Chapter 16
Designing Effective Web-Based Courses in Engineering

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ABSTRACT

Developing engineering study programs of high quality, able to satisfy customized needs, with flexible paths of study, with easy and rapid access to the most appropriate educational facilities and lecturers is a critical and challenging issue for the future of engineering education. The latest developments in communication and information technologies facilitate the creation of reliable solutions in this respect. Provision of web-based courses in engineering represents one of these solutions. However, the absence of physical interactions with the training facilities and the specificity of remote collaboration with lecturers rise up additional challenges in designing a high-quality web-based engineering course. In order to define superior solutions to the complex set of requirements, quality planning and an innovative problem solving are parts of web-based engineering courses design process. In this context, the present chapter introduces a generic roadmap for competitive design of web-based engineering courses. Methodology application is illustrated in a case study. An important conclusion arising from the case study is that no unique, best-of-the-world solution exists in developing a web-based engineering course; therefore customized approaches should be considered for each course category to maximize the impact of the web-based educational process.

INTRODUCTION

Today's evolutions in science and technology lead to a rapid depreciation rate of knowledge in engineering. There are areas where this rate is less than one year; however, countless opinions consider an average depreciation rate of knowledge in engineering around three years. Producing companies operate in environments influenced by globalization, emphasising horizontal integration, innovation and customer satisfaction, while focusing on small number of business areas. In this very demanding economic

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environment, continuous training of engineers is vital for ensuring business competitiveness from technological perspectives. The very wide areas in engineering study rise up many challenges on how to approach properly the educational process. Experience clearly shows there is no general pattern for success. Depending on the subject area, personalized models and means are required to maximize the impact of the educational process (Barros, Read & Verdejo, 2008; Brad, 2005; Ogot & Okudan, 2007; Popescu, Brad & Popescu, 2006). Dynamics of changes in the economic environment determines both undergraduate and postgraduate students in engineering to look for flexible, high quality and financially affordable paths of study, for easy and rapid access to the most appropriate educational facilities and to the most appropriate lecturers and trainers to satisfy specific needs. A good opportunity in front of such expectations stands in web-based education, which exploits the facilities provided by the latest developments in communication and information technologies to remotely access, either off-line and/or on-line, real and virtual labs, libraries, documentation, tutorials, seminars, courses, etc. (e.g. Bhatt, Tang, Lee & Knovi, 2009; Callaghan, Harkin, McGinnity & Maguire, 2008; Du, Li & Li, 2008, Ebner & Walder, 2008; Helander & Emami, 2008).

Provision of web-based courses is not a simple task (Finger, Gelman, Fay & Szczerban, 2005; Lau, Mak & Ma, 2006; Li & Wang, 2007). Beyond the immanent technological challenges, there are other issues that require meticulous treatment. Life-cycles of most engineering courses are very short, therefore a major concern on designing and developing high-quality courses from the very first time occurs; that is, a concern for effective and efficient engineering course design. Web-based engineering courses rise up supplementary requirements and must overpass additional constrains than classical, face-to-face courses, like: virtual collaborative experimentation, interactive remote approach, collaborative remote learning, off-line active learning, cross-institutional collaboration, remote test and assessment (e.g. Helander & Emami, 2008; Hutchings, Hadfield, Horvath & Lewarne, 2007; Jou, Chuang, Wu & Yang, 2008; Mackey & Ho, 2008; Rizzotti & Burkhart, 2006; Wang, Dannenhoffer, Davidson & Spector, 2005). Therefore, a comprehensive planning is required to design a high-impact web-based engineering course (Bier & Cornesky, 2001; Brad, 2005; Brad, 2009; Koksal & Egitman, 1998; Ogot & Okudan, 2008).

For web-based engineering courses, special attention should be given to course structure, course subject, communication technology, teaching process management, costs, effort and time to prepare the course, dynamics of information, dynamics of the educational models, technology to provide the information, etc. (Barros, Read, & Verdejo, 2008; Du, Li & Li, 2008; Ebner & Walder, 2008; Helander & Emami, 2008; Li & Wang, 2007; Saygin & Kahraman, 2004; Sessink, van der Schaaf, Beeftink, Hartog & Tramper, 2007; Toral, Barrero & Martinez-Torres, 2007; Vargas, Sanchez, Duro, Dormido, Farias, Dormido, Esquembre, Salzmann & Gillet, 2008; Xuelian, 2008). All these areas of intervention are important for setting up a competitive web-based course in engineering. From this perspective, a web-based engineering course is revealed as a complex adaptable system (Brad, 2008). A web-based engineering course, seen as a "living" complex adaptable system, should be able to internalize information, to modify its parameters and behavior over its life-cycle, to compress information gathered from the interaction with the external environment and to "learn" from this interaction. Thus, a web-based engineering course should be evolutionary; and from this point of view the search is not for the "best of the world" solution (because it does not exist) but for mature solutions able to balance various dimensions characterizing a web-based engineering course. Elementary aspects about these dimensions are further brought into discussion.

The first dimension is referring to the course structure. The web-based course structure usually

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