An Assessment of ICT-based Education for Mechanical Engineering in TEI Patras, Greece

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INTRODUCTION

There is no doubt that, over the last fifteen years, there has been a phenomenal growth in Information Communication Technology (ICT) in all aspects of society, and education is no exception. By the second half of the 1990s, the "C" was added (by educationalists) to "IT" acronym to be inclusive of the growing importance of the communication aspect of this technology. This communications' revolution was lead mainly by the development of the internet, which provided a platform for email and many other applications. Higher Education (HE) has been influenced by the new tools. Technologies in education have often been seen and used as providing the answers to all our educational problems. ICT is no exception, often being promoted by politicians and "enthusiasts" as the solution to efficient teaching and learning. This new approach in education is often called e-education. The term e-education will be used in this paper as it is considered the most suitable term to include all the activities concerning teaching and learning. E-education in engineering education is a serious debate that is currently takes place between the "traditionalists" and the "promoters" of e-education. What is often neglected in this debate is the recognition that is not the availability of the technology which is important, but how it is used. The faculty of Engineering, TEI Patras last five years has heavily invested in the installation of equipment for enhanced understanding and use of information and communications technology. Mechanical engineering department has introduced Information and Communication Technologies (ICTs) in it's curriculum as a tool that can facilitate and improve the quality of future mechanical engineers education. McCormick and Scrimshaw (2001) demonstrated that the new technology would not provide value for money without changing pedagogy and teaching approaches and the variety of learning styles favoured by individuals and groups in educational community. A well designed e-education strategy can motivate students, and help teachers and institutions to support deep learning. The implementation of e-education leads staff to new roles and unknown activities. To open up these new roles to university staff is very important, which is one of the main reasons why a strategic plan must be developed for the implementation of e-education. The priorities and perspectives of students, teachers and administrative staff are different and are difficult to find a consensus.

ICT-based education for mechanical engineering is a new learning approach that challenges the traditional training methodologies. Recent theories of learning stress the value of dialogue, negotiation and feedback. Learning is seen to take place within communities of practice, where members collaborate to construct and understanding of their field of study. Teaching and learning communities are vital in re-conceptualising common professional identities, which I would argue is even more important at times of rapid change and uncertainty. E-education is a new service and its understanding needs basic knowledge not only for the realization of information and communication infrastructure, but also the new environment for the content and management of engineering education. There are new players in e-education, and the roles of the players have changed. This change of players and roles will bring a change to the university staff structure, establish new positions and create changes in the teaching methodology. The change of the education process is based on the understanding of new ICT possibilities, the content and the methodology. The first stepping-stone to the new education process was redesigning of pedagogical documents such as university and faculties study plans and curricula. Changing the manner in which interaction occurs, calls for redesigning not only of the formal structures within the company, but also in the informal patterns of interaction between individuals and processes.

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In this paper, we present an assessment of the influences, and the consequences that brought in the learning and working environment of the department. Also we present the results on the educational process that have been accumulated during the last three years of using the e-learning material as a tool for improving the quality of the education in Mechanical engineering department. Based on the findings of above study, the paper analyses the necessary future actions that must be taken for improving the learning outcomes of the integration of ICTs in the engineering education.

EVALUATION OF E-EDUCATION IN MECHANICAL ENGINEERING DEPARTMENT

The engineering studies at the Mechanical Engineering Department of TEI Patras consist of 4 years studies leading to a degree of Bachelor of Science in engineering discipline. The engineering education community has recently started to initiate studies on the conceptions of engineering teaching and learning. Viiri (2003) conducted a study to understand teachers' conception of "moment" compared to their students' conceptions of the same topic. The implementation of ICT in Mechanical engineering education is an innovative approach and identifying the elements to be evaluated is more complex for general (macro) elements (evaluation of the technology, of the course materials, of the cost/benefit ratio) as well as for specific (micro) ones (evaluation of participation, goal achievement, evaluation of individual learning, etc), (Begnigno & Trentin 2000). Consequently, it is much harder to find criteria by which to evaluate the performance of an e-education system which differs from the traditional engineering educational systems. The e-education is largely based on collaborative learning models, where education is designed on one-to-many communication channels.

DESIGN AND CHARACTERISTICS OF ICT SYSTEM

In the article Engineering Education: Where do we go from here, by Chang (2001), there are at least four major forces for change in engineering education. These are:

- The shift of manufacturing to services;
- The explosive growth of ICT;
- Increasing globalisation; and
- Multi-disciplinary engineering

ICT has brought fresh impetus to the engineering education. ICT can bring revolutionary changes to education, which can be used for pedagogical purposes alongside the lectures and textbooks. Mechanical engineering department was one of the first departments in Greece that embraced the ICTs in their education process. The department decided to introduce ICT not as the main educational tool but as a complementary material available to the students. The project has been funded by European Commission. The design and the characteristics of the ICT system that has been used are based on the e-class platform. E-class platform is a national strategy and has been developed by Greek specialists for the Greek universities. During the pilot phase of the didactic material development the basic requirement was simple presentations of the subjects by using the power point software, which normally is used in the class. Last year the material has been improved by using advanced software. The evaluation in this paper is based on the primarily version is the one that is assessed. The material is free accessed in the website: www.teipat.gr/e-class/mechanical engineering department.

METHODOLOGY

The evaluation of the ICT educational system that has been implemented is based on the qualitative analysis of the influence that has been occurred in the major stake holders (students, educators and administrators). For this purpose one questionnaire was used for students (a full copy of the questionnaires may be obtained from the author). The purpose of above questionnaire is to gather and examine the views of individual participants about their experience in using the e-education of the

department. The population of the students is 950. Around 12% of the whole student population answered to the questionnaire and the data analysed using SPSS software package (mainly cross-tabulations and chi-square tests).

For the educators semi-structured interviews have been used (20 Full-time tutors and 5 part-time tutors). Only 25% interview participants have PhD degrees in engineering. Above fact is the main obstacle of using ICT in the department efficiently. We used purposive sampling, since we needed to select individuals who can provide information that the study requires. As shown in Table 1, the interview questions were designed to provide a direct mapping to the purpose of the study. Specifically, we asked the educators of the department about the courses they teach, specific learning goals for their courses, and corresponding approaches through the ICT, they use to achieve these goals. This enabled us to collect detailed data to answer the research questions, while at the same time enabled us to bind the data collection in a reasonable way (Miles & Hubeman, 1994). During the interviews, emerging and follow-up questions were posed to further elaborate the topic discussion and illuminate the meaning of certain interviewees' responses. Each interview was conducted face-to-face and lasted approximately one hour. All were recorded and transcribed.

Table 1: Interview questions that guided the conversations with the educators of mechanical engineering department
• Please describe the courses you typically teach.
• Please describe the content and the pedagogical approach of your e-learning material.
• What are the most important things you expect your students to achieve in your e-courses?
• What techniques/strategies/approaches do you use to encourage your students to use the e-material?
• Do you think that the e-learning material helps your student to achieve the expected goals that you have set?
• Are you planning to increase the use of the ICT in the future?

Based on the findings of the questionnaires that had been addressed to the students and the interviews of m colleagues, the evaluation of the ICT system of mechanical engineering department is focused on the following topics:

- Quality of the courses (contents, course activities, educational approach adopted in the courses, ect.)
- The influence of the new learning environment in learning process
- The role of the educators
- The role of the administrators

FINDINGS

The interview analysis revealed several teaching strategies mechanical engineering department often utilise. The data indicate that department recognise specific areas where students have difficulties in understanding the subject matter, and employ a range of instructional approaches to make the subject matter comprehensible to others. Only 10% of the educators utilise the strategy to encourage the students to use the e-learning material. Actually they refuse the possibility the ITC to facilitate the educational process in a mechanical engineering.

Quality of the e-learning courses

Strategy one: recognise the specific difficulties in learning subject matter (design, mechanics etc)
The educators and the students described several detailed examples related to some subject matter. The educators strongly believe (80%) that the best strategy for achieving the learning goals is the presence of the students in the class. Students agree with above approach only by 60% as the rest of them find very

useful the availability of the didactic material in the internet. The publication of the study materials and links to them in the e-education system of the faculty, enables a guarantee of the content of the study programs and the branches, Drozdova, M., and Dado, M., (2007). The democracy of the internet and the accessibility to the didactic material forced all the educators of the department at the early stages of the ICT application to improve the didactic material before to be posted in the e-class platform. The standards of the material required to present their lectures in the power point presentation software and to be supported by documents in the Word software. Three years later 70% of the material remained at it appeared in its early versions. One of the reasons for this negative approach is connected to the age of the educators. Half of the educators have been retired or they will receive their pension the next year. The second reason is associated with the luck of supporting mechanism for developing didactic material suitable for the e-education. A third reason is the structured classical approach of the engineering education. According to Neumann et al. (2002) description adequate to the extent that it acknowledges engineering is a distinct from other disciplinary teaching cultures. The majority of the colleagues embrace above views and expressed it through their resistance to develop new didactic material based on more sophisticated software or to modify the pedagogical approach of the existing didactic material. Only 10% of the colleagues -"the enthusiasts"- got the opportunity to introduce innovative teaching techniques.

Only 50% of the students expressed their opinion about the quality of the courses to restricted accessibility to internet facilities from their homes. Above fact was expected as Kabouridis and Kakarelidis (2006) at their research amongst the students of Mechanical engineering department found that 72% own a personal computer at their home and 60% have ADSL internet access -a prerequisite condition to use e-learning effectively-.

Strategy two: contextualising the engineering education: give real world examples and hands-on activities

The educator and the students agree that e-education does not provide the opportunity of learning by doing which is very essential for the future engineers. The majority of them agree that e-learning material doesn't cover above need and it must be improved. Engineering requires more hands-on activities, illustrative examples, problem solving, and simulation and modelling compared to other fields of studies. These specific disciplinary differences may have an influence on department's teaching approaches. The virtual experiments give the same results for the same inputs which is not the case for the real life problems. The active participation of the students is missing. The danger is that technology drives the pedagogy and that it encourages a "transmission" approach whether this is via presentation packages or within a virtual learning environment. Wilson (2003) refers to "pedagogic poor" applications of technology. The enthusiasts of ICT receive above message of above uncomfortable situation and started to use advanced software (for example AUTOCAD) to teach basic design knowledge. The impact on the teaching and learning process was tremendous. Students and colleagues recognised the absolute need of using advanced software to present even the basic engineering concepts.

The influence of the learning environment

Numerous research studies have examined the relationship between learning processes and the environment in which they unfold. Jegede et al. (1995) defined the learning environment as a series of elements that influence (both positively and negatively) the acquisition of new knowledge and skills. These range from the climate created among the participants (students, tutors, administrators, ect.) to the physical setting where study is undertaken, and a whole series of other factors that make the individual student's situation unique. The educators usually use the face to face connection to support their students. This support extends the practice of supporting only on the cognitive domain, but they include the personal and emotional dimensions of learning. They do not appreciate the ICT as a mean of personal connection with their students and their colleagues; they consider it as very cold. TEI of Patras did not embraced the new technology in the whole University -only four departments decided to participate in this pilot application of e-education-. As a consequence of this policy the learning environment has not been expanded in the whole community. Teaching and learning communities are vital in re-conceptualising common professional identities, which I would argue is even more important at times of rapid change and uncertainty (Wenger 1998). Above policy of the Institute has influenced negatively in developing a competitive learning environment that could be facilitated by the new technologies. The first

stepping-stone towards to building a new education process is the adaptation of the new technology in the 15 departments of the Institute. In this way, it is expected the educational culture of the organisation to be harmonised. The second step is the redesign of the educational fundamentals documents such as study plans and curricula. The design of a new education process is a must in order to maximize the benefits of the new technology provided that this strategy does not require much more additional investments. The growth and the impact of ICT is a key strand for the future of the Institute. The main key players - educators and students- evaluated the existing learning environment as very poor.
Key to the learning process is the interactions among students themselves, the interactions between faculty and students, and the collaboration in learning that results from these interactions. In other words, the formation of a learning community through which knowledge will be distributed is a high priority. The educators strongly believe that ICT make the students "passive recipients of knowledge". Kenway and Bullen (2000) point out that ICT wide implementation will bring more fundamental changes in the way educational institutes operate and most probably it will influence the future of the society. The main arguments are based on the following aspects: There will be a reorganisation of time and space caused by both technological and economic change which, in turn, impacts on local community and global relationships. Also, they introduce the concept of reflexivity, where people and institutions are shaped by ever changing structures of knowledge. Educators are obliged to make multiple and complex decisions which can lead to doubt and potential lack of ontological security.

The role of the educators

In the New World of accountability, conscientious professionals often find that the public claim to mistrust the HE educators- but the public still demand their services (O'Neill, 2002). E-education brings in light and transparent view not only the quality of the educators but also their competences in using the up contemporary technologies. As cited by Kenway and Bullen (2000) educators live on a "post-traditional order", where traditions are forced into the open and "called to account". Even though the policy of the department was based as a progressive implementation of e-education, some teachers did not accept the new approach. Gourales (2001) points out: "Changing the manner in which interaction occurs calls for redesigning not only of the formal structures within the company, but also in the informal patterns of interaction between individuals and processes". The majority of the teachers at the beginning of the project accepted the commitment to produce didactic material for the e-education but in the following years 80% of them did not enriched it. The above results are in accordance with Laurillard (2002) who makes important points about the lack of conceptual frameworks and the variability of academics engagement with ICTs, which reduce the potential gains they might offer. As a result of above attitude only 20% of the educators recognise the need of continuously improvement of the didactic material. The main reason for this attitude is based on the lack of staff training policy and support for the production of e-education materials. As a matter of fact students are not encouraged by the educators to use the facilities of the website. There is a possibility for the e-learning didactic material of separating the role of the teacher and the role of the author. Authors could produce the material and the teaching instructions that could be used by many teachers (especially for the part time teachers).

The Greek Higher Institutions in Greece use a significant number of part-time staff and short-term contracts. The mechanical engineering department is not an exception of the above rule. The 98% of the above staff felt reluctant to invest time and effort with the latest technologies. In some cases they refused to renew their contracts. In a way these staff feels "ICT marginalised". In the Higher Education context it could be seen as leading to professional disadvantage. Learning technology often seems an amnesiac field, reluctant to cite anything out of date (Oliver, (2003)).

The role of the administrators

The ICT implementation in Mechanical Engineering Department was not connected to the administration of students' data. It was limited to the educational process. As a consequence of this fact the administrators were out of the whole process, their behaviour was neutral, and they had no reason to motivate the students to use the webpage of the e-class. It is my belief that the active participation of the administrators in the ICT implementation would facilitate and would enforce the students to use the new technology.

CONCLUSIONS

This paper has attempted to look the influence and the results of the three years implementation of ICTs in the education process of Mechanical engineering education of TEI Patras. Importantly, in Higher Education, as courses expand and embrace learning technologies, the results of this research could provide useful guidelines about the design of the courses the needed support for the older teachers and the training of the administration staff. However, it is apparent that the importance of professional learning communities should not underplay when developing and running courses in contemporary Higher Education. The importance of this collaborative aspect of professionalism is emphasized by Freidson (2001), who refers to "disciplines" and "epistemic communities". Additionally, the presence of ICT "enthusiasts" can assist the design and developmental process, allowing the potential pedagogic gains of ICTs to be maximised. The development of critical and inquiring pedagogic gains of ICTs community can challenge the pedagogical validity of often market-driven "down-loadable" approaches to knowledge construction.

The experience of the implementation for the major stakeholders could me summarised as follows:

The data suggest that mechanical engineering department teaching does not adhere to the precise definition of learner-centred. The ICT could facilitate and re-define the learner-centred approach. Also ICT provides new opportunities of improving the access to didactic material at the convenient time of the students, according to their needs. Following this sentiment, the author as an ICT enthusiast, does not dismiss the value of lecturing or suggest the engineering education discard lecturing as an instructional approach. Consistent with Van Driel et all (1997), I strongly believe that having a more formal understanding of department's teaching approaches would inform and support educational reform efforts.

Students and teachers will require support moving from "pen and paper"- based engineering education to those based on ICTs. For students the key issue is gaining confidence in the use of the technology and their early preparation for their future working environment. For teachers the issues relate to changing workloads, new pedagogical approach, the effective use of new technologies and advanced software, quality assurance and careful evaluation of systems.

ICT implementation is a good opportunity in developing a learning community and a new learning environment, provided that the new staff appointments will guarantee sufficient knowledge of e-education techniques and will promote the use of ICT in every subject matter.

The stakeholders of the University in 21st century must realised that cannot ignore the new academic framework of the e-education. The University must be prepared for a new status in which new tasks are generated. When ICT Is used in the existing education process, it does not bring as much innovation as it does in a new education process developed around this approach. It replaces former manually or mechanically performed activities that improve the quality and efficiency of the educational processes. The basic question for the educators remains fundamental: How to improve the quality of the engineering education and give satisfaction to our students, taking into the account that the number of students increase dramatically while the funs remain the same at the best case? We can try to accept the answer: The effective use of ICT could give the solution to contemporary challenging matters. Institutions will face hidden costs, but the benefits will accrue in the form of stimulating and challenging environments for learning. The self-reflection of the educators related to their teaching approach and the continuous improvement make them "thinking visible" as well as to create a sense of community. Above approach will provide the opportunity to the students to express their alternative conceptions and to spread the collective knowledge which has been developed through virtual open discussions.

Greece is a relatively small country and it is easy a virtual cooperation to be developed. As the majority of the Mechanical Engineering departments run similar courses it would be for the benefit of our students if the tutors start to cooperate and share the same didactic material. A national cooperation would improve dramatically the efficiency of the tutors and also it would improve the quality of the e-education. Also it would be easies and less costly the establishment of an e-education quality assurance system and widely accepted. The "enthusiasts" of ICT must stop working individually, and become more integrated into their course teams and professional learning communities.

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