Competence based learning for an on-line course on flood modelling for management

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ABSTRACT

In their future working and professional environment higher education graduates are expected to effectively work in the “Information Society”. This work is knowledge intensive and ICT-rich. Implied is a change from application of disciplinary topics to competence based working where knowledge, skills and attitudes are integrated across separate disciplines. Students in higher education need a learning environment in which they can learn to operate at the level required for starting a professional career. The learning environment therefore should take realistic account of the future working and professional environment with the main focus on development of professional competences of students. The students learn to apply knowledge in professional situations; their competence development is measured and assessed. This is the characteristic of an educational concept which is often termed ‘competence-based education’.

The present paper presents the Hydroinformatics on-line courses, with focus on “Flood Modelling for Management”, designed for competence based learning. An analysis is given for the differences between classical on-line learning and competence-based learning courses, as well as the evaluation of the two given by the participants.

EUROPEAN CONTEXT OF LEARNING

On 1999, an agreement between 29 European countries have been signed in Bologna as a commitment to reform the higher education structures of the countries education systems in a consistent common way. The commitment is freely taken by each signatory country, and leads to an action programme searching for answers to common European problems. The declaration starts from the recognition that “in spite of their valuable differences, European higher education systems are facing common internal and external challenges related to the growth and diversification of higher education, the employability of graduates, the shortage of skills in key areas, the expansion of private and transnational education, etc”. The Declaration therefore recognises the need for reforms and compatible systems throughout Europe.
The Bologna declaration fits the EU strategy to become “the most competitive knowledge based society in the world”… “capable of giving its citizens the necessary competencies to face the challenges of the new millennium”. Following the Bologna declaration there were other Communicates regarding the way the declaration should be implemented. The one of main interest for the knowledge society is the lifelong learning, which was issued in 2001 in Prague. This declaration states that lifelong learning is an essential element of the European Higher Education Area (EHEA), because of the challenges raised by competitiveness and the use of new technologies to improve the quality of life and provide equal opportunities for European citizens. There is in this respect consensus on promoting the attractiveness of the European Higher Education Area and the need of enhancing attractiveness of European higher education to students from Europe and other parts of the world. This will lead to “a common framework of qualifications, as well as by coherent quality assurance and accreditation/certification mechanisms and by increased information efforts.” [12]

The main changes, which appeared in the European higher education, since the implementation of the Bologna standards, can be summarised as follows:

- A European Credit Transfer System (ECTS) has been introduced and is nowadays in use in most European Universities. One credit stands for 28-30 hours student study load, including contact hours, preparation, assignments and assessment. A credit also should reflect the expected learning outcomes of a student and is of value for lifelong learning.

- European Higher Education has minimum 2 levels: Bachelor and Master. The Bachelor level has 180 to 240 credits and the Master has 60 to 120 credits. The Bachelor level has to give direct access to the labour market and employment, whereas Master degrees should be a specialization. Doctoral studies (PhD) have been introduced as a third level.

- Learning outcomes and the competencies associated with them are the basic parameters in order to be able to compare higher education between different universities and different countries. They are used as a reference for transparency, benchmarks for quality assurance and accreditation, and for employability as a tool for better communication with the stakeholders in the field.

As the result of this process, the most important change is the concept of competence based learning, which is a new learning concept.

A CHANGED LEARNING CONCEPT

The change with the most impact on educational process, coming out of the Bologna declaration, is the shift from a teacher perspective into a student perspective. Learning is now defined as a student-centered activity, which has to be facilitated by the teacher and have its effects measured in terms of students’ learning outcomes. This changes how the learning process has to be set up. The traditional learning concept is defined by three main components: the teacher, the student and the
content, known as didactical triangle. This learning process is focused mainly on knowledge transfer. Nowadays new learning paradigms are developed, paradigms in which the didactical triangle has been updated so that the teacher becomes a facilitator or coach, the student becomes a learner and the content is replaced by competencies. Students’ abilities are completed with acquired competencies. Objectives are replaced by educational and professional competencies. Transferring knowledge, in this context, is extended with a range of methods. Next to practicing skills, attitudes need to be developed.

The main challenging questions are how to measure “students’ learning” and how to set up such a system where students’ learning is facilitated. The present paper describes a pilot application, which tries to find answers to these questions.

The first steps in setting up such a complicated didactical process is done in a context in which subjects became modules. A module contains a cluster of subjects, which brings learning to a sum of studying different subjects. The module aims to integrate the subjects during the learning process and does not only leave the integration as a task for the student.

HYDROINFORMATICS EDUCATION

The concepts of Hydroinformatics as a new and distinct academic discipline were conceived and implemented by Professor Michael B. Abbott (Abbott,1991). Hydroinformatics is broadly defined as the application of modern information technologies to the solution of problems associated with the aquatic environment.

The Hydroinformatics course at UNESCO-IHE aims at enriching traditional engineering practice by introducing innovative approaches in order to open up for the students much broader perspectives. The course introduces students to the process of developing mathematical models as a means for solving real problems, by looking at several different modelling situations that utilize a variety of topics, but with continued reference to their use in finding the solutions to problems. There are three major goals for the hydroinformatics course taught at UNESCO-IHE: to establish the underlying principles of hydroinformatics, to reinforce students' modelling skills through investigation of applications involving those skills, and to give students the opportunity to develop projects and assignments for later use in their career as water professionals. The course focuses heavily on the use of technology to solve problems in the aquatic environment.

Organisationally, the Hydroinformatics specialisation in the first 12 months is divided into fourteen modules. Each module has duration of three weeks. After every two modules there is one week reserved for examination. This modular structure of the programme means that during the period dedicated to a particular module, students are intensively focusing on one group of thematically interrelated subjects. The last six months are dedicated to the MSc thesis research.

The volume of information that hydroinformaticians are called upon to know is increasing far more rapidly than the ability of engineering curricula to “cover it.” Now the graduates are increasingly finding employment in non-traditional (hydraulic engineering) fields as computer engineering, environmental science, health and safety
engineering, and even business and finance. To be effective across this broad spectrum of employment possibilities, the graduates should understand concepts in physics, mathematics, ecology, geography, computer and software engineering that are well beyond the range of the traditional hydraulic engineering curriculum. At the same time, the work done by any one engineer tends to occupy a relatively narrow band in the total spectrum of engineering knowledge.

For these reasons, structuring the curriculum that meets the needs of most students appears to be an increasingly elusive goal. The solution is to institute multiple tracks for different areas of specialization. Due to this the content of the course, has two modules organised on three tracks, for which the content vary depending on the interests of the participants. They can choose between “Urban systems modelling”, “Environmental systems modelling” and “Flood modelling for management” tracks.

The course has in its curricula fieldtrips, during which students are exposed to a wide range of applications and problems involving hydroinformatics.

Water problems usually cut across boundaries and it is becoming more and more frequent to build alliances that link professionals at many locations. The growing complexity and the increased interdisciplinary nature of engineering projects require a wide academic education and practical training of modern-day engineers. Therefore the demands of teaching hydroinformatics today are substantially different than they were as recently as 10 or 15 years ago. Hydroinformatics teaching nowadays consider new methods of transferring knowledge, like group learning via collaborative engineering as well as on-line courses, not previously found in the curricula.

A new approach to be tested in teaching is the competence-based learning, which is part of the current research in Hydroinformatics, regarding the use of new technologies and methodologies in teaching and in education. Currently TENCompetence is a 4-year EU-funded project that develops a technical and organisational infrastructure for lifelong competence development. The infrastructure uses open-source, standards-based, sustainable and innovative technology. With this freely available infrastructure the European Union aims to boost the European ambitions of competence based, lifelong learning. UNESCO-IHE is partner in the project, testing the methods and models developed within the TENCompetence project, by testing two pilots in water management field: Flood modelling for management (FMM) and Decision support system (DSS).

COURSE DESIGN BASED ON COMPETENCIES

The word competence in the educational context is new concept. “Being competent” means that he/she “disposes the ability to select within a specific context from a range of available actions and handles in order to reach a certain aim”.

Water resources management has become a field where computer-based techniques are expected to facilitate the complex process of decision making which involves several stakeholders with varied interests and various socio-economic objectives, of the natural resources. The decision-making related to water resource
management is a process that requires water resources engineering expertise combined with suitable use of hydroinformatics models.

Formulating competencies for hydroinformaticians, acting as flood modellers for river and urban floods is not an easy task as it demands a thorough knowledge in the core elements of the profession. A curriculum built on competencies is one of the cornerstones for educating learning professionals. A first pitfall is to reduce competencies too much to skills (can), without really taking into account the attitude and/or the motivation. This limitation occurs by focusing knowledge only in function of “can”. A second pitfall has to do with the interpretation of knowledge. In some competencies the understanding is rather insights (has insight in…, understands…), which is too narrow for defining a competence. Related to the modularisation process there are also some difficulties which can become a pitfall. If a module is not broadly enough conceptualised it can be reduced to a subject to be taught or to a mixture of some related subjects.

The essence of a module is the integration of different disciplines in relation to research, methodology and practice. The TenCompetence concept approach entails – besides the integration of different competence development tools - an understanding and transformation of the content of a topic driven course into a Competence development based course. Competences are modelled in the TENCompetence project as follows: each learning network has a competence map which contains a series of competence profiles for roles, functions and jobs. A competence profile, which is an instance of a certain competence model, contains one or more competences, which must be attained, in order to meet the demand of the profile. Moreover, each profile has several levels.

The competence model adopted by UNESCO-IHE, to build a flood modelling community, is the Cheetam and Chivers model. This model stresses the importance of developing professionals in four well-balanced and integrated domains: the cognitive, the vocations skills, the personal competencies, and the ethic / values domains.

THE FLOOD MODELLING FOR MANAGEMENT ON-LINE COURSE

With the growing scarcity and quality deterioration of water resources, in many developing countries, in addition to the current trends of increasing floods and climate change, the contribution and role of modellers in river basins has increased and become a necessity as well. The users of Hydroinformatics tools, and of river basin models in particular, need a substantial experience to develop models, which will in the end build organisations capacity to manage and protect water resources in order to optimise their utilization.

Based on the above described competences, currently at UNESCO-IHE, two on-line pilots on Flood Modelling for Management and one pilot on Decision Support Systems for Water resources, are set-up, in order to test the lifelong learning based on competences. This paper presents focuses on the first Flood Modelling for Management course.

The overall goal of the “Flood Modelling for Management” (FMM) course is to teach water professionals that by using catchment, river basin and urban flooding
models they can maximize economic and social well-being in an equitable manner without compromising the sustainability of their ecosystem.

The two FMM pilots run in a competence-based learning environment were the set-up was done with two different focuses, one a teacher centered approach, when the learning path was given by the teacher, and the second one a student-centered approach, when the student could choose his/her own study path.

For the teacher centered approach of the FMM a group of 90 participants was selected to follow the course and for the student-centered run a group of 50 participants were selected to follow the course.

The FMM constituents for the proposed model are four: Knowledge / Cognitive competence, Functional, Personal behavioural competence and Ethical. Each of the component had specific sub-constituents such as tacit/practical (identification of the problem to be solved, analyse the best economical solution), or Technical/ theoretical (linked to underlying knowledge base) for the Knowledge/Cognitive competence or Functional Competence (range of occupation specific tasks, such as Data analysis, Model selection (HEC-HMS, HEC-RAS, MOUSE, SWAT) or Model building- step by step).

In the FMM teacher-centered approach, quantitative data were collected in two questionnaires: a pre-test answered at the launch of the pilot dealing with the participants’ characteristics and expectations of the pilot; a post-test evaluation of the pilot, which was completed by the learners after the learning experience. A total of 90 participants, 69 men and 21 women, started with the FMM Pilot. Their mean age is 34, with a standard deviation of 7,5 years.; all participants are between 23 and 54 years old, except for one participant who is 63 years old. Three quarter of the participants are 38 years or younger, and participants come from all over the world (47 different countries). As a Bachelor’s degree is a requirement for participating in the pilot, all participants are highly educated, 29 % have a Bachelor’s degree, 52 % have a Master’s degree, and 19 % have a PhD degree.

The majority of the participants (62 %) are engineers, and 13 % have a degree in earth sciences or life sciences. The remaining participants mentioned a profession which is related to their current job function. Of these participants, 12 % have a profession related to research and teaching, and 9 % are working ‘in the field’ as a consultant, manager or planner

CONCLUSIONS

The experience, of the learners, in the professional field of Flood Modelling is very diverse. 43 % of the participants have 0 years of experience with flood modelling, 5 % have 2 to 6 months of experience, 25 % have 1 to 2,5 years of experience, 21 % have 3 to 6 years of experience and the remaining 6 % have 7 to 18 years of experience. Correspondingly, 17 % consider themselves a novice, 47 % a beginner, 26 % intermediate and 7 % advanced [from pre-test questionnaire]. Note that most probably ‘0 years’ of experience does not necessarily mean no experience at all, as the number of people with 0 years of experience is almost three times as large as the number of people who consider themselves novices.
All different types of competences that can be acquired, are considered important by the participants. But there is a difference in how important they are. The evaluation shows that knowing how to find creative solutions is considered most important (see figure 1):

![Figure 1. Importance of competencies for learning](image)

Over half of the participants (54%) have not followed a distance learning training before. 24% have followed one distance learning training, 15% have followed two distance learning trainings, and 4% has followed three or four trainings. Three participants (3%) are experienced distance learners with 11 or 15 trainings followed. Regarding the use of web tools, 75% of the participants use search functions such as google very often; 12% use the search function often, and only 3% uses this sometimes or occasionally. The use of the other tools is much more diverse. A substantial part of the participants use the tools never (ranging for each tool from 9 to 28%) and only 4 to 13% uses any of these tools very often.

One of the most important outcome of the pre-test questionnaire was that 74% of the participants prefer to be given an outlined learning path, but also the possibility to choose their own learning path. 21% prefer to be given a learning path that they have to follow, and 5% prefer to be given the learning resources only, and the large majority of the participants (84%) enjoyed this way of learning (very much). 11% held a neutral position and 5% did not enjoy this way of learning. A large majority of 89% want to continue to develop this competence further in the future, and 11% doesn’t know [post-test questionnaire outcome].

The group of participants who followed the FMM course are a very homogeneous group and relatively young. They are highly educated, know how to search for information, and with many of them their motivation is a combination of intrinsic motivation to develop their Flood Management competence and job-related motivation. In other respects they are a very heterogeneous group: participants come from all over the world, the number of years of experience in the profession differs
widely, and the same applies to their experience with web-based learning other than searching for information.

The post-test and log files show that the number of hours spent on the FMM is very divergent. In spite of this, participants do not differ very much in how much they have learnt with respect to the various competence types, which in generally is a lot. When compared to how important they valued learning on the various competence types, it can be seen that most important to them was how to find creative solutions related to the competence, but this was not the competence type on which they indicated they learned most. They learned most on cognitive knowledge, which in the pre-test was considered less important than finding creative solutions. Social skills were considered least important. This was also the competence on which they learned least, and, in line with this, the collaboration with other participants was valued moderately positive, but not as high as other aspects of the pilot.

As the learning path was basically planned by the experts, it is not surprising that participants felt moderately positive in control of their own learning, and that there was a moderate use of self-assessment and the possibility to mark activities as completed. In line with this, most participants followed the plan as indicated by the expert

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