AIS Transactions on Human-Computer Interaction

Volume 9 | Issue 3 Article 1

10-1-2017

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Recommended Citation

Janson, A., Söllner, M., & Leimeister, J. (2017). Individual Appropriation of Learning Management Systems—Antecedents and Consequences. *AIS Transactions on Human-Computer Interaction, 9*(3), 173-201. Retrieved from https://aisel.aisnet.org/thci/vol9/iss3/1
DOI:

Transactions on Human – Computer Interaction

Research Paper

Individual Appropriation of Learning Management Systems—Antecedents and Consequences

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Abstract:

IT support in the learning process constitutes a key factor for the success of innovative teaching/learning scenarios. To ensure learning success in innovative teaching/learning scenarios, learners need to faithfully apply learning management systems (LMS). However, we lack theoretical insights into which factors affect whether they do so. To help solve this issue, we first used adaptive structuration theory to identify antecedents and consequences regarding faithful LMS appropriation and embed them into a theoretical model. Second, we conducted a survey study with 173 participants to evaluate the model. The results show that the perceived IT support, interactivity, and the task-technology fit significantly affect the degree to which learners faithfully apply a LMS. Moreover, the results indicate that faithful appropriation is a significant indicator of the learning process satisfaction as well as perceived learning success. The present paper thus theoretically contributes to the scientific discussion concerning technology-mediated learning processes while also making a practical contribution by deriving implications for LMS application.

Keywords: Technology-mediated Learning, E-learning, Learning Process, Faithfulness of Appropriation, Learning Management Systems.

The manuscript was received 12/15/2015 and was with the authors 6 months for 3 revisions.

1 Introduction

Education and training in human resource management constitute key factors to increase the productivity of individuals and, thus, knowledge-intensive companies (Arthur, Bennett, Edens, & Bell, 2003; Gupta & Bostrom, 2013). In this context, human resource management often relies on using information technology (IT) and, more specifically, human resource information systems (HRIS) for training initiatives (Chakraborty & Mansor, 2013; Docebo, 2014). By using HRIS in training human resources, companies can provide cost-efficient training that offers many potentials in contrast to classical training (e.g., individual and self-paced learning on the job) (Wirtky, Laumer, Eckhardt, & Weitzel, 2016) and more effective training (Sitzmann, Kraiger, Stewart, & Wisher, 2006). Therefore, IT support in the learning process constitutes a key factor for the success of innovative human resource training initiatives. Companies often implement HRIS for training initiatives using learning management systems (LMS) (Wirtky et al., 2016), which play a significant role in the management of learning in companies (Dunne & Butler, 2004). These learning systems are information systems (IS) that companies use to deliver, assess, and manage education and training (Islam, 2012); as such, they are especially important for human resource departments to ensure the fast and effective delivery of learning content to a large number of people in an organization (Welsh, Wanberg, Brown, & Simmering, 2003). This importance holds also true for learning in higher education where LMS are an essential part of IT-supported learning initiatives (Cerezo, Sánchez-Santillán, Paule-Ruiz, & Núñez, 2016). Furthermore, besides content delivery, these IS offer an individualized learning process to support users with effective feedback in order to engage learning success in self-regulated learning phases.

However, research shows that education and training supported by advanced IT lack features that support self-regulated learning phases, which often results in the failure of innovative training scenarios (Adamopoulos, 2013; Cusumano, 2014). In this context, self-regulated learning refers to the process of self-managing behavior, the use of corresponding learning strategies, motivation, and cognition (Zimmerman, 1990). Researchers consider self-regulated learning as more important in technology-mediated learning compared to face-to-face learning scenarios since learners have a more active role in the learning process and, thus, more responsibilities (Eom & Ashill, 2016; Wan, Compeau, & Haggerty, 2012). When considering the role of a more self-regulated, active learner with full learner control and the above-described failure of learning scenarios that heavily build on advanced IT, the nature of LMS may explain these phenomena. These systems are also complex IS with plenty of features and varying usage patterns, which means they can overburden learners and cause the learners underuse them (Tennant, Mills, & Chin, 2014). Learners may perceive LMS as not fitting to the tasks in the learning process, which may indicate a putative missing task-technology fit. Thus, the ability to manage how individuals use such IS is a critical success factor for organizations. Even though the usage process as a core factor therefore heavily influences the outcomes of such an IS, it has received little attention in previous research (Gupta & Bostrom, 2009). Hence, there is a need in research and practice to generate a clear understanding of what characterizes a personalized usage process of a LMS and which implications one can derive for the usage process-oriented and, thus, user-centered design of a LMS. In particular, research in human-computer interaction (HCI) needs such research because LMS are the central IT artifacts for mediating interactions between learners, instructors, and content (Carswell & Venkatesh, 2002).

In this paper, we focus on closing the gap related to the factors that drive individuals to faithfully appropriate a LMS—which the literature refers to as a kind of black box (Gupta, Bostrom, & Huber, 2010)—by developing and evaluating a theoretical model that focuses on individual users and how they appropriate a LMS embedded in a blended learning scenario. Faithful appropriation has emerged as an important performance indicator regarding the learning process in technology-mediated learning. Such a model would offer a better theoretical understanding of all learning contexts where technology mediates the learning process, such as in corporate training contexts or university education. Thus, we analyze faithful appropriation with regard to its determinants and effects on the learning process and LMS success. In particular, we address two research questions (RQ):

RQ1: Which determinants significantly affect faithful LMS appropriation?

RQ2: How does a faithful LMS appropriation affect the learning process and success?

This paper contributes to the literature by offering a theory for explaining and predicting (Gregor's (2006) type 4 theory) and provides practical implications for designing learing management systems. The paper proceeds as follows: in Section 2, we discuss the theoretical foundations of technology-mediated learning. In Section 3, we derive the theoretical model based on adaptive structuration theory (Chin, Gopal, &

Salisbury, 1997; DeSanctis & Poole, 1994) and several hypotheses. In Section 4, we present the research methodology we used to empirically evaluate the theoretical model. In Section 5, we present our results. In Section 6, we discuss the study's findings and implications. In Section 7, we present the study's limitations and future research possibilities and, in Section 8, conclude the paper.

2 Theoretical Background

2.1 Technology-mediated Learning

To understand how learning management systems are embedded in the learning process and relate to learning outcomes, we first take a step back and consider technology-mediated learning (TML). TML refers to "an environment in which the learner's interactions with learning materials (readings, assignments, exercises, etc.), peers, and/or instructors are mediated through advanced information technologies" (Alavi & Leidner, 2001, p. 2). Research often synonymously uses the terms e-learning and TML (Gupta & Bostrom, 2013). However, note that TML works in many forms and may combine different learning styles and methods in practice (Gupta & Bostrom, 2009):

- Web- or computer-based learning
- Asynchronous or synchronous learning
- Instructor-led or self-paced learning, and
- Individual-based or team-based (collaborative) learning.

When combining these modes of TML with face-to-face instruction, research also refers to blended learning (Graham, 2006; Gupta & Bostrom, 2009). In this case, TML is blended with face-to-face instructions that, for example, could take place in a classroom. Modes for blending TML with traditional learning modes are manifold and could in our context include the self-regulated preparation of learners with advanced IT (e.g., a LMS) while meeting with the class face to face afterwards to work on the prepared topics.

This variety of options for TML and their consideration in a blended learning scenario poses particular challenges for research. In consequence, empirical research has found mixed results concerning the impact of TML related to the individual and team levels (Gupta & Bostrom, 2009). As for one reason why, TML studies focus on input and output research designs that consider the above-listed elements of TML but neglect, among other things, the learning process (Alavi & Leidner, 2001; Hannafin, Kim, & Kim, 2004). In order to address these challenges, we refer to the theoretical boundaries of Gupta and Bostrom (2009), who developed a framework for TML based on adaptive structuration theory (AST) (DeSanctis & Poole, 1994). AST allows one to examine the complex relationships between technologies in social structures, which researchers first investigated in group decision support systems and their application in organizations (DeSanctis & Poole, 1994). The framework considers input and output factors of TML and, in contrast to previous research approaches, the learning process, which is particularly important for the actual learning outcomes and, thus, the quality of TML (Alavi & Leidner, 2001).

Referring to AST, this framework has two basic assumptions (Gupta & Bostrom, 2009). The first one refers to the structures implemented in a specific context; that is, the rules, resources, and possibilities in a given context (DeSanctis & Poole, 1994) (e.g., a LMS applied by learners). The second one relates to the design of the learning process. This process view considers learners' interaction with the structures of TML described above (Gupta & Bostrom, 2009) (e.g., by means of a learner's adaption to the applied learning methods and materials provided by a LMS). Therefore, Gupta and Bostrom (2013), for example, have shown in an experimental study that the appropriation of learning methods and structures moderates their influence on learning outcomes. However, they did not further investigate which antecedents relate to the appropriation of such learning methods (e.g., a LMS). Therefore, we further adjust this view by taking a closer look on how individuals appropriate a LMS in TML when explicitly considering the antecedents for the appropriation process to derive LMS design implications.

2.2 Learning Management Systems

As we note above, we focus on LMS that learners use in a variety of TML combinations. Hence, we need to understand and recognize the IT artifact and, therefore, define LMS, which is especially relevant since theory and practice have different understandings of what a LMS is and what it is not. In this context, the literature often differentiates between learning management systems (LMS), learning content management systems (LCMS), and content management systems (CMS) (e.g., Qwaider & Hattab, 2010).

LMS focus on delivering, assessing, and managing education and training (Islam, 2012). Furthermore, these IS offer an individualized learning process to support users with effective feedback in order to engage learning success in self-regulated learning phases. Considering this definition, e-learning authors or lecturers have already created learning content for the student interaction, while the LMS manages the learning process of individuals. In contrast, the scope of LCMS includes managing, creating, and delivering content and learning objects (Süral, 2010). As such, LCMS offer one the possibility to create learning content such as SCORM packages that one can integrate in a LMS. Therefore, LCMS focus at first on the lecturer or designer of the learning content, while LMS focus on the learner. Finally, a CMS offers frameworks to display various content types, which could also include learning materials (e.g., Web-based training embedded in a CMS-powered blog) (Qwaider & Hattab, 2010).

However, we acknowledge that the theoretical boundaries between the three types of IT artifacts blur since all types of management systems offer possibilities in practice for managing learners, creating content, and offering frameworks for storing and displaying content (Qwaider & Hattab, 2010). For example, the widely known LMS solution Moodle offers possibilities to support and manage learners' learning process by providing a sophisticated access system to enable individual learning paths and various learning activities. Learners can use these activities for their own learning process, such as in the form of peer assessment or group discussion forums to name just two learner-centric characteristics that form a LMS. However, LMS such as Moodle also offer the possibility to create learning material, similar to LCMS. In addition, they enable one to display learning content, similar to a CMS. In our study, though, we focus on the learner and, in particular, on how a learner appropriates an IS in the learning process; as such, we adopt the term LMS when developing our hypotheses.

3 Research Model and Hypotheses Development

As we note above, the learner plays an important role in the interactive process of learning. Therefore, recent research has considered the learning process while analyzing procedural factors of TML by focusing on the interaction between learners and TML's structural potential (Gupta & Bostrom, 2013). In this context, we elaborate on the theory base and derive the hypotheses of our paper in this section. Figure 1 depicts our research model.

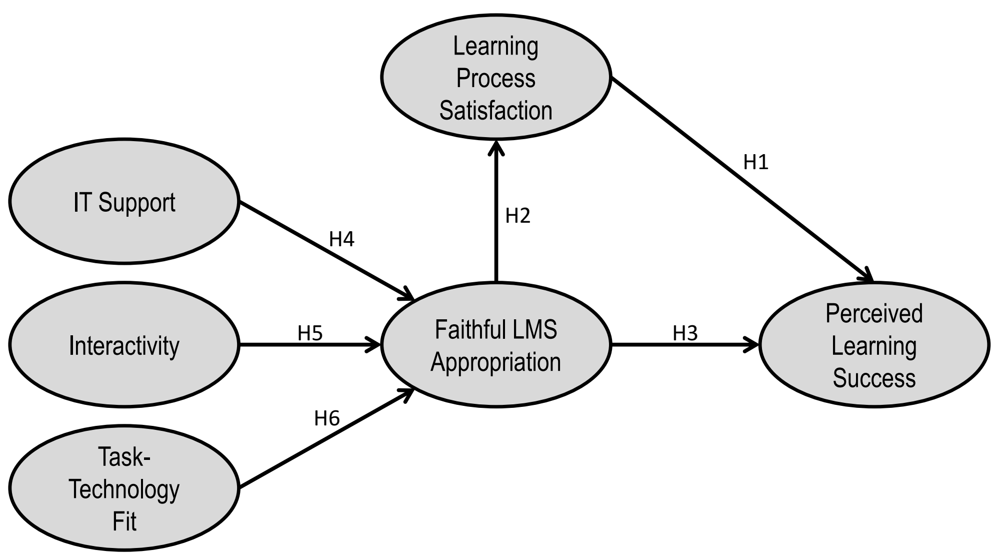

Figure 1. Theoretical Research Model

As research in various areas has indicated, the learning process is a complex phenomenon that includes cognitive processes and interactions based on the aforementioned learning methods and individual differences between learners, support for the learning process (scaffolding), and other elements of the teaching/learning scenarios that influence learning outcomes (Gupta et al., 2010). The latter represents "the goal assessment or measures for determining the accomplishment of learning goals" (Gupta

& Bostrom, 2009, p. 713) and is one of the key outcome measures of TML. Learning outcomes relate to several dimensions (for a review on learning outcomes, see Gupta et al., 2010) and often include meta-cognitive and affective learning outcomes (e.g., Gupta & Bostrom, 2013; Wan et al., 2012). Researchers consider meta-cognitive outcomes such as perceived learning success (Alavi, 1994) to be important since they indicate individuals' knowledge regarding their own learning processes (Gupta & Bostrom, 2009) and may correlate with cognitive knowledge acquisition (Benbunan-Fich, 2010). In turn, affective outcomes such as learning process satisfaction focuses on emotional aspects of the learning process (Gupta et al., 2010). When considering the link between the learning process and learning outcomes, we suggest that perceived learning success strongly depends on how an individual learner perceives the learning process from an affective domain. When learners are more satisfied with their own process of learning, they may espouse a higher level of self-efficacy and, in turn, achieve higher learning success. Therefore, in line with previous studies (Gupta & Bostrom, 2013; Hattie & Yates, 2014), we hypothesize:

H1: Learning process satisfaction positively influences perceived learning success.

3.1 Relevance of Faithful LMS Appropriation in the Learning Process

Numerous studies consider the success of LMS from multiple perspectives such as the learner or the instructor perspective (Al-Busaidi, 2012). As Al-Busaidi (2012) points out, most studies that have considered LMS success have investigated how certain antecedents of LMS success such as characteristics from learners, instructors, courses, and/or the used LMS relate to outcome factors such as technology acceptance or user satisfaction (Al-Busaidi, 2012; Sun, Tsai, Finger, Chen, & Yeh, 2008). However, this predominant view neglects how learners appropriate provided IT structures such as a LMS in their learning process. Therefore, we additionally consider the application and appropriation of a LMS in the theoretical concept of AST (Gupta & Bostrom, 2009). Researchers originally applied AST to understand the appropriation process of groups in the domain of group support systems (GSS) (Chin et al., 1997). Despite this major focus on GSS, research has also highlighted that AST may serve as a meta-theory (Bostrom, Gupta, & Thomas, 2009) for understanding other complex information systems, such as LMS (Tennant et al., 2014) or massive open online courses (MOOCs) (Whitaker, New, & Ireland, 2016) that are applied in sociotechnical systems. Though in the past usually used on a group level, AST serves as a multilevel theory (Bélanger, Cefaratti, Carte, & Markham, 2014), and researchers have applied it particularly in a TML context on an individual level to understand how individuals use IT in their learning process (Gupta & Bostrom, 2013; Hardin, Looney, & Fuller, 2014). The appropriation process is a central construct in the learning process that complements content acquisition (Gupta & Bostrom, 2013). During this process, one can observe faithful appropriation as a social aspect with respect to technology use as individuals establish certain expectations of the role and benefits of technology (DeSanctis & Poole, 1994). Faithful appropriation refers to the degree to which the appropriation is consistent with the developers' original design objective(s) (Chin et al., 1997). In the context of TML, a faithful appropriation occurs when learners appropriate the learning methods and structures in a way consistent with the general learning objectives and epistemological perspective (i.e., the TML spirit) and, consequently, influences the learning success (Gupta & Bostrom, 2009).

Consistent with AST, TML design dimensions characterize the TML spirit (see Table 1), and the structural features that learners can draw on in their appropriation process reflect these dimensions. As DeSanctis and Poole (1994) suggest in their seminal paper on AST, we treat the LMS technology as "text" and develop a reading of its philosophy based on the design metaphor, features, the user interface, and documentations. Table 1 overviews how TML design dimensions relate to each other.

To provide a better contrast to other TML studies drawing on AST, we draw in Table 1 also on the studies of Gupta and Bostrom (2013) and Hardin et al. (2014), who both relied on social cognitive theory in end user training that used enactive and vicarious learning methods via the Web. In contrast, we draw on a constructivist view of learning with problem-based learning methods and use the Moodle open-source LMS. Howland, Jonassen, and Marra (2014) have identified in this context five dimensions that are prevalent for constructivist TML approaches (see also Gupta & Bostrom, 2009): 1) active (learners are actively engaged by meaningful tasks, able to manipulate their environment, and observe the results of their manipulations), 2) constructive (learners construct their own mental models of what they have learned), 3) intentional (learning is goal directed), 4) authentic (learning has to take place with complex and contextual learning materials that may be situated in real-world situations), and 5) cooperative (learning takes place collaboratively, which ensures the natural learning process in which learners interact, create knowledge together, and profit from learning with peers).

Table 1. AST in TML Studies (Based on Gupta & Bostrom, 2009; Hardin et al., 2014)

TML dimensions	Description	Epistemological perspective and reference studies
Production pattern	The lag between someone's demonstrating an action and the learner's practicing it	Social cognitive theory: Gupta and Bostrom (2013); Hardin et al. (2014)
Structuredness of practice	The extent to which technology imposes its procedures on the learner.	
Restrictiveness of practice	The degree to which the system limits an action.	
Feedback	The degree to which a system provides a response, including correction, addition, or approval and speed of response.	
Guidance	The degree to which a system provides active direction or advice towards a course of action.	
Active (manipulative/observant)	The degree to which a system provides active learning opportunities.	Constructivist: present study
Constructive (articulative/reflective)	The degree to which a system provides the possibility to construct own knowledge and reflect on it.	
Intentional (goal-directed/regulatory)	The degree to which a system provides opportunities to articulate and represent their understanding of a learning goal.	
Authentic (complex/contextual)	The degree to which a system provides authentic tasks that represent the natural complexity of real-world problems.	
Cooperative (collaborative/conversational)	The degree to which a system provides the possibility to interact collaboratively with peers.	

For example, if one implements a constructivist learning scenario driven by collaborative learning with a LMS via a discussion forum as a structural feature to discuss learning material, a faithful appropriation would occur if learners actively engage, discuss, and solve proposed assignments. Consequently, learners are satisfied with their learning process because these engaging discussions might relate to a more efficient learning process that results in higher learning outcomes. In contrast, a non-faithful or ironic appropriation occurs when students do not fully understand a complex LMS and the learning focus shifts to the technology itself (Gupta & Bostrom, 2009). As a result, they may not acquire the learning material in cognitive processes but rather focus solely on the LMS appropriation itself, which impairs the entire learning process (Gupta & Bostrom, 2009). Results may, on the one hand, show that learners are dissatisfied with their own learning processes as an affective outcome and, on the other hand, include that they may achieve lower levels of learning success. Therefore, we hypothesize:

H2: The faithfulness of LMS appropriation positively influences learning process satisfaction.

H3: The faithfulness of LMS appropriation positively influences perceived learning success.

3.2 Determinants of Faithful LMS Appropriation

In order to derive further insights into how certain determinants can affect whether learners faithfully appropriate a LMS, we need to identify corresponding determinants. These determinants may affect the learning process itself and, thus, indirectly influence learning success (Gupta & Bostrom, 2009) via influencing the interaction between learners and the applied methods and structures (Gupta et al., 2010). These determinants are actively influenced by the lecturer to support learning in the learning process (Gupta et al., 2010; Gupta & Bostrom, 2009). As such, we introduce three constructs that affect faithful appropriation in the form of learning process determinants: IT support, interactivity, and task-technology fit.

IT support as the first determinant refers to applied IT artifacts' suitability to foster communication and learning support in the learning process (Bitzer, Söllner, & Leimeister, 2013). IT support refers to the learner's individual self-reflection in the learning process (Gupta & Bostrom, 2009; Hui, Hu, Clark, Tam, & Milton, 2008) and, thus, constitutes a learning process control (Sorgenfrei, Smolnik, Hertlein, & Borschbach, 2013). For example, instructors can promote learners' continuously acquiring learning methods and structures by instructing them on how they should apply methods and structures according to their purpose. Therefore, we hypothesize:

H4: IT support positively influences faithful LMS appropriation.

When considering the learning process, interactivity is a crucial and distinct learning process variable (Arbaugh, 2000; Bitzer et al., 2013) that influences learning outcomes in a positive way (Evans & Gibbons, 2007; Sims, 2003; Smith & Woody, 2000). Defined as learning activities that include interactions between learners (learner-learner interaction), interactions with the lecturer (learner-lecturer interaction), and interactions with the learning methods and structures (learner-content interaction) (Moore, 1989; Schrum & Berge, 1997), interactivity closely relates to how learners act in their learning process. In a corporate learning context, interactivity is prevalent since TML has to draw on interaction with multiple stakeholders to ensure its success (Johnson, Hornik, & Salas, 2008). Otherwise, one might recognize TML in corporate training only as the simple transfer of learning material without drawing on rich interactions with learners. Considering the learning process, we argue that interactivity contributes to a more faithful LMS appropriation because, with a higher degree of interactivity in the classroom and online, individual learners will be more likely to recognize the TML spirit and appropriate the LMS more faithfully. On the one hand, when learners can easily interact with a trainer or lecturer via a LMS and in class, they will be more likely to perceive information regarding the underlying TML spirit and, thus, receive support for a faithful appropriation. On the other hand, if learners cannot easily interact with the lecturer (e.g., in MOOCs), they may not easily receive feedback regarding their learning activities and will be less likely to faithfully appropriate a LMS in the learning process. Therefore, we hypothesize:

H5: Interactivity positively influences faithful LMS appropriation.

In addition to IT's and interactivity's supporting the learning process, we also need to analyze LMS's suitability for a faithful appropriation. We do so using the construct of task-technology fit (TTF), which works well for predicting the success of information systems (McGill & Klobas, 2009) and has proven to be an important indicator of faithful appropriation in AST (Dennis, Wixom, & Vandenberg, 2001; Fuller & Dennis, 2009). In a LMS context, TTF refers to learners' requirements to accomplish their specific tasks, their individual skills, and an IT artifact's functionality (Goodhue & Thompson, 1995). The latter refers in our case to the functionalities of the LMS that enable learners to fulfill tasks in the learning domain. Typical tasks might include accessing learning materials, communicating with instructors and other students in discussion forums, or undertaking interactive activities such as quizzes, peer assessments, and other activities that the LMS offers (McGill & Klobas, 2009). Thus, the TTF of a LMS is reflected through dimensions other than the originally developed TTF conceptualization from Goodhue and Thompson (1995); these authors relate TTF to IT-supported decision making and represent it with factors such as quality or locatability (see Goodhue and Thompson (1995) for an overview concerning the eight final factors of TTF). Therefore, we rely on McGill and Klobas's (2009) conceptualization: these authors operationalize TTF as a multi-faceted measure including the dimensions of ease of use, ease of learning, and information quality. In contrast to the IT support construct, TTF relates to a LMS's functionalities and how suitable they are for supporting the learner (McGill & Klobas, 2009). In contrast, IT support as a construct explicitly refers to how a LMS structures the learning process via IT support (Bitzer et al., 2013; McGill & Klobas, 2009). Originally, TTF was embedded in the nomological network of the task-to-performance chain (TPC), which focuses on how TTF and its antecedents (task, technology, and individual characteristics) and technology use lead to higher performance (Goodhue & Thompson, 1995). However, we do not hypothesize that TTF has a direct influence on performance (or, in our case, perceived learning success). Rather, we hypothesize that TTF and its perception act as an antecedent of the faithfulness of the LMS appropriation in the learning process, which mediates the performance impacts of TTF. As we note above, AST-related research has embedded TTF in, for instance, the nomological network of the integrative fit appropriation model (FAM) and argued that a high level of TTF more likely has an impact on the performance of the provided technology because a high level of TTF initially suggests a more faithful appropriation (Fuller & Dennis, 2009). In the context of a LMS such as Moodle, an example for the TTF would be the support of a learning method such as peer assessment via a workshop activity (MoodleDocs, 2016). If the workshop module fits the tasks users need to do (e.g., submitting their assignments and commenting on other learners' works), the high level of fit guides appropriation and faithfulness is more likely to occur. In turn, if learners perceive the fit level to be low (e.g., the peer assessment activity does not offer learners sophisticated technology characteristics to comment on each other's work), individual learners will be more likely to not initially faithfully appropriate the provided structures. In this case, they will not provide rich feedback to other students, which will possibly result in a lower degree of faithfulness. Thus, we assume that a high level of TTF would increases a faithful LMS appropriation. Hence, we hypothesize:

H6: Task-technology fit positively influences faithful LMS appropriation.

4 Research Method

4.1 Participants

A total of 175 undergraduate business majors from a European university participated in our study. They were all enrolled in the one-semester course "Introduction to Business and Information Systems Engineering" (see Section 4.2 for further details). We collected 173 usable data sets, a number that shows that almost all students in the class participated (174 students completed the exam). We incentivized participation with extra credits for the final exam. The sample comprised 80 male students and 87 female students (six students chose not to identify their gender). Their mean age was 23.34 years. Table 2 depicts the participants' demographic information. In line with Compeau, Marcolin, Kelley, and Higgins' suggestions (2012), a student sample is appropriate because the LMS used for supporting the learning process is consistent with a broad range of corporate training initiatives (Docebo, 2014).

Table 2. Demographics

Description	Value
Gender	
Female (n = 87)	50.3%
Male (n = 80)	46.2%
No answer (n = 6)	3.5%
Age	
Mean (S.D. 2.57)	23.34
Median	23
Range	19-31
Major	
Business administration (n = 161)	93.1%
Humanities (n = 2)	1.1%
Engineering (n = 4)	2.3%
No answer (n = 6)	3.5%

4.2 Study Context

We collected our data in a semester-long "Introduction to Business and Information Systems Engineering" course. We designed this course as a blended learning course using the LMS Moodle (an open source system) as the central tool for the learning process (see Section 4.3 for details about the LMS). The course focused on the technical basics of information systems and system analysis and design with an emphasis on process- and data-modeling techniques.

We designed the class using a constructivist approach (Gupta & Bostrom, 2009; Howland et al., 2014). We implemented this approach by relying on the five dimensions described in the theoretical background. First, we used learning active and constructive learning tasks in that we offered a wide range of learning opportunities for learners to achieve the overarching learning goals, including those we describe in Section 4.3. Therefore, we provided, for instance, complementary learning materials and activities related to higher-learning goals such as business process modeling skills. In doing so, learners could actively construct knowledge and reflect on the constructed knowledge with activities such as quizzes or peer assessments. Second, and related to the first point, we designed the whole course and its learning material related to differentiated learning goals to provide learners with intentional and goal-directed learning opportunities. Third, we provided authentic and complex tasks concerning higher-order thinking skills, which learners solved in a collaborative and cooperative setting. For example, we asked students to contextualize their constructed knowledge in case studies. In addition, by collaboratively reflecting the constructed knowledge, the described setting addressed further reflective processes.

To further reflect the constructivist perspective from an instructional perspective, we also designed the course as a flipped classroom (also known as an "inverted classroom") (Strayer, 2012). In a flipped classroom, the process of acquiring knowledge or learning course content takes place away from the classroom (e.g., at home or at the workplace) when not in direct contact with a lecturer or trainer. Learners need to teach themselves basic knowledge and classroom time focuses on mastery activities. Outside of class, learners have access to online videos and learning material to study the subject matter on their own. In class, learners concentrate on understanding, applying, and analyzing the subject matter they previously studied (Keengwe, Onchwari, & Oigara, 2014). They do so via group or individual problem-solving activities, group discussions, or other learner-centered activities that enhance critical thinking, problem-solving skills, or the ability to discuss learning material (Garrison & Kanuka, 2004; So & Brush, 2008; Strayer, 2012).

The course comprised five learning cycles, and each cycle comprised four phases: 1) self-regulated preparation, 2) collaborative preparation, 3) collaborative clarification, and 4) collaborative application. Each learning cycle lasted for two to three weeks. In the first phase, learners had access to videos and slides via the LMS to help them learn the basics of each topic. They could access this material at any time and from anywhere. Furthermore, we offered knowledge tests that comprised single- and multiple-choice questions via the LMS, where the learners automatically received individual formative assessments. The course provided learners with the flexibility to repeat learning content via videos, slides, and additional learning material provided in the LMS.

In the second phase (collaborative preparation), the learners prepared a solution to an extensive open-ended free-text assignment (we assigned each group different assignment parts). To complete this solution, the learners worked together in groups while using their own LMS group forum (Janson, Söllner, & Leimeister, 2016). The system limited learners to 40 per group, though group size differed on a range from 12 to 38 students (on average, each group comprised 22.9 learners) because they formed groups on their own. In addition, student assistants controlled the learners' work in each group forum, guided the collaborative working process, and provided help when needed. Each group solved and uploaded the assignments to the LMS, which we used as input for the next phase (collaborative clarification). We held this third phase in the classroom, and it allowed the learners to discuss the content in the learning cycle and the group assignments (Janson, Ernst, Lehmann, & Leimeister, 2014). We conducted the last phase (collaborative application) in tutorials, which we held in a classroom and student assistants directed.

4.3 Learning Management System in Present Study

We used the open source system Moodle as the LMS in the present study. Because the course was a first-year course, the learners had no prior experience with the LMS as implemented in this course. The LMS guided learners through the learning process by providing learning materials and lecture videos, various mock exam resources such as tests and peer assessment features, and homework group forums (Oeste, Lehmann, Janson, & Leimeister, 2014). We introduced students to using the LMS. Also, the learners could contact and talk to the first author if they had questions about using the LMS.

4.4 Procedures

We conducted an online-based survey to evaluate the theoretical model at the end of the semester before the exam. We also considered common method variance (CMV) caused by the measurement method rather than the construct measures (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003; Sharma, Yetton, & Crawford, 2009). To control these biases, we made several procedural remedies. In order to ensure a psychological separation of measurement, we did not reveal the purpose of the survey and provided a cover story (Podsakoff et al., 2003). Additionally, we guaranteed participants' anonymity. In order to control effects such as socially desirable responses (Paulhus, 2001), we assured participants that there were no wrong answers and that they should answer questions as honestly as possible (Podsakoff et al., 2003). Regarding the statistical remedies, we decided to not conduct any test since researchers have criticized the existing tests such as Harman's single factor test and the UMLC technique (Liang, Saraf, Hu, & Xue, 2007) for not being able to detect CMV (Chin, Thatcher, & Wright, 2012).

4.5 Measures

We applied all indicators from the literature and adapted them to the context of the object of investigation if applicable. Considering IT support and interactivity, we used both scales from previous research that embedded IT in blended learning (Bitzer et al., 2013; Siau, Sheng, & Nah, 2006). To measure the TTF, we used the measurement instrument of McGill and Klobas (2009), who adapted TTF to the domain of learning and especially LMS. Therefore, we did not vary the TTF throughout the study and fully drew on the individual TTF perception. For measuring faithfulness of appropriation, we used the original instrument of Chin et al. (1997) and adapted it in accordance with Gupta and Bostrom (2013) to the TML domain in general and LMS domain in particular. As our two outcome variables, we used learning process satisfaction as an affective learning outcome variable (Gupta & Bostrom, 2013) and perceived learning success (Alavi, 1994) as an meta-cognitive learning outcome (Gupta & Bostrom, 2013). Table 3 shows the instrument we used to determine the respective constructs, their construct types, and the corresponding literature sources for the indicators. In addition, we provide the statements of the final survey items and the items we used for the control variables (see Section 4.6) in the Appendix. We measured all latent variables with reflective indicators. Thus, we pre-evaluated the indicators regarding their correct specification according to Jarvis, MacKenzie, and Podsakoff's guidelines (2003). To evaluate the items, we used a seven-point Likert scale (1 = strongly disagree, 4 = neither agree or disagree, 7 = strongly agree) (Porst, 2011). Exceptions were items TTF5-TTF9 measured with a seven-point Likert scale that ranged from "never" (1) to "always" (7) and the learning process satisfaction measured with a bipolar scale (see Table A2). In addition, the survey participants could select "N/A" if no statement was applicable in order to prevent a tendency towards neutral responses.

Table 3. Operationalization of the Latent Constructs

Latent construct	Latent construct type	Literature source
IT support	Reflective	Bitzer et al. (2013)
Interactivity	Reflective	Siau et al. (2006)
Tak-technology fit	Reflective	McGill and Klobas (2009)
Faithful LMS appropriation	Reflective	Chin et al. (1997), Gupta & Bostrom (2013)
Learning process satisfaction	Reflective	Gupta & Bostrom (2013)
Perceived learning success	Reflective	Alavi (1994)

4.6 Control Variables

In line with previous research related to TML (e.g., Gupta & Bostrom, 2013; Wan et al., 2012), we controlled for the effects of several variables on the faithfulness of LMS appropriation and perceived learning success. We specifically included control variables that relate to learners' individual differences (Bitzer & Janson, 2014; Gupta et al., 2010) that could have influenced our outcomes. For one, we used personal innovativeness in the domain of IT (PIIT), which refers to "the willingness of an individual to try out any new information technology" (Agarwal & Prasad, 1998, p. 206). Since PIIT may influence the perceptions of IT in general, we controlled for its influence on the faithfulness of LMS appropriation because individuals who are more willing to try out technology may more easily recognize the underlying TML spirit and, thus, appropriate the LMS in a more faithful way. We measured it (see also the Appendix) with Agarwal and Prasad's (1998) original four-item instrument. As such, we also control for the direct effect of computer self-efficacy (CSE) on faithfulness to account for the readiness of learners for online learning. Therefore, we drew on the concept that Bandura (1997) also applied: "a judgment of one's capability to use a computer" (Compeau & Higgins, 1995, p. 192). Thus, we controlled for the possible effect that individuals with a higher self-efficacy might more easily use IT in their learning process; thus, levels of faithfulness might be also be higher for individuals with a higher self-efficacy. We measured CSE with Hung, Chou, Chen, and Own's (2010) three-item instrument that we adapted. Finally, we controlled for the self-efficacy regarding self-regulated learning (SRL), which "refers to a general skill that keeps people focused on a task, helps them monitor their task-completion progress, and explains success in a broad range of phenomena" (Santhanam, Sasidharan, & Webster, 2008, p. 30). This variable might also influence both learning outcomes and faithfulness of LMS appropriation in a positive way because individuals might focus more on how to appropriate TML and to achieve their own learning goals. We measured SLR with Santhanam et al.'s (2008) original 11-item instrument. The Appendix shows all items of the control variables.

4.7 Analysis

We applied the variance-based partial least squares (PLS) approach in order to evaluate our structural equation model (Chin, 1998; Wold, 1982) since it is more applicable to evaluate the influence of specific determinants on target constructs than covariance-based approaches (Hair, Ringle, & Sarstedt, 2011). In addition, we had a sufficient sample size (n = 173) for the PLS approach with respect to Chin's rule of thumb (Chin, 1998) according to which one derives the minimum number of required instances from the maximum number of structural paths that affect a construct (but only reflective constructs). In our case, faithful LMS appropriation constituted such a construct because three constructs influenced it. According to the rule of thumb, we multiplied this number by 10 to derive a minimum sample size of 30, which our sample clearly exceeded. We used SmartPLS 2.0 M3 as our analysis tool (Ringle, Wende, & Will, 2005).

5 Results

We evaluated the model in two steps. We evaluated the external model first and the internal model second (Hair et al., 2011; Hair, Sarstedt, Ringle, & Mena, 2012; Henseler, Ringle, & Sinkovics, 2009). We evaluated the external or measurement model first to determine its reliability and validity with respect to certain criteria for the latent variables. We evaluated the internal model and structural dependencies second because this evaluation only makes sense if the external measurement model is sufficiently reliable and valid (Henseler et al., 2009). For this purpose, Table 4 presents the quality criteria of the external model. We measured the indicator reliability with standardized indicator loadings. All indicators load above the minimum value of 0.70 (Hulland, 1999).

We measured internal consistency, which analyzes how indicators reflect the latent variables, via construct reliability, which is more appropriate for the PLS procedure since Cronbach's alpha tends to underestimate the internal consistency in the course of the PLS approach (Hair et al., 2011; Hair et al., 2012; Henseler et al., 2009). Values above the 0.70 threshold indicate that the construct reliability is acceptable and, thus, substantiate the internal consistency of the latent variables (Bagozzi & Yi, 1988). We measured convergent validity using the average variance extracted (AVE); a value above the 0.50 minimum indicate that the related indicators explain at least half of a latent construct's variance and, therefore, that it is acceptable (Bagozzi & Yi, 1988).

We measured discriminant validity using the Fornell-Larcker criterion, which indicates that the square root of the AVE of a construct should be higher than the correlation of the latent construct with other constructs of the measurement and, thus, whether a construct shares more variance with its own indicators than with other constructs (Fornell & Larcker, 1981). Table 5 shows the results.

As Table 5 illustrates, the results meet this standard. Moreover, the results of the cross-loadings indicate that all indicators loaded the highest on their own construct (Chin, 1998). We include the individual cross-loadings in the Appendix. Since we found that the measurement model to be sufficiently reliable and valid, we proceeded with evaluating the internal structural model.

The results of the structural model include path coefficients, the coefficient of determination R^2, and the significance levels. The evaluation also includes the measurements of the effect sizes and prognosis relevance (Ringle, Sarstedt, & Straub, 2012). We applied the path weighting scheme as a PLS algorithm with 300 iterations for evaluation (Henseler, 2010). We used the bootstrapping procedure to determine the significance levels (Henseler et al., 2009), and we applied individual sign changes as sign change option (Hair et al., 2011). Figure 2 shows the results.

Table 4. Quality Criteria of the Measurement Model

Construct	Indicator	Loading	AVE	Composite reliability
IT support	ITS1	0.736	0.695	0.919
	ITS2	0.735		
	ITS3	0.883		
	ITS4	0.909		
	ITS5	0.886		
Interactivity	Int1	0.982	0.899	0.946
	Int2	0.912		
Task-technology fit	TTF1	0.856	0.626	0.937
	TTF2	0.843		
	TTF3	0.826		
	TTF4	0.702		
	TTF5	0.807		
	TTF6	0.775		
	TTF7	0.763		
	TTF8	0.752		
	TTF9	0.782		
Faithful LMS appropriation	Approp1	0.884	0.734	0.917
	Approp2	0.820		
	Approp3	0.935		
	Approp4	0.780		
Learning process satisfaction	LP1	0.820	0.655	0.884
	LP2	0.765		
	LP3	0.790		
	LP4	0.860		
Perceived learning success	LE1	0.736	0.610	0.926
	LE2	0.831		
	LE3	0.780		
	LE4	0.746		
	LE5	0.756		
	LE6	0.765		
	LE7	0.847		
	LE8	0.783		

Table 5. Discriminant Validity

Construct	1	2	3	4	5	6
1) IT support	**0.83**					
2) Interactivity	0.10	**0.95**				
3) Task-technology fit	0.65	0.06	**0.79**			
4) Faithful LMS appropriation	0.36	0.22	0.36	**0.86**		
5) Learning process satisfaction	0.48	0.18	0.41	0.36	**0.81**	
6) Perceived learning success	0.56	0.31	0.47	0.32	0.57	**0.78**

Note: diagonal elements are square roots of the AVE and off-diagonal elements are correlations of the latent variables. For the sake of brevity, we do not include control variables in the latent variable correlation table.

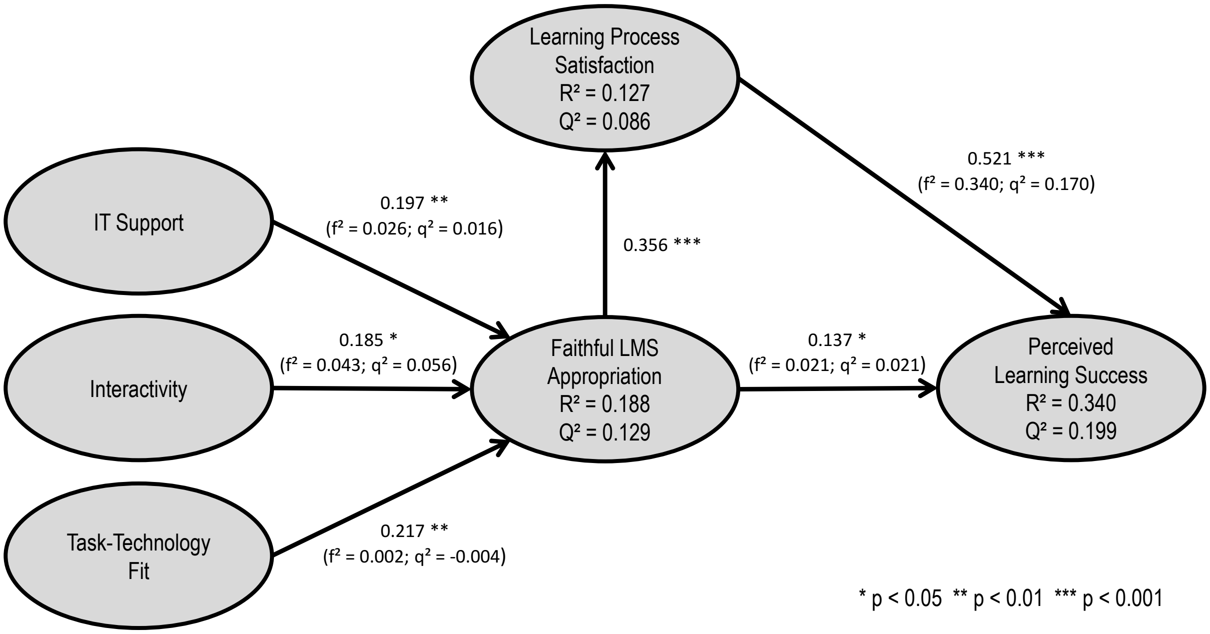

Figure 2. Results of the Structural Model Analysis

The results of the structural model show that all relationships in the structural equation model were significant at least at $p < 0.05$ level. According to the value of the path coefficients, TTF ($\beta = 0.217$) had the highest influence on faithful LMS appropriation in the learning process. IT support ($\beta = 0.197$) and interactivity ($\beta = 0.185$) had a nearly similar high and significant influence. Faithful appropriation influenced the learning process itself ($\beta = 0.356$). In addition, the learning process ($\beta = 0.521$) and the faithful appropriation of the LMS ($\beta = 0.137$) significantly influenced the perceived learning success. We also included in the present study three control variables. However, none of them had a significant influence on faithful LMS appropriation (PIIT: $\beta = 0.044$, $p > 0.05$; CSE: $\beta = 0.103$, $p > 0.05$; SRL: $\beta = 0.098$, $p > 0.05$) or perceived learning success (SRL: $\beta = 0.038$, $p > 0.05$).

The endogenous constructs, faithful appropriation, and perception of the learning process showed very low coefficients of determination of $R^2 = 0.188$ and $R^2 = 0.127$. In contrast, the explained variance of the construct perceived learning success was at a moderate level of $R^2 = 0.340$ (Chin, 1998). In a next step, we measured the effect size f^2 for the determinants of faithful IT appropriation and the influence factors on perceived learning success. The effect size f^2 constitutes the influence of exogenous constructs on an endogenous construct by considering the changes in the coefficient of determination R^2 (Cohen, 1988). Values above 0.02, 0.15, and 0.35 indicate a low, moderate, or high effect on the structural level, respectively (Henseler et al., 2009). Thus, our results indicate that IT support of the learning process ($f^2 = 0.022$) and interactivity ($f^2 = 0.041$) had a respectively low effect on faithful LMS appropriation. Furthermore, the effect value for faithful appropriation was low ($f^2 = 0.021$), while the perception of the learning process had a moderate, almost high ($f^2 = 0.340$) effect on perceived learning success.

In the last step, we determined the predictive relevance as a final evaluation of the structural model (Chin, 1998) by applying the sample reuse technique for data reusability that Geisser (1975) and Stone (1974) used in order to determine the predictive relevance Q^2 via the blindfolding procedure. This procedure systematically omits a part of the data collected for the endogenous variables and then estimates the omitted data parameters using the PLS model (Hair et al., 2011). The omission distance d refers to the distance between the omission of two consecutively omitted and predicted data parameters. We chose the omission distance $d = 7$ according to literature recommendations in order to ensure that it was additionally no integral divisor of the analyzed sample size ($n = 173$) (Hair et al., 2012). We applied the procedure in accordance with literature recommendations to endogenous and reflective constructs. A positive value of Q^2 for a particular construct assumes the prognosis relevance of the respective construct (Henseler et al., 2009). Further, we applied Q^2 as cross-validated redundancy rather than cross-validated communality as the literature recommends since it approaches the structural model and measurement models for predicting data. We found positive values for faithful LMS appropriation, learning process satisfaction, and perceived learning success; thus, we conclude the prognosis relevance of the research model.

Similar to the effect size f^2, one can also evaluate the prognosis relevance relatively via q^2 as change of Q^2. Values above 0.02, 0.15, and 0.35 similarly indicate a low, moderate, or high predictive relevance of both endogenous constructs, respectively (Henseler et al., 2009). The blindfolding results show that only interactivity ($q^2 = 0.056$) had a low predictive relevance to the faithful appropriation of the learning process, while both IT support and TTF were below the threshold. In addition, the faithful appropriation had a low ($q^2 = 0.021$) and learning process satisfaction a moderate ($q^2 = 0.170$) predictive relevance for perceived learning success. Table 6 summarizes the results of the inner model evaluation.

Table 6. Results of the Structural Model Analysis

Hypothesis		Path coefficient	T-value for path	Hypothesis supported?
H1	Learning process satisfaction→ perceived learning success	0.521	7.651	Yes
H2	Faithful LMS appropriation → learning process satisfaction	0.356	4.750	Yes
H3	Faithful LMS appropriation → perceived learning success	0.137	2.063	Yes
H4	IT support → faithful LMS appropriation	0.197	2.097	Yes
H5	Interactivity → faithful LMS appropriation	0.185	2.721	Yes
H6	Task-technology fit → faithful LMS appropriation	0.217	2.513	Yes

6 Discussion

6.1 Findings

We found several important results. For this purpose, we identified determinants of faithful LMS appropriation and analyzed the corresponding consequences for the learning process and learning success. We found that IT support, interactivity, and the TTF positively influenced faithful LMS appropriation and explained 18.8 percent of the construct variance. This contribution represents the first to identify the determinants that cause learners to faithfully appropriate IT artifacts in the learning process, although a high proportion of the variance remains unexplained, which means we still need to identify more constructs to explain faithful appropriation. Also, we found that all control variables did not have a significant influence on faithfulness of LMS appropriation, which indicates in particular that IT-related dispositional factors such as PIIT or CSE do not necessarily influence the faithfulness of appropriation. Furthermore, we found that faithful appropriation as an important AST construct had a positive effect on the learning process and success. In addition, a high-quality learning process was a significant factor that influenced perceived learning success.

Concerning RQ1, we identified TTF as a significant and, thus, substantial factor that influences faithful appropriation. IT support during the learning process had the lowest but still statistically significant positive effect on the faithful appropriation of a LMS, which indicates it is necessary to support learners in the TML process because it allows them to faithfully appropriate the IT artifact while being supported in the learning process. TTF as the last factor had the strongest effect on faithful LMS appropriation, although one cannot consider its f^2 effect size as small.

Concerning RQ2, we found that a faithful appropriation had a significantly positive effect on satisfaction with the learning process and perceived learning success. When individual learners recognize the TML spirit and appropriate a LMS accordingly, learning outcomes are positively influenced. Although the direct and also significantly positive effect of the learning process satisfaction on the perceived learning success was higher according to the path coefficients in the structural model than the correlation between faithful appropriation and perceived learning success, one can explain this finding by the strong correlation between the learning process and faithful appropriation. Considering the learning process as a mediator indicates that the effect of a faithful appropriation on the perceived learning success was highly significant ($p < 0.001$) and with an indirect effect ($0.356 * 0.521 = 0.185$) higher than the direct effect (0.137), which illustrates that lecturers must coordinate the learning process and faithful LMS appropriation in order to eventually enhance perceived learning success in TML.

6.2 Theoretical Implications

Our results provide support for the theorized model and the corresponding hypotheses regarding the antecedents and consequences of individual LMS appropriation. Thus, we provide several major contributions that relate to the use of IT in blended learning scenarios in higher education and corporate training initiatives.

First, in contrast to other studies that have focused on an input-output view in considering LMS success (e.g., Al-Busaidi, 2012), with our research model, we highlight the role of the faithfulness of LMS appropriation for the learning process and learning outcomes. Our results demonstrate the central role of the faithfulness of appropriation for the success of LMS embedded in a blended learning scenario when considering the outcomes of learning process satisfaction and perceived learning success.

Second, our research provides theoretical insights into the antecedents of LMS appropriation. We identified three constructs from theory that act as predecessors for the faithfulness of LMS appropriation. For theory, IT support as the first antecedent implies that one should support learners with IT in order to gain a certain level of faithfulness. Interactivity as a second factor also significantly affected faithful appropriation. This finding is not surprising because many studies in the field of TML assume the important role of interactivity (Siau et al., 2006; Zhang, Zhou, Briggs, & Nunamaker, 2006). We still lack implications for understanding how interactivity supports a faithful appropriation. Last, for theory, the high influence of the TTF on the faithfulness of LMS appropriation indicates the importance of learners' perceptions regarding the fit of a LMS to perform tasks in a learning scenario. Although the influence of the TTF might diminish over time (Fuller & Dennis, 2009), we highlight that, especially in early phases of LMS use, TTF matters for its success.

Third, we used AST as a guiding theory and appropriation faithfulness as the central construct of our theoretical model. In doing so, we empirically confirmed existing theoretical assumptions (Gupta et al., 2010; Gupta & Bostrom, 2009) and first research results (Gupta & Bostrom, 2013), which indicates the importance of faithfulness for TML. While Gupta and Bostrom (2013) found empirical support for the moderating role of faithfulness for Web-based training (WBT) with their experimental study, we also found direct effects of faithfulness as a construct for LMS appropriation. When comparing both studies and considering the IT artifact under investigation, one can consider LMS as complex IS (Tennant et al., 2014), while Web-based training are often more structured. For example, Gupta and Bostrom (2013) used a WBT that explicitly considered the process of vicarious and enactive learning to facilitate the learning process and, thus, that offers lower levels of learner control (Kraiger & Jerden, 2007; Sorgenfrei et al., 2013). However, a LMS embedded in a constructivist learning approach often provides multiple sources of learning material and learning methods such as quizzes in multiple stages of the learning process without strongly offering appropriation support such as strong facilitation. Thus, our research contributes to the field of learner control and suggests several things. When we consider on the one hand such open-ended learning needs and when we take, on the other hand, high levels of learner control when providing learning materials and methods into account, considerable support in the learning process is needed. By drawing on Kirschner, Sweller, and Clark (2006), problems might occur when using an instructional design with minimal guidance for constructivist learning approaches. Thus, as Tennant et al. (2014) suggest, users are not "passive takers" of complex technology and shape their LMS use during the appropriation process. Faithfulness as the belief of an individual to use TML in a manner consistent to the subjective spirit should, therefore, directly increase learner self-efficacy, guide the learning process, and strengthen learning outcomes.

One can also find interesting research about other theories in this context. For example, Santhanam, Yi, Sasidharan, and Park (2013) suggest that attribution theory (Steiner, Dobbins, & Trahan, 1991) might provide feedback that improves self-efficacy beliefs regarding IT artifacts in the learning process and should, in turn, leverage faithfulness beliefs. As such, cognitive load theory also provides valuable insights for theory and the design of LMS, especially in the area of HCI (Sweller, 1988; Sweller, Ayres, & Kalyuga, 2011; Sweller & Chandler, 1991). By minimizing the extraneous load during the appropriation process (e.g., by considering the modality effect end engaging visual and auditory channels in a complementary manner (Sweller et al., 2011)), learning with technology could be more efficient since the cognitive load is balanced towards acquiring knowledge and not used for understanding complex LMS.

6.3 Practical Implications

Our study has practical implications for the ways in which education and training providers might increase the faithful appropriation of LMS and, thereby, increase the learning outcomes as well. In this context, scaffolds known from educational research serve as a design implication and, therefore, leverage perceptions regarding the IT support of a LMS. While initially supporting the learners in their learning process (Delen, Liew, & Willson, 2014; Gupta & Bostrom, 2009) by, for example, providing learning paths, scaffolds could relate to sustaining the faithful appropriation of a LMS. Therefore, scaffolds prevent learners from being overwhelmed by large amounts of learning material and allow them to focus on the learning itself via initial support in the learning process. One can find implementation examples in Kim and Hannafin (2011), who provide practical implementation examples for scaffolding constructivist and problem-solving learning scenarios with IT support. In our case, appropriation support measures for LMS could provide procedural assistance to organize learning processes and resources (Kim & Hannafin, 2011) with, for example, learning dashboards (Janson & Thiel de Gafenco, 2015), which offer the possibility to check the progress concerning learning goals, achievements, and new challenges for learning. One can also find empirical support for the positive effects of such design implications for the appropriation support in the area of GSS that shows that appropriation support engages satisfaction with the process and general outcomes (Dennis et al., 2001; Wheeler & Valacich, 1996). When also considering insights from HCI research, learner-centered design could offer valuable advice to TML designers so they could acknowledge the individuals needs of learners during the learning process (Luchini, Quintana, & Soloway, 2004; Soloway et al., 1996) and, thus, ensure that learners receive IT support when they actually need it.

When considering interactivity's effects on faithfulness, one could derive corresponding design implications from the context of interactions with learners, lecturers, and learning materials (e.g., a more faithful appropriation via interactivity using gamification elements) (Domínguez et al., 2013; Santhanam, Liu, & Shen, 2016). Reward elements mapping the right learning process path in the form of feedback are one option concerning a faithful appropriation, which offers another possibility to provide an automated interaction with the lecturer and reward faithful appropriations. When also considering open-ended learning scenarios in group discussion forums, one design implication would be to provide guidance via scripted collaborative learning activities (Haake & Pfister, 2010; Kobbe et al., 2007; Kollar, Fischer, & Hesse, 2006) designed in accordance with the TML spirit. Such measures would ensure that learners interact more faithfully with learning materials and other learners.

Referring to peer learning activities often applied in innovative teaching/learning scenarios, practical implications apply to the support of communication activities in LMS.. In this context, our findings indicate that a system such as Moodle does not necessarily support meaningful discussions between learners. Instead, fast and possibly mobile means of communication might be more appropriate. One design implication could be that one should implement social media instead of typical discussion forums in a LMS. TML research has proven that social media groups (e.g., via Facebook groups) contribute to learning outcomes (Hong & Gardner, 2014). As an implication, one should ensure that a LMS particularly supports the tasks that results from learning methods and structures. Otherwise, learners cannot faithfully appropriate a LMS because they cannot conveniently establish communication, which impairs the TTF. Therefore, MOOC providers, which often use a LMS such as Open edX (edX, 2016), should also precisely generate a high level of TTF to ensure that learners faithfully appropriate right from the beginning, which tackles challenges with MOOCs such as poor learning outcomes or high dropout rates (Adamopoulos, 2013; Alraimi, Zo, & Ciganek, 2014; Clow, 2013; Cusumano, 2014; Morrison, 2013).

Last, concerning the implications for the overall design of a blended learning course supported with IT such as with a LMS, we also highlight the role of the epistemological perspective. For example Hornik, Johnson, and Wu (2007) provide empirical support for the negative effect of frictions between epistemological beliefs of individual learners and the epistemological perspective TML supports on learning outcomes. Therefore, we advise that one should carefully consider the individual in the learning process and either adjust the TML spirit as a design implication if there are significant frictions impairing the learning outcomes or support the faithful appropriation with measures such as scaffolding.

7 Limitations and Future Research

This paper has several limitations one should consider. When considering our research model, we evaluated only how learners interact with and faithfully apply a LMS. Therefore, the faithfulness of LMS appropriation was the central construct in our model, and we omitted other IT-based learning content such as Web-based training. We consciously accepted this limitation because particularly complex LMS face the problem of faithful appropriation. However, future research should still address this context by, for example, comparing faithful appropriation and its determinants regarding different e-learning solutions.

Concerning the model evaluation, a further limitation concerns our using a university student sample (Compeau et al., 2012) that researchers often (see Santhanam et al., 2013) use to evaluate TML models or training interventions (e.g., Gupta & Bostrom, 2013; Santhanam et al., 2008; Santhanam et al., 2016; Yi & Davis, 2003), which limits our findings' generalizability and external validity (Bordens & Abbott, 2011; Compeau et al., 2012). Although we used university students as study participants, one can consider our findings from evaluating our model to be fairly realistic and, therefore, generalizable given that most of the students used the LMS for the first time—akin to employees in corporate settings who participate in new blended learning scenarios. Therefore, researchers should evaluate faithful LMS appropriation antecedents and impacts in other blended learning scenarios (e.g., in company training or mobile learning) (Ernst, Janson, Söllner, & Leimeister, 2016; Söllner, Bitzer, Janson & Leimeister, 2017). Still, we stress that the learning process, which we represented in our study with faithfulness of LMS appropriation, is important regardless of the training context, and our study, therefore, makes an important contribution to further our understanding of a TML process view. In consequence, one could use our model as a starting point for replication studies in different training contexts to generate results that are more generalizable and to elaborate on how different training contexts influence the faithfulness of appropriation in TML processes.

Another aspect concerns the data collection and measurement. We used the same instrument to assess the dependent and independent latent variables among all participants of the study due to possible CMV. Nevertheless, we took procedural remedies to avoid biases ex ante. Since no sufficient statistical test for CMV exists (Chin et al., 2012), we cannot exclude bias, which holds true for the learning success measurement as well, which we measured as perceived learning success via self-assessments. Research discussions indicate that the fact that self-assessments do not always correspond to an objective learning outcome measures such as cognitive knowledge acquisition could distort our results (Benbunan-Fich, 2010; Janson, Söllner, Bitzer, & Leimeister, 2014; Sitzmann, Ely, Brown, & Bauer, 2010; Sharma et al., 2009). Therefore, future research should apply objective learning outcomes such as cognitive knowledge acquisition and skill-based learning outcomes (Yi & Davis, 2003).

Finally, in the context of the model evaluation, we note that we focus on providing a deeper theoretical understanding of faithful appropriation in the TML field and that we provide, with our variance-based view, a first understanding of the causal relationships of how the faithfulness of LMS appropriation relates to the learning process and learning outcomes. However, a variance-based analysis does not offer the possibility to reconstruct the single processes that lead to specific outcomes of the LMS appropriation. For this purpose, future research needs to adopt a process-based approach to better illuminate which events and processes really lead to certain outcomes (Poole, Van de Ven, Andrew H., Dooley, & Holmes, 2000). Such a process-based approach could also help show the reciprocal causation embedded in AST that we did not consider in our variance-based study, which relates to reproduction, refinement, or rejection of a LMS through appropriation (Bostrom et al., 2009). Hence, we need qualitative and also longitudinal studies to further research how LMS appropriation relates to the learning process and learning outcomes. The same applies for the influence of the antecedents of faithful LMS appropriation. For example, GSS research has shown with the FAM that the TTF's negative impact on the faithfulness of appropriation and on the performance diminishes over time (Fuller & Dennis, 2009) because users often repurpose the provided IT structures and often overcome restrictions that a low TTF induces over time.

8 Conclusion

The faithful appropriation of e-learning applications is an important construct that positively influences learning process satisfaction and perceived learning success. To illustrate what constitutes faithful e-learning appropriation, we derived a theoretical AST-based model to answer two research questions. In this context, we identified IT support, interactivity, and the TTF as determinants of faithful appropriation. In a second step, we operationalized the theoretical model and evaluated it concerning faithful LMS appropriation. We collected data as part of a university large-scale lecture with a LMS as an essential part of the teaching/learning scenario. The according results show that IT support, interactivity, and the TTF had a significantly positive effect on faithful appropriation. Further, we found that a faithful appropriation had a significantly positive effect on satisfaction with the learning process and that it directly and indirectly positively influenced perceived learning success with the learning process as mediator. In this context, we also illustrate that the learning process is a crucial determinant of perceived learning success.

Our findings clearly reveal the urgent need to evaluate the learning process and its determinants, such as a faithful appropriation in blended learning scenarios. We need to further identify other components that explain faithful appropriation to deepen and accordingly implement the insights we present in collaboration with design-based research (Lyytinen, 2010).

Acknowledgments

We thank the two anonymous reviewers for their valuable feedback. Especially, we thank the accepting senior editor Richard D. Johnson for his guidance and advice during the reviewing process. This research project was partially funded by the German Federal Ministry of Education and Research (BMBF) within the projects StaySmart (02L12A170) and ExTEND (02K14A172), both managed by the Project Management Agency Karlsruhe (PTKA). The authors are responsible for the content of this publication.

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Appendix A: Additional Details

Table A1. Cross Loadings

Item	IT support	Interactivity	Task-technology fit	Faithful LMS appropriation	Learning process satisfaction	Perceived learning success
ITS2	**0.736**	-0.016	0.477	0.267	0.318	0.314
ITS2	**0.735**	-0.009	0.509	0.203	0.363	0.369
ITS3	**0.883**	0.094	0.657	0.277	0.385	0.516
ITS4	**0.909**	0.169	0.548	0.353	0.505	0.545
ITS5	**0.886**	0.127	0.546	0.350	0.396	0.555
Int1	0.111	**0.982**	0.077	0.253	0.177	0.308
Int2	0.069	**0.912**	0.028	0.116	0.155	0.283
TTF1	0.556	0.039	**0.856**	0.330	0.307	0.397
TTF2	0.501	0.040	**0.843**	0.304	0.301	0.346
TTF3	0.501	0.023	**0.826**	0.275	0.275	0.351
TTF4	0.446	0.011	**0.702**	0.201	0.270	0.265
TTF5	0.681	0.163	**0.807**	0.371	0.500	0.520
TTF6	0.530	0.017	**0.775**	0.269	0.362	0.435
TTF7	0.446	-0.054	**0.763**	0.210	0.294	0.320
TTF8	0.461	0.115	**0.752**	0.254	0.302	0.315
TTF9	0.448	0.036	**0.782**	0.259	0.242	0.342
Approp1	0.291	0.171	0.325	**0.884**	0.300	0.253
Approp2	0.274	0.160	0.291	**0.820**	0.265	0.283
Approp3	0.358	0.167	0.390	**0.935**	0.378	0.343
Approp4	0.294	0.271	0.192	**0.780**	0.261	0.208
LP1	0.297	0.163	0.305	0.320	**0.820**	0.443
LP2	0.343	0.237	0.259	0.221	**0.765**	0.510
LP3	0.482	0.072	0.362	0.245	**0.790**	0.429
LP4	0.430	0.096	0.401	0.358	**0.860**	0.459
LE1	0.356	0.253	0.329	0.161	0.436	**0.736**
LE2	0.500	0.235	0.404	0.338	0.539	**0.831**
LE3	0.489	0.187	0.308	0.200	0.361	**0.780**
LE4	0.383	0.265	0.372	0.285	0.297	**0.746**
LE5	0.315	0.295	0.243	0.195	0.373	**0.756**
LE6	0.435	0.222	0.420	0.177	0.440	**0.765**
LE7	0.519	0.217	0.450	0.313	0.575	**0.847**
LE8	0.479	0.304	0.387	0.298	0.432	**0.783**

Table A2. Final Survey Instrument

Construct	Construct type	Source	Item	Statement
IT support	Reflective	Bitzer et al. (2013)	ITS2	Moodle increases the communication between the participants and the trainer.
			ITS2	Moodle increases the opportunities to exchange ideas with each other.
			ITS3	Moodle is the end of the course a clearer structure.
			ITS4	Moodle allows me to make my structured learning process.
			ITS5	Moodle allows greater comprehensibility of the learning process.
Interactivity	Reflective	Siau et al. (2006)	Int1	I am engaged considering the lecture (e.g., by asking questions).
			Int2	I participate in discussions during the lecture.
Task-technology fit	Reflective	McGill & Klobas (2009)	TTF1	Moodle is easy to use.
			TTF2	Moodle is user friendly.
			TTF3	It is easy to get Moodle to do what I want it to do.
			TTF4	Moodle is easy to learn.
			TTF5	Do you think the output from Moodle is presented in a useful format?
			TTF6	Is the information from Moodle accurate?
			TTF7	Does Moodle provide you with up-to-date information?
			TTF8	Do you get the information you need in time?
			TTF9	Does Moodle provide output that seems to be just about exactly what you need?
Faithful lms appropriation	Reflective	Chin et al. (1997), Gupta & Bostrom (2013)	Approp1*	I probably used Moodle improperly.
			Approp2*	The instructor of Moodle would view my use of the system as inappropriate.
			Approp3*	I failed to use Moodle as it should have been used.
			Approp4*	I did not use Moodle in most appropriate fashion.
Learning process satisfaction	Reflective	Gupta & Bostrom (2013)	LP1	How would you describe your learning process on a bipolar scale: efficient–inefficient
			LP2	How would you describe your learning process on a bipolar scale: coordinated–uncoordinated
			LP3	How would you describe your learning process on a bipolar scale: fair–unfair
			LP4	How would you describe your learning process on a bipolar scale: satisfying–dissatisfying
Perceived learning success	Reflective	Alavi (1994)	LE1	I feel more confident in expressing ideas related to Information Technology.
			LE2	I gained a good understanding of the basic concepts of the material.
			LE3	I improved my ability to critically think about information technology.
			LE4	I improved my ability to integrate facts and develop generalizations from the course material.
			LE5	I increased my ability to critically analyze issues.
			LE6	I learned to identify the central issues of the course.

Table A2. Final Survey Instrument

			LE7	I learned to interrelate the important issues in the course material.
			LE8	I learned to value other points of view.
Note: overview of the final survey instrument and after dropping items due to unsufficient indicator loadings. We reverse-coded items marked with an asterisk. We rated all items rated on a 7-point Likert scale.				

Table A3. Control Variables

Construct	Construct type	Source	Item	Statement
Personal innovativeness in the domain of IT	Reflective	Agarwal & Prasad (1998)	PIIT1	If I heard about a new information technology, I would look for ways to experiment with it.
			PIIT2	Among my peers, I am usually the first to try out new information technologies.
			PIIT3*	In general, I am hesitant to try out new information technologies.
			PIIT4	I like to experiment with new information technologies.
Computer self-efficacy	Reflective	Hung et al. (201)	CSE1	I feel confident in using Moodle.
			CSE2	I feel confident in using online-communication tools.
			CSE3	I feel confident when uploading/downloading necessary materials from the internet.
Self-efficacy for self-regulated learning	Reflective	Santhanam et al. (2008)	SRL1	I am able to finish homework assignments by deadlines.
			SRL2	I am able to study even when there are other interesting things to do.
			SRL3	I am able to concentrate on class subjects.
			SRL4	I am able to take class notes of class instruction.
			SRL5	I am able to use the library and the internet for information for class assignments.
			SRL6	I am able to plan my schoolwork.
			SRL7	I am able to organize my schoolwork.
			SRL8	I am able to remember information presented in class and videos
			SRL9	I am able to arrange a place to study at my residence/home without distractions.
			SRL10	I am able to motivate myself to do the assignments.
			SRL11	I am able to finish homework assignments by deadlines.
Note: we reverse coded items marked with an asterisk. We rated all items rated on a 7-point Likert scale.				

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