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Conceptualizing Task-Technology Fit and the Effect on Adoption – A Case Study of a Digital Textbook Service

Abstract

Although information technology has revolutionized virtually every aspect of how we interact with products and services, it has changed learning to a surprisingly small degree. In a study of a digital textbook service, we provide a new conceptual definition and measurement of technology fit. We conceptualize task-technology fit as how well a technology is integrated with a set of interrelated tasks included in achieving the goal of the behavior where the technology is used. Whereas research on technology adoption typically explains around 40 percent of the variance in motivation to adopt, our model explains as much as 76 percent.

Key words

Digital learning technologies
Task-technology fit
Social norms
Technology acceptance model
E-textbook

Introduction

Information technology has revolutionized how we interact with products and services, but has had less of an effect on learning. Despite schools and universities investing heavily in computer technology during recent decades (Christensen et al., 2008), the effects on learning have been minimal. The OECD's Director for Education and Skills, Andreas Schleicher, concluded: "The reality in our schools lags considerably behind the promise of technology as the basic skills in reading, mathematics or science remain unchanged in the countries that have invested most heavily in computer technology" (OECD, 2015, p. 3). Critics have argued that computers add expenses, but fail to revolutionize the classroom learning experience (Cuban, 2001). A comprehensive meta-analysis by Sung, Chang, and Liu (2016) of 110 experimental and quasi-experimental journal articles published between 1993 and 2013 on research related to the effect of integrating mobile devices with teaching and learning on students' learning performance found that such methods had only a moderate effect. They reported that the effect of technology on learning outcome depends on instructional strategies; that is, in order for technology to have an effect, the technology must be integrated with the overall learning process addressing specific pedagogical challenges. Also, successful classroom implementation of technology requires active support of technology from teachers, adequate computer proficiency among students, and development of classroom technology that is easy to use and directly related to course outcomes (Dufreene, Lehman, Kellermanns and Pearson, 2009). Therefore, understanding the conditions under which students and teachers adopt new digital learning technologies to improve learning outcomes is an important research issue, from both theoretical and managerial perspectives.

Theories of technology adoption propose that the better an information technology fits the task environment (TTF), the more motivated potential users will be to adopt it (Goodhue and Thompson, 1995; Petter et al., 2012; Dishaw and Strong, 1999). However, the challenge is how to conceptualize the task environment to reflect the user's goals and the causal mechanisms for adoption (Davis et al., 1989). For example, a digital learning technology can enhance and improve the task of reading text material. Alternately, the digital service can enhance and improve the task of learning, which is another goal. In a review of the literature related to adoption of digital learning technologies, we find that researchers have conceptualized technology fit as a degree of efficiency and not effectiveness. While efficiency refers to how well something is done, effectiveness refers to how useful something is. Effectiveness is about doing the right task, completing activities and achieving goals.

Efficiency is about doing things in an optimal way; for example, doing it the fastest or least expensive way. Conceptualized technology fit as a degree of efficiency is a problem because efficiency is not likely to have the same level of effect on adoption as effectiveness. If students find that a digital learning technology can really help them to improve their learning and subsequently their grades, they are likely to be very motivated because good grades are important for being accepted at the best schools and universities, and also later when they enter the job market. Our literature review also shows that researchers have more or less ignored the social context in conceptualizing the task environment.

The task-technology fit model (TTF) and the technology-acceptance model (TAM) have received significant academic attention and gained support for their explanatory and predictive properties. However, as scholars leaning on sociocultural perspectives (e.g. Geels, 2005; Shove and Pantzar, 2005) have argued, one might reasonably ask whether these models are able to capture the subtleties and characteristics of various use contexts when new technology is adopted. Even though the TTF model emphasizes the importance of fit between task and technology, it does not provide a coherent understanding of what constitutes a task environment and how such an environment affects adoption in a multifaceted context in which the interrelatedness between tasks might be high. The present research contributes by conceptualizing the task environment through an alternative lens that emphasizes how the interrelatedness of various tasks predetermines the intention to adopt new technology. Importantly, our research shows that the fit of a new technology with a set of interrelated tasks (practices) has a strong, positive effect on intention to adopt. Hence, our study supports the notion that acceptance of a technology is closely connected to the acceptance of existing and emerging practices (Alakärppä et al., 2010). We also show that intention to adopt is mediated by perceived usefulness and ease of use, as predicted by the TAM.

The purpose of our research is to provide a better conceptual understanding of what task-technology fit should mean, as well as a theoretical rationale for why task-technology fit should have an effect on motivation to adopt and use a digital learning technology. Although we use a digital textbook service to empirically test the proposed model, our conceptualization should be general across different types of information technologies where users have free will to adopt the technology or not. We believe that this paper will provide technology providers and managers with a better understanding of how to develop and implement new information technologies.

Theory and hypotheses

Derived from the more general theory of reasoned action (Ajzen and Fishbein, 1980), Davis (1989) proposed that adoption of a new technology is driven by perceptions of its ease of use and usefulness, mediated by attitudes about using the innovation and the behavioral intention to adopt. The proposed theory, referred to as the Technology Acceptance Model (TAM), became the dominant approach in analyzing information technology adoption (Davis, 1989; Davis et al., 1989; Venkatesh, 2000; Legris, Ingham and Collerette, 2003). The model's emphasis on utility complements the attributes of relative advantage (usefulness) and complexity (ease of use) proposed in Roger's diffusion theory (1995).

A particularly helpful aspect of TAM, from a managerial perspective, is its assertion that any factor that influences adoption behavior only does so indirectly by influencing perceived usefulness, perceived ease of use, and intention to adopt (Davis et al., 1989). Numerous studies across a wide variety of technologies (Doll et al., 1998), user groups (Gefen et al., 2003), and cultures (Calantone et al., 2006) have supported the generalizability of the TAM model.

Although TAM tells us that an information technology needs to be perceived as useful (that is, effective), the theory does not address antecedents other than perceived ease of use (Davis et al., 1989). However, Goodhue and Thompson (1995) proposed that the most important antecedent of a technology's effectiveness is how well the technology fits the task for which it is used. Other innovation researchers have proposed similar antecedents, such as job relevance, output quality, and result demonstrability (Venkatesh and Davis, 2000), task compatibility (Taylor and Todd, 1995), relative advantage (Moore and Benbasat, 1991), and outcome expectations (Compeau and Higgins, 1995). A main challenge in this line of research is that the exact causal mechanism between task-technology fit and perceived usefulness (that is, effectiveness) is not clear. We believe that the main reason for this lack of clarity is that previous research has not properly addressed the conceptual definition and understanding of what constitutes a task environment, and the meaning of fit to a task environment.

Conceptualizing task-technology fit

Goodhue and Thompson's (1995) definition of task-technology fit does not take the interdependence of tasks into account. Although they defined task-technology fit as "the degree to which a technology assists an individual in performing his or her portfolio of tasks" (p. 216), they did not address the interrelatedness among the portfolio of tasks. In learning, for example, students engage in a set of interrelated tasks, such as attending lectures, writing term papers, and reading textbooks. Interdependence means that attending lectures will affect, and is affected by, reading the textbook and with writing a term paper. As tasks are interdependent, task-technology fit needs to be addressed as how well the technology facilitates and improves the set of interrelated learning tasks.

We find that practice theory (Schatzki, 2001; Reckwitz, 2002) provides guidance for how to conceptualize the interrelatedness of tasks. Practices have been defined as "routinized types of behavior which consist of several elements, interconnected to one another. Adoption of a new technology is seen as a resource-integration process that enhances individuals' practices, leading to an improved practice or the possible emergence of a new practice" (Korkman et al., 2010).

Social norms and the symbolic meaning of a new technology

Practice theorists propose that the adoption of new technologies is not only a matter of individual decisions, but grows out of how a new social reality is formed through changes in the nexus of practices (e.g., Bourdieu, 1990; Giddens, 1986; Schatzki, 2001; Reckwitz, 2002). As such, *practice* refers to activity patterns across individuals that are infused with broader meaning and provide tools for ordering social life and activity (Jarzabkowski, 2004).

Interestingly, Goodhue and Thompson's definition of technology environment does not include the social network among potential users of the technology. This is surprising given that adoption theories emphasize that innovation and adoption occur in a social environment (Triandis, 1971, 1980; Ajzen and Fishbein, 1980; Turner et al., 2010; Burkhardt, 1994; Kraut et al., 1998). In learning, students interact with other students and teachers affecting their learning activities.

Following this line of reasoning, we propose that task-technology fit should be conceptualized and defined as *how well the technology is integrated with the set of interrelated tasks (practices) in a social context*.

Adoption of digital learning technologies

We identified 10 empirical studies of the adoption of digital learning technologies grounded in the TAM framework (see Table 1). The different types of digital learning technologies include e-textbooks, company e-learning systems (platforms), and internet-based learning systems. With the exception of Islam (2015), explained variance in adoption ranges from 26.0 percent to 49.2 percent. This is in line with other TAM research, where explained variance in adoption (usage) is 40 percent or lower (Venkatesh and Davis, 2000, p. 186; Legris, Ingham and Collerette, 2003, p. 202). The explained variance of Islam (2015) is 60.0 percent; that study included usage satisfaction (Beta=0.22) as an independent variable in addition to perceived usefulness and perceived ease of use, and is therefore not directly comparable with the other TAM models as an additional variable is included.

Table 1 here

Table 2 shows how these 10 studies measured perceived usefulness and also shows the effect of perceived usefulness on adoption. We observe that the 10 studies vary in terms of what is considered as the overall goal of the technology, including course performance, job performance, reading performance, and learning. Therefore, we observe that the measures are a combination of efficiency and effectiveness. Although some technologies are used to enhance efficiency, we believe that a much stronger motivation for adopting a digital learning technology is to enhance their goal of learning (that is, effectiveness). This is in line with the original proposition in Davis (1989, p. 320), which states that "people tend to use or not use an application to the extent they believe it will help them perform their job better." Therefore, we propose that perceived usefulness should reflect how well the new digital learning technology improves effectiveness in learning.

Table 2 here

Following the general predictions in TAM (Davis, 1989; Davis, Bagozzi and Warshaw, 1989), students are expected to be more motivated to adopt a digital learning technology they find useful. The causal mechanism is grounded on the proposition that positively valued outcomes often increase a person's affect toward the means to achieving those outcomes. Next, students are expected to be more motivated to adopt a digital learning technology they find easy to use. The easier a system is to interact with, the greater the user's sense of efficacy and personal control should be regarding his or her ability to carry out the sequences of behavior needed to operate the system. Perceived ease of use was first proposed to have a direct effect on adoption (Davis, 1989) and an indirect effect through perceived usefulness (Davis et al., 1989; Venkatesh and Davis, 2000). The easier a system is to use, the more useful (that is, instrumental) the system is expected to be. Later, Venkatesh et al. (2003) found that perceived ease of use has a direct effect on adoption early in an adoption process, but that this effect goes away after some time. In a review of TAM models, Legris, Ingham, and Collerette (2003) determined that 21 out of 26 studies found that perceived ease of use had a positive effect on perceived usefulness (five non-significant), and that 16 of 19 studies find that perceived ease of use had a positive effect on behavioral intention (three non-significant). Thus, we propose:

H1a: The more useful a digital learning technology is perceived to be in terms of improved learning, the more likely students are to be motivated to adopt it.

H1b: The easier to use a digital learning technology is perceived to be, the more likely students are to perceive the technology as useful.

H1c: The easier to use a digital learning technology is perceived to be, the more likely students are to be motivated to adopt it.

We identified four studies related to adoption of digital learning technologies and TTF. In the first study, McGill and Klobas (2009) used TTF to evaluate the performance impacts of a web-based course management system (WebCT) related to supportive learning processes, such as delivering, managing, and tracking online learning. They found that the TTF of the WebCT had a strong and positive effect on perceived learning performance (*Beta = 0.53*), both directly and indirectly via level of utilization. This highly cited study demonstrates how TTF is a factor that influence both the use of information systems and their performance impacts.

The second study, an exploratory research conducted by D'ambra, Wilson and Akter (2013), sought to investigate how academics perceive the fit of the functionality of e-books towards tasks such as teaching and research. They found that the TTF of e-books had a positive effect (*Beta = 0.14*) on faculty's job performance in terms of task, technology and individual characteristics related to use of e-books. More specifically, the study confirmed the significant impact that TTF has on individuals' performance and use, and the impact of using e-books on individual performance. Consequently, they showed how users' perception of the

TTF of e-books and related use explain a significant amount of the variance of perceived performance.

In the third study, Gerhart, Peak, and Prybutok (2015) examined a student-perspective model of e-textbook usage in order to comprehend how students perceive their task of learning to fit with e-textbook technology. In doing so, the study developed a model for testing the relationship between perceived TTF of e-textbooks and specific user characteristics that encourage certain adoption behaviors. The authors concluded that perceived TTF positively correlates (*Beta* = 0.38) to students' expected improvement in reading and learning performance using e-textbooks compared with ordinary textbooks. The fourth study – Gerhart, Peak, and Prybutok (2017) – is a replication of Gerhart, Peak, and Prybutok (2015). Again, the finding is that TTF of e-textbooks has a positive effect on students' expected improvement in reading and learning performance using e-textbooks compared with ordinary textbooks (*Beta* = 0.38).

All of the above-mentioned studies have attempted to contextualize TTF in specific use settings in order to understand how perceived TTF correlates with performance and use towards specific user tasks and needs.

Researchers in other areas of technology applications have also studied the role of TTF and adoption employing the TAM framework. For example, Kim et al. (2010) found that TTF has a strong effect on perceived ease of use (*Beta = 0.34*) and on perceived usefulness (*Beta = 0.68*) in a study of hotel employees' usage of hotel information systems. In a study of restaurant managers' usage of a point-of-sale (POS) system, Moon et al. (2015) found that TTF has a strong effect on perceived ease of use (*Beta = 0.93*) and on perceived usefulness (*Beta = 0.71*).

Following the reasoning that task-technology fit should be conceptualized as how well the technology is integrated with the set of interrelated tasks (practices) in learning, we propose that the TTF will enhance both the perceived usefulness and the ease of use of a new digital learning technology. A better integrated technology with learning practices implies that the technology is well aligned with the tasks and less effort is required to adjust existing practices with new tools. Next, the technology is more useful because better integration implies better resource utilization and synergies across learning practices, and is therefore also more meaningful (Korkman et al., 2010). Thus, we hypothesize:

H2a: The better a new digital learning technology is integrated with a set of interrelated tasks that constitute learning, the higher the perceived ease of use of the digital learning technology.

H2b: The better a new digital learning technology is integrated with a set of interrelated tasks that constitute learning, the higher the perceived usefulness of the digital learning technology.

As discussed above, individuals' adoptions of innovations are highly influenced by social mechanisms. For example, in their analysis of Nordic walking, Pantzar and Shove (2010) found that developing this new practice (usage of an innovation) was strongly connected to developing new symbols associated with walking sticks. Adoption was not only a function of the perceived usefulness of the innovation, but also of the signals associated with using the technology. Also, the theory of reason action (TRA) proposes that subjective norms affect attitudes, where a social norm is defined as the degree to which an individual believes that people who are important to her/him think she/he should perform the behavior in question (Fishbein and Ajzen, 1975). Following this reasoning from TRA, Venkatesh and Morris (2000) argued that social norms should be included in the TAM model. They proposed and found an effect of social norms on adoption (that is, use) of a new computer system.

We propose that the social norm of a new digital learning technology will enhance the motivation to adopt and start using the technology. The social context is important for students and the social integration with other students has a major influence on students' motivation to learn (Tinto, 1975; 1987). In line with theory of reasoned action (Ajzen and Fishbein, 1980) and TAM (Venkatesh and Morris, 2000), we believe that a favorable symbolic meaning of a digital learning technology will develop a social norm that favors adoption. Interestingly, only two of the studies we reviewed that related to adoption of learning technologies addressed the role of the social network connected to learning; that is, the role of other students and teachers. Maduku (2015) found that social influence had a strong effect on intention to adopt (Beta = 0.23). Rey-Moreno and Medina-Molina (2016) found that the effect of social norms on adoption depended on the specific e-learning technology. Only when a social network site was part of the e-learning platform did social norms affect intention to adopt.

Based on the above, we propose:

H3: The more positive the social norm for a new digital learning technology is perceived to be within the students' social network, the more likely students will be motivated to adopt it.

Figure 1 illustrates the proposed model and hypotheses. We conceptualize the integration of a new digital learning technology as two integration processes, one related to fit of technology to a set of interrelated tasks (TTF) and the other related to the social norms and the symbolic meaning of the technology in the social context where learning takes place (SOCIAL). TTF is predicted to affect both the perceived ease of use (PEU) and the perceived usefulness (PU) of a new digital learning technology. In line with the general TAM framework, we propose that the effect of TTF on adoption is mediated by perceived ease of use and usefulness. SOCIAL is proposed to affect adoption directly and therefore not change perceptions related to ease of use and usefulness.

Figure 1 here

Method

The conceptual model was tested in a field study. A group of students in a business school tried a new digital textbook service in one introductory course in marketing for a semester. The book was also the main textbook in the course. The digital service was voluntary and provided as a free supplement to the physical textbook. The textbook provided a user access code that was needed to log on to the service. The service includes a wide assortment of learning aids, such as interactive quizzes, definitions of key constructs, and a digital text that students could not only read on their desktops or tablets, but also search, mark, comment, and copy text and figures. The instructors were asked to motivate students to use the tool. Apart from that, the digital learning technology was not integrated with the teaching activities of the course.

The digital learning technology was introduced to approximately 1500 students attending the course in eight different classes. In this context, adoption means that students have adopted the idea of using this type of textbook technologies in learning, which means that they are motivated to use a similar textbook system in other courses, willing to pay a premium for this type of service, and willing to recommend this type of learning system to other students.

There have been calls for research on this type of information technologies within the TAM framework given that most studies to date have examined the introduction of office automation software or system development applications (Legris, Ingham, and Collerette, 2003). Adoption of textbook technologies should be relevant for studies of several service technology applications targeted towards clients and customers, where usage is more voluntary and more motivated by the individual's perceived value of using the technology.

The selected context ensured minimum variance on demographics, technological capabilities, and knowledge of the subject (that is, marketing). The setting also ensured that the participants had similar goals in terms of writing a term paper and obtaining a good grade in the course. Most importantly, the setting ensured that all participants had a similar task environment. Therefore, differences in adoption are likely to come from differences in how students perceived the digital learning technology to fit into their study activities and the social norm for the new technology.

A total of 690 students registered and used the digital textbook service. On average, the service was used (logged on to) 6.27 times (SD = 8.86). The top 20 percent of users used the service nine times or more. At the end of the course, users received a survey measuring the focal constructs for hypothesis testing. Of the 690 students who used the service, 147 responded (21.3 percent) to the questionnaire. On average, respondents used the service 8.56 times (SD = 11.69), which is 2.9 more times than the average of those who did not respond. The top 20 percent of users among the respondents used the service 14 times or more. As the purpose of the study is to test the proposed causal mechanisms, the bias is not likely to be a problem because we sampled users with more experience. The demographic profile of the sample is reported in Table 3.

Table 3 here

Scales

Table 4 lists the items that researchers have used to measure TTF. We observe that all studies have used different scales and that the items used in each scale do not have a common subject matter. Therefore, we developed a new scale grounded in the conceptualization presented above; that is, a scale that reflects how well the digital learning technology is integrated with a set of tasks constituting the main activities of the focal task (learning). Through a focus group with students, we identified four practices that constitute their learning process: reading a textbook, writing a term paper, working in groups, and attending lectures. We measured TTF as the perception of how well the digital textbook service was appropriate for and tailored to the set of these four tasks.

The scales measuring perceived ease of use (PEU), perceived usefulness (PU), intention to use (ADOPT), and social norms (SOCIAL) were derived from scales developed in previous TAM research. All scales are reported in Appendix 1.

Table 4 here

Measurement model

The measurement model was estimated using Lisrel. Table 5 presents the statistical properties of the items for the five scales. All loadings were significant and all loadings except the second item for adoption are high (larger than 0.5). This particular item measures "willingness to pay extra for the digital learning technology" and is of a different type than the other two items (that is, "motivation to use in the future" and "motivation to recommend to other students"). We observe that the mean score on this item is 2.94, which indicates that students are not willing to pay extra for this service. Although the item has a low loading, the item captures an important dimension of the motivation to adopt, and is therefore important to keep (Bagozzi and Yi, 1989). Table 6 reports the composite reliabilities (CR), the average variance extracted (AVE), and the correlation between scales. All scales have composite reliabilities above 0.6 and AVE above 0.5. We also observe that the squared AVE (on the diagonal) are larger than the correlation between the scales, indicating discriminant validity (Fornell and Larcker, 1981). The measurement model achieved acceptable fit (Chi-Square =259.79 with 142 d.f.; NFI = 0.96; NNFI = 0.98; SRMR = 0.05; RMSEA = 0.07; CFI = 0.98; AGFI = 0.79). The low AGFI may be due to sample size. All other fit indices indicate fair measurement model fit (Hooper, Coughlan, and Mullen, 2008).

All items for the TTF scale are high (0.90, 0.88, 0.87, and 0.87) and the composite reliability is 0.93 and extracted variance is 0.91. Moreover, all correlations between items are high (0.80, 0.81, 0.76, 0.76, 0.75, and 0.75). These figures indicate that the set of learning activities are highly interrelated and that our items reflect an overall perception of how well the technology is integrated in the learning process.

Table 5 and 6 here

Structural model

The structural model was estimated using Lisrel. All hypothesized paths except the effect of PEU on ADOPT were significant ($p < 0.05$). The model was then estimated without this path. The standardized path-coefficients are reported in Figure 2. The structural model achieved acceptable fit (Chi-Square =262.79 with 146 d.f.; NFI = 0.96; NNFI = 0.98; SRMR = 0.05; RMSEA = 0.07; CFI = 0.98; AGFI = 0.79). All hypotheses except H1c were supported.

In order to test the mediating role of PEU and PU between TTF and ADOPT, we first opened a direct path from TTF to ADOPT and closed the effects from TTF to PEU and PU. The path coefficient from TTF to ADOPT is now significant. Next, we opened the paths from TTF to PEU and PU. The path coefficient from TTF to ADOPT is now not significant. These results support the proposition that the effect of TTF on ADOPT is mediated through PEU and PU (Baron and Kenny, 1986).

We proposed that the social norm (SOCIAL) for the new technology affects adoption (ADOPT) directly and is not mediated through perceived ease of use (PEU) and perceived usefulness (PU). In order to confirm this, we estimated the paths from SOCIAL on PEU and PU and closed the path from SOCIAL on ADOPT. Neither of the two paths were significant ($t=1.79$ and $t=-0.42$, respectively), with a chi-square of 264.85 (145 d.f.). Thus, modeling PEU and PU as mediators provides an equal degree of fit, but the paths are not significant. This finding confirms our theoretical argument that social norms affect motivation to adopt directly.

Explained variance in the focal constructs are reported as percentages in the boxes in Figure 2 (squared multiple correlations of the scales). We observe that our model explains 76 percent of the variance in adoption; this is substantially higher than the previous TAM studies we reviewed (Table 1) and in other TAM studies. TAM models typically explain around 40 percent of the variance in intention to adopt (Venkatesh and Davis, 2000, p. 186; Legris, Ingham and Collerette, 2003, 202.). In addition, our conceptualization of TTF explains 71 percent of the variance in PEU and 85 percent of the variance in PU.

Figure 2 here

Because the sample that participated in the survey have somewhat more experience than the population of users, we checked whether experience (EXPERIENCE = number of times the service was used) affected the proposed model. We used principal component to compute factors for each of the theoretical constructs (that is, PEU, PU, ADOPT, TTF, and SOCIAL).

We computed the interaction term between experience and task-technology fit (EXPERIENCE*TTF) and the interaction term between experience and perceived ease of use (EXPERIENCE*PEU). Multiple regression was applied to estimate the effects of the interaction terms in predicting perceived usefulness (PU) and likelihood of adoption (ADOPT). Neither the interaction terms nor the main effects of experience were significant in either model, which indicates that experience does not moderate the proposed causal mechanisms.

DISCUSSION

By conceptualizing adoption as an integration process in which a new digital learning technology is integrated into a set of interrelated learning tasks in a social context, the present study provides a new understanding of the meaning of task-technology fit and how this relates to users' motivation to adopt and use a new technology. We tested the conceptual model in a field study of a digital textbook service and found that the proposed constructs and conceptual model explain substantially more variance in adoption than previous research within the TAM framework.

Our findings demonstrate that adopting a digital learning technology such as a digital textbook service is about integrating a technology with a set of interrelated learning tasks, where the new technology is evaluated on its effect on learning. A new digital learning technology should also provide symbolic meaning in the social context in which the learning takes place. Therefore, the slow adoption of digital learning technologies in the education sector could be related to a myopic understanding of students and how they learn. The digital revolution in education is less likely to be about moving the classroom online (Allen and Seaman, 2010; Christensen et al., 2008) than about how digital services can improve the set of tasks involved in learning, of which the classroom is only one of several.

Schools and universities need to set precise goals for what students should learn and must develop a clear understanding of how the different set of learning activities contribute to achieve the learning objectives. When this is clear, managers can search for digital learning technologies that fit the different sets of learning activities; this will improve their students' actual learning. Our research indicates that digital learning technologies need to fit the set of different learning activities in the classroom, reading, solving problems, group work, writing term papers, preparing for exams, and so on. Although we have not addressed this point in our study, we believe teachers and professors should play a key role in managing students learning and how digital learning technologies should be used in the various courses and programs. This belief is supported by some of the studies reported in the introduction of this paper (i.e., Dufreene et al., 2009; Shapley et al., 2010; Sung et al., 2016). Islam (2015) also addressed the importance of including educators in the deployment of learning technology platforms.

As digital learning technologies become more effective at assisting students' learning processes, educators must also rethink their business model from the traditional perspective of classroom teaching and exam testing. Teachers and professors provide lectures with presentations of theories, concepts, methods, etc. Students are then asked to read and study course material before they are tested through various forms of exams. As students pass the exams, educators conclude whether the students have learned. An alternative business model is that each student is mentored individually throughout the learning process. Whenever students struggle to learn something, the mentor can assist and provide more guidance. The problem, of course, is that such a business model is not viable because of the high teaching costs. However, digital learning technologies can be designed to provide individual mentoring during the learning process. This can be functionally related to students' variation in learning styles, machine-based feedback on assignments and exercises, digital tutoring, and the like. The rapid development of mobile technologies will probably provide a rich array of opportunities for how such individual machine-based mentoring can be achieved (Liu and Guo, 2017). In the emerging business models, educators need to develop more precise and objective measures of the different stages in the learning process.

An important limitation of our research is that independent variables related to task-technology fit were not systematically manipulated in an experimental design. We believe that future research should employ experiments in which features and communication of a digital learning technology can be systematically tested to uncover more of the underlying causal mechanisms between technology fit and motivation to adopt. Also, future research should investigate objective measures of learning in addition to the types of subjective measures commonly used in adoption research. This could be a measure of change in learning before and after digital learning was implemented, or it could be a comparison of learning level between those who uses the technology (treatment group) and a comparable reference group (control group).

Another limitation is that we have only tested one specific textbook technology. The speed of technology development and continuous learning suggests that more recent technologies are more effective at providing learning than what has been found in previous research (namely, Sung, Chang, and Liu, 2016). Therefore, more research on recent digital learning technologies is extremely important; in particular, we believe future research should investigate application technologies that capture relevant learning interactions within social networks among students and teachers as discussed in Rey-Moreno and Medina-Molina (2016).

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Figure 1

Conceptual model integration of technology and adoption of digital learning technologies

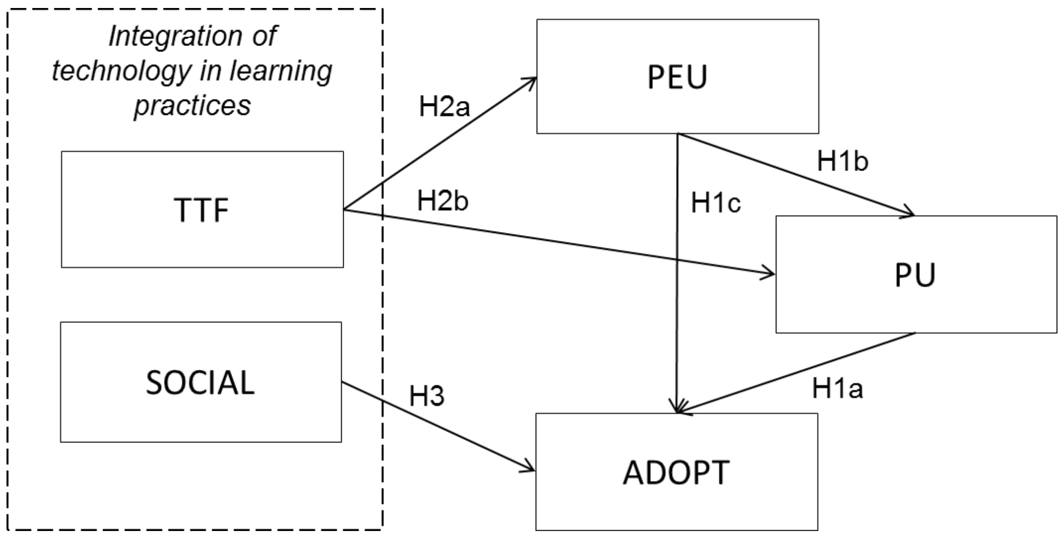

Figure 2

Estimated structural model for integration of technology and adoption of a digital learning technology – standardized effects and explained variance

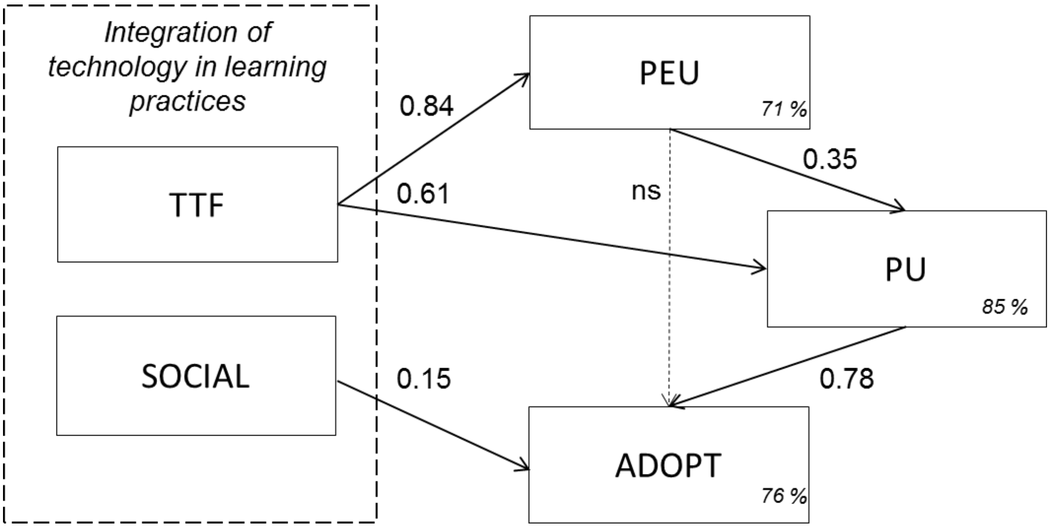

Table 1

Summary of relevant research on acceptance of digital learning technologies

Study	DV	IV	Sample	R^2	Technology
Ong, Lai and Wang (2004)	Intention to use	Perceived usefulness, perceived ease of use, perceived credibility	Employees in six international organizations in Taiwan (n=140)	44%	Company e-learning systems
Saade and Bahli (2005)	Intention to use	Perceived usefulness, perceived ease of use, cognitive absorption	Students with experience in using e-textbook in one or several courses (n=397)	26%	E-textbooks in general
Saadé and Galloway (2005)	Intention to use	Perceived usefulness, Perceived ease of use, attitude towards application	Samples from two successive semesters with students taking the same course delivered by the same professor with the same characteristics (n=128)	38.3%	Multimedia learning system (MMLS)
Terpend, Gattiker and Lowe (2014)	Subscription to e-textbook service	Internet self-efficacy, perceived usefulness, perceived ease of use and environmental concern	Students with option to purchase ordinary textbook or subscription to a digital textbook in two different courses (n=180)	NA	E-textbook
Maduku (2015)	Intention to use	Perceived usefulness (performance expectancy), effort expectancy, social influence	Students with experience in using e-books (N=439)	49.2%	E-books in general (which may include e-textbooks)
Cheng (2015)	Intension to use	Perceived usefulness, perceived ease of use, enjoyment,	Taiwanese mobile phone users (n=486)	45.5%	Internet Learning system
Islam, (2015)	Intention to continue using	Perceived usefulness ease of use, satisfaction,	Students and educators at a Finnish multidisciplinary university (N= 170 educators and 233 students)	60.0%	Learning management system
Rey-Moreno and Medina-Molina (2016)	Intension to use	Perceived usefulness (performance expectancy), effort expectancy, social influence	Students with experience in using e-platform (N=156)	33.1%	E-Learning platform
Liu and Guo	Mobile	Perceived usefulness,	College students from 13	NA	Mobile e-

(2017)	computing devices acceptance	perceived ease of use, social benefit, trust and perceived financial cost	universities and colleges in China (N=343)		learning in general
Liebenberg, Benadé, and Ellis (2018)	Intention to use	Perceived usefulness (performance expectancy), effort expectancy, attitude towards using technology, facilitating, conditions, self-efficacy, anxiety	First year students at North-West University in South Africa taking an introductory course in computers and programming (N=738)	NA	eBook and E-learning platform

Table 2

Measures of perceived usefulness and the focal task in studies related to learning

Study	**Effect of PU on Adoption**	**Items measuring Perceived Usefulness**	**Focal task**
Ong, Lai and Wang (2004)	0.34	Using the e-learning system improves my job performance. Using the e-learning system enhances my effectiveness in my job. Using the e-learning system in my job improves my productivity. I find the e-learning system to be useful in my job.	Job performance
Saade and Bahli (2005)	0.43	Using the ILS would reduce my ability to perform well in the course. I think that an ILS such as this one should be part of each and every course in the university. Using the ILS in the course would enhance my performance in the course. Using the ILS in the course would make it easier for me to study for tests and exams. Using the ILS in the course would make it easier for me to do my assignment(s).	Course performance
Saadé and Galloway (2005)	0.284	I feel that using the MMLS has improved my performance in the Comm301 course. Using the MMLS in the Comm301 course has improved my productivity. Using the MMLS has enhanced my effectiveness in the Comm301 course. I find the MMLS useful in the Comm301 program.	Course performance
Terpend, Gattiker and Lowe (2014	0.206	I know a lot of other people who have successfully used online textbooks for other classes. The online textbook seems useful. I believe the online textbook will help me succeed.	Reading performance
Maduke (2015)	0.543	Using e-books (enables/would enable) me to read more quickly. Using e-books (makes/would make) it easier for me to obtain information. Using e-books (makes/would make) it convenient for me to read anywhere at any time. Using e-books (enables/would enable) me to have easy access to books.	Reading performance
Cheng (2015)	0.399	Using m-learning enhances my learning effectiveness. Using m-learning gives me greater control over learning. I find m-learning to be useful in my learning.	Learning
Islam, (2015)	0.36	The Moodle (name of LMS) is of benefit to me. The advantages of the Moodle outweigh the disadvantages. Overall, using the Moodle is advantageous.	Intention to continue using a learning management system
Rey-Moreno and	0.141	Using E-learning platform would enable me to access education material more quickly. Using E-learning platform would make it easier to access	Accessing learning material

Medina-Molina (2016)		education material. Using E-learning platform would enhance my effectiveness in accessing education material.	
Liu and Guo (2017)	0.469 (females) 0.553 (males)	Mobile computing devices will increase my study efficiency. Mobile computing devices will give me access to information that I cannot get elsewhere. Mobile computing devices provide me with information that would lead me to produce better study.	Acceptance of using mobile computing devices in studying
Liebenberg, Benadé, and Ellis (2018).	0.466	eBook: The eBook is useful in my studies. Using the eBook enhances the quality of my work. The advantages of using eBook outweigh the disadvantages. Using the eBook enables me to accomplish tasks more quickly. Using eBook improved my academic achievement. Using the eBook improved my productivity. SAM (specialized learning management system): SAM is useful in my studies. Using SAM enhances the quality of my work. The advantages of using SAM outweigh the disadvantages. Using the SAM enables me to accomplish tasks more quickly. Using SAM improved my academic achievement. Using the SAM improved my productivity.	Using e-learning technologies in studying

Table 3

Demographic characteristics of sample (N=147)

Demographic	**Category**	**Frequency**	**Percentage**
Gender	Male	64	43.5
	Female	83	56.5
Age	< 20	17	11.6
	20–24	88	59.9
	25–30	21	14.3
	> 30	21	14.3
Grade average from high school	1	0	0
	2	1	0.7
	3	17	11.6
	4	77	52.4
	5	51	34.7
	6	1	0.7
Average hours per week spent on study during semester	1–10	13	8.8
	11–20	27	18.4
	21–30	46	31.3
	31–40	35	23.8
	41 +	26	17.6
I can usually find out how technology devices work without asking others!	1 – Completely disagree	4	2.7
	2	4	2.7
	3	7	4.8
	4	7	4.8
	5	21	14.3
	6	25	17.0
	7 – Completely agree	79	53.7

Table 4

Measurement of Task-technology fit

Study	Measurement items	Technology
McGill and Klobas (2009)	WebCT fits well with the way I like to study. WebCT is compatible with all aspects of my study. WebCT is easy to use. WebCT is user-friendly. It is easy to get WebCT to do what I want it to do. WebCT is easy to learn. It is easy for me to become more skillful at using WebCT. New features of WebCT is easy to learn. Do you think output from WebCT is presented in a useful format? Is the information from WebCT accurate? Does WebCT provide you with up-to-date information? Do you get the information you need in time? Does WebCT provide output that is exactly what you need?	Web-based course management system (WebCT)
D'ambra et al. (2013)	Within an e-book, I would like to be able to: • Bookmark • Annotate • Highlight • Browse table of contents • Browse the index • Link from indices to text • Search across full text • Copy • Have a read-aloud option • View high-resolution images • Translate to other languages • Print	e-books
Gerhart et al. (2015)	Compared to traditional textbooks: Functionalities of e-textbooks are sufficient Functionalities of e-textbooks are adequate Functionalities of e-textbooks are appropriate Functionalities of e-textbooks are compatible Functionalities of e-textbooks are helpful	e-textbooks
Kim et al. (2010)	HIS is appropriate to my job HIS is available when needed HIS is important to my job HIS can help me deal with unexpected situations HIS is able to integrate information across multiple departments	Hotel Information System (HIS)
Moon et al. (2015)	Adequecy Usefulness Compatibility with the task Helpfulness Sufficiency Fit with the task	POS

Table 5

Statistical properties of measurement scales

Scale	Items	Mean	SD	Loadings
PEU	It is easy to understand how to use ST[2].	5.52	1.57	0.70
	It is easy to make ST do what I want it to do.	4.61	1.85	0.74
	It is easy to explain to others what you can achieve with ST.	5.25	1.68	0.77
	The purpose with ST is easy to understand.	4.91	1.77	0.87
PU	ST improves the quality of learning.	4.85	1.78	0.93
	ST facilitates learning.	4.87	1.80	0.93
	ST provides new ways of learning.	4.72	1.84	0.87
	ST improves reading the curriculum.	5.22	1.80	0.89
ADOPT	I will use ST if available in courses I take in the future.	5.65	1.73	0.89
	I am willing to pay a little extra to get ST with a textbook.	2.94	2.01	0.45
	I will recommend next year's students in this course use ST.	5.14	1.99	0.95
TTF	ST is appropriate for, and tailored to, writing a term paper in a course.	4.62	1.78	0.90
	ST is appropriate for, and tailored to, reading curriculum in a course.	4.68	1.91	0.88
	ST is appropriate for, and tailored to, group work in a course.	4.46	1.78	0.87
	ST is appropriate for, and tailored to, attending lectures in a course.	4.63	1.72	0.87
SOCIAL	Using ST signals fellow students that you are a serious student.	3.74	1.86	0.82
	ST is something students talk about.	3.38	1.96	0.77
	In my student network many use ST.	3.55	1.77	0.66
	Smart students use ST.	3.16	1.81	0.68

Table 6
Convergent and discriminant validity

	CR	AVE	PEU	PU	ADOPT	TTF	SOCIAL
PEU	0.86	0.78	**0.88**				
PU	0.95	0.94	0.86	**0.97**			
ADOPT	0.83	0.77	0.78	0.85	**0.88**		
TTF	0.93	0.91	0.84	0.90	0.82	**0.96**	
SOCIAL	0.82	0.72	0.60	0.56	0.59	0.61	**0.85**

APPENDIX

Measurement scales

Scale[1]	**Items**	**References**
PEU (Perceived ease of use)	It is easy to understand how to use ST[2]. It is easy to make ST do what I want it to do. It is easy to explain to others what you can achieve with ST. The purpose with ST is easy to understand.	Adopted from Davis et al. (1989) and Venkatesh et al. (2003), and adjusted to context.
PU (Perceived usefulness)	ST improves the quality of learning. ST facilitates learning. ST provides new ways of learning. ST improves reading the curriculum.	Adopted from Davis, et al. (1989) and Venkatesh et al. (2003), and adjusted to specific context.
ADOPT (Intention to use)	I will use ST if available in courses I take in the future. I am willing to pay a little extra to get ST with a textbook. I will recommend next year's students in this course use ST.	Adopted from Davis (1989) and Venkatesh et al. (2003), and adjusted to the context.
TTF (Task-Technology Fit)	ST is appropriate for, and tailored to, writing a term paper in a course. ST is appropriate for, and tailored to, reading curriculum in a course. ST is appropriate for, and tailored to, group work in a course. ST is appropriate for, and tailored to, attending lectures in a course.	Developed in this study
SOCIAL (Social Norm)	Using ST signals fellow students that you are a serious student. ST is something students talk about. In my student network many use ST. Smart students use ST.	Adopted from Moore and Benabsat (1991) and Venkatesh et al. (2003), and adjusted to context.

[1] All scales were 1–7, anchored with "completely disagree" and "completely agree".

[2] ST is an abbreviation of Smart Textbook (name of the digital textbook service).