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e-Technologies in Engineering Education Learning Outcomes Providing Future Possibilities

e-Technologies in Engineering Education: A Case of Pedagogy Development

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Abstract

The paper describes some pedagogical issues to achieve the effective use of e-technologies in engineering education. The question is not only in the technical conditions for the use of e-technologies in engineering education but also in assuring that the faculty will be mentally prepared for it. The lack of a pedagogical architecture for the technical solution is one of the main obstacles inhibiting the effective use of e-technologies in engineering education in the Ukraine.

I. Introduction

Electronic technologies (e-technologies) in various forms have come to play an important role in the infrastructure of engineering education in the Ukraine. The changes caused by the use of e-technologies are often surprising, and they proceed according to their own dynamics. The question is not only in the technical conditions for the use of e-technologies but also in assuring that the faculty will be mentally prepared for it. The lack of a pedagogical architecture for the technical solution is one of the main obstacles inhibiting the effective use of e-technologies in engineering education. The key to success in it is not in the speed of the computer and Internet channels, it is through liberated educators whose understanding and creative use of e-technologies can help them to achieve a higher level of excellence for themselves and their students.

Advances in e-technologies are bringing about a new educational revolution which is having a profound impact on the world of education and training. If we wish to implement e-technologies into all fields, we must educate users in those technologies. The use of e-technologies in engineering education is too widespread to be assessed only through extensive surveys, so we must use typical case studies to try to outline the possibilities offered by e-technologies for supporting engineering faculty training in the use e-technologies in their instructional activities.

II. Educational Staff Development and Engineering Faculty Education

The development of e-technologies for use in engineering education and the increased use of open and distance learning technologies means that support staff will need to be more closely involved in resource development, delivery, and student support. Further pedagogical training is needed to answer the many questions that are connected with using e-technologies for design and development by engineering faculty in their own telematic-based instructional programs.

New and improved technologies and telecommunications have already given learners and faculty access to many alternative resources and facilities, which support their learning needs. Faculty training to apply e-technologies in their teaching activities is a central concept in the engineering educational information strategy in the Ukraine. Preparing faculty to use e-technology is emerging as a critical factor limiting the contribution of modern e-technologies to improve learning. The faculty must become e-technologies proficient educators who know how to use modern technologies to achieve instructional reforms.

Today less then 20% of Ukrainian teachers use e-technologies in a pedagogically significant way. We would like to improve the quality of work in the area of staff and educational development where for a long time we have concentrated on the practical rather than the theoretical or conceptual. How do engineering educational organizations help staff become more professional to apply e-technologies? What incentives are offered to faculty to acquire e-technology-related skills and apply them for teaching and learning? It is essential to know what purposes the e-technologies are being used for and what teaching and learning is being dispensed with its help.

Having five years experience in faculty training, we have observed that the faculty needs can be divided into three major areas.

- *Access to E-technologies*. A total lack of availability of e-technologies is a major barrier to their use (excluding those faculty who have a background "computer science"). We believe that every citizen should be able to access the education and training that they need, at any time in their lives, and when and where they need it.

- *Appropriate Training*. Training should stress the application and benefits of e-technologies (in this case the faculty will have the interest and incentive to learn).

- *Ongoing Support.* Ongoing support is needed to encourage progression, including technical support, evaluation of resources, supporting organizational culture. Faculty need to know where e-technologies development fits into the organization's priorities and development plans. They need to know that time spent on developing their skills and knowledge is valued, and that they are not working in isolation.

The faculty must become e-technology proficient educators who know how to use modern e-technologies to achieve instructional reforms within educational organization. E-technologies must become a tool for lifelong learning for faculty. Training must be flexible and allow a choice and guidance where appropriate for faculty who are at different stages of e-technologies literacy, who teach different levels and curricula, and who are at different stages in their own carrier. Below we look at a range of five main streams for faculty professional development activities in the e-technologies area.

Stream 1: Skills in using particular software applications, such as word processor, an operating system or Internet access.

Stream 2: Integration of e-technologies into existing curricula with which a faculty member is working, such as "e-technologies using for organization online modeling" and "electronic learning material preparation."

Stream 3: E-technologies related changes in curricula, such as introducing the course, "Curriculum and E-technologies," has provided an opportunity to change the nature of experimental work in educational organization. E-technologies-related changes allowed more collaboration and cooperation activities within the curricula. Instead of focusing on "What are e-technologies and how to deal with e-technologies" this course reflects on the curricular values and impact of e-technologies.

Stream 4: Changes in teacher and student roles in learning, such as group work and collaborative learning activities can be enhanced when e-technologies are used to develop strategies for adaptive learning. In this case, faculty need a course "distance learning management using e-technologies."

Stream 5: Instructional design of e-learning and teaching. Our experience in e-technologies use showed that the instructional use of e-technologies has not been generated by technology-related changes in the curriculum; the teachers have to be prepared to apply e-technologies in educational process first.

Telematic-based distance curriculum for engineering faculty training, "The Use of E-technologies in Engineering Education," has been developed at the International Research and Training Center UNESCO for Information Technologies and Systems (Kiev, Ukraine) and disseminated among Ukrainian faculty [1]. The curriculum is aimed at providing students-faculty with basic knowledge about e-technologies and giving them the ability to use the e-technologies most often demanded in the workplace today. The main goal of the curriculum is to teach how to design and implement multimedia telematic-based distance courses in engineering areas by faculty. As a result the students-faculty will be able to create their own multimedia fragments of a distance course. The curriculum is thought of as a multimedia tutorial for improving faculty professional skills in instructional design of telematic-based courses and in multimedia use for engineering learning material creation.

Although some of the faculty have had an experience in utilizing basic Internet services for education purposes, they still are in the great need of the training support in this area that includes the telematic-based courses useful for faculty educational applications. To support intensive dissemination of e-technologies in engineering education in Ukraine requires access to information about teaching methods and possible instructional approaches that have to be applied in the scope of engineering education.

III. Curriculum and Pedagogy Development

The basis and background of the pedagogical development of e-technologies in engineering education is provided by epistemologies of social constructivism and the philosophy of dialogue teaching as they had been defined by Alexei Dovgialla [2]. In the post-modern age of transition the dialogue philosophy includes hidden possibilities for developing the theory and philosophy of teaching. The learning system has been changed as the object of support from active learning to cognitive learning, and to constructive learning.

In the Ukraine, there were and still are two main directions in the problem solving approach for engineering education: modeling problem solving as a process in learning and teaching; and problem-based teaching and learning.

The work in problem-solving modeling of learning and teaching were initiated by a team from Glushkov Institute of Cybernetics under the supervision of Professor Alexei Dovgiallo at the end of the 1960s. During the next few years, the team's investigations were concentrated on working out the

fundamentals of generalized Problem Solving Theory (PS-theory) [3] and its application to the engineering educational process. At that time, the PS theory confirmed some of its benefits, namely:

- the PS theory is a tool for the design of scenarios for solving different kinds of problems (among them the Cognitive Problem, Problem of Learning and Teaching, Cooperation and Collaboration Problems, etc., within engineering education);
- the PS theory is open for different developments; and
- the PS approach is a way of "unified" thinking for e-technologies applications in engineering education.

The PS approach in e-technologies for education means that the development of the theoretical apparatus for representation of instructional designs to increase communication between students, instructors and experts, technology uses and level of interactivity, impacts the interaction among learners.

The main idea behind problem-based teaching is that an instructor should systematically organize problem situations and stimulate learners to creatively resolve them through work in pairs, or in a small groups, to produce a paper or report, conduct a project, to discover new knowledge, and to share results with the class. The effectiveness of problem-based teaching depends on a methodically correct organization of the process in which the main factor is the faculty member's control of the activity of every learner through the collaborative activities of the learners. Problem-oriented methods usually require more time and highly-developed creative skills and abilities, consequently, it does not disseminate widely in the Ukrainian engineering educational organizations.

The use of problem-based learning approaches is very new in the Ukraine, so experience is limited with large areas of uncertainty. We still have a great deal to learn about online communication, design and delivery, so it would seem to be sensible to at least employ or adapt what we already know in effective interactive learning design from other media. The focus should be on learning with the technology applied to meet learning requirements, not the learning adapted to suit the technology. New learning styles, pedagogical strategies aimed at communication, cooperation, and collaboration, champion, culture are the base of successful online learning.

The other major concern whenever a new technology allows us to deliver learning in a different way, is that we get excited about the technology and forget about the principles of learning. We have made mistakes in the past when new technologies became available and we have not learned from our experience. We do not seem to be spending enough time on instructional design. We seem more concerned about the technology.

So, faculty need to consider the impact of e-technologies within their own beliefs about how best to teach. For the faculty who use a variation of the traditional, didactic pedagogy, using the full potential of e-technologies in the classroom will allow teachers to move [4]:

- from adopting technology in support of common instructional practices;
- to adapting technology for experimenting with different instructional practices;
- to appropriating technology to create new strategies;
- to creating learning situations where e-technologies are used by students to invent learning experiences.

IV. A Strategy for the Future

E-technologies are having a rapid effect on the learners' approaches to studying in educational organizations. Collaborative learning through Web-based conferencing tools is leading the way to new learning.

It is possible then to identify a seven-point strategy for the future use of e-technologies in engineering education:

1. Develop a clear vision for the use of e-technologies in engineering education that includes appropriate goals, target groups, and curriculum models that take into consideration the technical capabilities that can already be identified as emerging over the next years.
2. Find ways to fund the development of large quantities of multimedia learning materials through partnerships between media producers, telecommunications companies, and educational institutions.
3. Keep the human role in teaching by linking "real" people with students through telecommunications, and giving them the tools to access, reconstruct and create knowledge.
4. Create new (or transform existing) curricular models that enable more negotiation between learner and teacher to meet individual needs.
5. Develop new institutional or oganizational structures built around the digital collection, storage, creation and distribution of learning materials in the engineering area.
6. Provide political leadership in the development of e-technologies in engineering education and training networks.

7. Create a regulatory environment that provides universal access, choice and competition to instructional programs, information resources, and e-technology applications.

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Author's Biography

Svetlana Kudrjavtseva is a Head of Department at the International Research and Training Center UNESCO/IIP of Information Technologies and Systems. She has been involved in the European projects which have investigated the impact of different media in the process of knowledge and skills transfer through telematic educational networks. Her current research is focused on application of e-technologies to teachers' training.