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The Relationship between LMS Use and Teacher Performance: The Role of Task-Technology Fit

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Abstract

The way in which instructors work has changed markedly since the introduction of learning management systems (LMS). This paper uses Goodhue and Thompson's (1995) technology-to-performance chain (TPC) as a starting point to explore the roles of task-technology fit (TTF) and level of LMS use in the performance impacts of LMS for instructors. A mixed method approach was used: an initial quantitative study followed by collection of additional in-depth data using open ended questions. The results showed that whilst TTF has a direct influence on instructors' perceptions of the impacts of the LMS on their performance, level of utilization is either not associated with performance impact or is associated with performance impact in ways that are not readily captured by simple linear modelling.

Keywords

Task-technology fit, technology to performance chain, learning management system, e-learning, IS success

INTRODUCTION

The way in which instructors work has changed markedly since the introduction of learning management systems (LMS). Whether courses are taught entirely online or whether a blended approach is used, most university instructors must design and develop online materials and create and maintain course web sites (Zastrocky et al. 2007), and LMS have become the predominant means of communication with students for many instructors.

Research on LMS use has focussed primarily on students with mixed results. Meta-studies confirm that, on average, there is "no significant difference" between the amount students learn with and without the aid of online systems, but that there is considerable variation in student outcomes depending on how instructors use the technology (Coates et al. 2005). In order to better identify what advantages have been obtained from their investments in ICT, universities are turning their focus toward academic users of LMS (Campbell et al. 2007; Laurillard 2007).

To date, there has been little research on the use of LMS by instructors, and even less on how using LMS impacts on teaching. Given the significant changes that LMS use has necessitated in the way instructors work, and the influence instructor perceptions of LMS are believed to play in the success of e-learning for students (Hartman et al. 2000; Newton 2003), research is required to investigate the performance impacts of LMS. Better understanding of this issue will benefit not just universities but also instructors, academics and professionals interested in the relationship between LMS use and teacher performance. This paper uses Goodhue and Thompson's (1995) technology-to-performance chain (TPC) as a starting point to explore the roles of task-

technology fit (TTF) and level of LMS use in the performance impacts of LMS for instructors. A mixed method approach was used: an initial quantitative study followed by collection of additional in-depth data using open ended questions.

Background research

The bulk of the previous research about instructor use of LMS has addressed factors that inhibit LMS use. The major inhibiting factors reported in the literature include the time needed to learn to use an LMS (Pajo and Wallace 2001), the time requirements for online teaching (Browne et al. 2006; Lazarus 2003; Pajo and Wallace 2001; Schifter 2000), lack of technical support (Browne et al. 2006; Schifter 2000), concerns about the quality of courses (Schifter 2000) and money to support development of courses (Browne et al. 2006; Schifter 2000). Time issues appear to be the dominant inhibiting factor. In their study, Pajo and Wallace (2001) found that the time required to learn how to use the technology was the most significant inhibitor. Continuing time requirements was also a significant barrier. The research, however, has not provided much insight into why the time factor is such an important issue for instructors. Woods, Baker and Hopper (2004) speculated that it may be partially due to the prevalence of blended courses. Instructors may perceive their overall level of work to be increasing as they add variety to their mode of teaching. This would account for the findings of McGill and Hobbs (2008) that instructors are less satisfied with their LMS use than are students. However, Yueh and Hsu (2008) have shown that it is possible to increase LMS usage by instructors, by focussing on appropriate design of LMS. This suggests that if LMS support the work of instructors well they will be used more.

Given that the work of instructors has changed in response to the introduction of LMS, research that explicitly addresses the performance impacts of LMS on the work of instructors is required. LMS are information systems (IS) as their goal is to process, store and disseminate educational material and to support communication associated with learning. Instructors use them to support their teaching and class management tasks. Models that address the use and success of IS should provide effective frameworks for research that explicitly addresses the impacts of LMS on the work of instructors. Goodhue and Thompson's (1995) TPC is one such model.

Goodhue and Thompson (1995) argue that an understanding of IS success needs to incorporate both the task for which the technology is used and the fit between the task and the technology. They define TTF as "the degree to which a technology assists an individual in performing his or her portfolio of tasks" (p216), and focus on the need for a match between task requirements, individual abilities, and the functionality of technology. In the case of instructor use of a LMS, TTF refers to the ability of the LMS to support the instructor in the range of teaching and course administration activities they engage in whilst accommodating the range of skills instructors have with information technology.

The relationships between several aspects of IS success are modelled in the TPC. As shown in Figure 1, the model proposes that task characteristics, technology characteristics and individual characteristics determine TTF. TTF in turn influences performance both directly and indirectly via utilization and its precursors.

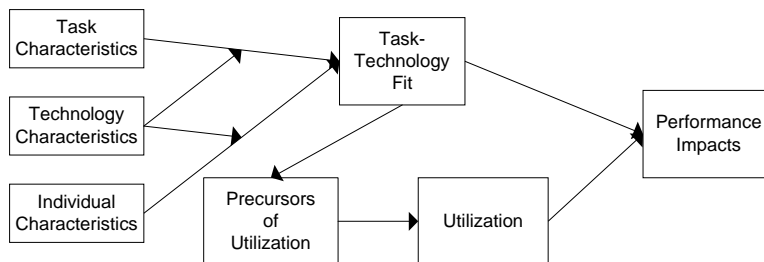


Figure 1. The technology-to-performance chain (TPC) (Goodhue and Thompson 1995)

The TPC has been used to explore the role of TTF in various domains. Staples and Seddon (2004) found strong support for the impact of TTF on performance, in their study of use of library management systems and personal productivity software in universities, while utilization had no significant effect. There has been no published research on the role of TTF in the e-learning domain (we use "e-learning" as the broader domain of which LMS are part). Given the need for rigorous research on factors that influence the success of LMS, and the central role that instructors play in the success of e-learning, this paper addresses this gap by examining the roles of TTF and level of LMS use in the impact of LMS on the performance of instructors.

RESEARCH MODEL

In this study, we are concerned with both the direct and indirect paths through which TTF might impact on the performance of instructors using LMS. Given our focus on TTF, we will not model task, technology or

individual differences. We will assume, as does the TPC, that it is sufficient to know an instructor's evaluation of TTF to examine the influence of TTF on utilization and performance impacts. The model tested in this research is shown in Figure 2 and the associated hypotheses are discussed below.

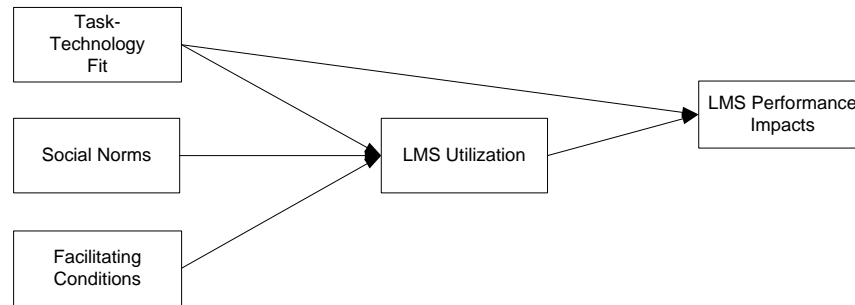


Figure 2: The tested model

Consistent with the TPC, the model to be tested proposes that the two major influences on LMS performance impacts are task-technology fit and level of utilization. In addition to its direct effect, TTF should also have an indirect effect via level of utilization.

Performance impact refers to the effect of the system on the outcomes of use for the user. For instructors, potential performance impacts can include both effectiveness of teaching and instructor efficiency (or productivity). The influential role of TTF on performance is a key component of the TPC, and its role has been confirmed in numerous studies by Goodhue and colleagues and others (D'Ambra and Wilson 2004; Goodhue et al. 2000; Goodhue et al. 1997; Goodhue and Thompson 1995; Staples and Seddon 2004). It was therefore hypothesized that:

H1: TTF will positively influence LMS performance impacts for instructors.

The positive influence of utilization on performance is also a key component of the TPC. Although Staples and Seddon (2004) did not find an association between level of utilization and performance, Goodhue and colleagues (Goodhue et al. 1997; Goodhue and Thompson 1995) found support for the relationship, as did D'Ambra and Wilson (2004). The proposed positive relationship between level of utilization and performance impact is also consistent with the DeLone and McLean model of IS success (DeLone and McLean 1992; DeLone and McLean 2003). Thus, if the TPC applies in the context of LMS use by instructors, increased use should lead to increased LMS performance impacts. On the other hand, the importance given in the literature of instructor use of LMS to the inhibiting impact of time requirements, increased utilization may not lead to positive outcomes for instructors using LMS: To test these alternative possibilities, we hypothesised (consistent with the TPC) that:

H2: Utilization will positively influence LMS performance impacts for instructors.

In addition to its direct effect on the work of instructors, TTF should also have an indirect effect via its influence on precursors of LMS utilization. The TPC is a large model, and hence difficult to test in a single study (Goodhue and Thompson 1995). As the primary focus in this study is the relationships between TTF and performance, and level of utilization and performance, the model shows the relationship between TTF and LMS utilization as a direct one, consistent with the reduced model tested by Goodhue and Thompson (1995). Yueh and Hsu (2008) showed that it is possible to increase LMS use by instructors, by focussing on appropriate design of LMS to obtain TTF that meets instructors' needs. It was therefore hypothesized that:

H3: TTF will positively influence LMS utilization by instructors.

Social norms refer to a user's beliefs that other people who are important to them want them to perform a behaviour. In the case of instructor use of LMS, the other people might include other academics and administrators. The role of social norms in IS success has been investigated with mixed results. Some authors have found that it influences utilization (Venkatesh and Davis 2000), while others such as Dishaw and Strong (1999) have found that social norms do not influence intention to use. In their recent study of LMS use by students, van Raaij and Schepers (in press) did not find the anticipated direct effect of social norms on intention to use, but did observe an indirect effect via perceived usefulness. Given the uncertainty of the role of social norms in the success of systems in general and in LMS use in particular, it was considered important to include it as a possible influence on utilization in this study. Thus, consistent with the TPC, we hypothesised that:

H4: Social norms will positively influence LMS utilization by instructors.

Organizational support for system use (such as ease of access to the system, training, relationship of the user with support staff etc) can influence use and performance. The importance of facilitating conditions is reflected in DeLone and McLean's addition of service quality to their updated model of IS success (DeLone and McLean

2003). Although Staples and Seddon (2004) did not find that facilitating conditions influenced utilization, a positive effect was found in Chang and Cheung's (2001) study. Given that lack of technical and financial support have been cited as important inhibitors for instructor LMS use (Browne et al. 2006; Schifter 2000), facilitating conditions are likely to play an important role in determining levels of utilization. Consistent with the TPC it was therefore hypothesized that:

H5: Facilitating conditions will positively influence LMS utilization.

STUDY 1

The first study described in this paper takes a quantitative approach to exploring the roles of TTF and level of LMS utilization on instructor's perceptions of the impacts of LMS on their performance.

Study 1 Method

Both Study 1 and Study 2 were conducted at an Australian University. This university is one of the Innovative Research Universities Australia group. The participants in Study 1 consisted of instructors from a wide range of disciplines who were using WebCT in their teaching. WebCT has been one of the most commonly used LMS (Browne et al. 2006). Instructors who had been added to an email list because they were users of WebCT provided the participant pool. They were initially contacted via email and invited to participate in the study by clicking on a link to complete a questionnaire on the web. The questionnaire took approximately 10 minutes to complete. Completion of the questionnaire was voluntary and all responses anonymous. The questionnaire and completion process were pilot tested by four instructors and slight changes made to clarify some items¹.

The first section of the questionnaire asked about the participants and their previous training and experience with information technology and WebCT. Given that several relationships in the TPC appear to be influenced by the degree to which use is mandatory (Staples and Seddon 2004; Venkatesh and Davis 2000), participants were also asked to provide their perceptions of the degree to which their use of WebCT is mandatory by indicating their agreement with the statement 'I am required to use WebCT in my teaching' on 7 point Likert scale labelled from 'strongly disagree' to 'strongly agree'.

The second section asked about the participants' perceptions of WebCT, and its impact on their teaching performance. Construct measurement was based on previous studies with minor rewording to suit the e-learning domain. Unless otherwise stated, all items were measured on a 7 point Likert scale labelled from 'strongly disagree' to 'strongly agree'. LMS performance impact was measured using three items from Goodhue and Thompson (1995). TTF was measured using eight items. The items were drawn from Moore and Benbasat (1991), Doll and Torkzadeh (1988), and Staples and Seddon (2004). Social norms was measured using four items from Hartwick and Barki (1994). Facilitating conditions was measured using five items drawn from Baroudi and Orlikowski (1988), Thompson et al. (1994) and Taylor and Todd (1995).

LMS utilization was measured using four items. Participants were asked how many hours a week they used WebCT, and how many hours per week they intended to use WebCT over the rest of the semester. They were also asked to assess both their current and intended use of WebCT on a 5 point scale ranging from (1) 'light' to (7) 'heavy'.

The relationships in the model were tested using partial least squares (PLS). PLS provides an alternative estimation approach to traditional structural equation modeling (SEM) for the analysis of small data samples (Hair et al. 2006). A two-step approach commonly used in SEM was used. The fit and construct validity of the proposed measurement model are tested first. Once a satisfactory measurement model is obtained, the measurement model is "fixed" when the structural model is estimated (Hair et al. 2006). SmartPLS version 2.0 was used for this process.

Study 1 Results and Discussion

A total of 67 instructors (42.2% females and 57.8% males) participated in the study. Ages ranged from a minimum of 25 to a maximum of 65 (with an average of 46.12 years) and the participants covered a broad spectrum of IT experience and training. They had a wide range of levels of usage of WebCT with the average length of use being 4.74 semesters. Participants also had a wide range of perceptions about the degree to which their use of WebCT was mandatory. Table 1 provides a summary of the background of the participants.

The measurement model was assessed in terms of: individual item loadings, reliability of measures, convergent validity and discriminant validity. Two social norms items and two facilitating conditions items were found not

¹ Please contact the first author for a copy of the items.

to load sufficiently highly on their corresponding construct and were excluded from the analysis. All remaining items loaded significantly on their latent constructs ($p < 0.05$) and exceeded the minimum threshold of 0.70 (Chin 1998). Reliability was assessed using composite reliability (CR). All constructs were above the minimum value of 0.70 (Hair et al. 2006). Convergent reliability was assessed using average variance extracted (AVE). All constructs met the guideline of AVE greater than 0.50 (Hair et al. 2006).

Table 1: Participant background information

	<i>N</i>	<i>Mean</i>	<i>Std. dev.</i>	<i>Min.</i>	<i>Max.</i>
Age (years)	63	46.00	8.71	25	65
Years of computer experience	64	19.98	6.77	8	40
Years of Internet experience	64	11.52	3.64	5	28
Perceived information technology skill (/7)	64	5.61	1.19	3	7
Semesters using WebCT	64	4.55	3.44	1	15
Perceived skill using WebCT as a designer	63	4.13	1.87	1	7
Degree of mandatoriness of use (/7)	64	4.63	2.05	1	7

For satisfactory discriminant validity each item should load more highly on its own construct than on other constructs. In addition, the average variance shared between a construct and its measures should be greater than the variance shared by the construct and any other constructs in the model (Chin 1998). Two items measuring TTF loaded too heavily on other constructs so were dropped. Table 2 provides a summary of the reliability and convergent validity of the final scales used in the study. Table 2 also provides the final construct inter-correlations and the square root of AVE for each construct (in bold on the diagonal). In all cases the square root of AVE exceeds the corresponding construct inter-correlations thereby demonstrating discriminant validity (Chin 1998).

Table 2: Measurement model information

Construct	CR	AVE	1.	2.	3.	4.	5.
1. TTF	0.948	0.727	0.852				
2. Social norms	0.800	0.667	0.629	0.817			
3. Facilitating conditions	0.876	0.703	0.333	0.414	0.839		
4. LMS utilization	0.946	0.814	0.221	0.207	0.232	0.902	
5. LMS performance impact	0.933	0.823	0.551	0.531	0.289	0.236	0.907

Two criteria were used to assess structural model quality: the statistical significance of estimated model coefficients and the ability of the model to explain the variance in the dependent variables. Figure 3 shows the standardized coefficients for each hypothesized path in the model and the R^2 for each dependent variable. TTF had a significant positive influence on LMS performance impacts for instructors thus H1 was supported. However, level of utilization was not found to influence LMS performance impacts, so H2 was not supported. In addition to its direct effect on the work on instructors, TTF was also proposed to have an indirect effect via its influence on LMS utilization. TTF did not however influence LMS utilization, so H3 was not supported. Neither social norms nor facilitating conditions was found to influence LMS utilization, so H4 and H5 were not supported. The model explained 31.7% of the variability in LMS performance impacts.

In view of the unexpected results, tests of the potential for background factors to influence these relationships were conducted using graphical and correlational methods. Only two significant correlations were observed: perceived mandatoriness was correlated with social norms ($0.41, p = .001$) and perceived skill as a designer which had a moderate correlation ($0.28, p = .012$) with LMS utilization. Neither of these relationships had a significant effect on the results of the structural model tests.

This analysis shows that TTF plays an important role in the success of LMS for instructors. However, only a direct influence emerged from this study. The hypothesized indirect influence through utilization was not observed. TTF did not influence LMS utilization, and furthermore LMS utilization did not affect LMS performance impact. In addition, contrary to the TPC, neither social norms nor facilitating condition appeared to influence level of LMS utilization. These unexpected findings are discussed below.

As proposed in the model, and consistent with the TTF literature (D'Ambra and Wilson 2004; Goodhue et al. 2000; Goodhue et al. 1997; Goodhue and Thompson 1995; Staples and Seddon 2004), TTF played an important role in influencing the performance impacts of LMS use for instructors. Improvements in the TTF of LMS should lead to significant improvements in what instructors are able to achieve in their teaching, as demonstrated in a practical sense by Yueh and Hsu (2008).

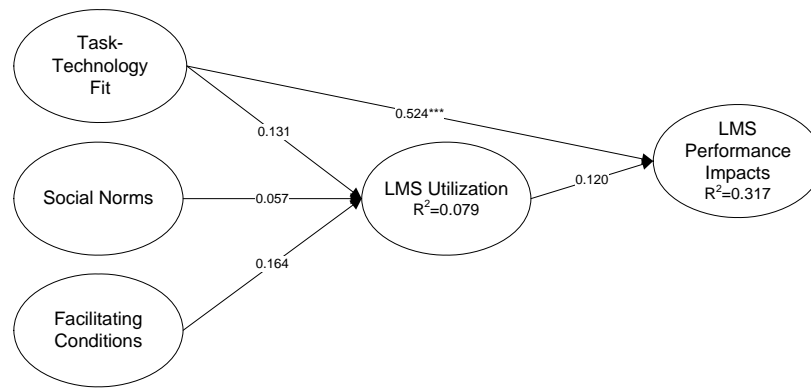


Figure 3: Structural model results

On the other hand, TTF did not influence LMS utilization, and LMS utilization did not have an influence on LMS performance impact. These findings are inconsistent with what is proposed by the TPC, which includes both the influence of TTF on utilization (via precursors of utilization) and the influence of utilization on performance, as key components of the model. There are however precedents in the literature for this lack of influence. In the context of the TPC, Staples and Seddon (2004) did not find an association between level of utilization and performance, and several authors who have used the DeLone and McLean model of IS success (1992) as a framework have also noted that level of utilization may not be influenced by related factors such as system quality and information quality (Iivari 2005; Landrum et al. 2008; McGill et al. 2003) and that it may not influence performance (Gelderman 1998; McGill et al. 2003; Wu and Wang 2006). Seddon (1997) went as far as to suggest that the causal relationship between use and individual impact proposed by DeLone and McLean may not exist. The variety of findings suggests that the relationship between level of utilization and performance impact may be domain specific. In their update to their model, DeLone and McLean (2003) acknowledged that the nature of relationships can vary from context to context. For example, users may need to use a system with poor TTF more frequently to meet their needs. Alternatively, they may choose to use a system with good TTF more frequently because it meets their needs well. Given that the dominant factors inhibiting instructor adoption and use of LMS discussed in the literature relate to time (Browne et al. 2006; Lazarus 2003; Pajo and Wallace 2001; Schifter 2000), it is perhaps not surprising that the relationships between TTF, utilization and performance impacts are more complex than hypothesized on the basis of the TPC. It is not difficult to imagine, for example, that regardless of TTF, there is an upper threshold to the amount of use that is both useful and feasible; only so much time is needed to upload teaching materials, too much instructor time spent on online discussion may inhibit student learning as well as interfere with other uses of an instructor's time. Thus, level of LMS utilization may well be independent of TTF just as performance impact may be independent of level of LMS utilization, as observed in this study. Clearly the results of this study suggest that further research is needed to understand reasons for differences in levels of utilization, as well as the relationship between utilization and LMS performance impacts.

Previous research on the role of social norms in influencing usage intentions has provided mixed results and very little has been done in the e-learning domain. Venkatesh and Davis (2000) found that social norms significantly affected intention directly only when usage is mandatory and experience is in the early stages. The participants in this study varied greatly in their perceptions of how mandatory their use was and also had a wide range of experience (see Table 1), yet a *post hoc* hierarchical regression analysis showed that, although mandatoriness was associated with social norms, mandatoriness did not contribute to explanation of LMS utilization, either alone or through its interaction with social norms. This result is consistent with a study of students in the LMS domain that found that social norms had no effect on use of a LMS (van Raaij and Schepers in press).

Although facilitating conditions are considered important for the success of e-learning (Selim 2007), and instructors have noted lack of technical support as one of the major factors inhibiting use (Browne et al. 2006; Schifter 2000) facilitating conditions did not influence LMS utilization by instructors in this study. These results are consistent with Renzi's (2008) observation that support services have little effect on the ways in which university teachers incorporate LMS in their teaching. On the other hand, the relationship between self-reported skill as a WebCT designer and LMS utilization observed in this study suggests that other factors such as self-efficacy for LMS use might affect level of utilization. Self-efficacy is a person's belief in their capacity to perform a behaviour with a certain level of competence (Bandura 1997). Computer self-efficacy is associated with use of and intentions to use several types of IS, including student use of LMS (Chang and Tung 2008) and may well be associated with LMS utilization by instructors.

STUDY 2

In order to understand the unexpected results of Study 1 better, we conducted a set of email interviews using open ended questions. Responses to the open-ended questions were examined interpretatively in order to triangulate and validate the findings of Study 1, and to attempt to gain additional insights into the nature of the relationships under consideration.

Study 2 Method

The participants in Study 2 were seven instructors from the same university, who had used LMS in their teaching. They ranged in age from 43 to 62. They were contacted by email and invited to participate in the study. They were provided with general information about the findings of Study 1, and asked to reflect upon their own experiences using LMS. They were then asked to answer a series of open-ended questions about their perceptions of the roles that TTF, social norms and facilitating conditions play in the level of their LMS utilization and in the impacts of their LMS use on their teaching. Participation was voluntary and all responses confidential. The responses were inspected for statements that addressed the relationships contained in the research model (Figure 2). These statements were then classified into general themes representing the relationships of interest. The themes were permitted to emerge from the data. A multiple classification scheme was used so that each remark could be classified into more than one category.

Study 2 Results and Discussion

Table 3 summarizes the main themes that emerged from the analysis. All responses relating to the relationship between TTF and LMS performance impacts were consistent with the model. The following is a typical comment:

Some aspects can improve efficiency eg getting students to email via LMS allows easy id of student emails and an efficient audit trail, assignment submission is auditable ... the announcement section is easier than bulk emailing etc.

Table 3: Major LMS utilization and performance impact themes grouped by relationship

Relationship	Themes
TTF → LMS performance impacts	The LMS enhances communication and coordination The LMS has the capability to improve teaching productivity Poor TTF leads to inefficiency
TTF → LMS utilization	Aspects of the system that don't fit our practices discourage use Ease of use led to increased use Lack of TTF meant more time had to be spent using system to deal with problems
LMS utilization → LMS performance impacts	Use improves efficiency, productivity Need to invest a lot of time to get returns LMS creates more work
Social norms → LMS utilization	What students think about LMS influences me Level of use doesn't relate to social norms
Facilitating conditions → LMS utilization	If more support would use it more Level of use doesn't relate to facilitating conditions. Wrong kinds of facilitating conditions provided? Lack of support led to more work

Remarks relating to the influence of TTF on level of LMS utilization were more mixed. Whilst several participants noted that improved TTF led to increased utilization and lack of TTF led to reluctance to use, there were also participants who felt that lack of TTF had led to the necessity for increased utilization:

Every time I go to answer this I start grinding my teeth again..... unannounced downtime, frequent errors, inability to read Office 2007 files, and a thousand other glitches (mostly now fixed) have strongly coloured my opinion. I estimate I lost 5 - 10 full days last semester just dealing with technical faults and corresponding with students who experienced them, so the effect on my productivity very negative.

Thus, contrary to what is proposed by the TPC, and consistent with the literature on factors inhibiting use, poor TTF can result in instructors needing to spend more time using a LMS their work, rather than less time.

Similarly, whilst some participants felt that increased utilization had positive performance impacts, others had less positive perceptions. Some felt that a large initial investment of time was required to reap benefits, and others had yet to reap benefits:

I have spent a lot of extra time on it but persevered and am now reaping the benefits.

One of my main gripes with WebCT is that it creates work instead of assisting

Two themes emerged from the responses relating to social norms. Consistent with the results of Study 1, several participants did not believe that their utilization was influenced in any way by social norms. However, three of the participants commented that their use was influenced by the expectations of students:

Social norms – include students? The fact that students expect one to use WebCT/CE6 has influenced my use.

As no items relating to students were included in the measurement of social norms in Study 1 this aspect could not have been identified. The importance of instructor perceptions of student beliefs should therefore be investigated in future research.

Only one participant commented that facilitating conditions influenced their level of utilization. The reaction that facilitating conditions did not influence use was more common. But one participant noted that the support provided was not the kind of support needed.

I believe the training and support offered in 2007 was well-intentioned but ultimately not useful due to the system's technical shortcomings.

As discussed with respect to the results of Study 1, further research is clearly needed to investigate what role facilitating conditions can play in the successful use of LMS by instructors.

CONCLUSION

The study described in this paper was designed to investigate the role of TTF in LMS success for instructors. It used the TPC as a starting point to address the question of how TTF influences the performance impacts of LMS for instructors. The results showed that whilst TTF has a direct influence on instructors' perceptions of the impacts of the LMS on their performance, level of utilization is either not associated with performance impact or is associated with performance impact in ways that are not readily captured by simple linear modelling. We suspect that this complexity can also be observed in other domains.

Apart from confirming the importance of TTF in obtaining positive performance impacts for instructors using LMS, this study suggests several areas for future research. We have speculated that, whilst good TTF might lead to increased utilization and increase performance benefits, there is a limit on the amount of use that is both valuable and feasible. On the other hand, poor TTF can result in instructors needing to spend more time on use to circumvent problems and this in turn may result in negative impacts on performance. Possible explanations for the lack of influence of both social norms and facilitating conditions emerged from the discussion of Study 1 results and the qualitative analysis in Study 2 and should be explored future research. The work of Zmud and his colleagues on differences in adoption of system features by individuals following organization level adoption of an IS (Jasperson et al. 2005) may provide a framework for more fine-grained analysis of utilization and influences on it by guiding researchers to focus on individual LMS features rather than attempting to uncover complex patterns from studies of undifferentiated LMS use.

Perhaps most importantly, the results reported here suggest that it may be useful to re-think our approach to studying the role of ICT in education. Our study, and the TPC, begin with the premise that there must be a fit between task and technology. Educational technologists concerned with understanding the impact of technology on teaching claim that a fit between task and technology is not enough. They emphasise the ability of instructors to integrate a technology into their teaching and observe that this is a function of the instructor's pedagogical skills rather than technology and technological skills alone. Their work suggests that good instructors can produce TTF even when the ICT and facilitating conditions are imperfect (Renzi 2008; Van den Dool and Kirschner 2003). Thus, we might learn more about how to improve LMS performance impacts by paying closer attention to individual system features, and the active process of how the instructor integrates pedagogy and technology than focusing more passively on the fit between technology and task.

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