Computers in Human Behavior 30 (2014) 614–622

Contents lists available at ScienceDirect

Computers in Human Behavior

journal homepage: www.elsevier.com/locate/comphumbeh

Adapting the Technology Acceptance Model to evaluate the innovative potential of e-learning systems

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ARTICLE INFO

Article history:
Available online 22 August 2013

Keywords:
E-learning
Evaluation
Technology Acceptance Model (TAM)
Tracking
Learning outcomes
Educational innovation

ABSTRACT

This paper describes an experience where the Technology Acceptance Model (TAM) has been adapted for use in the evaluation of methodological and technological innovations determined by the introduction of a new e-learning system in an Italian online university. While the original TAM allows one to assess acceptance and adoption of a new technology, in this case there was also a need to consider all the phases of use of the system (course design, running and evaluation), all the users of the system (students, teachers and e-learning management), and all the system's components (the e-learning platform, the learning resources and mostly the underlying pedagogical approach). The resulting model, which is an extension of the original TAM, is a three-dimensional one, with three aspects to be considered on each axis (phases of use, users and components). For each of the 27 combinations of these aspects, indicators of usefulness and ease-of-use have been identified. When available, data concerning actual use (derived from the tracking functions of the platform) and effectiveness (based on teachers' adoption of new tools and students' learning outcomes) have also been used to complement the data.

1. Introduction

E-learning is becoming an increasingly widespread approach in higher education institutions in Europe and worldwide. Many traditional universities are equipping themselves with e-learning systems with the aim of providing not only a common platform for course management and delivery, but also a common space hosting the communication and sharing processes that are needed by a lively learning community. In many cases, the aim is to determine a profound change in the way teaching and learning take place in universities, from the still widespread transmissive model to the more participated, self-regulated and interactive approaches that are believed important to develop a solid base for life-long learning in our citizens (Garrison & Anderson, 2003).

However, it is well known that such a change does not take place overnight (Laurillard, Oliver, Wasson, & Hoppe, 2009; Conole, White, & Oliver, 2007). The availability of a technological infrastructure is not sufficient to determine the uptake of new approaches, either on the side of the teachers or on that of the learners. Even in online universities, which are not strongly rooted in a tradition of face-to-face teaching, innovative methods often fail to be adopted because of a complex tangle of reasons: the university staff must be trained not only in the use of technology, but also in the new collaborative online methods, and the organisation of the university must be fit for the purpose. Even the students' expectations and learning habits might turn out to be part of the problem (Persico, Manca, & Pozzi, 2012a, 2012b; Piskurich, 2003).

The process of change ignited by the introduction of a new e-learning system is thus bound to have a slow, complex evolution that needs to be understood and sustained, rather than just evaluated in a summative way. Models for scaffolding the innovation process should be accompanied by evaluation approaches that are able to appreciate changes, even small ones, in the whole complex e-learning system, intended as a comprehensive disposition including not only the technological platform, but also the way people use it, not only the outcomes, but also the process which is being undertaken.

This paper aims to present the approach adopted to investigate the impact of the introduction of a new e-learning system into a small Italian online university. The study was aimed at gathering information about the suitability of the new system for the needs of its different users (students, lecturers and e-learning management staff) in the various phases of development or re-purposing of its courses. Given these premises, the e-learning system in question was not seen just as a new hardware and software platform for use by lecturers and students, but as a complex environment comprising the technological platform, the underlying pedagogical approach and the related learning materials. The intent of the evaluation was diagnostic and formative, that is, aimed at detecting critical issues and identifying ways for further development and improvement of the system itself.

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0747-5632/$ - see front matter © 2013 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.chb.2013.07.045

The evaluation model adopted in the study was an adaptation and extension of the Technology Acceptance Model (TAM) (Davis, 1989). While the TAM focuses on perceived ease-of-use and usability as the main indicators to investigate the impact of a new technology on its users, the approach proposed in this study extends its outreach by triangulating such evidence with information about actual use of the system, obtained thanks to the tracking capabilities of the e-learning system, and data on the effectiveness of the formative processes in terms of changes produced in the teachers' pedagogical approach and students' learning outcomes.

The paper is organized in five sections: this introduction, the theoretical framework of the study, the study method, the main results of the study, discussion of the results and the conclusion.

2. Theoretical framework

When looking at evaluation from the point of view of its goals, a distinction is usually made between formative evaluation, aimed at obtaining both general and detailed information in order to improve the object of evaluation, and summative evaluation, aimed at formulating a comprehensive judgment on the object to be evaluated, often with certifying purposes (Guskey, 2000; Zinovieff, 2008). When the object of the evaluation is an educational system, formative evaluation is usually carried out *in itinere*, so that problems are identified and dealt with as early as possible while the system is being developed and implemented (Bloom, Hastings, & Madaus, 1971; Flagg, 1990; Macdonald, 2003; Scriven, 1991). This can be done through field tests involving a subset of the target population before the whole system is adopted by the complete students' cohort of a given institution. Summative evaluation, on the other hand, is usually carried out at the end of the learning process, or at any particular stage of its development where a global judgment of the results is needed.

The above-mentioned concepts have been used and investigated for over 50 years in both face-to-face and distance education (Scriven, 1967; Bloom et al., 1971). The meanings of the terms have remained basically unvaried, whilst the methods used to carry out the evaluation continue to undergo many changes due to the evolution of the teaching and learning methods and of the technological affordances.

According to Guskey (2000), in order to evaluate a learning system, a systematic study should be carried out to judge its effectiveness, its fitness-for-purpose, its efficiency and any other aspect deemed relevant. The evaluation process normally includes the collection, analysis and interpretation of information on its various aspects, such as the quality of learning materials, the effectiveness of the teaching and learning approach, the suitability, user-friendliness and efficiency of the tools used for communication exchanges (Alvino & Persico, 2009). When the system is technology based, acceptance by all of the actors involved, of all of the system's components – technological, human and methodological – is considered of paramount importance, because it covers many of the above aspects (Venkatesh, Morris, Davis, & Davis, 2003).

To assess users' acceptance of a technological innovation, one of the most well-known models is the Technology Acceptance Model (TAM), originally proposed by Davis (1989). At the core of the TAM are two important acceptance indicators: perceived *ease-of-use* and perceived *usefulness*, which respectively refer to "the degree to which users believe that adopting a particular technology would be free from effort" and "the degree to which a person believes that using a particular system would enhance his or her job performance" (Davis, 1989, p. 320). The TAM has subsequently been extended and adapted by various authors. For example, TAM2 (Venkatesh & Davis, 2000) includes "subjective norm determinants", i.e. indicators of "the person's perception that most people who are important to him think he should or should not perform the behavior in question" (Fishbein & Ajzen, 1975, p. 302). Another well-known extension is UTAUT (Venkatesh et al., 2003; Venkatesh, Thong, & Xu, 2012), aiming to synthesize previous TAM versions in an effort to relate technology use to Performance Expectancy, Effort Expectancy and Social Influence. As demonstrated by Lee, Hsieh, and Hsu (2011), the TAM can also be effectively combined with Rogers' Innovation Diffusion Theory (Rogers, 1995), to investigate innovation processes.

Although the original TAM model was not specifically developed for the evaluation of e-learning systems, its two core indicators are often used to assess the impact of technology in educational contexts. However, given that acceptance alone does not guarantee effective learning processes, the TAM indicators are not sufficient to assess the impact of educational innovation (Edmunds, Thorpe, & Conole, 2012; Park, 2009; Teo, 2009; Un Jan & Contreras, 2011). As a consequence, rather than adopting more refined models of technology acceptance, further extensions of the TAM for evaluating e-learning systems need to take into consideration indicators of quality of the learning processes and of the learning outcomes.

Indeed, several authors (Lee, 2005; Novo-Corti, Varela-Candamio, & Ramil-Díaz, 2013) indicate effectiveness as a key factor in the evaluation of a learning system, because detailed information about effectiveness can lead to reflection and revision of the educational approaches adopted. The assessment of effectiveness usually takes into consideration the extent to which the learning outcomes have been achieved, possibly compared to those obtainable with similar or previous approaches and methods. This indicator is rather difficult to measure empirically, unless all the variables involved can be controlled, which is rather difficult to do in real life environments, such as field tests. So, the analysis of the students learning outcomes can yield useful indications about effectiveness, provided that great caution is taken in interpreting them. However, another indicator of effectiveness, in educational innovation, is a measure of the (positive) changes taking place in the learning process, and this is often easier to verify.

In digital environments, learning processes can be monitored thanks to the tracking capabilities featured by most e-learning platforms (Trentin, 2000; Daradoumis, Martinez-Monés, & Xhafa, 2004; Persico, Pozzi, & Sarti, 2010). All of the actions performed by users inside the system can be tracked and analyzed (automatically or semi-automatically) to provide both quantitative and qualitative information about the use of the system. Indicators of system use may relate to fruition of material, completion of and performance in learning activities, communication exchanges with other participants, sharing of material, resources and ideas, but also motivational and emotional aspects (Aviv, Erlich, Ravid, & Geva, 2003; Dettori & Persico, 2008; Martinez, Dimitriadis, Rubia, Gomez, & De La Fuente, 2003; Pozzi, Manca, Persico, & Sarti, 2007; Schrire, 2006).

This paper therefore proposes an approach to the formative evaluation of an e-learning system that, in agreement with much of the literature (Ardito et al., 2006; Britain & Liber, 1999; Giannakos, 2010; Silius, Tervakari, & Pohjolainen, 2003), is considered as a comprehensive set of components comprising virtual and/or real learning environments, human resources and learning material. Special attention is paid to the underlying methodological approach that, explicitly or by tacit agreement, pervades the whole system and heavily influences the work of those who use it (i.e., institutions, teachers and learners). Finally, since the system was introduced in the context of an innovation initiative, the evaluation study is strictly integrated with all of the actions aimed at supporting the innovation itself (Lanzilotti, Ardito, Costabile, & De Angeli, 2006; Rovai, 2003), such as, for example, staff training and monitoring of the uptake.