ENGAGING THE APPROPRIATION OF TECHNOLOGY-MEDIATED LEARNING SERVICES – A THEORY-DRIVEN DESIGN APPROACH

Research in Progress

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Abstract

Technology in the learning process is a key success factor for innovative learning services such as massive open online courses (MOOCs). Prerequisite for the success of both service provider and recipient is the faithful appropriation of the provided learning methods in technology-mediated learning services (TMLS). However, information systems research lacks insights how to systematically support the appropriation in such IT-supported services. In this research-in-progress paper, we use the insights of scaffolding theory to design IT-supported scaffolds that support users in TMLS and engage the appropriation process. We therefore derive requirements from scaffolding theory for TMLS design. We address in a second step these requirements with IT-supported scaffolds that are implemented and evaluated in a TMLS. As practical contributions, we are able to engage the integration of service recipients and ensure productive TMLS. As a theoretical contribution, we enrich the knowledge body of IT-supported services by considering scaffolding theory to support the service process. The implementation is currently running and the evaluation is planned.

Keywords: Technology-Mediated Learning Services, Blended Learning, E-Learning, Scaffolding.

1 Introduction

Education and training are one of the most prevalent and pervasive methods to engage the productivity of individuals (Gupta and Bostrom, 2013; Arthur *et al.*, 2003). In this context, technology influences the majority of current learning scenarios. Usually, this concept is referred to as technology-mediated learning services (TMLS). TMLS as a learning experience are considered important because they improve learning outcomes, facilitate cost advantages, foster the sharing of expertise in a global setting, and provide learning opportunities for disadvantaged locations (Webster and Hackley, 1997; López-Pérez *et al.*, 2011). For example, massive open online course (MOOC) service providers offer outstanding educational resources that were years ago only available to a very limited number of service recipients and enabled these providers to develop new business models. However, massively IT-supported learning services have some serious pitfalls such as information overload for service recipients, which are in our case learners (Shrivastav and Hiltz, 2013; Grisé and Gallupe, 2000).

TMLS research is still lacking systematic guidance on how to design such services (Morrison, 2013). This results in high dropout rates among service recipients and therefore the failure of a promising TMLS approach. Connected with these issues is the black box of the service process in TMLS research, which is considered to heavily influence TMLS outcomes, like learning success and learning satisfaction (Gupta and Bostrom, 2009). Interaction and support in the learning process are considered to be significant predictors of TMLS outcomes (Bitzer and Janson, 2014), and are often not considered

in TMLS design, for instance in large-scale TMLS. The described learning process as focal phenomenon refers to the appropriation or structuration process where service recipients learn and adapt the learning method structures (Gupta and Bostrom, 2009).

In this context, information systems (IS) research suggests the concept of scaffolding to guide and facilitate the appropriation process of TMLS (Gupta and Bostrom, 2009; Janson *et al.*, 2015). To ensure the appropriate use of TMLS, scaffolding elements attune the learners' individual learning paths and experiences. With its origin in social constructivist theory (Wood *et al.*, 1976; Vygotsky, 1978), intersubjectivity between the instructional designer, the individual learner, and between learners is vital for successful appropriation. For this purpose, the goal of this research-in-progress paper is the conceptual design of scaffolds that support the appropriation process of provided TMLS structures in the learning process to ultimately improve service outcomes. The developed scaffolds are implemented in a TMLS.

To achieve our goal, we follow a design science approach in accordance with Peffers *et al.* (2007). To ensure that our design considers all important aspects of scaffolding, we derive our requirements for the design rationale from theory (Briggs, 2006; Gehlert *et al.*, 2009). This enables us to derive theoretically grounded requirements and according scaffolding elements that engage TMLS appropriation and outcomes. As depicted in Figure 1, we present the first three phases of the design science approach of Peffers *et al.* (2007) in this paper in order to develop the scaffolding elements.

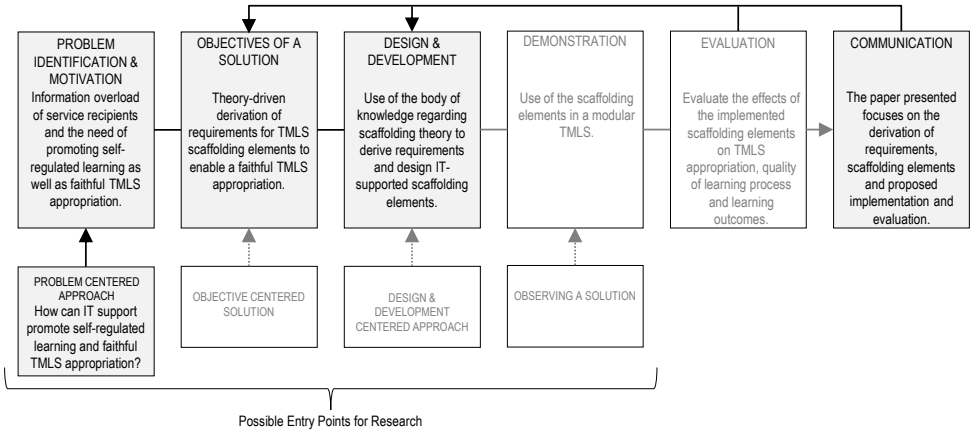

Figure 1. Research Approach to Design Scaffolding Elements According to Peffers et al. (2007)

The introduction has addressed the problem identification and motivation of our paper. The next sections focus on the theoretical background of TMLS, appropriation, and scaffolding. We then describe in section three the objectives of a solution phase by identifying requirements from scaffolding theory, while deriving theory-driven scaffolds and illustrating the planned implementation. The planned evaluation is described in section four and the paper closes with next steps of our research and expected contributions of the completed research in section five.

2 Theoretical Background

2.1 Technology-mediated Learning Services

In a comprehensive sense, TMLS describe *"environments in which the learner's interactions with learning materials (readings, assignments, exercises, etc.), peers, and/or instructors are mediated through advanced information technologies"* (Alavi and Leidner, 2001, p. 2). In consequence, research often uses the term e-learning as a synonym (Gupta and Bostrom, 2013). However, it should be noted that TMLS have many variations in practice and are often a combination of different learning modes and methods. They can therefore be considered a blended learning approach including web- or

computer-based approaches, asynchronous or synchronous, led by an instructor or self-paced, and finally individual- or team-based learning modes (Gupta and Bostrom, 2009). In consequence, TMLS are often considered complex services that are person-oriented and knowledge-intense (Janson *et al.*, 2014b).

For researching TMLS, Gupta and Bostrom (2009) proposed an accordant research framework based on adaptive structuration theory (AST) that enables to investigate the relationship between technology and social structures, for example how group decision support systems are used in organizations (DeSanctis and Poole, 1994). AST, developed by DeSanctis and Poole (1994), is a meta-theory describing the social existence of a group beyond their information processing activities (Chin *et al.*, 1997). According to them, the social aspect of group work determines the adoption of technology supporting their own working processes, and therefore influences the information process and interaction features within the internal group work, and finally their output. By this means, the appropriation of technology gives the group process a structuration and is therefore produced and reproduced in social action (Comi *et al.*, 2013). In consequence, this theory is a prime candidate to investigate the relationship in IT-supported and person-oriented services such as TMLS.

These thoughts are based on two premises (Gupta and Bostrom, 2009). The first one relates to the influence of structures that are embedded in a specific context and are defined as rules, resources, and capabilities in a given context (DeSanctis and Poole, 1994). Applying this in a TMLS context, we consider the learning methods and structures reflected through the social setup of the instructor team, the deployment of information technology (IT), and learning techniques. The second premise focuses on the learning process. Within this process view, we acknowledge that the learners interact with the above described structures through the process of appropriation where TMLS participants learn and adapt the learning methods and structures (Gupta and Bostrom, 2009). Both parts influence the learning outcomes of the service, which *"represent the goal assessment or measures for determining the accomplishment of learning goals"* (Gupta and Bostrom, 2009, p. 713) and are referred to in the following as learning success. Specifically considering the influence of learning methods and structures, we acknowledge that they do not automatically have a positive impact on learning success and the appropriation process. We therefore posit, in line with recent TMLS research (Gupta and Bostrom, 2009), that the learning methods have to reflect and support the underlying learning theories, i.e., they have to be of high quality.

2.2 Scaffolding for the TMLS Appropriation Process

Recent research has shifted towards a more in-depth view of the learning process that is for example determined by the interaction of the learner and TMLS provider , such as the interactivity during a specific course (Gupta and Bostrom, 2013; Bitzer *et al.*, 2013). We adopt this view referring to the AST-based framework of Gupta and Bostrom (2009) by recognizing the appropriation process of TMLS methods and structures. During this process, faithfulness as a social aspect (DeSanctis and Poole, 1994) regarding the use of technology can be observed since certain perceptions about the role and utility of the technology are created. Referring to TMLS, a faithful appropriation occurs, when the learning methods and structures are appropriated consistent with the overall learning goals and epistemological perspective and in consequence influence learning success (Gupta and Bostrom, 2009). An example would be the use of a forum in a learning management system (LMS) to discuss learning materials. In contrast, an unfaithful or ironic appropriation occurs for example if learners do not fully comprehend a sophisticated LMS and need to shift their focus on technology understanding, which in consequence detracts from the overall learning process (Gupta and Bostrom, 2009). Besides faithfulness, the agreement among group members on how technology should be used can be characterized, namely the consensus and the attitude towards using technology (Chin *et al.*, 1997). In our context, we refer to the members of the learning groups. These three aspects can vary among groups because of different assumptions and appropriation of technology.

In addition to learning methods and structures, there are other antecedents of the appropriation process that may affect this process and therefore indirectly learning success as well. We here refer to the concept of scaffolding to influence the interaction of the learner with the applied methods and structures (Gupta *et al.*, 2010). The scaffolding metaphor by Wood *et al.* (1976) describes temporary instructional support for learners, meant to overcome learning challenges within their zone of proximal development (Vygotsky, 1978). These supportive structures are provided by a more knowledgeable other (Wood *et al.*, 1976), such as a fellow student. However, in most cases the scaffolding is made available by a teacher or, in case of TMLS, an instructional designer through prior development of the TMLS. For instance, wizards may support the faithful appropriation of learning methods and structures by giving advice on how to use the methods and structures coherent to its purpose (Gupta and Bostrom, 2009; Mao and Brown, 2005).

3 Theory-driven Design for TMLS Scaffolds

3.1 Research Method

For the design of the TMLS scaffolds, we draw on a theory-driven design approach (Briggs, 2006; Gehlert *et al.*, 2009) for engineering TMLS. Therefore, we base our subsequent design decisions on the constructs linked to our phenomena of interest.

In particular, we focus on TMLS appropriation as ancillary phenomenon and on learning outcomes as the focal phenomenon. Scaffolding measures are associated with technology appropriation in a learning scenario. Hence, we want to design TMLS scaffolds that address TMLS appropriation and ultimately learning outcomes. In consequence, we draw on a multidimensional approach, considering a structural, process, as well as results perspective of TMLS (Fitzsimmons and Fitzsimmons, 2006). Figure 2 depicts our theory-driven design approach in line with the framework of Gupta and Bostrom (2009).

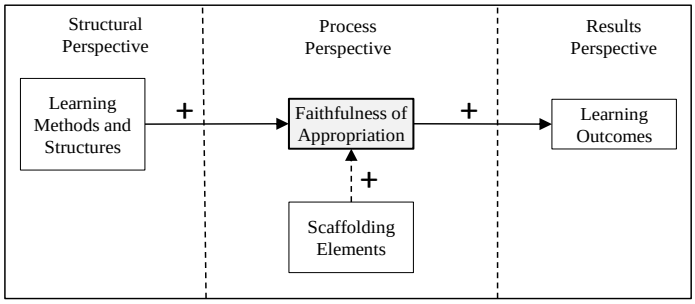

Figure 2. Theory-driven Design Approach According to Gupta and Bostrom, 2009

As depicted in Figure 2, we derive scaffolding elements that engage TMLS appropriation process and its faithfulness. For the further design of these scaffolds, we derive requirements from scaffolding theory (section 3.2). These requirements are addressed by scaffolding elements that should influence the TMLS appropriation and linked phenomena like TMLS outcomes (section 3.3). Ultimately, the scaffolding elements are then implemented in a TMLS (3.4).

3.2 Requirements from Scaffolding Theory

As already introduced, scaffolding theory proposes that initial assistance engages the faithful appropriation of provided learning methods and structures in a TMLS setting. Considering the notion of a theory in IS research, we refer to scaffolding as theory of design and action (Gregor, 2006), which serves as our theory basis for the design rationale. Scaffolding is a concept that gradually fades in the learning process. This fading is dependent on the learner and the specific learning process. As learners become more independent, confident, and competent, scaffolding measures are less important. Four

types of process scaffoldings to engage TMLS appropriation have been identified, which also serve as a framework to derive requirements from scaffolding theory: procedural, metacognitive, conceptual, and strategic scaffolds (Hannafin *et al.*, 2004; Gupta and Bostrom, 2009). Table 1 provides an overview of the different scaffolding types, their description, as well as according requirements for design elements to engage TMLS appropriation.

Scaffold Type	**Description**	**Requirement**
Procedural scaffolds	With emphasis on appropriation, procedural scaffolds encompass elements that facilitate initial orientation and navigation in a TMLS artifact (Hannafin *et al.*, 2004). Consensus is being developed primarily between the instructional designer and the individual user; secondarily between the learners.	R1) Learners should develop consensus on utilization of the TMLS. R2) Learners should maintain consensus on utilization of the TMLS.
Metacognitive scaffolds	Metacognitive scaffolds focus on learners' awareness of their own learning progress (Way and Rowe, 2008). Comparing initial goals and individual results provide valuable information for instructional designers and learners alike.	R3) Learners should apprehend the appropriate use of the TMLS as learning objectives have been met.
Conceptual scaffolds	Conceptual scaffolds support meaningful use of the TMLS concerning the underlying didactic intentions. Synergetic concepts become generally intelligible to the users as they become familiar with the TMLS' instructional purpose. Regarding the individual learning objects, conceptual scaffolds encourage a change of perspective on given tasks and modify learners' existing problem-solving strategies. (Way and Rowe, 2008).	R4) Learners should identify key elements of a posed challenge, which are necessary for successful content completion. R5) Learners should identify key elements of the learning activities and their purpose via the effective design of the TMLS.
Strategic scaffolds	Strategic scaffolds promote potential problem-solving strategies (Way and Rowe, 2008), both regarding the TMLS use in general and within concrete learning objects.	R6) Learners should make use of suggestions within posed challenges. R7) Learners should be able to transfer and transform acquired problem-solving strategies.

Table 1. Requirements for Scaffolding Elements

Procedural scaffolds aim to engage appropriation in the early use process of a TMLS in order to facilitate the initial faithful use of an IT artifact deployed in TMLS. Considering the appropriation process, TMLS recipients may not have a consensus on how to interact with the provided methods and structures. Hence, the derived requirements aim to foster the development and also maintenance of this consensus in order to support the underlying spirit of the TMLS (R1 and R2). Metacognitive scaffolds deal with the awareness and reflection in the learning process and the learning progress of service recipients (van den Boom *et al.*, 2007; Janson *et al.*, 2014a). Considering a MOOC with several provided learning structures, such as videos or quizzes, metacognitive scaffolds should enable the service recipient to anticipate learning outcomes (R3). The conceptual scaffolds are concerned with the objective appropriation, referring to the objective spirit of the TMLS as intended by the TMLS designer. Hence, design elements require allowing learners to identify the key elements, which are necessary to complete the learning service (R4), and the purpose of provided structures (R5). The latter deals with scaffold requirements that enable learners to identify key elements of the instructional design in order to modify their learning process in accordance with the aforementioned instructional design. Strategic scaffolds are related to the solving of problems in TMLS. Therefore, scaffolds should first provide suggestions within posed challenges of the TMLS (R6) that are necessary to complete a single learning objective. Such scaffolds may for example address the acquisition of factual knowledge necessary

to solve a higher-order learning objective, and second enable the service recipient to transfer and modify the problem-solving strategies suggested and applied so far to other problems (R7).

3.3 Designing Scaffolds to Engage TMLS Appropriation

To design scaffolding elements that engage TMLS appropriation, we draw on a framework of Baumgartner and Bergner (2003) that considers the structural and process perspective as key determinants of service outcomes. The structural perspective is divided into the didactical scenario level and the IT level, while the process perspective refers to the level of didactical interactions patterns.

Level	Scaffolding Element	Description	Requirement
Didactical Scenario	Recommendations	Automatic personalized recommendation of learning resources (Khribi *et al.*, 2009).	R6, R7
	Concept Mapping	Hierarchical diagrammatic representation of knowledge structures and concepts. Provided partially or fully completed for lecture or assessment (Northern Illinois University, 2008).	R4, R5
Structural IT	Hints	Suggestions for further action related to TMLS use (Northern Illinois University, 2008).	R1, R2
	Presentational Priming	Manipulation of information on technological features with visuals and text for instructional purposes (Comi *et al.*, 2013).	R1, R2
Process Level	Self-Assessment	Activity of self-reflection on learning progress (Nicol and Macfarlane-Dick, 2006).	R3,
	Feedback	Evaluation of student progress; Information that helps students to evaluate their own progress and identify discrepancies between their intentions and resulting effects (Nicol and Macfarlane-Dick, 2006).	R3, R4
	Mind Mapping	Visual and non-linear representations of (individual) ideas and their relationships (Biktimirov and Nilson, 2006).	R5
	Prompts	Physical and verbal cues to aid on recall of prior or assumed knowledge (Northern Illinois University, 2008).	R6
	Examples	Samples, problems or illustrations. Includes best-practice and facilitates authentic problem-solving challenges (Bennett *et al.*, 2002).	R6, R7

Table 2. Derived Scaffolding Elements

As shown in Table 2, we derived for the level of the didactical scenario recommendations and concept mapping as elements driving the appropriation of the overall learning service. The elements on the structural IT level aim to engage the faithfulness of how the employed IT artifact is used, for instance with hints supporting further actions or the priming actions that help to fully exploit the features of the IT artifact in a learning scenario. In contrast, the process level scaffolds engage the learning process in TMLS, especially by providing interaction (feedback and self-assessments) as well as scaffolds that aim to build connections between learning resources on a process level.

3.4 Implementation in TMLS

The implementation of our scaffolding elements for TMLS is currently conducted at a German university in Introduction to Information Systems, which is attended by business administration and economics undergraduate students. This course is offered each semester and attended by 150 to 300 participants. This particular TMLS is an adequate case for the implementation, since the service is highly supplemented with IT (cf. for further details Oeste *et al.*, 2014). In specific, it is a modular learning

service, building upon the principles of cohesion and loose coupling (Sanchez and Mahoney, 1996). The TMLS includes an online preparation module (module 1), an online collaboration module (module 2), a presence module in the lecture hall that is IT-supported by a classroom response system (module 3), and finally tutorials (module 4). All modules are fully interchangeable (e.g., the online module could also be offered by an external MOOC service provider) with few adjustments to the other modules. Since we want to focus on the IT-supported modules of the service, we focus our implementation of the scaffolding elements on the online module. This module is in our case embedded in an LMS, where we provide all learning materials and group discussion forums. As such, there are a lot of learning methods and structures provided for the service recipients, usually causing an information overload (Shrivastav and Hiltz, 2013; Grisé and Gallupe, 2000). However, the goal of this approach is to promote self-regulated learning by offering extensive IT support. Hence, we implement scaffolding elements to faithfully appropriate learning methods and structures offered in the LMS. The planned implementation of the scaffolding elements according to the learning phase is shown in Table 3.

Learning Phase	**Implementation**	**Description**	**Scaffolding Element**
Orientation Phase	What's new?	In order to provide initial guidance in the orientation phase, a priming is conducted stimulating the basic functionalities of the TMLS that are necessary to complete the learning goals and other modules.	Presentational Priming
Learning Acquisition Phase	Comprehensive explanations	Comprehensive explanations are provided within quizzes as feedback to reflect the solved task from different perspectives.	Feedback
	Quizzes	Self-assessment functionalities a a learner takes after completing specific learning materials to ensure knowledge acquisition.	Self-Assessment
	Dashboard	Learning progress-tracking functionalities are provided by a learning dashboard that tracks completion of learning materials, quiz scores, and achievement of learning objectives.	Feedback
	Wiki	A wiki is provided to capture and relate knowledge to other topics in the TMLS, building a concept map that relates different topics to each other.	Concept Map
Transfer Phase	Recommendations of related learning materials	Recommendations are provided for the learners to stimulate transfer knowledge, i.e., after completing specific learning materials, learners are given recommendations for learning materials with new problems that engage transfer knowledge.	Recommendations

Table 3. Implementation of Scaffolding Elements

As depicted in Table 3, the implementation of scaffolding elements is classified into three phases describing the service module: the orientation phase, learning acquisition phase, and transfer phase. Since we were not able in our research setting to implement every scaffolding element possible, we addressed every requirement by the implemented scaffolds. Since it is the goal of the orientation phase to understand the basic functionalities of the TMLS, we implemented presentational primings that simulate the basic TMLS functionalities (Comi *et al.*, 2013). Such scaffolds are usually provided in mobile applications and introduce new functionalities when first installing or updating an application. We use this "What's new?" mechanism to prime users with the basic functionalities to achieve appropriation. The second phase deals with the learning acquisition. The comprehensive explanations, quizzes, and dashboard are highly interrelated and facilitate awareness and reflection in the phase of learning acquisition. Thus, these scaffolds provide assistance, if the provided learning materials in the TMLS are faithfully appropriated. However, the implementation of a wiki in this phase seeks to identify and collect the key elements of the proposed learning materials. By considering wikis as a social

media tool highly driven by collaboration, peer tutoring helps to guide the TMLS appropriation. Ultimate goal of the wiki is to derive a concept map of the learning topic under investigation, which recaps important knowledge (Eppler, 2008). In the transfer phase, as a last step to connect knowledge to new problems, recommendations are a scaffold linking learning materials. These linked learning materials provide new learning opportunities that transform the known problem-solving strategies.

4 Evaluation

In line with the design science research approach (Peffers *et al.*, 2007), we evaluate our scaffolding concept to derive insights on further design cycles (Hevner *et al.*, 2004). Therefore, we propose a longitudinal research design with several measurement points. As pointed out in 3.1, we focus with our implementation of scaffolding elements to engage the faithfulness of the TMLS appropriation as well as service outcomes such as learning success and satisfaction. We therefore conduct a quantitative survey to examine the scaffolding effects. In this study, the participants are assigned a unique code to properly identify them in the longitudinal research design. We check for several control variables in our first evaluation (t1), including personality (Rammstedt and John 2007), self-regulated learning (Pintrich and De Groot 1990), and technology readiness (Parasuraman 2000). In our second evaluation point, we measure the initial TMLS appropriation by measuring faithfulness with the scales of Chin *et al.* (1997) and Gopal *et al.* (1992) as a learning process variable (t2). At the third measurement (t3), learning satisfaction with the scales of Arbaugh (2001) and the appropriation constructs are measured. The latter are to account for longitudinal changes suggested by research (Gupta and Bostrom 2009). Learning success is measured by means of the exam results. Since our TMLS is embedded in an action research project (Wegener *et al.*, 2012), we use the same type of scales and final exam, and are thus able to show whether our scaffolding elements improve the learning process and learning outcomes. Hence, the past semester is used as a control group, to test if the scaffolds significantly improve appropriation and service outcomes. To evaluate the effects of our scaffolding elements, we use a t-test for independent samples and our tool of analysis is SPSS 22.

5 Next Steps and Expected Contribution

According to Gregor (2006), we provide with our research a theory of design and action and contribute to theory by extending the known solutions of scaffolding theory to the domain of TMLS (Gregor and Hevner, 2013). We contribute to the service science by systematically deriving theory-driven requirements for reusable scaffolding elements that hinder information overflow in heavily IT-supported, person-oriented services, promote self-regulated learning, and engage the faithful appropriation of provided structural potentials in an IT-supported service. To practitioners, this paper provides concrete ways to improve TMLS by implementing our derived design elements, to positively influence the process of service delivery, and ultimately engage TMLS outcomes such as learning satisfaction and success. We now implement the design elements in the chosen TMLS. After implementation, we advocate our research to the demonstration and evaluation phase of the design science research approach according to Peffers *et al.* (2007) as described in section four, in order to finally communicate the research results of the completed research as a last step and derive learnings for further design science research cycles (Hevner *et al.*, 2004). Next steps include first the implementation of the other derived scaffolds and second, beyond this particular case of TMLS, as suggested by Bostrom *et al.* (2009), the transfer of these insights of scaffolding for service design to other heavily IT-supported services, in order to engage service outcomes such as customer satisfaction.

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