A Numerical Methods Course Based on B-Learning: Integrated Learning Design and Follow Up

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ABSTRACT

Information and communication technologies advance continuously, providing a real support for learning processes. Learning technologies address areas which previously have corresponded to face-to-face learning, while mobile resources are having a growing impact on education. Numerical Methods is a discipline and profession based on technology. In its education, technology has been included in the curricula as a basic tool given the complexity of applied mathematical problems. This paper presents a blended learning design for a Numerical Methods course for engineers, combining class, online and mobile activities to strengthen and to develop different abilities related to it. Mobile activities have been incorporated into the latest design, including an e-book with online resources prepared specially for this course. The follow up for the last three years shows a meaningful impact due to growing use of technology compared with previous practice.

Keywords: Blended, Course Design, Mathematics, Mobile, Online, Performance Comparison

INTRODUCTION

Current generations have an expectation of freedom to work, learn and study anywhere and anytime. In addition, other challenges are present in education: the increasing professional value of digital skills, pressure for more economic educational models with improved outcomes and a greater demand for personalized education (Laurillard, 2008).

Current educational trends normally include the acquisition of technology skills, which have been identified as success factors for professional life. This underlies a growing demand for easily accessible educational resources through different media. In higher education, this contrasts with some resistance to change by faculty, while students are turning to alternative education in order to learn different subjects by multiple media, mainly via the Internet (Laurillard, 2002; Johnson et al., 2011a).

All these aspects are developed and fostered by a very fast technology evolution which is impacting on each generation of students and every discipline which uses it. In particular, mobile technology is now a new option to stay always connected with the world and information. This technology is proving to be a creative and innovative media through which education...
may reach its final consumer (Traxler, 2009). It is estimated that in the current year, it will be the primary channel for Internet access by at least 80% of users around the world (Johnson et al., 2011b).

In recent years, there are a growing number of experiences in mobile learning (m-learning), driven by an exponential spread of this technology. Many of these experiences are in primary and secondary education, proposing innovative mobile applications (Apps) for specific educational goals: mathematics, languages, science, etc. These Apps were developed fulfilling recommended pedagogical issues (Conole et al., 2008; Laurillard, 2008), and particularly taking care of learners’ expectations (Conole, 2008). In contrast, m-learning experience in higher education is still limited and commonly centered on the construction of repositories, with mobile learning advantages related to accessibility, but seldom with improvement of learning or increasing education quality (Traxler, 2009; Laurillard, 2005). Nevertheless, mobile technology in teaching is increasingly more common in higher education with the use of associated software and/or use of multimedia resources and online activities (Laurillard, 2002), so many courses at this level are now adopting this practice.

This paper shows the evolution and the evaluation of a Numerical Methods course using a blended learning (b-learning) scheme, using technology to improve lifelong learning and to give support to students by combining the use of computers and mobile resources. In this design, mobile technology has addressed different needs from the main technology implementation to enhance the professional use of the discipline, providing abilities for employment, high quality courses and flexibility to study Laurillard (2008). The analysis and the evaluation presented are based on high-level abilities (González, 1997) developed in the course due to a complementary use of technology, in order to understand their dependence. Supplementary information about mobile resources and students’ perception of their educative value is reported too.

**CONTEXT AND FIRST EXPERIENCES IN B-LEARNING**

Numerical Methods courses are mandatory in most engineering programs at university. This discipline has been rapidly developing with the evolution of technology. Its traditional teaching has changed dramatically in recent decades, since its birth as modern discipline in the early 1940s, with the spread of computer systems, and their affordability. For this reason, in the last ten years, rapid expansion of technology forced a fast ongoing adaptation of curricula and teaching methodology. The spread of programming languages, use of software and inclusion of real applications allowed a transition from a Numerical Analysis course into a modern Computer Simulation course. Some years ago, the absence of emphasis on visualization and simulation left a gap between theory and professional practice (Delgado, 2008b). Subsequently, their inclusion has allowed us to integrate the engineering curriculum and to develop higher order thinking abilities (Delgado & Martinez, 2011).

**Context of the Course**

In its most traditional form, the Numerical Methods course in our university has been directed to learning content just based on classical numerical methods. Currently, technology affordability lets us accompany the course with: a) a professional tool for visualization in agreement with interests in engineering programs (using Mathematica for engineering programs or Python for computer science programs), b) a continuous programming practice by teaching the class full time in a computer lab, and c) a simulation project development based on integration of several numerical methods in order to mathematically analyze complex engineering problems. Note that this last aspect is rarely considered in traditional courses and books in this discipline.

In our engineering curricula, this course has evolved thus. Ten years ago it barely contained the use of Fortran or C++ as programming
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