A New Approach to Geothermal Education

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ABSTRACT

The University of Miskolc is the only institution in Hungary to offer Geothermal Engineering programs. It has done so since 2008, with a 4-semester program that covers twenty curricula topics. In this program, students can receive the equivalent of a B.S. or an M.S. in Geothermal Engineering. The university won a prestigious 2012 EU competition to continue developing geothermal post-graduate e-learning courses.

Partnering with the University of Colorado, the University of Miskolc has also brought together international professors and geothermal experts to create a more up-to date geothermal curriculum for e-learning undergraduates. E-learning students can choose from the following courses: Elements of Hydrogeology, Enhanced Geothermal Reservoirs, Fluid Mechanics, Heat Transfer, Geothermal Systems, Geothermal Power Plants, Direct Use, Environmental Impacts of Geothermal Systems, Reservoir Mechanics, Geothermal Economics, Applied Geophysics, Applied Geology, Heat Pumps, Geochemistry, Drilling and Well Completion, and Thermal Water Production Technologies.

It will be of particular interest to working engineers, (people already employed in the geothermal industry), that geothermal professors from the University of Miskolc have recently worked with colleagues from the University of Colorado to develop a short course in geothermal engineering. First offered in the summer of 2014, this course provides the essentials of longer degree programs, addressing the production, utilization and environmental impact of geothermal energy, and the natural conditions which geothermal energy requires. The goal of this short course was to provide students with a broad understanding of these topics and their history.

The University of Miskolc's experience with the two-year geothermal e-learning course demonstrated the clear advantages of e-learning: increased flexibility made life easier for both students and professors, while linking them to the world-wide geothermal community, and to GEOCOM, the EU's FP7 program. International students were also able to participate more easily, as the learning materials were offered in English and accessible from any place with an internet connection.

1. INTRODUCTION

Hungary has a long tradition of geothermal use. Surface manifestations of geothermal potential have been known in Hungary since ancient times, and thermal springs in Budapest were used during the Roman and medieval eras. Exploration for deeper thermal waters began in 1877, primarily for balneology. During the 1950's and 1960's hundreds of geothermal wells were drilled, many of these used for agricultural purposes.

As of 2016, agricultural is still one of the country's most important sectors for geothermal applications. Of increasing importance, however, are the more than 40 townships -- consisting of more than 9,000 residences – which use geothermal heat for district heating projects. Hungary also operates more than 4,500 geothermal heat pumps, mostly for residential housing but also for a few of the larger international companies and organizations. Examples of the latter include Telenor, Tesco, and the NATO airbase in Papa. Thermal waters are also used in secondary oil production, with hot water being injected into oil reservoirs for enhanced oil recovery. In some places, thermal water has even been used to heat and thus improve the flow of viscous oil flowing from secondary oil wells.

The push for further geothermal education in Hungary has been prompted mostly by industry demand. In the University of Miskolc Faculty of Earth Science, a petroleum engineering program was started in the early 1960's, from which geothermal education evolved. Courses are currently offered at the BSc, MSc, and PhD levels. The Postgraduate Certificate in Geothermal Energy Technology was created in 2008, and is now a well-established program.

2. THE GEOTHERMAL E-LEARNING PROJECT

In 2012, a project co-funded by the EU was begun at the University of Miskolc, with collaborative contributions from researchers at the University of Colorado (USA) and the Colorado School of Mines (USA). The project was carried out by the University

of Miskolc, and aimed at developing a postgraduate geothermal education program in an E-learning format. Entitled "Curriculum Development and Modernization for the Post-Graduate Training Program in Geothermal Engineering, University of Miskolc, Faculty of Earth Science and Engineering," the project had a January 2012 to January 2014 timeframe, a total budget of 600,000 Euros, and full compatibility with the Digital University educational portal.

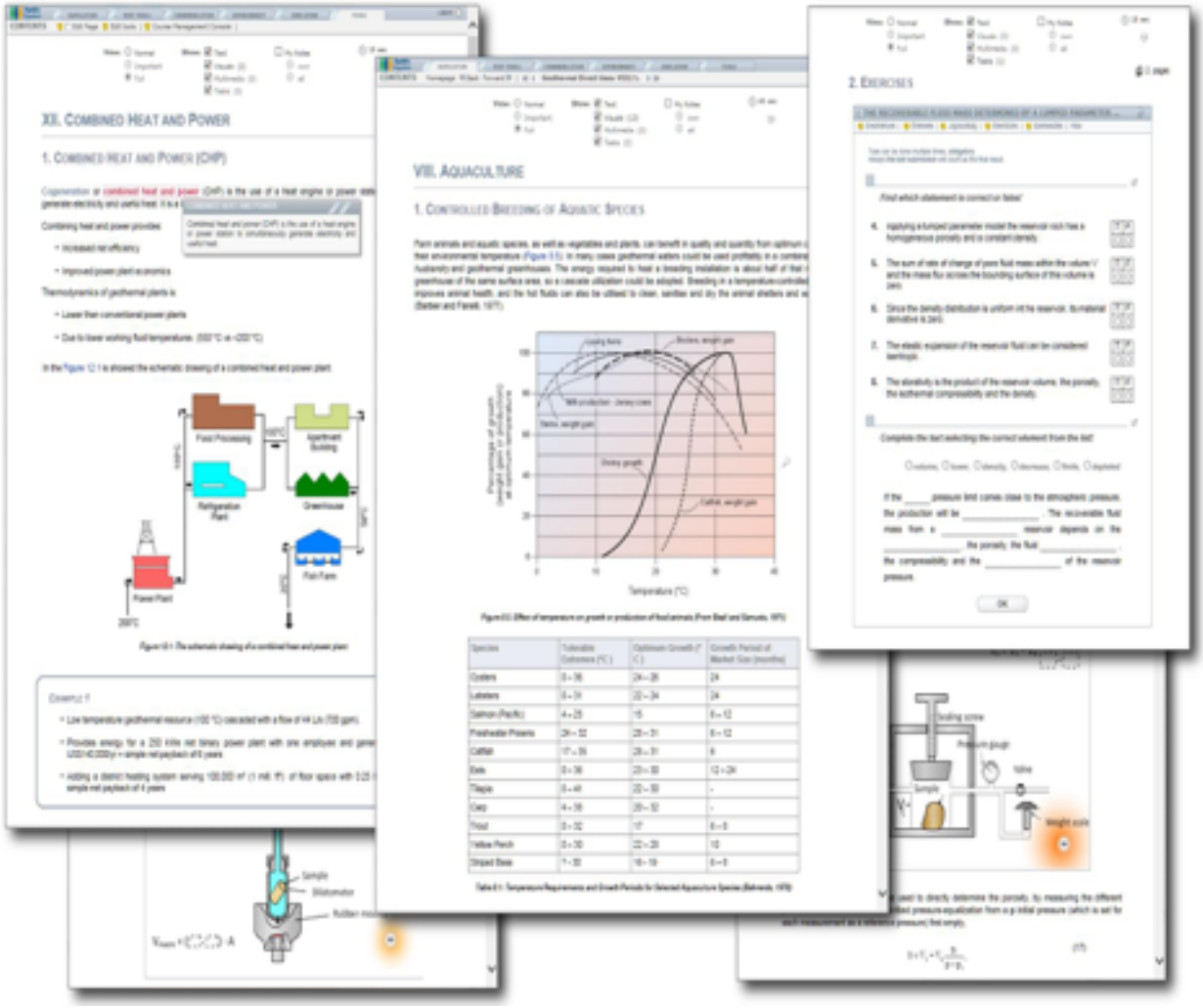

Figure 1: Some shots from our curriculum

As part of this project, the following courses were developed (the relevant number of credit hours for each course are shown in parenthesis): Renewable Energy (5), Advanced Geology (6), Advanced Geophysics (6), Fluid Dynamics (6), Hydrogeology (5), Drilling Well Design (6), Geothermal Reservoir (5), Geothermal Water Production (5), Geoinformatics (5), Geothermal Chemistry (5), Geothermal Heat-Transfer Systems (5), Geothermal Heat-Transfer Systems (5), Geothermal Power Production (5), Geothermal Direct Uses (5), Geothermal Heat Pump (5), Geothermal Environmental Impacts (5), and Geothermal Environmental Impacts (5).

The first step in the project was to prepare and develop drafts of the curricula by experts in geothermal engineering. Those drafts could then be translated into an E-learning format. During this period, contributions from domestic and international practitioners were solicited. One of the goals of the curriculum development was to develop practice-oriented education material. Another goal was to collaborate with U.S. and European educators to develop a state-of-the-art curriculum.

2. DIGITAL CURRICULUM DEVELOPMENT

The course notes were written in both English and Hungarian, to allow online access to both domestic and international students. The digital courses were student-centred, and integrated both individual work and team assignments into the online training program. The state-of-the-art curriculum used the most recent scientific achievements published in international journals. Industry consultants helped adapt the written curricula for each course, designing

tables, presentations and videos to make the material more suitable for the E-learning format. Subject-matter experts, editors and proof-readers then corrected the first drafts. As designed, the courses should address the institutional and disciplinary requirements necessary for receiving credits from a major university.

3. INSTRUCTOR TRAINING

For this project, altogether 16 training programs for university instructors (60 people) in 5 topics were developed for the E-learning courses. Training courses include the following:

1. Training curriculum developers
2. Enhancing digital literacy in education
3. Applying modern pedagogical tools and devices to E-learning efforts
4. Using modern pedagogical methods in E-learning
5. Training in English professional terminology

The overall aim here was to promote the instructors’ online pedagogic skills and abilities.

The results of the development can be viewed at http://www.tankonyvtar.hu/eng/.

4. E-TRAINING THE TRAINERS

Even experienced geothermal educators need time to learn how to use the new e-learning methods, but with a little patience, they soon realize how powerful this new tool can be.

The digital text of the learning materials was divided into paragraphs and stored in the database separately, with distinct attributes attached to each. This method allowed for a dynamic text with different views and abstracts. Navigational features, table of contents displays with adjustable detail-level, and linking to text objects were all standard functions of this dynamically compiled text. The rich-learning materials included multimedia content, illustrations, audio, video, interactive animations and tests.

Teachers could use 12 different exercise types for creating tests, which could be adapted to numerous different settings, which changed test functionality and display as needed. Test deadlines helped make scheduling for the learning process more manageable. Access to tests could be managed on both a group and an individual-user level.

NetLearn is a complex online learning management system (LMS), based on standard internet technologies, that provides a single framework for managing complete learning processes, including the authoring, distribution and publication of e-learning teaching materials and the administration of the different processes. After a standard authentication protocol, users logged into the LMS using any modern internet browser. The multimedia content of the learning materials could be accessed with a typical PC configuration. The LMS provided a rich array of tools for communication, student and teaching administration, statistical analysis, testing and evaluation, and access to authoring learning materials online. The software was developed using the PHP server-side language, HTML and Javascript. Run from a web server, data was stored in an online database. During the development, it was essential to use solutions based on international standards. A typical NetLearn server environment included, but was not limited to the highly affordable Linux environment with an Apache server and MySQL database server. NetLearn also came with its own mail server, which provided an interface for sending and receiving e-mail messages from within the LMS. The infrastructural backend for videoconferencing was provided by a dedicated server. NetLearn, as a multiuser environment, provided different user statuses for easy access-right management, but these typical roles could be further differentiated at the group level. The same user could have different roles in different groups; the tasks the user could carry out and the available tools were provided accordingly.

5. OUR EXPERIENCE, AFTER THE FIRST COURSE

Participating e-students appreciated the flexibility this course offered: Hungarian students didn’t have to take time off from work to travel to Miskolc, a drive of several hours from Budapest; even more importantly, international students from all over the world could (and did!) participate, as the course was in English.

As with anything new, however, it takes a while to get used to the e-learning ‘culture’. Students who craved face-to-face contact were more likely to request actual meetings with professors, which somewhat defeated the purpose of e-learning.

From the professors’ point of view, it was a relief not to have to delay instruction until all the students arrived at class, found their learning materials, etc. The biggest advantage: previously, when professors themselves had to travel to Miskolc to teach, they would often have to cancel or postpone classes if it seemed that not enough students would show up – e-learning eliminated this problem.

E-learning also allowed students and professors to easily connect on-line at any time to the worldwide geothermal community. In particular, they could engage with GEOCOM, the European Union’s 2010 FP7 program to unite the European and international geothermal community online.

6. CONCLUSIONS

A novel educational framework has been developed for geothermal education in an E-learning format. This framework included contributions from international

researchers, as well as practitioners. The E-learning format has the potential to be used by students from around the world.

An introductory graduate course provided the essentials of longer degree-programs, and was first offered in the summer of 2014 at the University of Colorado, Boulder. It covered the production, utilization and environmental impact of geothermal energy, as well as the natural conditions required of geothermal applications. The purpose was to provide geothermal engineering students with a broad understanding of these topics and their history – information which will prove useful in similar courses, in individual research, in the analysis of related literature, and in future geothermal engineering practice.

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