

1 Introduction

For decades electronic learning systems constitute the basic enablers of e-learning in the private and public sectors. Though designations as categorisations of such learning systems are rather heterogeneous and also change over time, current systems can be pooled under the rubric of virtual learning environments (VLE).

VLE can be understood as electronic information systems (IS) for the full administrative and didactical support of learning processes in (higher) education(al) and vocational training settings. They provide systematically learners with adequate learning resources (i.e. learning materials and tools) to develop intended qualifications (e.g. Fry, Ketteridge, & Marshall 2009; Hornik, Johnson, & Wu, 2007; Strohmeier, 2008; Weller, 2007). In accordance with the literature, VLE are referred to the entire category of technology enhanced learning systems (Seddon, Staples, Patnayakuni, & Bowtell, 1999), offering full administrative- and didactical-supportive functionalities. In consequence, each sub-category of technology enhanced learning systems is included, e.g. adaptive learning environments (Tobing, Hamzah, Sura, & Amin, 2008), blended learning systems (Wu, Hsia, Liao, & Tennyson, 2008), digital libraries (e.g. Hong, Thong, Wong, & Tam, 2001-2002), distance education systems (e.g. Cho, Cheng, & Lai, 2009), e-learning services (Chiu, Hsu, Sun, Lin, & Sun, 2005), enterprise e-learning systems (Wang, Wang, & Shee, 2007), online courses (e.g. Sun, Tsai, Finger, Chen, & Yeh, 2008) or learning-related search engines (e.g. Liaw, Chang, Hung, & Huang, 2006). Likewise, the VLE concept is not restricted to any application domain originating in the huge plethora of different (higher) education(al) and vocational training settings (e.g. companies, schools, [distance learning] Universities). In brief, VLE are seen as the main comprehensive category in the domain of technology enhanced learning systems.

An ideal-typical VLE architecture encompasses an administrative database, a content database as well as an administrative, analytical, communicational, authoring and learning process management component (Bodendorf, 1993; Strohmeier, 2008). Depending on the kind of learning process management component, linear VLE are distinguished from adaptable and adaptive ones (Bodendorf, 1993; Strohmeier, 2008). Whereas linear VLE show a simple, non-adaptive sequence of learning materials that are equal to every single VLE user (synonymously called end user/learner/student), adaptable VLE enable the user to specify the

learning process actively (e.g. modifying the appearance of a VLE's graphical user interface, having control over the learning sequence) (Strohmeier, 2008). As distinct from this, adaptive VLE allow for an automated personalisation of the overall learning experience (Strohmeier, 2008). To realise this, adaptive VLE build models of, for instance, users' context of work (e.g. local vs. mobile VLE) or users' (pre-)knowledge in order to adapt these models persistently to users' individual requirements (e.g. Brusilovsky & Millán, 2007; Brusilovsky & Peylo, 2003; Hoever & Steiner, 2009; Kopp, Stanford, Rohlfing, & Kendall, 2004; Tobing et al., 2008; Torrente, Moreno-Ger, & Fernandez-Manjon, 2008). Beside such ideal-typical manifestations of linear, adaptable and adaptive VLE, the frequently applied combination of adaptable and adaptive learning process management components allows VLE users to be in control of and, thus, improve the accuracy of the adaptive learning experience (Bodendorf, 1993; Höök, 1997). Hence, the subsequent elaboration primarily focuses on combinatorial configurations of adaptive and adaptable learning process management components (Bodendorf, 1993).

The usage of VLE is commonly justified on diverse advantages such as advanced collaboration and communication, convenience, (costs, didactics, learning) efficiency, VLE user control, personalisation, ubiquity, task orientation and timeliness of VLE-driven learning and teaching (e.g. Ozkan & Koseler, 2009; Sitzmann, Kraiger, Stewart, & Wisher, 2006). Such advantages may also explain the ever-increasing adoption and impact of VLE on the design and development of (higher) education(al) and vocational training curricula/programs (e.g. Holsapple & Lee-Post, 2006; Johnson, Gueutal, & Falbe, 2009; Wang et al., 2007).

However, VLE success strongly depends on the appropriate development, implementation and (continuous) improvement of VLE, since only well-designed and, hence, appropriate VLE yield success (e.g. Dennis, Wixom, & Roth, 2006; Kavanagh & Thite, 2009; Sommerville, 2007). This implies that VLE success is manageable, at least, to a certain degree (Strohmeier, 2009). In particular, the so-called design characteristics (synonymously called object-based beliefs) may support VLE-related stakeholders such as decision makers, system developers, system implementers and content providers, respectively, training and development-related stakeholders in accomplishing successfully VLE-related processes such as the development, implementation and improvement of VLE (e.g. Dennis et al., 2006; Kavanagh & Thite, 2009; Sommerville, 2007). Technically- (e.g. ISO, 2005) as well as managerially-oriented literature (e.g. DeLone & McLean, 2003; Venkatesh & Bala, 2008;

Wixom & Todd, 2005) congruently understands design characteristics as a set of those inherent IS properties which determine, respectively, explain/drive/predict IS success in general (e.g. Davis, 1993; DeLone & McLean, 2003; Van Aken, 2005; Venkatesh & Bala, 2008), and VLE success in particular (e.g. Cho et al., 2009; Wang & Wang, 2009). To enhance VLE success even further, the compatibility between these design characteristics and VLE stakeholders' requirements by means of user-centred design approaches should be constantly ensured (e.g. Bittner & Spence, 2003; ISO, 1999). VLE success from a VLE user viewpoint, in turn, is conceptualised as users' satisfaction with a VLE, users' (perceived) net benefits of using this VLE, or users' behavioural intention to use and actual use of it, among others (e.g. Davis, 1989; Davis, Bagozzi, & Warshaw, 1989; DeLone & McLean, 2003; Venkatesh & Bala, 2008).

Given this, it is of particular academic interest to support practitioners in the elicitation and evaluation of VLE stakeholder-relevant design characteristics so that they can develop, implement and improve VLE even more successfully (e.g. Hevner, March, Park, & Ram, 2004; Mueller, Strohmeier, & Gasper, 2010; Kavanagh & Thite, 2009). Taking into account the holistic VLE approach being pursued in this study it should be stated that generally valid design characteristics are of major interest. Such design characteristics are, hence, not restricted to specific sub-categories of technology enhanced learning systems or particular application domains these VLE are applied in. However, there is currently little research and, hence, knowledge concerning the systematic elicitation of a holistic set of well-defined, simultaneously detailed and operative VLE design characteristics (e.g. Cho et al., 2009; Fu, Chou, & Yu, 2007; Pituch & Lee, 2006; Sun et al., 2008). Eliciting such a holistic set of VLE design characteristics systematically, however, is an important prerequisite to better evaluate the impact of these design characteristics on relevant VLE success indicators (i.e. VLE success measures). Yet, before elaborating on the elicitation and evaluation of the desired VLE design characteristics in more detail, it is of major importance to further contextualise these crucial process steps. This, in turn, implies that both steps have to be embedded into, and enriched by, a broader set of aspects being relevant to and surrounding the elicitation and evaluation of VLE design characteristics. That is, without researchers' precise understanding of what to consider when eliciting and evaluating VLE design characteristics practitioners may draw the wrong conclusions based on prior, research-related misconceptions as they would rely on proper outcomes related to VLE design characteristics.

Therefore, the **first objective of this study** is to derive a multidimensional research framework simultaneously outlining and concretising particular aspects being relevant to and surrounding the elicitation and evaluation of VLE design characteristics. From a methodological point of view, however, there is a question if the proposed research framework has a) the potential and b) actual ability to simultaneously outline and concretise particular aspects being relevant to and surrounding the elicitation and evaluation of VLE design characteristics in general, and with a view to this study in particular. Besides, the question arises if the research framework has a) the potential and b) actual ability to derive the research design of this study in regard to the elicitation and evaluation of the desired set of VLE design characteristics. Finally, the relationship between the research framework, respectively, the research design and the theoretical underpinning of this study is clarified.

Based on this, the **second objective of this study** is to elicit for the first time a holistic set of well-defined, simultaneously detailed and operative VLE design characteristics systematically. From a methodological point of view, however, there is a question if the cumulative deployment of a literature review and a combined VLE expert-(i.e. course designer/learning facilitator/teacher, among others)/VLE user-oriented Delphi study supports the elicitation of the desired set of VLE design characteristics satisfactorily. This is due to the fact that both methods are considered to constitute a promising means to elicit and prioritise design characteristics appropriately (Mueller & Strohmeier, 2010; Mueller, Strohmeier, et al., 2010). There is the further question if there exists a theoretical underpinning that has a) the potential and b) actual ability to support the elicitation of the desired, holistic set of well-defined, simultaneously detailed and operative VLE design characteristics systematically?

Beyond that, the evaluation of the impact of these design characteristics on crucial VLE success measures is aspired, amongst them, users' behavioural intention to use and actual use of a VLE. However, in the absence of a completely developed theory of VLE design which would allow for a direct elicitation and evaluation of the desired set of VLE design characteristics, alternative foundations in the area of technology acceptance and general IS success research may be worthwhile to consider (e.g. Davis, 1989; Davis et al., 1989; DeLone & McLean, 2003). These foundations, however, show specific drawbacks if applied to the elicitation and evaluation of design characteristics, their impact on crucial VLE success measures in the shape of users' behavioural intention to use and actual use of a VLE included (e.g. Ajzen & Fishbein, 2005; Hong et al., 2001-2002; Mathieson, 1991). For example, in the

field of technology acceptance and IS success research there is currently no theory available that would provide more detailed information about VLE design characteristics than categorising them into *systems characteristics*, respectively, *system quality*, *information quality* and *service quality* (e.g. Davis, 1989; DeLone & McLean, 2003; Venkatesh & Bala, 2008). Similarly, none of these theories provides profound insights into the processes a) how are users' behavioural beliefs of a VLE determined/formed and b) how can these beliefs, in turn, be further influenced by means of specific VLE design characteristics to foster users' behavioural intention to use and actual use of this VLE and, thus, VLE success finally (e.g. Hong et al., 2001-2002; Mathieson, 1991)? To remedy these drawbacks the study builds further on, while extending, a promising theoretical amalgamation of two relevant theories in the field of technology acceptance and general IS success research (e.g. DeLone & McLean, 2003; Venkatesh & Bala, 2008; Wixom & Todd, 2005). The reason behind that is as follows: the IS success-, respectively, user satisfaction-oriented research stream provides rough categorisations of VLE design characteristics as mentioned above. As distinct from this, the technology acceptance-oriented counterpart provides sound predictions of individuals' VLE usage (intentions) by linking desired user behaviours related to a VLE/VLE success measures (i.e. users' behavioural intention to use and actual use of a VLE) with users' behavioural beliefs about this VLE that are consistent in time, target and context with the behaviour of interest (Fishbein & Ajzen, 1975; Wixom & Todd, 2008). Extending and amalgamating the key strength of each research stream, respectively, the corresponding theories related to them, it is presumed to evaluate the impact of the desired set of VLE design characteristics on crucial behavioural determinants (synonymously called antecedents/drivers) of users' behavioural intention to use and actual use of a VLE even better.

Hence, in reply to a recently articulated call for research (Venkatesh & Bala, 2008), the **third objective of this study** is to evaluate for the first time the impact of the desired set of VLE design characteristics to be elicited subsequently on crucial behavioural determinants of users' behavioural intention to use and actual use of a VLE in terms of the VLE success measures of this study. Such an investigation may reveal further, more detailed and operative, knowledge about design-related and behavioural drivers of users' current VLE use/refusal. Hence, practitioners are able to develop, implement and improve VLE as well as the learning materials inherent to them even more successfully based on more manageable and comprehensive VLE development, implementation and improvement guidelines, respectively,

corresponding VLE design interventions (Mueller & Zimmermann, 2009; Venkatesh & Bala, 2008; Venkatesh et al., 2007). From a methodological viewpoint, however, there is a question if the integrated research models to be derived subsequently have a) the potential and b) actual ability to remedy the weaknesses of their underlying theories indicated above so that researchers can evaluate the impact of the desired set of VLE design characteristics on crucial behavioural determinants of users' behavioural intention to use and actual use of a VLE. That is, do the integrated research models provide better insights into the processes a) how are users' behavioural beliefs of a VLE formed and b) how can these beliefs, in turn, be further influenced by means of specific VLE design characteristics to foster users' behavioural intention to use and actual use of this VLE and, thus, VLE success finally (e.g. Hong et al., 2001-2002; Mathieson, 1991)?

In order to achieve these objectives, particular aspects being relevant to and surrounding the elicitation and evaluation of VLE design characteristics in general, and with a view to the present study in particular, are contextualised by means of a multidimensional research framework. On this basis, the specific research design of this study is derived, and the relationship between the research framework, respectively, the research design and the theoretical underpinning of this study is clarified (Section 2). Subsequently, the theoretical underpinning is explained in more detail depending on which the integrated research models of this study are outlined (Section 3). By means of these research models, the desired, holistic set of VLE design characteristics is elicited (Section 4) and evaluated (Section 5), taking into account their impact on crucial behavioural determinants of relevant VLE success measures. In particular, these VLE success measures are: users' behavioural intention to use and actual use of a VLE. Finally, some overall conclusions are drawn (Section 6.1), particular implications for research and practice are derived (Section 6.2), and specific limitations of the approach undertaken are outlined (Section 6.3).

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