GC 2006-174: THE ROLE OF E- AND BLENDED LEARNING IN THE STRESS FIELD OF A FAST CHANGING INDUSTRIAL WORLD FOR CEE

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The role of e-learning and blended Learning for continuing engineering education in the stress field of a rapidly changing industrial world

Abstract: Today requirements from industry demand new ways of learning and teaching. Companies are no longer closed systems. They work internationally, linked to networks and collaborative workgroups that are operating on a virtual basis with shared knowledge management methods. To solve the problems of today, more than technical knowledge is required. Motivation, social competencies, languages, communication and leadership qualities have to be taken into account. Personalised learning itineraries delivered through e-learning scenarios and blended learning courses fit the needs and allow universities to capitalise on their expertise. This is confirmed by the practical example of the Ecodesign Course – environmental product design – offered at Vienna University of Technology.

Today, companies have to face new requirements. Technology changes rapidly, new work processes and methods are developed, product and market systems are becoming more complex, and outsourcing to cheaper locations is a daily reality. Innovation and product development are key success factors to prevail in the market.

Universities and organisations offering professional development and continuing education have to understand and recognise these needs. The difficulty to define what is necessary for companies is based on the requirements companies face, leading to the need to find new ways of learning as mirrored in new terms like just-in-time learning or learning on demand and the necessity of new competencies for engineers.

New requirements of universities and educators mirror the situation in industry. Teachers and students come from different backgrounds and knowledge levels, learning styles and methods differ, and motivation is becoming crucial. Universities and educational organisations have to face challenges such as budget cutbacks, situations with insufficient funding or other restrictions that make it difficult to survive.

On the other hand, the market segment of continuing education today is six times bigger than twenty years ago. However, its market share has increased by only 20%. Universities have not yet recognised their advantages towards private organisations.

Findings of the World Conference on Continuing Engineering Education in Vienna

The World Conference on Continuing Engineering Education (held April 19-21, 2006 at Vienna University of Technology in Vienna, Austria) offered a number of presentations and workshops about the future of Continuing Engineering Education. The position at the conference as the main author of the reporters team opened the opportunity to virtually see all presentations and their interconnecting topics.

It was possible to identify the following main issues for Continuing Engineering Education (CEE):

- design, didactics and course development,
- institutional framework,
- R&D, innovation and entrepreneurship,
- information and Communication Technologies.

The highest number of conference contributions referred to design, didactics and course development, followed by contributions about the institutional framework; R&D, innovation and entrepreneurship also played an important role. Technology was covered only marginally A rather small group of presentations already offered recommendations of how to fulfil the needs and requirements, giving suggestions for strategies and policies.

Interesting new approaches and course concepts show that abilities such as being creative and being able to implement innovation in practice gained importance. Learning is combined with R&D work. Entrepreneurial activities and innovative activities serve as an enterprise accelerator.

The findings presented at the World Conference on Continuing Engineering Education confirmed that the key issues identified across borders are the same.
The following requirements are crucial for the success of CEE:

- inter-disciplinary and cross departmental
- training and courses have to be offered internationally and in the English language,
- personalised and adapted delivery.

It has been shown that it is crucial to think of different types of learners: dependent, collaborative and autonomous ones. Personalised learning itineraries are necessary to fit companies´ needs. Requirements like the lack of time for education and therefore the need for a flexible and modular structure for a student-centred and self-regulated way of learning reflect the requirements of industry.

In this context, communication becomes essential – for several reasons:

- Complexity on the technological and on the managerial level is increasing.
- Students and teachers are very inhomogeneous in terms of motivation, knowledge, background and culture.
- The environment is changing rapidly.

These hidden conflict areas – which could easily grow to become real problems – can only be solved by using active, continuous and perceptive communication between all parties involved. This does not only include students and teachers, tutors and coaches, but also the HR and R&D departments of industry as well as heads of academic institutes and faculties of universities.

The growing complexity of problems and tasks of society today and the rapidly changing environments demand that individuals are not only able to handle technological change **(technological expertise)**, they also need problem-solving competences on an emotional and social level **(emotional intelligence)**. The integration of social and human values has become the challenge and the opportunity of today.

It is not the issue any more to find the technological solution to a problem, but to be able to master instrumental and competing relationships, evaluate values and norms, set goals and

standards, and take decisions that can be carried out by all parts of society. Leadership qualities and the ability to work in inter-disciplinary teams are the competencies companies are looking for.

Industry requirements state that learning and working are not divided anymore. This results in the demand for education using real life or close to real life projects. The principle of learning-by-doing, based on the concept that successful learning only takes place when acquired knowledge can also be applied and experienced, has to be taken into account, integrated into educational course design.

Recommendations from virtually all the presentations at the WCCEEmentioned in one way or another that only win-win situations work. Successful examples always involve joint visions with strong commitment of the partners and interaction in networks of industry, universities and in society as a whole.

It is concluded that universities are well-advised to look for and promote industry relations. Institutional interfaces between universities and CEE institutions to industry and society can play an important role in helping to maintain mutually beneficial relations on a long-term basis ensuring sustainability and growth.

Delivery of Continuing Education through E-learning and Blended Learning

A learning situation involves many different actors (learners, teachers, learning material and tutors) who are interlinked by various communication processes. For the success of learning, , whether face-to-face or electronically, feedback for the learner has to be provided. In traditional teaching, many elements of a learning situation are pre-determined, some elements can be influenced and determined by the educational institution, few or none can be influenced by the learner. But learners learn for different reasons, want to achieve different goals, have different previous knowledge, want to reach different levels of expertise, have different ways of how to acquire knowledge, etc. The more elements can be influenced by the learner – while at the same time preserving the high quality of the course - the better the course fits his or her individual requirements and the more beneficial it will be for the learner and his or her working environment. E-learning and blended learning offer a way to deliver a self-constructed and self-regulated way of learning.

The factors for success of e-learning are far more complex than for the success of the traditional class teaching situation which typically depends mainly on the personality of the teacher. Processes and relationships have to be taken into account before content production can take place.

The teachers' role has changed drastically. It is necessary to teach the core competencies in individual subjects to enable learners to build on this basis. An important factor for e-learning is to motivate learners. Communication and communication technologies give us the freedom to use different media and methods to transport the message to the learners. Processes and relationships have to be taken into account.

Virtual communication requires different support from teachers and experts. Active tutoring has proven to be very successful to substitute personal contact and traditional on-site teaching. A tutor or facilitator not only co-ordinates learners' activities, but also becomes a mediator between the learners and the different authors and experts in the field. Independent from the course content, learner activities are designed and monitored centrally and over the whole

duration of the course. This active facilitation has turned out to be a key to success in continuing education – see (Reichl, Vierlinger, Obermüller 2004) and (Reichl, Payr, Csanyi, Vierlinger 2001).

Especially in continuing education of engineers, self-directed learning is most effective. Significant learning is much improved if learners are given the opportunity to discover laws, concepts and theories – they should not be taught but coached – see (Sparkes 1985) and (Schön 1987). A facilitator should be willing and interested in helping the learners; facilitators should not repeat the contents or immediately answer the learners' questions; they shall help the group of learners to discover the answers by themselves – see (Gibbons 1977) and (Rowntree 1992).

The most important task of a facilitator is to take a "motivating" action – not in the sense of reinforcing extrinsic motivation (e.g. by sanctions), but by building a learning group that develops its own social dynamics and commitment.

In short, the facilitator has to react timely to every input by a participant, triggers self help and group support instead of direct answers by the facilitator or expert, and keeps the team learning going by setting tasks and deadlines, by ensuring information flow among participants, by being supportive and communicative.

It has now become visible that technological and managerial requirements in industry today somehow sound similar to how tasks and processes can be set up as a virtual environment on an e-learning platform. E-learning can simulate real life situations and practical learning, thus making it an ideal form to foster innovation. Learners are acting in a virtual environment that is almost real life; sometimes it is real life: take the scenario of a collaborative team of young engineers in the product development department, geographically located across Europe, coached and managed by a senior engineer who – depending on the respective problem or task to be fulfilled at the moment – switches between his role as an expert or coach and as a team member. In this case of work based learning, learning and working are the same; thus, it accurately pictures the working environments in industry.

The following advantages of e-learning compared with traditional learning in the context of the requirements of industry recommend the application of E-learning:

- **Independence from time and geographical location:**
  E-learning is fostering the requirement for collaboration and communication in a unique way by connecting people in a time and location independent way.
- **Communication:**
  Communication between learners and experts can be tuned to a very effective and practical way, ensuring that time resources are wisely used. Different forms of synchronous and asynchronous communication between the learners and between learners and experts are available.
- **Personalised and adapted delivery:**
  Content and background knowledge is accessible on different depth levels allowing the learner to individually choose and consume the respective parts needed.
- **Quality**:
  E-learning content can easily be kept up-to-date reflecting the high speed of change in technologies. Processes can be designed to fit to the respective tasks, close to or equal to practical reality in working environments.

- **Complexity / Inter-disciplinarity:**
  Problems today can only be addressed in an inter-disciplinary way requiring inter-disciplinary teaching and collaborative content production.

Universities have a unique selling proposition in this context and many have not yet capitalised their expertise. Following advantages in the market segment of education are waiting to be discovered:

1. University based continuing education is characterised by its vicinity to research – the birthplace of new knowledge. R&D and innovation are closely linked and can not be seen separately. Universities are in the unique position to offer to industry: R&D as a basis for innovative products and - implicitly or explicitly - continuing education at the same time.
2. Learners ask for university certificates, diplomas and degrees because they are highly valued in industry. Only universities can offer that.
3. Universities' most important and most innovative staff members and faculty usually have a unique expertise and knowledge in their field. They are well-connected and recognized worldwide. The development of e-learning content in the expert fields of a university creates a leading position at the "knowledge market" on a long-term basis.

This can be the basis and criteria for the selection process of course material to be developed. Focusing on these advantages it becomes obvious where to start. Detailed information on the potential of the own institution is the basis and key factor.

It is fundamental that the evolvement towards e-learning has to take place slowly and steadily. Equally important is that the courses fit with the overall position and image of the university.

This can be confirmed by the practical example of the Ecodesign Course – environmental product design - offered at Vienna University of Technology. The Ecodesign expert has been working in this field for more than 10 years, he is well-known and recognized internationally.

Ecodesign – Sustainable product development – a Blended Learning University Course offered at the Vienna University of Technology

Ecodesign has become more and more important for industrial companies, still it often needs a lot of enthusiasm to bring this topic to the attention of Austrian companies. The aim of the post-gradual university course Ecodesign is to learn how to apply a method for improving industrial products based on the principles of sustainable product design – see (Rester & Pohl 2005).

The course incorporates three disciplines in an inter-disciplinary learning platform: product design, production engineering and material selection. Facts and basic knowledge for all three areas are covered in the course material, in a library, and also in assignments during the first part of the course. The actors from different disciplines can cooperate via an online platform with different means of synchronous and asynchronous communication (chat, forum, email, etc.).

When completing the course, the learners shall be able to find innovative and sustainable solutions in their specific framework of action through using the Ecodesign method as a systematic approach. This ability cannot be assessed easily, since the outcome is not a simple reproduction of learned information. The students have to learn how to find the resources and know-how needed to produce innovative ideas.

However, for a successful application of e-learning, active learner support plays a very important role. Due to the various skills to be applied, learners need support to find the knowledge relevant for solving their specific problems. Such support does not aim at teaching the facts but to train the processes of retrieving the necessary knowledge (compare Rowntree 1992).

In the context of the Ecodesign course, one of the basic insights is that sustainable solutions accepted by all stakeholders can only be reached by co-operation amongst all disciplines involved, considering all the different viewpoints and integrating them into one solution. Only with the co-operation of experts from multiple fields of science and economy, innovative and successful solutions can be found. To apply the Ecodesign method for solving real world problems, it is necessary to cross the borders between disciplines. Thus, ideally the participating students work together in inter-disciplinary teams, complementing each other's knowledge.

This requirement was fulfilled by the learners in the Ecodesign course during winter semester 2004/05 at Vienna University of Technology: For the second part of the course, the participants could bring projects from their own working environment. The participants came from various backgrounds – some of them had engineering degrees, others had a management background or experience as researchers. The course demands a lot of technical expertise, knowledge about material selection, ways to join materials into products and industrial production as the basics for designing sustainable product solutions. Without controlling by teaching staff or course organisers, and without explicitly discussing it, the group composition reflected the requirements for trans-disciplinary co-operation. Each of the four project groups had at least one technical expert from the specific industrial sector, one person with management or marketing background and one researcher with experience in the respective industry.

The learners' presentations of their final solutions to the problems as well as feedback from the learners confirmed the importance of the co-operation between disciplines and among experts for finding applicable solutions. Even more, the participants could see the final solutions chosen by them composed from contributions by different group members and their specific knowledge; thus, real innovation was created through emergence of trans-disciplinarity. Since cross-disciplinary skills are not "magically" generated within the learners' heads from exposing them to separate input from the different disciplines, innovative forms of acquisition of knowledge and skills are required.

The first steps towards such a collaboration can be quite hard to take, since there often are social reasons why participants would decide not to work together, e.g. competition between students, industries or disciplines. The tutor continuously has to initiate steps to overcome such social "barriers" and thus create a climate of trust and rules for fair and balanced knowledge exchange. To really perform this function, the tutor has to possess and apply intuition on how to individually approach each learner personally, based on his/her specific background and specific way to learn. The tutor has to create a climate where open interaction between experts in different fields and with different personalities can take place to initiate and support a critical dialogue.

Based on these positive experiences and on the numerous enquiries from participants to see the solutions of the work assignments from all participants in the first part of the course, it is planned to motivate participants of future courses to form trans-disciplinary groups already

during the very first stage of the course. The exchange of individual solutions will promote the understanding and importance of the collaboration among different disciplines even further. The success of the course has led to the creation of a regulars´ table where diploma holders stay in contact with each other after completion of the course.

Conclusions

In order to stimulate innovation and economic growth in all social systems, it is necessary to actively promote the development of effective education and information tools as well as the respective communication channels between university and industry. The mutual acceptance of the different rationalities, roles and functions of the different systems of science and economy plays a fundamental role.

Continuing education is the basis for long-term university - industry co-operation and therefore has to be an essential part of a comprehensive university strategy. Technology transfer and continuing engineering education require an interfacial unit with the main goal to continuously support industry - university relations for a mutual benefit.

The development of E-learning and blended learning courses should be based on the potential of the providing institution involving the important and most innovative staff members as a key factor for taking a unique selling proposition in the educational market. The precondition is that universities understand e-learning as part of the university development process in the digital age rather than purely through the definition of the term e-learning. This involves the use of digital media in academic teaching and in university administration.

Feedback from industry on the relevance of the universities' initial education curricula is another important point that can be used for the strategic institutional development. In the growing international competition between universities and educational organisations it will be necessary to differentiate and to develop a more autonomous market position.

E-learning can be the foundations for services that do not only fit industry's needs but go beyond that by offering partnerships to foster innovation and growth on both sides. The re-use of learning resources in different contexts and subjects makes inter-disciplinary teaching possible and fulfils industry's requirements to counter all issues around the growing complexity of tasks. For example, a joint development of course material offers innovative ways to re-use the material in customer training or customer retention programmes.

The case study of the Ecodesign course has shown the potential benefits for university and industry, reaching far beyond the course itself.

Long-term and well-maintained industry-university relations are the key for improving the competitiveness of a region and a country.

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