CHEMICAL ENGINEERING TRANSACTIONS
VOL. 35, 2013
A publication of AIDIC
The Italian Association of Chemical Engineering
www.aidic.it/cet
Guest Editors: Petar Varbanov, Jiří Klemeš, Panos Seferlis, Athanasios I. Papadopoulos, Spyros Voutetakis

ISBN 978-88-95608-26-6; **ISSN** 1974-9791
DOI: 10.3303/CET1335113

E-learning as Supporting Tool for Cooperation in the Field of Process, Energy and Mechanical Engineering on International Level

Quido Smejkal[a,*], Martin Pavlas[a], Libor Skydánek[a], Günter Amann[b], Marcus Reppich[c]

[a] Institute of Process and Environmental Engineering , Faculty of Mechanical Engineering, Brno University of Technology, Technická 2896/2; CZ-616 69 Brno
[b] Faculty of Electrical Engineering, Augsburg University of Applied Sciences , An der Hochschule 1; DE-86161 Augsburg
[c] Faculty of Mechanical and Process Engineering, Augsburg University of Applied Sciences , An der Hochschule 1; DE-86161 Augsburg
quido@enproco-berlin.com

This contribution deals with the first experience from an educational cooperation between two universities using e-learning and e-teaching tools. The objective of the contribution aims the local conditions of these tools at the Institute of Process and Environmental Engineering at Brno University of Technology. Furthermore, this paper focuses on the application of electronic communication tools in learning, scientific communication and business in close cooperation with Augsburg University of Applied Sciences.

1. Introduction

The presented paper deals with the first experience from the preparation of educational cooperation between two universities using e-learning and e-teaching tools.
The objective of our contribution focuses on the application of e-learning tools at local conditions of the Institute of Process and Environmental Engineering (IPEE) at Brno University of Technology (BUT). Moreover, these electronic communication and education tools play an important role in close cooperation with Augsburg University of Applied Sciences (AUAS) in learning, scientific communication and business.
There are generally more levels to be discussed with respect to a successful implementation of digital tools. First of all, the implementation of e-learning and e-teaching methods in the pedagogic system of the university and its impact on the quality of the mechanical and process engineering education will be addressed, mostly in masters and PhD courses. This level of web-available learning materials and web-based team cooperation is moreover very useful in the international educational cooperation with other European Union universities.
Our paper summarises in detail the practical experience with the application of our e-learning surface in the intranet structure of the Faculty of Mechanical Engineering at BUT. Except common interdisciplinary feedback of the students and teachers, the international application of this e-learning structure is discussed, too.

2. E-learning platform at BUT – experiences with sharing data and know-how

The teaching activities of IPEE focus dominantly on the students involved in master and PhD courses in the highly-specialized area of the Process and Environmental engineering. The IPEE organizes and guarantees courses for a relatively small group of students, i.e. approx. 40 MSc (incl. a few Erasmus exchange students every year) and 20 PhD Students. An individual approach to each of the students is taken as a challenge. The education at the IPEE is therefore influenced by other important activities of the

Please cite this article as: Smejkal Q., Pavlas M., Skydanek L., Amann G., Reppich M., 2013, E-learning as supporting tool for cooperation in the field of process, energy and mechanical engineering on international level, Chemical Engineering Transactions, 35, 679-684
DOI:10.3303/CET1335113

institute in two general areas – the research oriented activities and the industrial expertise projects. As a logical consequence of these business directions, also our teaching activities and the involvement of students in project-oriented teaching at master students' level are affected. On-line cooperation, project responsibilities to industrial partners, deadlines, effective reporting skills (i.e. summary of activities and proposal for further research), reflects not only in daily business of the institute management, but also supports creative and innovative thinking, and the responsibility within the team structure, including the students of master and PhD studies.

There are several platforms of sharing the know-how and e-learning, which should be presented in this paper.

Probably one of our most challenging e-learning tools is represented by the W2E (Waste-to-Energy) software platform. It is a tool for technology oriented processes simulation. This software was created in-house as a supporting and results dissemination tool for research projects (Touš et al. 2009). It was originally created for waste to energy plants simulation, since this area was concerned with our recent R&D projects. But after several improvements done, currently, it could also be used in a more general way, i.e. for modelling of energy and mass flows within different processes, which makes the tool very useful for students. We decided to make it available online, see W2E Software, (2013) and include it within the teaching activities in a more extensive way. A concrete example of its application is the *Energy & Emissions* course.

The course is concerned with energy saving and reduction of emissions in the process industry, the design of effective utilities with focus on renewable energies and the implementation of cogeneration. The interesting relation between thermodynamics and economy is not omitted. The course itself provides the students with necessary theoretical background, which is further utilized in various exercises for calculations of equipment (boiler, heat recovery steam generator, steam turbine, gas turbine etc.) as well as more comprehensive case studies inspired by our research and industry/oriented activities. All of this is performed in W2E.

An integral part of this *Energy & Emissions* course is so called „project". It is an introducing example of student team work in the field of Waste-to-Energy. In particular, the goal of this project is to work in teams when using up-to-date tools for team work and for computer supported learning. The object the project is an up-to-date technology for incineration of municipal solid waste (see Figure 1). The project itself is composed of the following tasks: (1) locally-dependent input data gathering (e.g. waste potential, district heating system existence and its parameters) and general review on current state-of-the-art of technology development; (1) calculation of overall mass and energy balance of the plant; (2) calculation of single unit operations and involved equipment (e.g. solid fuel combustion on the grate, heat recovery steam generator sizing, appropriate steam turbine type selection, sizing and its electrical output determination; (3) simplified economic analysis. The attention is paid on effective energy utilization in district heating systems via cogeneration and assessment of benefits and negative impacts of the technology on the environment.

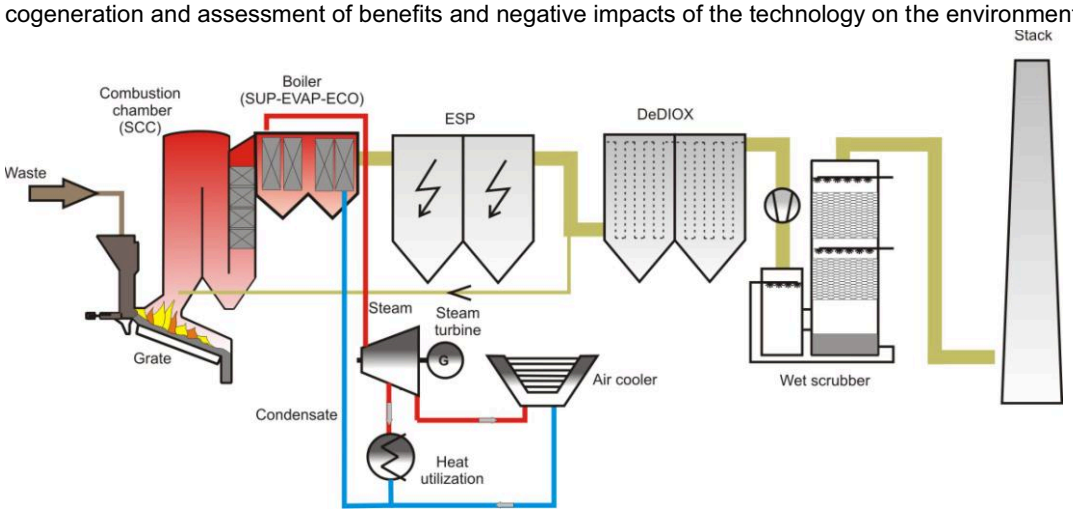

Figure 1: Simplified flowsheet of up-to-date technology for municipal solid waste incineration as the object of students' project (after Pavlas et, 2011)

The PBworks system for online team collaboration is used for trial projects execution and administration (PBWorks, 2013). PBworks is a commercial system for online team collaboration. It provides a hosted workspace service, which allows collaborative editing of files and documents. It is well recognized even in

academic environments. Within the project at IPEE, it is used for tasks specifications and background materials storage. Research literature is accessible to students as well. The deadlines revision and rating of student works is also supported by this system's environment, all structured according to the leadership hierarchy (i.e. institute director, head researchers, teachers, assistants, students).
Furthermore, the activities of the IPEE provide a possibility of project-oriented cooperation of PhD students with real-world industrial problems. Task management and progress evaluation is in this case supported by the Evernote tool (Evernote, 2013). Evernote is a suite of software and services designed for note-taking and archiving. We use it for traditional duties associated with project management, e.g. tasks specification, responsibility and deadlines monitoring and effective reporting (i.e. summary of activities and proposal for further research). It is also used for valuable information, new ideas and proposals storage. The using of Evernote reflects not only the daily needs of the students in master and PhD courses, but it also supports creative and innovative thinking and the responsibility within the team structure.
Last but not least, the quality of all available e-tools is proven by the acquisition of industrial projects and communication with business partners. In particular, examples of the bilateral cooperation with the Augsburg University of Applied Sciences, Faculty of Mechanical Engineering–shows the benefits of this virtual platform.

3. Web learning experiences from AUAS – junction with BUT activities

To promote web-based learning and teaching instruments in technical and engineering disciplines and to enhance bilateral cooperation with partner universities the AUAS follows three approaches at different levels: a cross-university approach using the platform of the Virtual University of Bavaria, an interfaculty approach initiated by professors, lecturers and faculty staff, and, finally, the use of established web-based teaching/learning tools integrated into lectures, courses and seminars. All these approaches can be successfully and efficiently adopted in the context of international cooperation between universities. In particular, such approaches substantially support the development and implementation of joint degree programmes.
The most comprehensive approach so far uses the features and benefits of inter-university network in the federal state of Bavaria, the Virtual University of Bavaria, VHB (2013). The VHB, which was founded in 2000, supports and coordinates the development and implementation of multimedia web-based teaching and learning environment. This platform is domiciled in Bamberg. The member universities participating in the network are the nine Bavarian state universities, the 17 Bavarian universities of applied sciences including the AUAS, and five other universities in church, private or government responsibility. The network character of the vhb guarantees that the professional, technical, didactical and media educational potential of the Bavarian universities is made available in the virtual learning and teaching environment, enabling the study independent of time and place, and regardless of the specific degree and study course that is being taken. Students who are enrolled at a Bavarian member university can take, in principles, courses from any subject area free of charge. Not only do students profit from this network. The VHB network also encourages an intensive exchange and close collaboration between the involved academic staff of the various universities and other institutions of higher education. The web-based courses are subject to strict quality criteria. Online course materials are developed by the member university lecturers and reviewed by experts. Because e-learning knows no borders the VHB collaborates with higher educational institutions also outside Bavaria, and intends to expand these cooperative activities in future. The multimedia courses are also made available to interested companies and other institutions of higher education. Cooperation exists for example with some universities in the federal state of Baden-Württemberg, with the Finnish Virtual University (FVU), with Bavarian Radio. As a concrete example in the field of process engineering sciences should be mentioned the courses Fluid Mechanics and Conceptual Process Synthesis, that could be chosen by exchange students at BUT under the Erasmus programme to improve and extend their knowledge in these areas, or for specifically preparation before starting their study period abroad.
In summary, the main tasks and activities of the VHB network are VHB (2013):

- Ccourses offered on a regular and long-term basis with the opportunity to acquire a certificate of performance
- Course supervision by specially trained online tutors
- Quality assurance through student evaluation, external expert reviews and the availability of financing for updating requirements
- Securing technical functionality
- Promoting national and international knowledge exchange and cooperation between universities.

The second approach is driven by the individual faculty. At the Faculty of Mechanical and Process Engineering at the AUAS professors and lecturers have many years of experience using web-based teaching and learning tools acting as complementary instruments for covering the lectures, courses and seminars in the field of process engineering. These intranet-based training tools generally include complete lecture notes, complementary material and study tasks deepen the learning experience, information concerning semester programme, lecture times and examinations, useful links related to specific field and bibliographical references, information regarding subject-related upcoming events, Reppich (2013). Moreover, the common e-learning platform of all the faculties at the AUAS, based on Moodle, allows online interaction with the lecturer and students, AUAS (2013). The aim of the second approach is to make a wide range of teaching resources available to all the students enrolled in the respective subject via intranet access. As mentioned above the e-learning platforms used at the Faculty of Mechanical and Process Engineering at the AUAS must never been seen as an alternative to the existing lectures, but they ideally complement and extend the traditional forms of learning, and support and promote self-guided forms of learning which meet individual needs. These instruments offer extensive opportunities and advantages especially for foreign students, who are enabled for individual training anywhere and anytime.

As the third and most individual approach the professors and lecturers at the Faculty of Mechanical and Process Engineering at the AUAS employ, especially in the field of process engineering, appropriate teaching tools based on best-practice solutions and examples from other universities, institutions or companies. In the area of thermal process engineering, several providers of high-quality teaching tools exist, allowing an excellent and vivid introduction into general principles of separation processes that are usually difficult to understand for undergraduate students. Examples of such learning and teaching tools are the websites Hyper-TVT (Mazotti, 2013), ChemgaPedia (2013), MIT OpenCourseWare (2013). Other commercial websites demonstrate the function of separation devices from the practical point of view, RVT (2013).

All these approaches discussed above very well fit into the traditional way of teaching. Their combination ensures a variety of teaching and learning methods, and improves the effectiveness of traditional face-to-face teaching methods. The instruments and methods described are suitable for fundamentally aligned and application-oriented teaching as well. Web-based learning and teaching instruments provide an efficient support, especially for foreign students aimed at overcoming language difficulties and differences in the educational background. The structure is of our interdisciplinary net given in Figure 2.

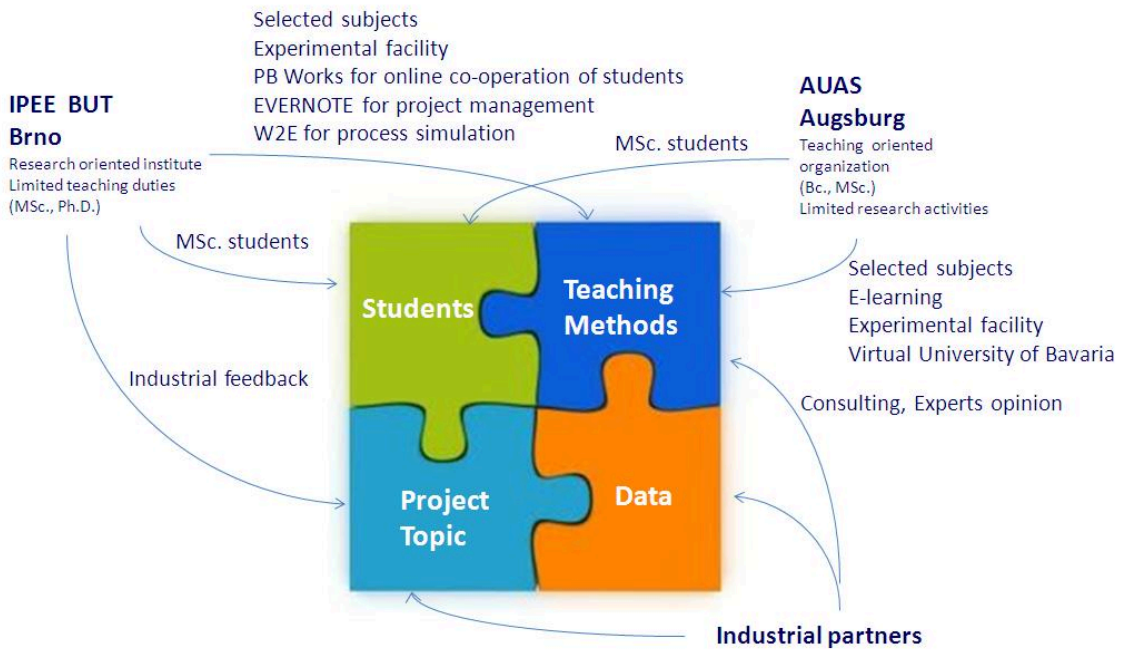

Figure 2: Schematic idea of mutual cooperation

4. Gathering activities by acquisition of industrial projects and international cooperation

Finally, an example of a challenging research/industrial project, being prepared in a collaboration between BUT, AUAS and other industrial partners, documents the importance of e-tools and know-how sharing in various scientific and commercial matters.

The project idea follows the paper Šomplak et al. (2013), where a short description of current position of the thermal treatment of waste within the EU is provided. The phenomenon of a rapidly growing unified waste market is emphasized, and together with that, also the associated need for waste flow simulation on this market. Our goal is an effective usage of the existing capacities in countries with well-developed waste management systems relying on waste incineration (Group 1 in Figure 3) and in the same time, a proper design of the future capacities in countries, where landfilling still prevails (Group 2 and Group 1). The experience of BUT in the development and practical use of sophisticated optimization tools in the field of waste-to-energy will be combined with the long-term know-how of AUAS, and with the know-how of our reliable partner from the waste management industry. Some of the planned activities will be advantageously covered by the students of both universities (BUT and AUAS) within their projects, which stresses the importance of effective project management based on e-learning and e-teaching tools.

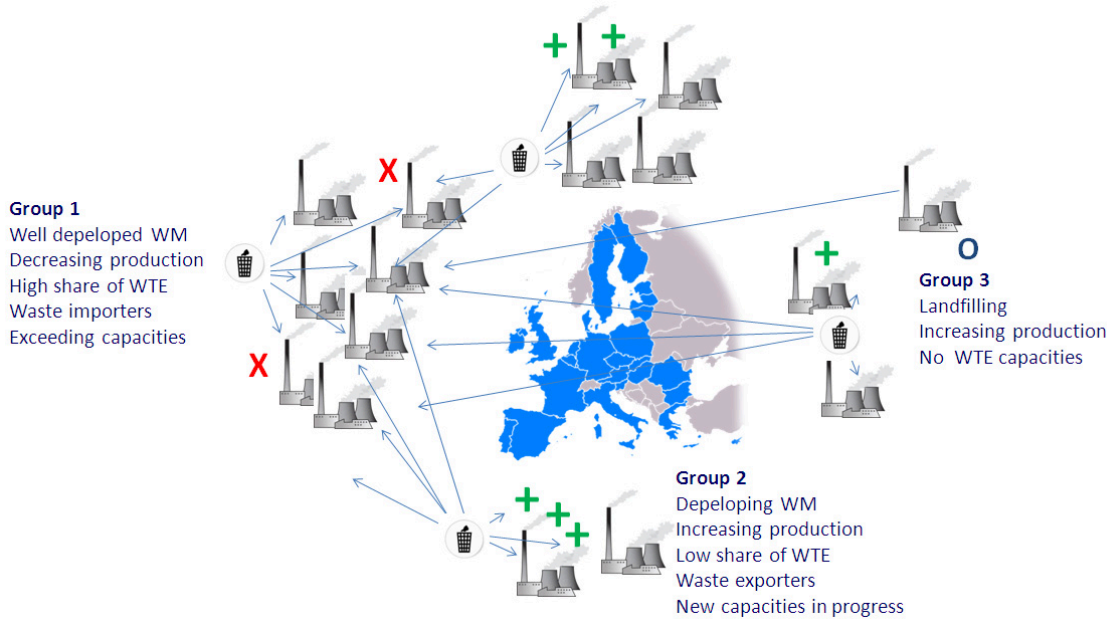

Figure 3: Illustration of changing position of thermal treatment of waste within EU and associated waste movement between countries as a topic of proposed research industrial project and documents existing network of the partners

The e-learning is not new subject in engineering work, but in a frame of international cooperation not so frequently used. There are papers and projects devoted to this field of research. Oprean et al. (2011) investigated the role of e-teaching for sustainable development in rapidly changing environments in Eastern Europe in accordance with the Europe 2020 strategy. Krause et al. (2009) examined whether cooperative learning is influenced by social context and feedback intervention (available vs. not available). They found that cooperative learning enhanced perceived performance and perceived competence. Gupta (2004) described cooperative learning of four to five university students. He showed that cooperative team education was very well received by students. In addition, cooperative learning offered many benefits such as increased teamwork, communication and problem-solving. E-learning and problem based learning usage in the field of chemical engineering was studied by Shaer et al. (2006) who described a developed e-learning course. The results showed that e-learning approach induces much more active learning, a better comprehension of technology and the possibility for the students to progress at their own rhythm. This work confirms our experience with the possibilities to address wide spectrum of student and young colleagues not only from narrow scientific field, but also from interdisciplinary branches of applied engineering. Furthermore, the accordance with this challenging project can be found in task oriented learning tools, which help the students to work on topic, they really wand and prefer. In contrast to the

mentioned advantages, Assareh and Hosseini Bidokht (2010) focused on the barriers of e-learning and e-teaching.

5. Conclusions

The presented paper summarises current experiences with the application of e-learning at Brno University of Technology and Augsburg University of Applied Sciences. The task is to present available learning tools for the students, but also interdisciplinary platforms for science exchange and business activities.
In close cooperation with the German partner university, BUT is able to perform an active international student exchange between Brno and Augsburg using a modern and efficient e-learning support. The student exchange initiated a much deeper cooperation and nowadays, also some of the first, very promising and successful industrial projects are recruited, thanks to the digital platforms used at both universities as well as their utilisation in cooperation with industrial partners.
Finally, in a close cooperation with AUAS and the German industry, we attempt to use our model to improve so far uncertain parameters in more complex way. The aim is to apply our tool for simulation and/or optimization of spreading EU waste market in more complex way, i.e. in the prediction of global behavior of larger area of waste management, exceeding the border of one country.

Acknowledgement

The authors gratefully acknowledge financial support provided within the projects No. CZ.1.07/2.3.00/20.0020 “Science for practice” and No. CZ.1.05/2.1.00/01.0002 “NETME Centre – New Technologies for Mechanical Engineering”.

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