. The first work stream covers the development, testing, and evaluation of a series of applications for training and entrepreneurship in the field of sustainable energy (project work package 2, 3, and 4). This report describes the project outcomes related to this work stream with focus on E-learning programmes and courses. It represents the project deliverable “D3.4 E-learning Programmes and Courses Evaluation Report”. The applications developed for entrepreneurship will be described and evaluated in the project deliverable “D4.3 e-link evaluation report”.

The second work stream (work package 5) covers the development of E-infrastructure that links VCH's applications together such that partners in the project can access each other's applications with the user name and password of their local institution. The E-infrastructure consists of a single sign-on system based on federated authentication and on the European research E-infrastructure eduGAIN². The access point is a web portal – the VCH Portal – which is used to manage users and groups. The E-infrastructure of VCH will be described and evaluated in the project deliverable “5.4 Virtual Campus Hub Technology Evaluation Report”.

The E-learning applications described in this report have been tested through a series of virtual events which took place before the applications were connected to the VCH Portal. Some of the tests were repeated with the VCH E-infrastructure in place.

Roskilde, July 2013

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Senior scientist

¹ www.virtualcampushub.eu

² <http://www.geant.net/service/eduGAIN/Pages/home.aspx>

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1. Introduction

The Internet and new learning technologies provide today's educational institutions with a means to offering new types of education within and across national and institutional borders. Similarly, continuing education offered by universities can benefit from the possibilities of online teaching. As a result, a growing number of higher education institutions in Europe and the United States are publishing their courses and learning material on the Internet.

1.1 E-learning

The term "E-learning" does not indicate that a new form of learning takes place, but rather that digital technologies are used to develop new educational practices as well as enhancing traditional educational practices. The term can denote both the digital tools and technologies used in the student's learning process and the new practices of the teachers and students that are brought about from using these tools. Digital tools/technologies used in E-learning may be software programs, web pages/portals/services, voting devices, etc. The new practices may be remote teaching via online conferencing, online collaboration and group work, digital exams, etc.

1.2 Online teaching and learning

Whereas E-learning can refer to tools and technologies, "online teaching" refers solely to the teacher's practices of teaching using web based tools and technologies. Similarly "online learning" means the learning process that goes on using E-learning tools on the web.

1.3 Peer-to-Peer Learning

Web 2.0 technologies such as blogs, forums, and wikis allow people to interact online, to exchange information, ask questions, and share knowledge with their peers. In recent years many platforms and services have sprung up that build on social interaction between the users. These are collectively known as "social media". Regardless of the topic, the users can connect in networks, comment on each other's entries, and often award each other social "credit", such as "liking" something on Facebook.

Some of these features, such as blog or forum functionalities, are often included in what used to be static web sites, such as news sites. They are also often integrated in standard learning management systems to a higher or lower extent to harness the possibilities of social interaction in the learning process. Web 2.0 features are also taken advantage of in different online learning platforms, where learners benefit from the diversity of each other's knowledge by asking and answering questions as part of their studying as described above.

An example of peer-to-peer learning is the web portal Open Study³. On this platform, learners can ask questions within a range of different topics in engineering, science, the humanities, etc., as well as answer questions raised by others. One of the mechanisms for motivating people to answer questions is a system of titles (e.g. champion, mentor, or life-saver) that you earn by answering questions. If you find another user helpful in answering your question, you can award him/her by marking that you are “a fan”.

1.4 International cooperation on online education

With the new development in online teaching and learning described above, it is possible for educational institutions to enhance present cooperation on education or make new partnerships regarding e.g.:

- international dual degree programmes offered by partner universities
- cooperation on education within a specialized field (e.g. Explore Energy⁴) across institutions, where each institution contributes with their special knowledge
- stand-alone courses offered across institutional and national borders as online or blended courses

DTU has made an agreement with Korea Advanced Institute of Science and Technology (KAIST) to offer two E-learning based educational programmes. This is an example of an international collaboration which uses online teaching and learning. At present, the cooperation is incipient but it involves a Cyber Dual Degree Programme in Digital Media Engineering and a Cyber Education Programme in the field of Mathematics.

Another example is the Nordic Master in Aquatic Food Production (AQFood)⁵ - cooperation between universities in Denmark, Iceland, Norway, and Sweden. Students do travel to one of the partner universities during their studies, but follow classes focusing on their special field of interest offered online by the other partner universities.

Common to the above mentioned partnerships is that they have so far focused their online teaching activities on live webcasts, i.e. streaming video and interaction between teacher and students at different locations, via the system Adobe Connect⁶, as a way to extend the classroom across the countries. The first course to be offered in the Digital Media Engineering programme, “User Experience Engineering”, will use Adobe Connect and combine it with prototyping tools such as PopApp⁷, which allows the students to easily make prototypes and peer review each other’s prototypes.

³ <http://openstudy.com/>

⁴ <http://www.exploreenergy.eu/>

⁵ <http://www.aqfood.org/>

⁶ <http://www.adobe.com/dk/products/adobeconnect/elearning.edu.html>

⁷ <http://popapp.in/>

This form of synchronous online learning potentially has the advantage of providing a rich and engaging learning experience. The disadvantage is that a slight disturbance in sound or image can disturb the learning process. Synchronous as well as asynchronous online learning requires of the teacher a new set of skills to function as a moderator in the online classroom. Similarly, online teaching often requires a re-thinking of the pedagogical design that must be considered, alongside the choice of technology and platform, when institutions and teachers begin the endeavour into online teaching.

1.5 International cooperation on sustainable energy

The demand for knowledge about sustainable energy is growing fast as most countries around the world are facing a number of challenges related to their energy supply and the national goals for reduction of greenhouse gas emissions. At the European level, initiatives have been taken to stimulate a transfer of sustainable energy expertise between member states of the EU. For example, the Erasmus Mundus Masters Courses⁸ (EMMCs) support a number of joint educational programmes in the field of sustainable energy where students follow courses at different leading universities and receive a combined M.Sc. degree. The partner universities of VCH are involved in SELECT, THRUST, and the European Wind Energy Master (EWEM) programme.

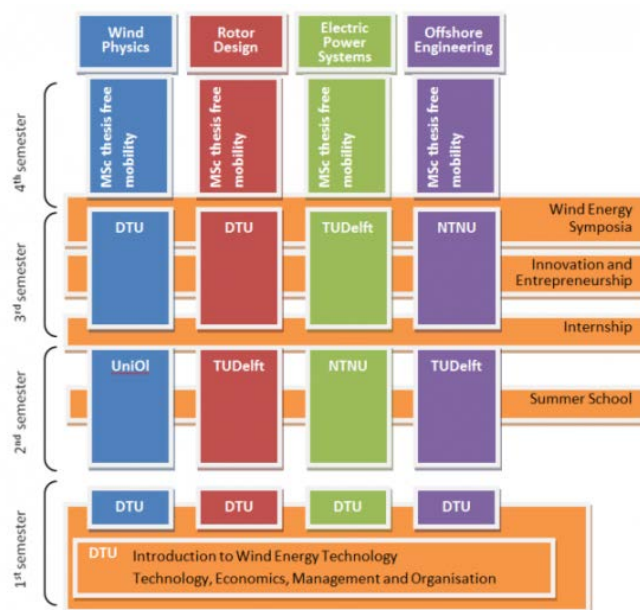


Figure 1. Illustration of the different paths a student can follow in the European Wind Energy Master (EWEM) programme⁹.

⁸ http://eacea.ec.europa.eu/erasmus_mundus/index_en.php

⁹ Figure from <http://www.windenergymaster.eu/>

Students who follow a joint educational programme typically travel to several different universities and follow courses from the universities' course catalogue physically. Figure 1 illustrates, as an example, the different paths which a EWEM student can follow. Students typically stay at 2-4 different universities during the 2-year duration of the EWEM programme. The amount of administration related to setting up user accounts, obtaining work and residence permits, finding a place to stay, etc. is significant and has to be repeated each time a student moves to a new university. Within the EU, many administrative procedures have been harmonized. A potential expansion of university collaboration to the global level would increase the administrative burden associated with staying abroad as procedures vary from EU standards. Online teaching and learning can help reduce the amount of traveling and administration in connection with joint educational programmes.

2. E-learning programmes and courses in VCH

The VCH partners share the vision that E-learning applications should be integrated in existing educational programmes and courses in sustainable energy. The benefits of E-learning programmes and courses would be that knowledge of excellence can be distributed from a small number of universities to a wider learning community. This learning community is not necessarily restricted to academic organizations but may also include partners from the industry.

E-learning programmes and courses of the future should address different career levels as opposed to just the B.Sc., M.Sc. and Ph.D. levels. E-learning programmes and courses might be used as building blocks for continuous education and life-long learning. DTU offers a flexible master programme targeted at employees in the industry. The flexibility turns out to be limited when flexible master students try to fit physical university courses, which take place at fixed times of the day and week, into a busy working schedule. Many E-learning applications offer a new degree of flexibility where students can learn anytime and anywhere.

2.1 Approach

A series of applications for online teaching and learning has been developed in the framework of VCH. The applications are:

- Three remote laboratories with exercises (KTH)
- Continuous online examination tools (KTH)
- An online course in wind energy (DTU)
- A collaboration environment based on MS Sharepoint (TU/e)

The intention from the beginning of the project has been to implement the listed applications in existing programmes and courses at the partner universities and to make them available for the joint educational programmes that the partners are engaged in.

Early in the project, an inventory was made of sustainable energy programmes and courses at the partner universities. This inventory showed that there are 12 on-going educational programmes and more than 150 courses in this field. The potential for using the E-learning applications developed in the project is thus very large. Three examples of courses were selected as test cases for VCH according to a set of criteria (see section 3. Selection of test cases).

Testing of E-learning applications has taken place through a number of virtual events. Each application has first been tested internally at the institution where it was developed. The partners have then tested each other's applications. Some of the tests have been repeated once the single sign-on system was in place such that partners

could login to each other's applications with the user name and password of their local university.

The virtual events have been evaluated by the teachers and participants involved. In the following, we describe the selection of test cases and evaluate each of the virtual events through a comparison with non-virtual processes.

3. Selection of test cases

Three test cases have been selected from a complete list of on-going and planned programmes (12) and courses (150+) in sustainable energy at the Master, Ph.D. levels, and in continued education at the partner institutions. The test cases were selected according to four selection criteria:

1. Cross-fertilisation between learning and innovation

Processes should foster knowledge development and transfer through, for instance, inter-sector and interdisciplinary schemes.

2. Interdisciplinarity

The tools must stimulate interdisciplinary contributions from several types of actors and participants in the learning and innovation process.

3. Mobilisation

The tools will have to facilitate a culture of interdisciplinary community building and the mobilisation of actors and users beyond the traditional boundaries of our existing partnerships.

4. Scalability

The tools typically allow for scalability to a European level and the different focus areas. This means that the tools will accommodate relatively large number of users, and be comprehensible to users with different backgrounds.

3.1 MJ2430 Thermal Turbomachinery course (KTH)

The MJ2430 Thermal Turbomachinery is an on-going second cycle of higher education (M.Sc.) level course offered at the Department of Energy Technology at KTH. The course runs for 10 weeks during the spring semester and involves every year about 50 students (2012, 2103 editions).

The MJ2430 provides insight into the area of thermal turbomachines used for power generation and energy conversion as well as for aerospace propulsion. The course starts off from recalling the basic principles of 1D aerodynamics moving thereafter to 2D and 3D aerodynamics, structural dynamics and aeroelasticity in turbomachinery, heat transfer and blade cooling. Additionally, topics such as today's and tomorrow's trends in power generation and aerospace, research needs and developments are addressed promoting discussion on an advanced level. Calculation exercises, remote laboratories, study visits and guest lectures from industry and academia are part of the course syllabus.

3.1.1 The MJ2430 Thermal Turbomachinery as a test case for VCH

The Thermal Turbomachinery course at KTH has been selected as the test case for the implementation and evaluation of the E-learning tools developed in WP2 of project VCH based on the criteria defined in the project DoW and reported in this document. In particular, the following elements were identified in the course that made it an ideal test case for the introduction of the remote laboratories and of the continuous examination tools:

- Interdisciplinary of the subject
- Significant presence of international students – either enrolled in a master at KTH, in the Erasmus Mundus Master’s programme THRUST, in student exchange programmes such as Erasmus - as well as of distant students, i.e. students following the course online
- High level of connection to research and innovation with guest lectures from industry and from academia, study visits
- Relevance of the subject to the content of the remote laboratories
- Extensive use of E-learning tools such as recorded lectures, Podcasts and other functionalities of the local learning management system (LMS) called Bilda

Such diversity of course participants and the well-established use of E-learning tools in the course offered a test case for the VCH elements and of the VCH technology with no major modification in the course syllabus.

3.2 WAsP – a wind energy course for continued education (DTU)

The Department of Wind Energy at DTU offers a 3-day training course called WAsP – the Wind Atlas Analysis and Application Program¹⁰. WAsP is the industry standard tool for wind resource assessment with more than 4,000 users worldwide. The course has been run 84 times since 1991. The WAsP training course is mainly directed towards the wind energy industry and to Ph.D. students. A slightly modified version of the course has been integrated in DTU’s Wind Energy master programme. The WAsP course is run four times per year on commercial terms and once as part of the annual DTU course “Wind resource assessment and siting”. Income generated by the WAsP software and courses is used to improve the tool through new research and development in wind power meteorology.

The purpose of the WAsP course is to teach users how to use the software WAsP and to understand the theory behind the tool well enough to avoid pitfalls. Errors in wind

¹⁰ www.wasp.dk

resource predictions can lead to a significant loss of power and income for wind energy developers. The “human factor”, i.e. the way users work with WAsP and assess the quality of the input data they apply, is very important for making high-quality WAsP outputs like the map in Figure 2. The WAsP course addresses all of the common pitfalls and is therefore a very good starting point for working with WAsP. DTU also offers a certification exam for experienced WAsP users.

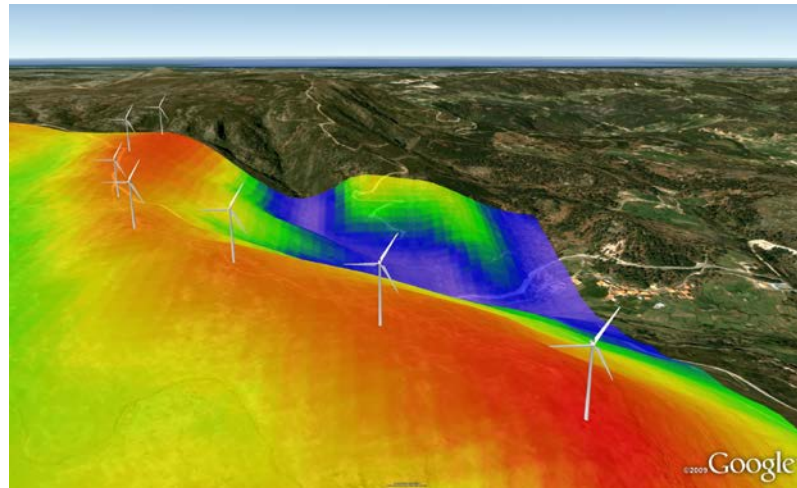


Figure 2. Wind resource map over a hilly site calculated with WAsP¹¹.

3.2.1 Motivation for developing a WAsP E-learning course

WAsP course participants normally travel to DTU or, if a larger group can be gathered from a given institution, DTU staff will travel out to teach the course. The traveling is costly and time consuming for both teachers and course participants. Some WAsP users, who are located far from Denmark and DTU, cannot afford to travel long distances to participate in a course. For others, especially in developing countries, complicated visa application procedures represent a major barrier for attending the course at DTU. Due to the very high intensity of the 3-day WAsP course, the time for reflection and discussion of the different course topics is limited and some participants report that they feel overwhelmed by the large amount of new knowledge they must digest in a short time.

The motivation for developing an online version of the WAsP course is:

- The time and cost of travelling is eliminated and more WAsP users will get access to the course
- The course can be run more efficiently with a larger number of participants, including university students
- Learning material is presented in a different way online, which gives course participants time to reflect and discuss course topics in depth

¹¹ Image courtesy Google Earth.

3.2.2 The WAsP course as a test case for VCH

The WAsP course fulfils all four criteria set up for the selection of VCH test cases. Participants who follow either a physical or an E-learning course in WAsP are recruited from the wind energy industry and also from DTU and its partner universities. This mixture of participants with different backgrounds ensures interdisciplinary contributions and is also stimulating for the cross-fertilization between learning and innovation. The effect is expected to be more significant for the online version of the course because this course has been designed with a high level of interactivity in mind.

The WAsP course contributes to mobilization. Some of the participants are from the joint educational programmes that DTU is engaged in; especially the EWEM programme. The online course, which is offered globally, is expected to reach new participant segments with other scientific and cultural backgrounds than the traditional target group for WAsP courses.

For the physical WAsP course, there is not much to be gained from upscaling because a larger number of participants would require additional teachers. The current model, where 24 participants follow each course, seems to be the optimum solution. The online WAsP course has been designed with upscaling in mind and it would be possible, and also more cost efficient, to run the course with 100-200 participants each time. This requires a system of teaching assistants who help the WAsP course teachers manage the course.

3.3 SELECT M.Sc. programme

SELECT M.Sc.¹² is a joint educational programme provided by a number of partners, many of them member of the KIC InnoEnergy¹³. Three of the four partners in project VCH are also partners in SELECT: KTH, Polito, and TU/e. It is therefore very relevant to use this joint educational programme as a test case for VCH. SELECT M.Sc. students start their 1st year at one location and move to one of the other partners for their 2nd year.

3.3.1 SELECT M.Sc. as a test case for VCH

The SELECT M.Sc. programme fulfils all of the four selection criteria listed above. Cross-fertilization between learning and innovation takes place in connection with many activities in the programme. For example, the industry is involved in student projects and most of the academic partners in SELECT have close bonds to the industry through KIC InnoEnergy. SELECT M.Sc. and project VCH are both EU-funded initiatives and they share some of the same visions when it comes to interdisciplinarity, mobilisation, and scalability in connection with sustainable energy education.

¹² <http://www.exploresselect.eu>

¹³ www.kic-innoenergy.com

4. Virtual events

The E-learning tools developed in VCH have been tested through nine virtual events. The events are listed in Table 1 and a detailed evaluation of each event is given in the sub-sections below.

Table 1. VCH virtual events.

Event no.	Event	Responsible partner	Event period	Number of participants	Partners involved
1	Remote cascade lab: implementation in 4 courses at KTH	KTH	November 26 – December 3, 2012 and February 20-26, 2013	153 students, 2 teachers	KTH
2	Remote pressure measurement lab: implementation in Measuring Techniques course at KTH	KTH	December 5-7, 2012	85 students, 2 teachers	KTH
3	Remote cascade lab: test with students from the partner institutions	KTH	May 8-20, 2013 (July 4, 2013)	6 students, 1 industry, (2 TU/e students)	KTH, DTU, Polito, (TU/e)
4	Continuous examination tools: internal participants (9 courses)	KTH	Throughout the A.Y. 2011/2012 and 2012/2013	701 Total number of users (Table 5-1 in D2.3). This does not correspond to the effective number of students (students took several of the courses)	KTH
5	WAsP E-learning course: test run of the course with internal participants	DTU	October 22 - November 26, 2012	12 students, 10 teachers	DTU
6	WAsP E-learning course: test run of the course with external participants	DTU	February 11 - April 19, 2013	24 students, 10 teachers	DTU, KTH, Polito
7	WAsP E-learning course: test of VCH connections and new login procedures	DTU	June 25-28, 2013	20 teachers	DTU
8	Online collaboration tool and unified communications environment: Student projects on entrepreneurship with supervisors and clients from industry.	TU/e	December 2012 - January 2013	15 students, 3 supervisors	TU/e

9	Unified communications environment: Select MSc project of the year event. Select MSc student groups (Y1 and Y2) presented their projects. Some supervisors and others attended online.	TU/e	May 16-17, 2013	5 virtual participants	TU/e, KTH, Polito
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4.1 Remote laboratories (KTH)

The MJ2430 Thermal Turbomachinery has represented the main but not the only test case for the remote laboratories developed in WP2 of project VCH. Other courses related to turbomachinery offered at KTH have been chosen that better fit with the content of the specific laboratories. Common to all of them is being applied sciences and include laboratory activities as part of the course syllabus. The nature, content and structure of the three remote laboratories is described in detail in the project deliverable D2.3 (Fransson et al., 2013) and a trial implementation with evaluation of the laboratories from the students and the teachers is reported in the project deliverable D3.2 (Fransson et al., 2012).

On a general basis, the remote laboratory exercise is designed such as to represent an independent learning module. The laboratory exercise takes approximately five hours and is usually performed in groups of 3 to 6 people. The exercise includes several phases: reservation of the lab resources, self-study, online self-assessment, execution of the measurements and observation of the phenomena, data analysis, and online survey.

The booking of the lab is done either in the local LMS (Bilda) or using a dedicated Doodle event depending on the preferences of the course leader. The self-study is based on lab notes, lecture material and an online gallery that includes video tutorials explaining the layout of the lab and how to remotely operate it. The self-assessment - performed individually - is a set of multiple choice questions dealing with the topic of interest for the exercise and only after successful completion of it students are granted control of the remote lab. The measurements session is designed as a series of tasks of increasing difficulty. Some of them are mandatory while others are optional depending on the specific interests of the group. The same applies for the data analysis. As a last requirement, students need to fill out an online survey that includes both questions on the content of the lab (e.g. achievement of the intended learning outcomes) as well as on the evaluation of the remote learning experience.

4.1.1 Internal testing of remote cascade lab (event no.1)

The remote cascade lab has been introduced in the last editions of the MJ2429 Turbomachinery, MJ2241 Jet Propulsion Engines – General Course and MJ2430, MJ2244 Airbreathing Propulsion II courses respectively. The laboratory exercise varies

slightly between the first and the last two courses to better adapt to their content and intended learning outcomes (e.g. 1D analysis in the former, 2D/3D analysis in the latter). This activity has overall involved 153 students and two teachers.

Prior to the introduction of the remote cascade lab, the laboratory activity was carried out in the following manner:

- MJ2429, MJ2241 - analysis of an existing set of experimental data
- MJ2430, MJ2244 - laboratory exercise performed on campus (on campus students) or analysis of an existing set of experimental data (distant students)

When compared to the previous editions of the courses, the introduction of the remote cascade lab has allowed improving the flexibility and enhancing the technical and pedagogical content of the laboratory: students are more free to decide when and where to perform the lab, which measurements they want to focus on and how to perform them.

The commissioning cost of the laboratory and the effort in creating the online exercise (and all related online tools) is significant. This is however compensated by the time saved in supervision of the students during the exercise. The overall judgment on the introduction in the course syllabus of the remote laboratory is positive contributing to make it more attractive, motivating teachers in creating interactive material (such as e-books with links to the labs) and in making the course fully accessible to distant students.

4.1.2 Internal testing of remote pressure measurement lab (event no.2)

The Remote Pressure Measurement Lab has been designed such as to cope with the needs of the MJ2240 Measuring Techniques course. Introduced in the 2012 edition, it has so far been used by 85 students substituting an existing laboratory exercise. A detailed description of the laboratory and of its test within the course is included in the project deliverables D2.3 (Fransson et al., 2013) and D3.2 (Fransson et al., 2012).

Similar considerations as for the Remote Cascade Lab apply here. While the laboratory itself has worked without any interruption or technical problem, the preparatory material has partially hindered the students from achieving the intended learning outcomes. The absence of a physical instructor, in fact, needs to be compensated by adequate supportive means such as FAQ, self-assessments, exhaustive instructions. These are all improvements that teachers in the course consider as a priority; at the same time they have appreciated the technical possibility offered by the new lab and the tremendous advantage in terms of preparatory time compared to the previous editions of the course when the laboratory exercise was performed in a research facility.

4.1.3 External testing of remote cascade lab (event no.3)

This event has interested students and researchers at the partner universities that have performed the remote cascade lab exercise from their home institution. Participants had no connection to the course activities at KTH and very different backgrounds. This has posed a very high challenge on the pedagogical level showing once again the importance of the material in support of a remote operation of the laboratory with no human interaction.

While the achievement of the intended learning outcomes has been unsatisfactory in some of the cases, the interest shown by all the participants in the technology and in the concept of the remote laboratory has been very high.

4.2 Continuous Examination tools (KTH)

The continuous examination tools developed in WP2 are created in such a way to avoid memorization of the possible alternative answers (MCQs) and to give partial grading to correct thinking despite wrong numerical values (calculation exercises). A detailed description is included in the project deliverables D2.3 (Fransson et al., 2013) and D3.2 (Fransson et al., 2012).

4.2.1 Internal testing of examination tools (event no. 4)

The continuous examination tools have been extensively used in several courses at the Energy Technology department at KTH in the form of exercises (for self-study), assignments and exams. As mentioned before, the MJ2430 is characterized by a well-established use of E-learning tools and the continuous examination tools have been included in the local LMS and integrated in the course as following:

- MCQs in a weekly self-assessment. One point (out of 100) is assigned to a successfully completed self-assessment (at least 75% score).
- Final exam: online exam consisting of one or more calculation exercises and a pool of MCQs chosen randomly out of large database. Students sit in a computer room at the University and ID check is performed manually.

Students in MJ2430 are positive with respect to the use of the continuous examination tools. In particular they find very useful the weekly self-assessment that helps assimilating the content of the course on a regular basis and trains in the conduction of an online exam. With respect to the calculation exercises, some students are sceptic on the capability of the system to evaluate and give credit to a correct thinking.

From a teacher's perspective, the introduction in the course of the self-assessments is very useful to keep the interest of the students high during the course and the online exam saves a lot of time in correction. The formulation of questions that are not ambiguous and that do not provide hints to the correct answer is one of the main challenges and sometimes correction or reformulation is needed.

4.3 WAsP E-learning courses (DTU)

The WAsP E-learning course covers the same scientific topics as the 3-day physical WAsP courses but the course material has been re-organized completely for online teaching and learning. Most importantly, the course content has been broken down to smaller modular units which follow a fixed structure.

The WAsP E-learning course is designed to run over 10 weeks with a total estimated workload of 40 hours for the students. Each week, students must complete one course module with an estimated workload of 3-4 hours. The modules contain a number of E-lessons where students listen to recorded presentations, perform hands-on exercises with WAsP, and discuss the related issues in online fora together with the teachers. The cloud service “itslearning” has been chosen as the learning platform for the course because it supports all of these activities. To facilitate the group discussions, the course is run in a semi-synchronous manner such that all participants and teachers work on the same module during the same week.

The interaction and community building between course participants is a very important aspect of the WAsP E-learning course. The course is built upon the fundamental idea that students online are more likely to complete a course if they receive continuous feed-back and support from their fellow course participants and the teachers. The five-stage scaffolding model of Salmon (2011) has been followed in the course design in order to gradually build up an interactive learning community where participants post messages frequently and respond to the posts of other participants in the fora for group discussions. The teachers’ role is to facilitate and moderate the group discussions and to summarize the most important learning points. A more detailed description of activities in the five stages is given in the project deliverable D3.2 (Fransson et al., 2012) and in Badger et al. (2013).

Students are divided into groups of 10-12 during the course in order to establish a “safe” learning environment where nobody is afraid to share information openly. The course can be run with several groups of students simultaneously. Each course is run by two E-moderators. An administrative E-moderator handles all of the practical aspects of the course (e.g. participant registration, follow-up on participant progress, distribution of course diplomas). A scientific E-moderator follows the group discussions on a daily basis and contributes with comments, questions, and summaries related to the course topics. The scientific E-moderator of the WAsP course is a different person each week. In this way, the teacher work load is distributed amongst several individuals and a number of teachers have built up the expertise it takes to be an E-moderator.

4.3.1 Internal testing of the WAsP course (event no. 5)

An internal test run of the WAsP course took place from October 22 to November 26, 2012 with 12 participants from DTU (students at Ph.D. and master level, scientists, and visiting scientists). The participants followed the course in a compressed form with two modules per week during five weeks.

Evaluation forms were filled out electronically by the participants after each course module and also by the end of the course. The teachers filled out an evaluation form and had an evaluation meeting by the end of the course. The feedback from participant and teachers was used to improve the course and to estimate more accurately the time it takes to complete each course module. This information is needed for the assessment of ECTS credits to the course and also to achieve a better match between participant expectations and reality when it comes to the course workload.

Overall, the internal test was successful. Nine of the 12 participants completed the course on time and three participants who were a bit behind schedule completed the course within a week after the end date. Everybody was then rewarded with a course diploma. All participants were active in the discussion fora throughout the course and posts from the fastest participants helped the others to complete the hands-on exercises in WASP. Several times the participants helped each other solve a specific problem before the E-moderator got involved. This indicated that the pedagogical model for the course had worked according to the expectations.

Participant feedback

The participant feedback was generally positive. Most of the participants indicated that the course had lived up to their expectations and all of them agreed partly or fully that the online learning process was fruitful (Figure 3).

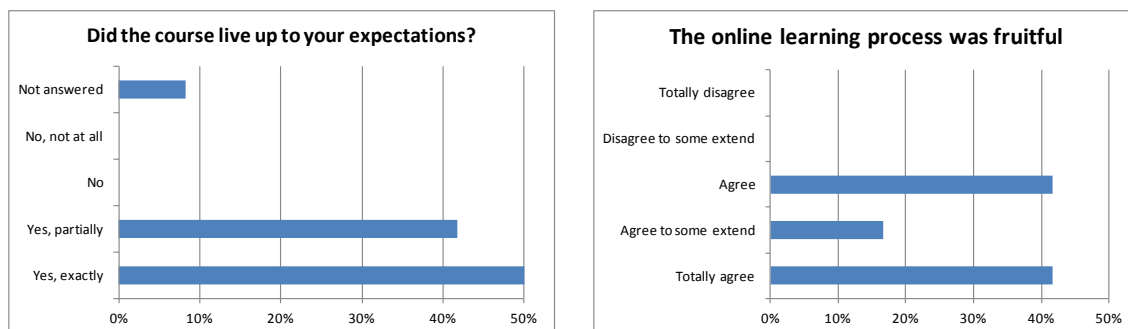


Figure 3. Plots showing examples of participants' feedback from the internal test run of the WASP E-learning course.

In the following, we summarize the participant feedback and the actions which have been taken after the internal test run to improve the WASP E-learning course. The complete participant feedback is included in the project deliverable D3.2 (Fransson et al. 2012).

- **Estimated work load**

Some participants expressed a frustration when they exceeded the work load estimated by the teachers in order to complete a given course module. The estimated work load was adjusted according to the real workload reported by the test participants. Figure 4 shows how there was a large spread of the workload amongst the participants so the estimated work load was set a bit higher than the average for all the modules.

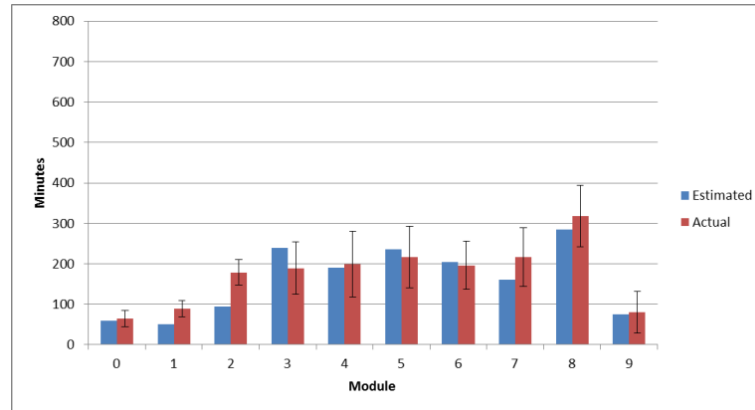


Figure 4. Plot showing the estimated and actual work load for participants in the internal test run of the WAsP course.

- **Consistency in the course material**
 Participants pointed out a lack of consistency between some of the course modules for example when it comes to the use of scientific terms. Also, some overlaps between course modules were pointed out. These issues become more noticeable online compared to a classroom situation because participants have the opportunity to return to a course module and go through the course material again. The course material was revised according to the participants' feedback.
- **Screen demonstrations of WAsP exercises**
 Some participants had difficulties with the hands-on exercises in WAsP and could not reach the correct solution. It was difficult for the teachers and fellow course participants to provide the necessary guidance when they could not see the participants' screen. To overcome this problem, a series of video demonstrations were added to the course material to show the WAsP exercises step by step.
- **Questionnaires for self-testing**
 Some participants pointed out that it was hard to contribute with new information to the group discussions once a few participants had answered a given question from the teachers. Some questions were revised so they were more suitable for group discussions. Other questions were replaced with a quick multiple-choice questionnaire for self-testing, which also made the course material more varied.
- **Group assignment**
 During the test, it became evident that some participants would complete their work early in the course week and others towards the end of the week (which was also the deadline for each module). A group assignment was introduced in connection with a larger case study in WAsP to enhance the team work and motivate the late participants to get started early. In this way everybody was expected to benefit more from the group discussions.

- Audio quality and narration for recorded presentations
The audio quality was variable for the recorded presentations because different teachers had recorded the material with the sound equipment at hand. The voice and English language skills were also variable for these teachers. Some of the test participants pointed out that a poor audio quality or a speaker who was difficult to understand had a strong effect on their ability to focus on the content. To improve these aspects, all of the presentations we recorded again with semi-professional equipment at DTU Learning Lab by two native English speakers.
- Adaptation for mobile devices
During the first test run, it was impossible to view the recorded theoretical presentations in Adobe Flash format on some mobile devices. All the recorded presentations were converted to format, which can be read by the mobile app Adobe Presenter Mobile. Most functionalities in “itslearning” work on mobile devices as well as on PCs so the entire course is now accessible on mobile devices. This adds flexibility and lets the course participants study anytime and anywhere.

4.3.2 External testing of the WAsP course (event no. 6)

The WAsP course was tested with 24 external participants from February 11 to April 19, 2013. This was the first time the course was run over the full 10-week period it has been designed for. The test participants were recruited from the partner universities and from the wind energy industry. The participants were located all around the world, as shown in Figure 5, and they had very different scientific and cultural backgrounds. Their previous experiences with WAsP were also very variable (from no experience to 5-6 years of experience). Participants in the external test filled out electronic evaluation forms after each module and completed a larger survey by the end of the course. The teachers filled out an evaluation form and had an evaluation meeting by the end of the course.



Figure 5. Map showing the location of WAsP course participants for the external test run.

Of the 24 participants, 20 persons (83%) completed the course and received a diploma. The completion rate is not necessarily representative for future WAsP E-learning courses because the participants in the test course attended for free and were picked in a more or less random manner. The payment of a fee (by industry clients) is expected to be an important motivation factor when it comes to completing the course.

Participant feedback

Overall, the external test run of the WAsP course went smoothly because many technical and pedagogical issues had been resolved after the internal test run. The participant feedback was generally positive. All of the participants agreed that the online learning process was fruitful and that they would recommend the course to others (Figure 6). Points of criticism in the participant evaluation forms were now addressing the scientific content of the course more than technical or pedagogical issues related to the learning process.

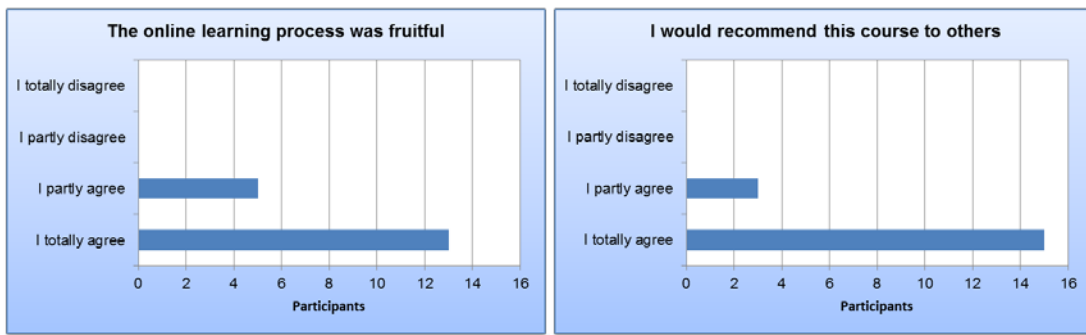


Figure 6. Plots showing examples of participant feedback from the external test run of the WAsP course.

“WAsP online course is a great idea and a great opportunity for all users that don’t have the chance to travel. Congratulations for the initiative.”

Feedback from a course participant from Brazil

In the following, we summarize the participant feedback and the actions which have been taken after the external test run to improve the WAsP E-learning course.

- **Estimated workload**

The participants’ feedback showed that the average time spent on the course had increased from 30 to 40 hours between the two test runs. This was partly because new course material had been added between the two tests (e.g. demonstrations of the WAsP exercises) and partly because participants had more time to complete and discuss the hands-on exercises in WAsP during the 10-week course run. The average actual workload continued to be higher than the estimated workload, even though the latter takes the added new material into account. Figure 7 shows how the spread of participants’ workload was large, especially for the case study in module 8 where workloads between 4 hours and 20 hours were reported.

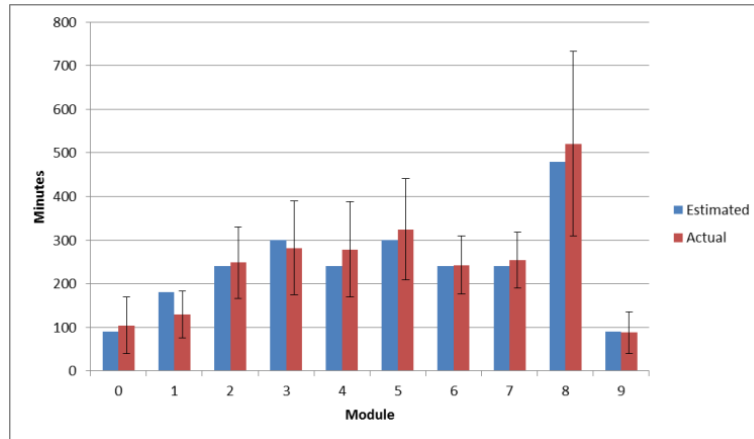


Figure 7. Plot showing the estimated and actual work load for participants in the external test run of the WASP course.

- **Course level and duration**
The external test run showed that most participants were satisfied with the level of the course and also with the duration of 10 weeks which is significantly longer than the 3-day WASP course that is offered physically at DTU (Figure 8).

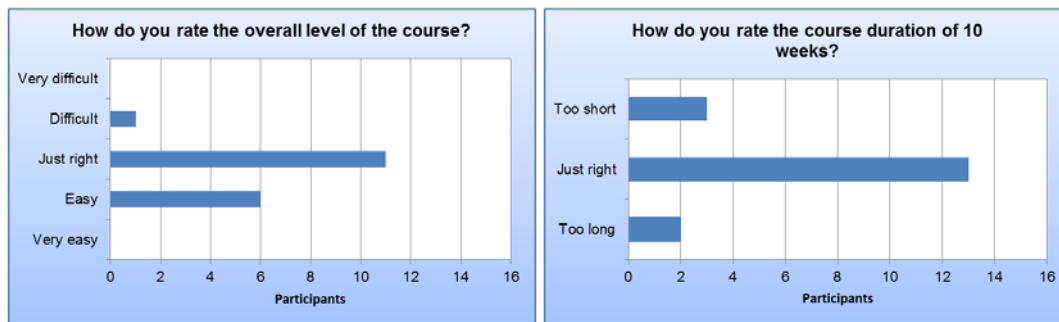


Figure 8. Plots showing examples of participant feedback from the external test run of the WASP course.

- **Printable course notes**
Some of the test participants requested that all slides from the theoretical presentations with narration were made available in a printable format because they found it hard to follow the presentations on their PC alone. This request was met through publication of a course note with all slides from the presentations before the external test course ended.
- **Participant motivation**
Participants who completed the course modules early or were located in an easterly country (e.g. New Zealand or China) had to wait for the rest of their group to finish the WASP exercises before the group discussions could really get started. As a result, most of the group discussions occurred towards the end of the course weeks. Two initiatives will be taken by the WASP team to motivate the participants

to get started as early as possible with the course work: A group assignment with peer-to-peer assessment will be added to one of the first course modules. Further, a few new socializing exercises will be added to the first course modules. Both of these initiatives are expected to strengthen the group feeling.

- **Group size**
Participants in the external test course were divided into two groups of 12. Some participants mentioned that they spend too much time following the many posts of other participants in the discussion fora. This feedback suggests that the groups should be a bit smaller in future course runs e.g. around eight participants per group. Teachers' summaries of the key discussion points is also expected to reduce the participant work load associated with the group discussions.

Teachers' feedback

The teachers, or E-moderators, of the WAsP E-learning course are all experienced teachers of the 3-day WAsP course at DTU. The feedback they have provided illuminates the main advantages and limitations related to both versions of the course. Overall, the E-moderators were satisfied with the test run and enjoyed the flexibility of teaching online. They also enjoyed communicating with participants from all over the world about WAsP and wind energy in broader terms. In the following, we highlight the most important feedback from the E-moderators of the external test run.

- **Teacher workload**
The teacher workload was reported to be from 6 to 15 hours per module for the scientific E-moderators. The administrative E-moderator, who followed the participants throughout the entire course, spent at least the same amount of time per week. Altogether, the workload associated with the E-learning course was comparable to that of the 3-day course. The workload is expected to decrease for the E-learning course in the future, as the team of teachers will gain more experience with E-moderating.
- **Level of activity**
Several teachers reported, like some participants, that the level of activity in the discussion fora was low in the first part of each module and increased towards the end of the module week. The teachers also noted that most of their communication was with a group of very motivated participants whereas other participants were not so active. The actions taken to motivate participants to be active in the discussion fora as early as possible are described above in connection with the participants' feedback.
- **Level of understanding**
The teachers highlighted that the discussions they had with the course participants were interesting and more in-depth than they experience for the 3-day WAsP course. Some of the questions that were raised online indicated that the

participants had reached a deeper level of understanding compared to what is possible during the intensive 3-day WAsP course.

“Students have way more time per module than on the physical course and many seem to get a deeper understanding of the topics”

Feedback from an E-moderator at DTU

- Number of teachers involved
Some teachers found it a bit difficult to connect with the course participants in only one week. They suggested that fewer E-moderators are involved in each course run so they get to know the participants better. This solution will be tested in a future course run.
- Course administration
The external test run showed that even though a lot of time was spent on the monitoring and follow up of the participants’ progress, it was a very important aspect of the course. Some of the procedures related to this effort might be automated further in future course runs. For example, the criteria for passing the course could be set in a way which can more easily be measured automatically in the LMS (here “itslearning”).

4.3.3 Testing of login procedures via the VCH portal (event no. 7)

The learning platform “itslearning” was connected to the VCH Portal in June 2013 such that users from the partner universities of VCH can login to the WAsP course environment with the user name and password of their local university¹⁴. A group of 20 WAsP teachers at DTU Wind Energy was invited to test the new login procedure and to provide their feedback through an online survey form. A total of 14 teachers performed the test and 13 of them could login successfully. One teacher has an e-mail address that differs from the standard DTU format and this caused some problems with the login. The login procedure was tested with different web browsers and on both PC’s and various mobile devices. No major technical problems were reported.

Several teachers found the new login procedure cumbersome because they had to enter the same information twice (the name of their institution and the Danish federation Where Are You From (WAYF)¹⁵. In addition, it was difficult to find ones institution name in a very long drop-down list of institutions. Despite these issues, 11 of the 14 respondents indicated that login with their university ID would be valuable for them if they were to teach or follow courses by DTU Wind Energy on a regular basis.

¹⁴ A demonstration of the login procedure from TU/e to “itslearning” is available at <http://youtu.be/0MOxmcP5160>

¹⁵ <http://wayf.dk/>

4.3.4 Final evaluation of the WAsP E-learning course

We end this section with an evaluation of the WAsP E-learning course as opposed to the corresponding physical process: the 3-day WAsP course at DTU.

The most obvious advantage of the E-learning course is that the time and cost associated with traveling is eliminated for the participants and teachers. The carbon footprint is thus limited for the E-learning course. Further, new segments of WAsP users can be reached. In the long run – when a vast experience with online teaching has been built up at DTU – the E-learning course is expected to be more cost efficient than the 3-day WAsP course because it can be run with more participants. The participants will also benefit from this as the course fee for the E-learning course is lower than for the 3-day course.

Two test runs of the WAsP course have shown that it is possible to achieve a completion rate close to 100% for online courses. The key to achieving a high completion rate is first and foremost E-moderating. Course participants are more likely to complete an online course when they receive continuous feedback and support from the teachers and from fellow course participants. The 5-stage pedagogical model, where confidence in communication online is built up gradually, works well according to our experiences. The same has been reported in Olsen and Monty (2006). A good E-moderator can to some extent make up for the missing personal contact in online courses. This aspect represents one of the major challenges in online teaching as compared to physical courses.

A second motivation factor for course participants is that the E-moderators of the WAsP course follow-up on their weekly progress by sending out a friendly e-mail to participants who are a bit delayed. This is often enough to encourage these participants to continue the course work. In the 3-day WAsP course, or any other physical course, there are also participants who cannot keep up. These participants are not always noticed, or the teachers are simply too busy to provide the extra help and support it takes to complete the course successfully.

A third way to motivate participants to complete an online course might be through a grade system. The WAsP course is primarily a continued educational course and therefore it does not include a grade system at present. Instead, the payment of a fee to enrol in the course is expected to motivate participants from the industry to complete the course. A grade system might be included if the WAsP course gets further integrated with university programmes and courses at DTU.

The high level of flexibility that a semi-synchronous online course offers is very much appreciated by the participants as well as the teachers of the WAsP E-learning course. The real advantage of this flexibility is that participants can fit the course work into a busy working schedule and they can spend as much time as they wish on the hands-on exercises as well as on reflection and discussion of their findings. Participants' questions appear to be more "thought through" in the online version of the course

compared to the 3-day course. The WASP team hypothesize that participants of the E-learning course know more about WASP by the end of the course period than participants in the 3-day WASP course. A self-test, which will be given to participants in both versions of the WASP course, is currently in preparation. The test results should reveal the strength of this hypothesis.

The WASP E-learning course has been developed as a team effort with more than ten WASP teachers involved. This working process is common for the design of online courses and perhaps less common for the design of physical courses. The engagement of many teachers ensures that more creative ideas come up. Creativity is extremely important in online teaching because the face-to-face contact is missing. It is therefore necessary to find other ways to add a bit of “personality” to the course. Another advantage of working as a team is that many teachers are able to act as E-moderators of the course. A physical course is typically taught by one or a couple of teachers and it is therefore more sensitive to staff replacements at the institution. One disadvantage of designing in teams might be that it takes more effort to keep the course material consistent e.g. when it comes to using the same terminology. Consistency is more important in the virtual classroom than in the physical classroom because participants can repeat the presentations online.

Finally, our test of the single sign-on system and the VCH Portal has demonstrated that it is possible for teachers at DTU to login to the external cloud service “itslearning”, which holds the WASP course, using federated authentication and eduGAIN. The potential of this technology is very large but our demonstration has also shown some limitations of the system, which must be addressed before it can be used more widely at the European or the global scale. First and foremost, the research infrastructure behind VCH (eduGAIN) does not support login from industry partners or other non-research institutions. The industry is the prime target group of the WASP course so the problem is particularly important in connection with this course. Secondly, the steps in the login procedure are many and not always logical. Some simplification is needed before users who are involved in cross-border collaboration in sustainable energy will be willing to and capable of signing in via a common portal. The technology behind VCH and how it supports E-learning programmes and courses will be described further in a separate evaluation report.

4.4 Online collaboration tool and unified communications environment (TU/e)

4.4.1 Student projects on entrepreneurship (event no. 8)

Outline of the event

The minor programme Entrepreneurship, optional part of the bachelor programme Sustainable Energy Technology (SET), aims to teach students how technological innovations can be turned into saleable products, while taking the relevant

environmental factors into account. Therefore, in this course, student groups (5-6 students) have to develop a business case for a certain technological innovation. To make this a realistic exercise, the client demanding the business case is a company and the development of the business case is also supervised by an expert from industry.

Motivation for the internal test

For regular courses with project work, the existing TU/e learning environment provides ample facilities for online collaboration (MS Sharepoint) and online meetings (MS Lync, videoconference or combinations of these). This works well as long as only TU/e employees and students are involved. Once external participants are involved (guest lecturers, supervisors from industry, etc.), collaboration becomes a lot more difficult. The aim of the internal test was to see if these existing facilities could also be applied to involve external participants in these student projects. To achieve that, a number of online project meetings were planned and course materials with external participants were shared through the regular collaboration environment.

Experience

The experience was disappointing. While the need was there for both students and supervisors, it turned out that the technical and administrative barriers to involve external participants were too high. As a result, the organizers of the course turned again to (fewer) physical meetings only, so interaction between the clients and supervisors from industry on the one hand and student groups on the other hand was much less intensive than was intended by adding the online facilities. It was, however, again a confirmation of the need to develop a platform, such as the VCH Portal, that enables easy access to facilities for external participants in educational activities.

4.4.2 SELECT M.Sc. Project of the Year event (event no. 9)

Outline of the event

During the SELECT M.Sc. programme, student groups with members from all locations collaborate on a so-called Project of the Year (PoY). This is done both in the 1st year (PoY-1) and in the 2nd year (PoY-2). At the end of the year, during a physical meeting at one of the locations, all student groups present their projects to other students, their supervisors and others involved in the Select M.Sc. programme (about 100 attendees). In 2012, the Select M.Sc. PoY event took place at TU/e (16-17 May).

Motivation for the test with unified communications

Although the PoY event is a physical meeting, some students, supervisors and others invited cannot make it to the meeting, but many of them might still attend online if possible. However, as the pilot at TU/e with the Technology Entrepreneurship Course proved, involving external participants (in this case meaning not student or employee at TU/e) through the existing infrastructure is not very easy.

Setup of the test

To achieve this, a demo platform for unified communications with the potential to be integrated into both the TU/e infrastructure and the VCH platform (federated logon, eduGAIN) was tried out to involve these external participants in the event. This platform could combine participation through a traditional videoconference (present in the room where the event took place and at one of the locations participating online) and participation through pc, notebook or smartphone (5 users, both students and supervisors).

Experience

The experience was mixed, as the test was hampered by technical problems, caused by using a demo platform located in the US, which not all users were able to access due to network security problems. Those who could get access could very well participate, which added value to the event. Both students and coordinators agreed that there is still much to do in order to realize a setting in which online participation is easy and reliable.

5. New developments in online teaching and learning

5.1 MOOCs and online learning

Providing online education can mean a number of different things from streaming content (e.g. screencasts or lectures on video) to offering complete online courses with online learning objects and synchronous and asynchronous online teaching and learning activities. In project VCH the focus has been on teaching and learning within established programmes and courses in sustainable energy.

A fairly recent development in distance education is the Massive Open Online Courses (MOOC) movement, where learning content is provided free of charge via the Internet. Users can enrol in any course they wish. The mindset of these new online education possibilities draws on some of the same principles as the open source movement, which has promoted free knowledge and sharing since the beginning of the Internet.

The principles of what might be denoted an “open education philosophy” are:

- Education should be made available over the Internet at no cost to the learner
- The content of such education is designed to be scalable and support an unlimited number of students
- The learning material should have at least the same quality as material taught in regular classes, thus empowering learners who would otherwise not be able to seek internationally renowned higher education
- The education can - but will not necessarily - provide the student with a diploma or graduation

5.2 Coursera - an example of a MOOC platform

As an example of a MOOC platform, this section provides some key information about teaching and learning in the MOOC platform Coursera¹⁶. Launched in March 2012, Coursera is a social entrepreneurship company that partners with universities, among them DTU, to offer courses online¹⁷. The first DTU MOOC in “Computational Molecular Evolution” was published in June 2013.

¹⁶ <https://www.coursera.org/>. Other examples of MOOC and open learning platforms are EdX, MiríadaX (spanish language) MIT OpenCourseware, and Open University’s OpenLearn.

¹⁷ Current partner universities can be reviewed at <https://www.coursera.org/partners>

MOOCs offered in Coursera contain (the possibility of):

- video clips with the possibility of in-video-quizzes for short video lectures
- discussion forums for community building and discussion of the course subject
- online quizzes for learning purposes as well as testing/grading
- embedded presentation slides or other material
- hand in of assignments
- message board

Students can study and learn at their own pace, test their knowledge, and reinforce concepts through further reading or other online material such as models or simulations.

The main limitations associated with free online education as opposed to regular university educations include (medium related differences aside) the limited ability of working directly with a tutor or teacher and the limited possibility of getting a degree or certification.

Coursera students cannot ask questions to the professor directly, but are referred to the discussion forum for peer-to-peer learning. Here students rank questions and answers, so that the most important questions and the best answers “bubble” to the top. Teaching staff monitor the forums, in order for important questions not answered by other students to be addressed.

Coursera in itself does not provide any valid accreditation for completed courses, but they do encourage students to list the classes they have taken on their resumes / transcripts, as appropriate. The partner universities have a possibility of offering a so called “signature track” on their courses for a student fee. Students following the signature track will receive a verifiable electronic certificate from the institution upon successful completion of the course.

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