

# DESIGN AND EVALUATION OF A DIDACTICAL SERVICE BLUEPRINTING METHOD FOR LARGE SCALE LECTURES

*Completed Research Paper*

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## Abstract

*University instructors face strict economic constraints when designing lectures. Intelligent usage of IT and higher degrees of learner integration can help to face this challenge, but it is difficult to decide which parts of a lecture should be re-designed and how. Thus, we present the Didactical Service Blueprint (DSB), a method to analyze and re-design large scale learning services with reasonable resources by integrating eLearning and peer learning activities. We have used DSB to iteratively improve an IS-lecture over the course of four years and evaluated learning success ( $n = 404$ ) and satisfaction ( $n = 389$ ). Results indicate that DSB is suitable to improve lectures considering reasonable consumption of resources. As theoretical contribution, this paper offers an advancement and adaptation of the traditional Service Blueprint explicitly designed for large scale learning services. The practical contribution lies in the application of DSB to develop solutions for common problems in large courses.*

**Keywords:** Service engineering, IS education, E-learning

## **Introduction**

German universities are facing increasing numbers of students while resources are stagnating due to economic constraints. Offering high quality learning services becomes more and more difficult, as many didactically effective teaching methods are resource demanding and difficult to scale. This results in mass lectures that often lack interactivity and individuality. Large scale courses also become increasingly important outside of university classrooms. Particularly in developing countries, but also in rich economies, many people cannot afford to attend traditional ways of education. With spreading Internet connections, however, these people might participate in virtual learning scenarios such as the relatively new phenomenon of massive open online courses (MOOCs) that are offered online for free and can be attended by thousands of users. As Kop states (2011), these courses also incorporate a lot of challenges to learners with regard to their self-managing processes. Structuring and managing such a large course from an instructor's point of view, however, cannot be done by traditional teaching methods.

When dealing with large numbers of students, instructors face the challenge of offering a valuable learning experience usually with sparse resources, that is, they need to bridge the gap between didactical effectiveness and economic efficiency. The service engineering domain offers several methods to re-design different kinds of service processes with regard to the customer's perceived quality as well as the provider's resources and effort (Leimeister 2012; Menschner et al. 2011a; Patrício et al. 2008). One of the best known methods is the Service Blueprint (SB) developed by Shostack (1984). It visualizes a service process by dividing it into single process steps that are then analyzed with regard to their strategic importance and potential for reducing the effort of the service provider. Since the SB should apply to any service domain, it is still very generic, offering only rough guidelines for process re-design. Overcoming this limitation, we developed the Didactical Service Blueprint (DSB), a progression of the traditional SB that is mainly focused on university large scale lectures, and evaluated it in a large scale Information Systems (IS) course. The method supports instructors in re-designing learning services to improve learning success and satisfaction with reasonable resource demand. It offers additional principles for visualization, identification of possible shortcomings and re-design of process steps through standardization, partial automation and outsourcing process steps to the learner.

Development of the DSB has been conducted in a long-term Action Research project that started in winter term (WT) 2008/2009. Following the steps of Action Research we diagnosed the problem situation as expressed by one of our own courses, planned and conducted actions for didactical improvements, evaluated students' learning success and satisfaction and drew conclusions from the results. This process was repeated several times to gradually improve not only the course but also the DSB method we used for analysis and re-design. Our theoretical contribution lies in the development of the DSB to re-design large scale learning services. As a practical contribution, we used the method to develop concrete solutions for common problems in large scale courses, implement them and evaluate the results.

The paper is structured as follows: The next section introduces theoretical foundations and related work from didactics and service science. The research methodology is described in the third section. The fourth section presents the DSB method, followed by an illustration of its applications and an evaluation of the results. The paper ends with conclusions, limitations, and recommendations for future research.

## **Theoretical Foundations and Related Work**

### ***Designing valuable learning services***

Gagne defines learning as a change of the state of the human being that is expressed in a change in the individual's behavior and is based on experiences (Gagne 1984). Thus, the main goal of a university learning service is to achieve specific changes in students' behavior. The desired learning objectives can be separated into different domains. The best known taxonomy of learning goals or learning domains was constructed by Bloom (Bloom 1956). Bloom separated learning into cognitive, psychomotoric and affective domains. The cognitive domain was further separated into six layers with pure knowledge as the lowest, followed by comprehension, application, analysis, synthesis and evaluation as the highest. Higher-

level learning goals are more complex and require that learners have already mastered necessary lower-level goals. The level also determines suitable methods to facilitate and to assess the achievement of a learning goal (Kraiger et al. 1993). When evaluating a learning service, apart from learning success, one should also take into account the learner's satisfaction. While there is not one single definition of learning satisfaction, researchers agree that it depends on different factors such as the instructor's attitude and competencies, quality of technology used, contents or task design (Sun et al. 2008). Learning satisfaction should be considered for two reasons: First, satisfied learners might be more engaged and thus achieve better learning results. Second, instructors should offer satisfying and motivating learning experiences, as they are competing for the best students.

To conclude, improving a learning service would ideally mean to raise satisfaction as well as learning success. Both are influenced by different factors. The basis of all learning is interaction occurring in three main forms: learners interacting with each other, with the instructor and supporting staff or with learning contents (Moore 1989). To improve the learning service from a didactical point of view, it can be concluded that it is most important to identify the activities in the learning and teaching process which directly represent one of these kinds of interactions. Unfortunately, raising interactivity in large classes often proves to be a major issue, as suitable activities have to be supported and possibly assessed by the instructor. This often demands too many resources. Thus, many instructors tend to rely on teacher-centered lectures that do not offer many opportunities for interaction and engagement.

### ***The Service Blueprint (SB)***

Originally developed by Shostack (1984), the SB method has since been adapted and supplemented by other researchers. Zeithaml et al. (2006) define the SB as a method of modeling the service process, the customer contact points and the perception of the service delivery from the customer's point of view. Basically, a SB is a two-dimensional visualization of a service process: The horizontal axis represents the chronological order of different activities performed in the service process; the vertical axis separates these activities into different levels of interaction between the service provider and the customer (Fließ and Kleinaltenkamp 2004). These levels of interaction are separated by different lines, the most important being the following:

- “Line of interaction”: This line differentiates between activities performed by the customer and those performed by employees of the service provider. Activities on this line are performed mutually by both.
- “Line of visibility”: Activities below this line are not visible to the customer.
- “Line of internal interaction”: Activities above this line are directly linked to the individual customer, while those below are supportive activities. For example, cooking a meal in a restaurant is an activity performed invisibly to the customer, but it is still done on an individual basis. Cleaning the dishes, on the other hand, is done independently from single customers and is a supportive activity.
- “Line of implementation”: Activities below this line refer to strategic decisions and are usually subject to the management of a service provider.

The strength of the SB is to model not only the process but also the customer contact points and the level of customer integration. As a visualization method, it is easy to understand and to perform. With regard to learning services, the SB offers several benefits: First, as already explained, interaction is the basis of the learning experience. Thus, a method that separates between different layers of interaction seems to be well suited. Second, the method is very easy to apply and to understand, and thus can also be performed by instructors that do not have any knowledge of more complex modeling techniques, as for example UML. Third, the Blueprint helps identify and re-design activities that can be supported by IT or be outsourced to the customer. As we expect eLearning and peer learning to be major aspects of learning service re-design, the method seems to fit ideally to our concept.

### ***Extending the SB – Design of the Didactical Service Blueprint (DSB)***

The goal of the Didactical Service Blueprint (DSB) is to improve a large scale lecture with regard to learning success and satisfaction. It is meant to help in analyzing current lectures, identifying key issues and offering guidelines to overcome these challenges with reasonable costs. The development of DSB is

oriented at the design process for the person-oriented services of Menschner and Leimeister (2012). Following this process, we first identify key challenges of university large scale lectures. We develop the design goals based on didactical research and derive a list of design principles to support the process of analysis and re-design. We then apply the DSB method and use these principles to develop several possible solutions for common challenges in large scale courses.

## **Research Method**

The development and application of the DSB is part of an Action Research project that started in winter term (WT) 2008/09. Set in a large scale course “Introduction to Business Informatics” (IBI), we used DSB to improve the lecture incrementally by developing several solutions to address its main shortcomings. Typically, Action Research focuses on evaluating measures in real life situations to solve specific problems, and is divided into five specific steps which are taken iteratively (Susman and Evered 1978): diagnosing, action planning, action taking, evaluation and specifying learning. We followed these steps and tried to improve our concepts and tools after each semester, before restarting the cycle from the beginning.

With regard to this Action Research project, the five steps included the following: We first identified key requirements for valuable learning processes and common problems in large scale courses by analyzing the literature and our own IS course (Diagnosing). We then developed the DSB method in order to re-design several parts of the course and used the DSB to develop several concepts and methods to overcome key challenges (Action Planning). These concepts and methods were implemented over the course of several semesters to incrementally improve our lecture (Action Taking). We analyzed the success of our solutions through an online questionnaire for learning satisfaction and a power-test for learning success (Evaluation). As a result, we refined our solutions and the DSB method (Learnings).

## **Concept of the Didactical Service Blueprint (DSB)**

### ***Challenges and Goals in Educating Large Classes***

As expressed previously, interaction is crucial for learning. However, as the number of students increases, the instructor has less time to offer to individual students. Giving prompt and individual feedback on learners’ assignments, for example, is important for learning, but may be unaffordable in large classes. Another typical problem is that due to limited time, large lectures often are very instructor-centered, offering few possibilities of interaction in the form of questions or in-depth discussions. Also, effective assessment often requires too much effort, and thus instructors rely on methods such as multiple-choice tests, which may not be suitable for assessing higher level learning goals.

Since lectures can differ a great deal with regard to the learning goals, instructors, learners, learning environment, etc., it is difficult to derive goals that are generally applicable. Regardless of the specific situation, most educators agree on some specific goals that most lectures should incorporate. Our set of design goals is based on well-known principles of good practice (Chickering et al., 1987). Given that usage of IT on the one hand, and outsourcing tasks to the learner as peer learning activities on the other are crucial steps in developing effective and efficient large scale learning services, we enrich these principles with guidelines from the domain of multimedia learning (Mayer and Moreno 2003; Moreno and Mayer 2007) and peer learning (Topping 2005; Wegener and Leimeister 2012). Based on the assumption that addressing the three dimensions of interaction is the key to successful and satisfying learning, we separate our design goals by these dimensions (Table 1).

**Table 1. Design goals***Student-Student interaction*

Students should be encouraged to cooperate with colleagues, e.g., by solving assignments collaboratively, as working with peers has proven to be beneficial for students' motivation (Gerald 2010). In addition, students learn from each other and construct new knowledge mutually (Topping 2005). Small group assignments have appeared to be more effective for this than are whole class discussions (Fasso 2010), especially if they should result in concrete group products that will be assessed by the instructor (Dewiyanti et al. 2007). Group tasks should be well structured, and the instructor should offer additional advice and help, e.g., by initiating discussions or encouraging learners to participate. Since variety plays an important role in learning, we also recommend implementing different didactical methods to structure group work in order to avoid feelings of repetition. Design goals could include:

- Assigning small-group tasks that result in a concrete product that will be assessed by the instructor.
- Supporting the collaboration process, e.g., by initiating discussions or providing feedback.
- Applying different didactical methods in the classroom, e.g., traditional group work, group puzzles, the fish bowl, etc.

*Student-Instructor interaction*

The instructor plays a crucial role for both learning satisfaction and success (Cohen 1981; Eom et al. 2006; Wang et al. 1993). Thus, students and instructors should interact regularly; if possible, on a face-to-face basis. Instructors should encourage students to participate and involve them in discussions in class. Ideally, students should have the opportunity to get help or feedback from instructors whenever they need it. Instructors, on the other hand, should gain an overview of how students are currently performing from time to time in order to offer additional help or advice for students that might fall behind. Instructors should also show support for students and be attainable and engaged, since such social aspects contribute much to learners' satisfaction. Design goals should involve:

- Interacting with students in the classroom through discussions and questions.
- Analyzing which learning goals may not have been achieved thus far (e.g., through an exercise) and taking measures (e.g., offering additional materials or tasks).
- Ensuring that students learn continually over the whole semester.
- Offering regular feedback with regard to students' current learning success, e.g., through exercises.
- Offering feedback with regard to students' processes of learning management, teamwork, etc.

*Student-Content interaction*

Learning materials should be designed in an engaging way to support active learning (Chickering et al. 1987). This refers to the content itself (its structure, problem orientation, etc.) as well as its presentation (e.g., using animations or interactive assessments). Materials should be developed with regard to instructional and multimedia design guidelines (Clark and Mayer 2008; Moreno and Mayer 2007) and should be open to different learning styles and preferences (Kolb and Kolb 2005; Zhang et al. 2004). Design goals could include:

- Supporting different learning styles and preferences, e.g., through different sorts of learning materials
- Designing learning materials in a didactically and cognitively effective way, e.g., self-learning materials may be designed with regard to instructional and multimedia design guidelines
- Designing engaging materials with tasks and self-assessments

## Analyzing and Informing Design

The SB allows segmenting the whole service process into single steps that are analyzed individually. The main goal when performing the analysis is to identify the value creating moments (Menschner and Leimeister 2012). These moments are meant to attribute most to the students’ learning success and satisfaction. Accepting that interaction is the core part of the learning experience, it follows that all activities involving active engagement of students in order to achieve didactical goals are considered to be of critical importance. These activities represent student–student interactions, but can also involve student-instructor or student-content interactions. In the traditional SB, all activities involving customers are arranged on the line of interaction or right above this line. In our case, this meant that any student–student interaction or student-instructor (including supporting staff) interaction would be placed on the line of interaction. Activities performed in a self-directed way, e.g., self-assessments or collaborative group work, would be placed above the line of interaction. In this way, activities referring to student-student interactions and student-content interactions could not be distinguished visually. Thus, we adjusted the Blueprint slightly by adding the “line of peer interaction” above the line of interaction. Any activities that could be referred to as collaborative learning are placed on this line. Below the line of interaction we place activities performed by students on their own. With this adjustment, a learning service can be modeled with the DSB like any other service with the traditional Blueprint, but the most important activities are separated into the three dimensions of didactical interactions.

## Principles to Guide the Process of Re-Design

The basic idea is to break down the learning process by assigning single activities to time and level of interaction. One can now analyze these process steps of critical importance and begin to improve them with regard to the design goals. As stated, most design goals can only be accomplished with much effort. The design principles developed in this section help to address this challenge. Basically, when a service process is re-designed, the goal is to optimize the combination of internal and external factors. Internal factors are all contributions of the service provider (i.e., the instructor and his staff, as well as university employees supporting the teaching process). External factors refer to all contributions from the customers, i.e., the students. They need to offer their time, effort and cognitive capacities in order for the learning process to be successful.

To improve the factor combination, several principles can be applied. The principles we derived are based on ideas from Menschner and Leimeister (2012) and Fließ and Kleinaltenkamp (2004). We used our own experiences, as well as educational literature, to concretize them with the problem domain in mind. For example, Menschner and Leimeister recommend dividing activities on the line of interaction into smaller segments to analyze which of these sub-activities really have to be processed mutually by the service provider and the customer (Menschner and Leimeister, 2012). We experienced that when segmenting a process step in a learning service it could be beneficial to segment it concerning different levels of learning goals. It is usually easier to assess gains in factual knowledge in an automated way than it is to assess achievements with regard to more complex competencies. An overview of the principles is presented in Table 2. It describes each principle and lists indicators for its applicability. For each indicator, an example is given.

<b>Table 2. Principles for learning service re-design</b>
<p><i>Segmentation: Divide a process step into sub-activities</i></p> <ul style="list-style-type: none"> <li>• Process step incorporates different levels of interaction: The process step “lecture” can be segmented into activities solely performed by the instructor, the students or both of them.</li> <li>• Process step incorporates different levels of learning goals (Bloom 1956): The process step, “assess students,” might be segmented into parts such as “assess factual knowledge” and “assess methodological skills.”</li> <li>• Process step incorporates different roles of the instructor (Goodyear et al. 2001): The process step “moderate forum” may be segmented into steps such as “answer organizational questions” (Adviser),</li> </ul>

<p>“answer questions about course content” (content expert), “facilitate in-depth discussion” (process facilitator) and “facilitate friendly atmosphere” (Administrator).</p>
<p><i>Standardization: Standardize processes or inputs</i></p> <ul style="list-style-type: none"> <li>• Process step requires homogeneous input (Fließ and Kleinaltenkamp 2004): If students are asked for their perceived best and worst aspect of each lecture, this can be easily standardized.</li> </ul>
<p><i>Automation: Automate processes with the help of IT</i></p> <ul style="list-style-type: none"> <li>• Organizational tasks: Signing in for the course itself, the exam or a tutorial should be automated.</li> <li>• Didactical tasks focusing purely on assessment: It seems to be easier to automate an assessment activity rather than a whole learning activity.</li> <li>• Didactical activities targeting lower level learning goals: Pure acquisition of factual knowledge may be assessed by an online multiple-choice test.</li> </ul>
<p><i>Semi-automation: Automate processes with IT, but also require some personal input</i></p> <ul style="list-style-type: none"> <li>• Organizational communication activities: Organizational/administrative questions involving dates and rooms should be answered in a forum and not in a personal consultation hour.</li> <li>• Communication activities that might suffer from feelings of inhibition or lack of time (Biggs et al. 1999): Discussions should take place online in a chat or forum instead of in the classroom.</li> <li>• Didactical activities not focusing on learning goals but on engagement, interest or feedback: Engaging learners through a poll can be done via mobile devices.</li> </ul>
<p><i>Electronic data capture: Data from the students is gathered automatically or entered</i></p> <ul style="list-style-type: none"> <li>• The instructor needs structured aggregated data from students (self-reported or automated): This may be done via online polls or even conducted in class via mobile devices. Capturing data in electronic form allows faster aggregation and evaluation (Menschner et al. 2011b).</li> </ul>
<p><i>Decision support: Aggregate data in way to support the instructor in his task</i></p> <ul style="list-style-type: none"> <li>• A personal intervention by the instructor is required but not possible due to the large number of students: If students are supposed to contribute to a forum or Wiki, the instructor should receive an automated overview of students who are just lurking compared to those that are especially engaged.</li> </ul>
<p><i>Face-to-face: Unsure that some crucial activities are performed face-to-face</i></p> <ul style="list-style-type: none"> <li>• No other face-to-face contacts between students and instructor: In a large scale lecture there is not much room for students and the instructor to meet personally. Thus, there should be at least some regular face-to-face meetings to establish social ties (Borup et al. 2011).</li> <li>• Didactical activity that is targeting higher level learning goals and/or is more difficult to master: The scarce time in a lecture should not be used to recapitulate easy basics and factual knowledge but should be reserved for the more complex and engaging topics.</li> </ul>
<p><i>Peer learning: Delegate activities completely to the learner</i></p> <ul style="list-style-type: none"> <li>• Not prohibited by ethical or legal issues: Peer assessments cannot be used for grading.</li> <li>• Solving the outsourced task contributes to students’ learning experience: Acting as peer tutors helps to reflect and understand the content.</li> <li>• The students have or can acquire the expert competencies necessary: It is easier for students to act as peer tutors for a course attended during the previous term.</li> </ul>
<p><i>Co-creation: Delegate activities partially to the learner</i></p> <ul style="list-style-type: none"> <li>• Peer learning activity needs final assessment or quality management by the instructor: The instructor might post an assignment online which is solved by students in a forum. When they manage to solve the task, the instructor should recapitulate and approve the right solution.</li> </ul>

## Application of the Method

### Background of the Action Research Project

The implementation of our proposed concept was conducted at a German University in the course IBI, mostly attended by students from the domain of business administration and economics. The course is offered each semester for around 150 to 300 participants. It is offered as a traditional frontal lecture (around twelve to thirteen sessions) supplemented by four small-class tutorials supervised by graduate assistants. Students are graded by the scores of a written exam at the end of a semester. All students that attend the course sign in on the university's central LMS where they can download the script and all other learning materials and receive E-Mails from the instructors. Apart from the professor in charge, the course is supported by a scientific assistant and four graduate assistants.

### Analyzing the Current Situation

At the beginning of our Action Research project we analyzed the given situation right before WT 2008/09. At this point, the course consisted of the lecture and tutorials, a real time video stream and recordings, a script based on PowerPoint slides used by the instructor and further resources, such as additional literature (Figure 1).

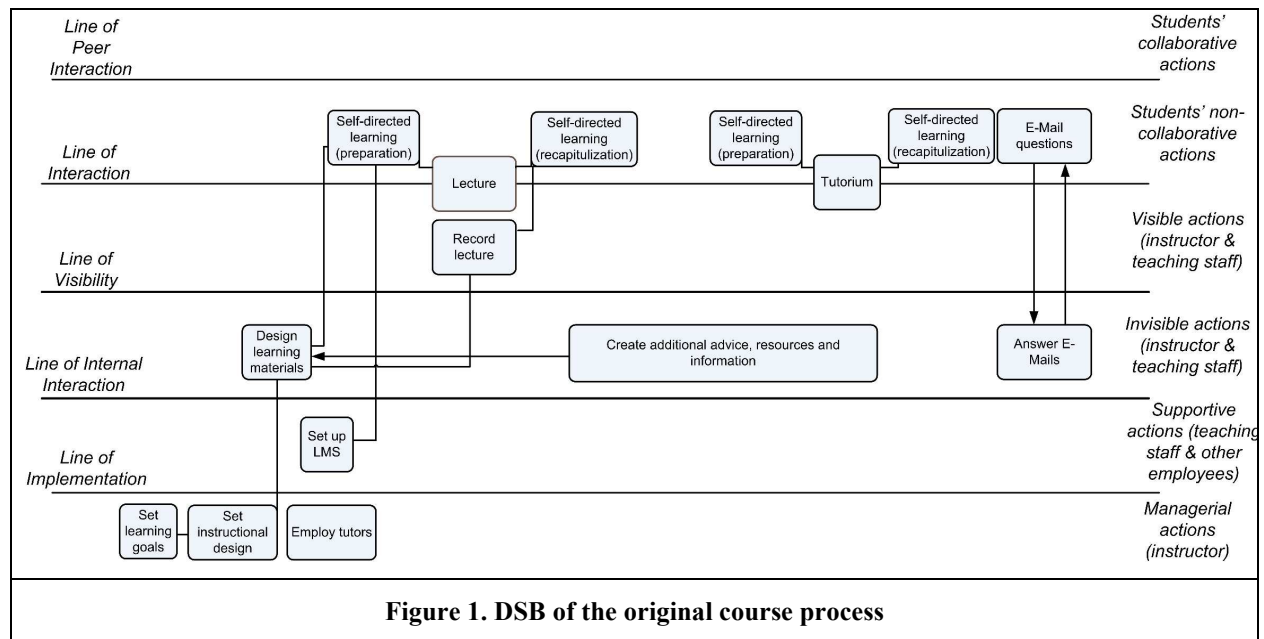


Figure 1. DSB of the original course process

We used the DSB to identify some major shortcomings in our lecture and to derive conclusions for solving these problems. Figure 1 illustrates the initial DSB. To be noted is that the activities shown may differ in their order and frequency of appearance, e.g., asking questions via E-mail may also take place before or after the lecture. Further, the process is iterative since the phase of self-directed learning and attending the lecture or tutorials alternates several times. Basically, students sign in for the course and use the learning materials (script and later on the recordings) from the LMS. In this way, they prepare for the lecture, attend it (although this is voluntary) and recapitulate it with the learning materials. The same process holds for the tutorial. There are four tutorial sessions with around 30 students attending each tutorial. The tutorials focus on specific contents of the lecture, especially modeling techniques such as Entity Relationship Models. Over the course of the semester, students may contact the instructor by E-Mail or during the regular consultation hour. In addition, organizational updates are sent via the LMS to all participants of the course. From the instructor's point of view, additional tasks include setting the



learning goals and the basic instructional design, employing the graduate assistants, setting up the course in the LMS, designing and uploading the learning materials, answering questions and offering additional advice. The DSB shows that while some of these activities are usually performed by the professor himself, such as setting the learning goals, other activities are performed by other members of the teaching staff.

Although the illustrated DSB is not very detailed, it reveals the course's major shortcomings:

- Student-student interaction: The lecture indeed offers no encouragement of peer interaction. There are no collaborative tasks, neither on the LMS nor in the tutorial sessions.
- Student-instructor interaction: This sort of interaction appears only during the lecture. As described in the problems section, interactions during the lecture suffer from a small amount of engagement and student inhibitions due to the large class. This situation is much better in the tutorials, but the graduate assistants still perceive that not all students contribute and are actively engaged. The tutorials are always comprised of the same sort of tasks with no variety such as different didactical methods. There are no feedback mechanisms, except e-mail, and there are no assessments.
- Student-content interaction: The materials for self-directed learning comprise only the traditional script and lecture videos. More engaging, interactive and cognitively effective learning materials are lacking.

### ***Re-Designing the Learning Service***

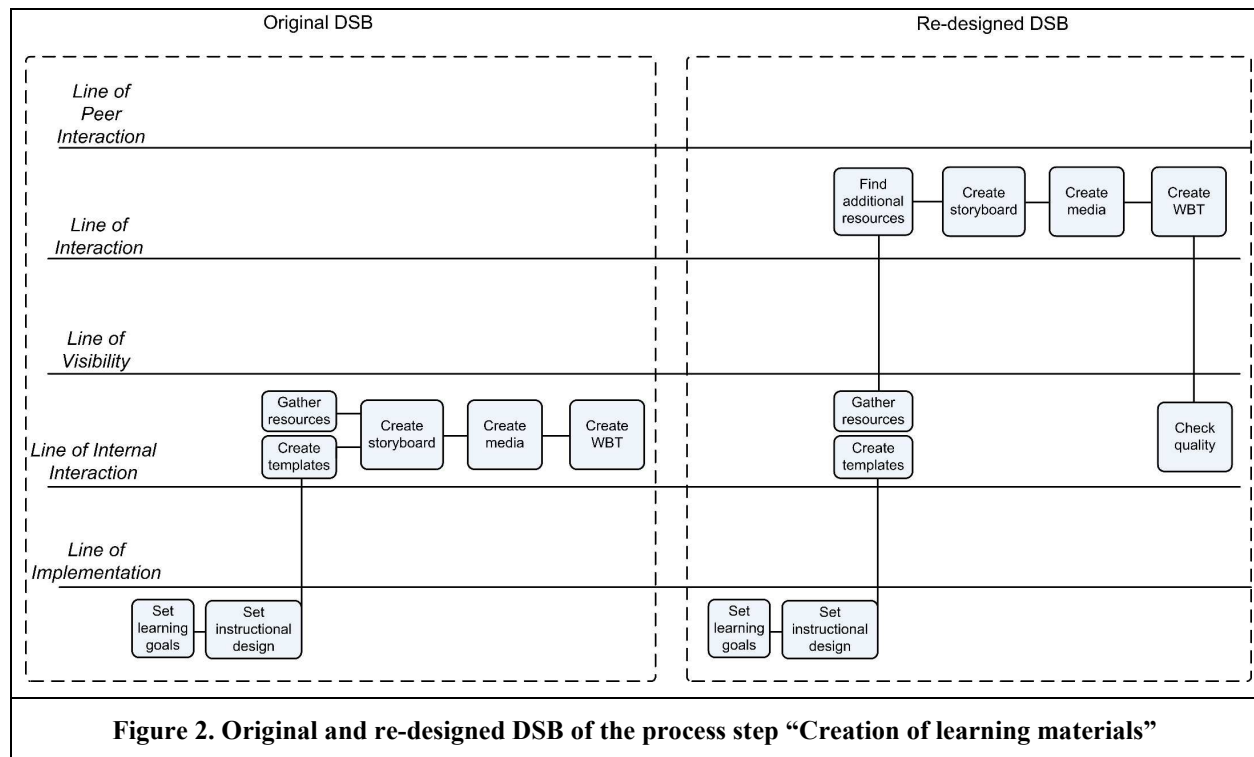
After identifying these issues, we started to look for ways to address these challenges by applying the principles of DSB. Since planning, implementing and evaluating our actions needed some time, we decided to use WTs for implementing actions, and the summer terms (ST) for evaluation, reassessment and planning of new actions. In the following, we focus on three core measures we applied and describe how they were developed in greater detail.

*Introduction of student-generated Web Based Trainings (WTs 09/10):* Self-directed learning materials were at the start limited to script and video recordings. As students usually spend more time with self-directed preparation and recapitulation activities than in face-to-face sessions, improving the learning materials was the first measure to be taken. We decided to create engaging Web Based Trainings (WBTs) and thus analyzed the process step of "Create learning materials" in more detail, by segmenting this process with regard to the different layers of interaction. Usually the main instructor, i.e., the professor, sets the learning goals and basic instructional design, after which members of the teaching staff create templates for the learning materials and gather resources. Storyboards are created for each learning unit, media is created and the final WBT is set up. This process happens completely underneath the line of visibility, but is so complex that automation is out of scope.

There do exist, however, some ways for standardization by creating a shared repository of resources if different people are involved in material creation and creating standardized templates, e.g., for assessments in a WBT. But even with these standardizations in mind, creating high quality WBTs seemed too resource demanding. Thus, we opted for delegating this task to our students. While the instructor still set up learning goals and guidelines for the instructional design and templates, the process of looking for further resources and creating the storyboard and WBT was delegated to students from a Web Engineering seminar, a follow-up course of IBI. We applied several principles of peer learning and co-creation: Since the students of the Web Engineering seminar had already attended the course, IBI, and would learn web engineering capabilities in any case, they could be considered experts. Further, creating learning materials for their peers was believed to contribute to their learning experience, since this involved developing didactical and lingual skills. Creating learning materials for a course already taken could also be considered as a measure to transfer, repeat and deepen their knowledge. We also made sure that there were no legal or copyright issues in using the learner-generated contents. Finally, the process we set up incorporated the instructor to check the final WBTs and to select only those that qualified to be used as learning materials in the course. Figure 2 compares the original and re-designed process for the creation of learning materials.

We expected benefits of this process to be two-fold: The students creating the WBTs would benefit, as they would work on a meaningful task and deepen their knowledge on the contents of the IBI course (more details on this can be found in (Wegener and Leimeister, 2012) and (Wegener et al. 2010)). The students from IBI who would use the peer-created WBTs would also benefit from the new supplemental

learning materials. The WBTs should raise students’ perceived quality of the learning materials and accordingly, their overall satisfaction. As self-paced learning plays a major role in this course, we also expected the WBTs to contribute to the learning success.

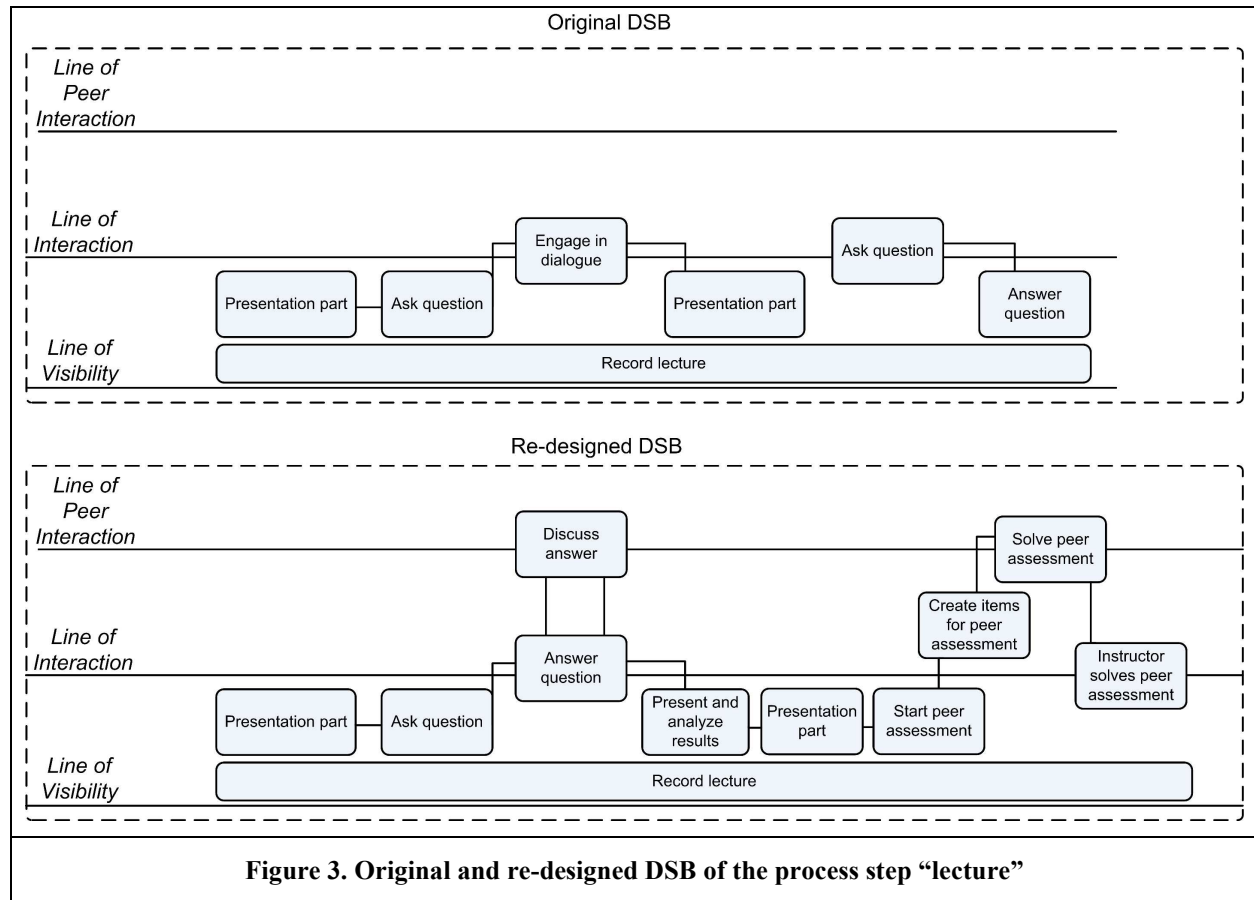


**Figure 2. Original and re-designed DSB of the process step “Creation of learning materials”**

*Raising interaction through in-class assignments on mobile devices (WT 10/11):* The second measure of re-design refers to the lecture. While we initially placed this process step on the line of interaction, a more detailed analysis shows that, in fact, most activities do not really encourage or require an active participation of the students (Figure 3). The biggest part of the lecture is reserved for the instructor to present the contents, resulting in a lack of interaction. When the instructor asks a question, only a few students have the opportunity to answer. Some feel inhibited and most do not ask questions themselves. This also poses a challenge to the instructor, as he often lacks feedback from students as to whether they have understood the contents explained thus far. The lecture is crucial for learning satisfaction, since it is the only contact between many students and the instructor (face-to-face principle). Thus, beginning in WT 10/11, we implemented in-class assignments in the lecture. Our goal was to reduce feelings of inhibition, coercing all students to interact with the instructor and resulting in the instructor getting feedback from students. If students were engaged in small tasks, applying and testing their knowledge, we expected to raise the level of interaction. Accordingly, this would also influence the learning success.

To allow the huge number of students to engage and to aggregate their feedback, we applied the principles of semi-automation and electronic data capture. This was possible because most students already owned some sort of mobile device such as a laptop. Those who did not were allowed to borrow a netbook or tablet PC from the university’s IT service center. We developed two main kinds of activities. From time to time during the lecture the instructor would ask a question and start a poll. Students voted for an answer, discussed their opinion with their peers and then could change their mind and vote again. As a variation of this concept, sometimes the instructor provided a graphic, e.g., a model such as ISO-OSI, containing some flaws that students had to find. For this, they worked in pairs, in turn, identifying and discussing the flaws. In this way, all students had the opportunity to answer questions and to become engaged with their colleagues. In addition, the instructor received aggregated feedback from all students, either the results of the poll or the number of students who identified the flaws in the diagram correctly.

The second activity focused on reflection and peer-assessment. In this activity, students created true-or-false items with regard to the learning contents they had just heard about (peer learning expert principle). The students created these items through a web application on their mobile devices in a highly standardized manner (standardization principle). They entered exactly three statements with at least one being true and one false. There was no opportunity to create open ended questions, nor could they forget to mark their statements as true or false as might be the case if the task was performed with pen and paper. The items were sent and stored in a central database. From this database, each student then randomly received three items from his or her peers. To increase interaction with the instructor, he/she also solved some random items in front of the class. Storing items in a database also enabled students to access them later on for testing purposes, as we will explain in the next section.



*Offering new assessment tools (WT 11/12):* The third measure we implemented was a new way of assessment. In the original course there was no assessment except for the final exam. Thus, we had to set up a whole new process. Assessment can be segmented into the creation and selection of tasks, the students solving these tasks, and the instructor checking the solutions and providing feedback. A further segmentation can be conducted with regard to the learning goals (Bloom, 1956). Usually an assessment addresses different levels of learning goals, from acquisition of factual knowledge to methodological skills and more complex competencies. Taking into account the principles of automation and standardization, assessment of factual knowledge is easier to be automated, as it resembles a lower level learning goal and requires more homogeneous input. To assess whether a learner can distinguish between the different constructs in an Entity Relationship Model, he might, for example, solve a multiple-choice test or enter the terms in a text field. Assessing the methodological knowledge to construct a diagram from scratch, on the other hand, would be much more difficult, as this task offers many more possible solutions, with the need for additional explanations or discussion.

With different learning goals in mind, we applied two different ways of assessment. For lower level learning goals (with regard to Bloom mostly knowledge and comprehension) we used an automated online test. As previously described, students in our course participated in a peer assessment activity conducted on mobile devices. The items they created were stored in a database and well suited for assessing factual knowledge. Therefore, we changed this peer assessment activity in such a way that students also had to rate the items they received with regard to their quality. The best rated items were checked by the instructor right after class and then uploaded to the LMS as small automated self-assessments (automation principle, co-creation principle). To offer a way to assess higher level learning goals such as methodological skills, additional tasks were created by the instructor and uploaded to a moderated forum. As these tasks were more complex and offered different solutions, complete automation was out of scope. Thus, they were solved and discussed mutually online. If students shared and explained their solutions, they would reflect on their own understanding and thus deepen their knowledge (peer learning principle). As the forum was moderated, the instructor was still able to approve the final solution (co-creation principle). Figure 4 illustrates the process.

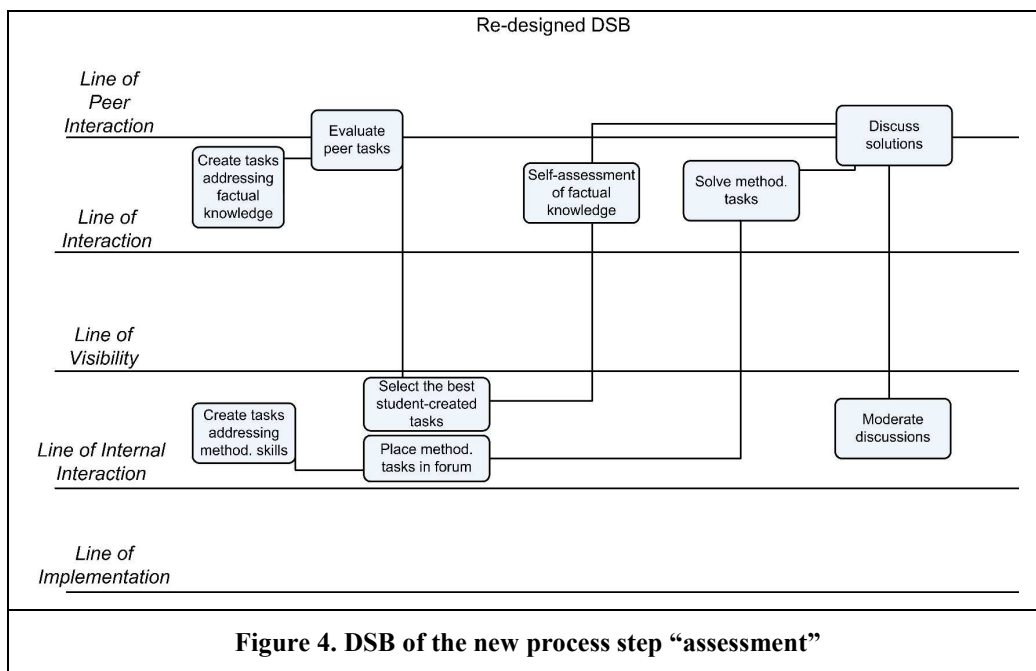


Figure 4. DSB of the new process step “assessment”

Similar to the lecture, we also *re-designed the tutorials* with regard to methodological variety and a higher level of peer interaction. Therefore, we analyzed the amount of activities conducted by the graduate assistants and the students and shifted more activities towards the students. Our measures were distributed over three semesters in order to be able to evaluate and refine them (Table 3).

Table 3. Overview of measures and terms	
Term	Measures taken to enhance learning service quality
WT 09/10	Introduction of student-generated Web Based Trainings
WT 10/11	Raising interaction through in-class assignments on mobile devices
WT 11/12	Offering new assessment tools: <ul style="list-style-type: none"> <li>• Weekly interactive multiple-choice self-assessment based on student-generated items</li> <li>• Moderated forum for solving more complex tasks mutually</li> </ul> Re-design of tutorials with more peer interaction activities

## Evaluation

To draw conclusions about DSB, we evaluated the method's product, i.e., the learning service by measuring students' satisfaction and learning outcomes. Satisfaction was measured by a questionnaire and learning by a power-test. Both were conducted online and independent from each other at the end of the semester before the exam. As participation was voluntary, the number of participants for both the questionnaire (Table 4) and the power test (Table 5) differs. In creating the questionnaire, we followed traditional dimensions of learner satisfaction proposed by Cohen (1981). "Overall" is the main dimension that refers to general satisfaction compared to other courses. "Structure" contains items with regard to course content and clarity, e.g., transparency of expectations towards the students. The instructor himself is measured through "skill" and "rapport." Skill refers to his factual expertise and preparation. Rapport describes the extent to which students perceive the instructor as being pleasant and attainable outside of the classroom. "Difficulty" refers to the overall difficulty of the course and the students' perceived relation between the amount of learning content and the necessary effort and available time. "Interaction" describes perceived overall interaction as well as one's own engagement and interest in the course.

	Term	WT 08/09	WT 09/10	WT 10/11	WT 11/12
		Mean (n = 106)	Mean (n = 72)	Mean (n = 128)	Mean (n = 83)
Overall	General course satisfaction*	2.65	2.57	2.38	2.25
	Comparison to other courses*	2.77	2.65	2.41	2.19
	Course innovativeness*	2.31	2.11	1.88	1.78
	Recommendation of course*	2.57	2.40	2.37	1.96
Structure	Overall structure*	2.47	2.22	1.98	1.81
	Course content*	2.92	2.83	2.70	2.60
	Practical relevance	2.49	2.49	2.50	2.63
	Learning Materials*	2.36	2.13	1.98	1.80
	Transparency of expectations	2.62	2.89	2.43	2.63
Instructor Skill	Instructor overall*	2.48	2.21	2.07	1.75
	Expertise*	1.30	1.19	1.20	1.12
	Explanations provided*	2.19	1.90	1.80	1.59
	Preparation for lecture	1.44	1.36	1.37	1.31
	Answering student questions	1.94	1.74	1.73	1.66
Instructor Rapport	Enthusiasm*	2.84	2.51	2.16	2.11
	Raising interest for topics*	2.84	2.47	2.23	2.17
	Pleasance*	2.40	2.24	2.15	1.80
	Attainability	2.15	2.17	2.25	1.92
Difficulty	General course difficulty	3.20	3.39	3.23	3.22
	Ratio content / effort	3.32	3.58	3.28	3.24
	Ratio content / time available	3.51	3.42	3.44	3.33
Interaction	General course interaction*	2.51	2.35	2.13	1.82
	Own effort invested in course*	2.42	2.29	2.36	1.98
	Own participation	2.28	2.60	2.65	2.18
	Interest in course topics	2.76	2.69	2.80	2.57
	Course raises interest*	3.06	2.90	2.80	2.58

\* difference of mean between WT 08/09 and WT 11/12 significant at level  $p < .05$

All items were rated on a Likert scale ranging from 1 (full agreement) to 5 (no agreement). The questionnaire was available online for several days before the exam. Participation was anonymous and voluntary. Each of the constructs we measured consisted of three to five items. Cronbachs alpha was computed using SPSS and was between 0.70 and 0.88 for all dimensions. Thus, reliability of all constructs can be assumed to be at least acceptable and mostly good. As this is a long term research project, our focus rests on the comparison between the initial semester, WT 08/09, and the final one, WT 11/12. A Kruskal-Wallis test was conducted to check whether any differences between the mean values of these terms were significant (Table 4).

The table reveals that several items increased significantly from WT 08/09 to WT 11/12. The most important is surely the general course satisfaction that was raised by 0.4 points. Satisfaction with course structure and learning materials increased on a similar level (0.66 and 0.56). Also, perceived interaction increased by 0.69 points. These increases indicate that the lecture was perceived as much more satisfying after we implemented our measures. None of the items decreased in a significant way. Taking into account that 3.0 would be a medium rating, most results can be considered generally positive. However, there are some aspects of the lecture that students did rate slightly negative, i.e., the course difficulty as well as the amount of content compared to effort and time available. This suggests that the course is generally perceived as being more difficult and demanding than other courses. What is also striking is the fact that the rating of the instructor increased by 0.73 points. This might hint at the instructor’s individual learning curve in conducting the lecture.

To measure learning outcomes, we used an online power test (multiple-choice). Power tests are a suitable way to measure cognitive learning outcomes (Kraiger, et al., 1993). This multiple-choice-test originally consisted of 20 items created by two instructors. The items were designed to cover all of the course’s learning goals equally. Since some of the learning goals changed over time, two items were removed. Two further items were answered correctly by more than 80 percent of the students and thus were removed for being too easy. The presented results refer to a total of 16 items. The test was offered online for three days before the exam, and participation was voluntary. The test was first introduced in this way in WT 2010/11, and thus only two semesters can be compared. With the results from these, a split-half analysis was conducted in SPSS revealing a moderate Spearman-Brown coefficient of 0.71. The mean scores from both power tests are 6.62 out of 16 in WT 2010/11 and 8.21 in WT 2011/12 (Table 5), which is a significant increase by 1.59 points, as revealed by a Mann-Whitney-U test. This indicates that the measures we took in WT 11/12 had a positive impact on student learning. This would not be surprising, as in WT 11/12 we offered new ways of assessment which should be suitable to help students prepare for the exam.

<b>Term</b>	<b>Mean Score*</b>	<b>N</b>	<b>Standard Deviation</b>
WT 10/11	6.62	248	3.208
WT 11/12	8.21	156	3.292
* significant at level $p < .05$			

Unfortunately, as power tests were introduced in WT 10/11, we cannot compare the results to semesters before WT 10/11. This limits our ability to draw conclusion on our measures. To evaluate the measures from WT 09/10 and 10/11, we can refer to the questionnaire results which show increases in categories like overall satisfaction, satisfaction with learning materials and perceived interactivity in these semesters. As this does not necessarily mean that learning success increased as well, we would also like to refer to a pre-study that completely focused on the student-created WBTs. In that study a significant correlation between usage of the WBTs and learning success as measured by the power test in WT 10/11 could be proven (Wegener and Leimeister, 2012). While this additional and specific evaluation is out of the scope of this paper, it was another early indicator that the new process of material creation was working.

## Discussion of Results

This case shows that the DSB method can continuously be applied to derive a solution design for IT-supported educational large scale services. Overall, our experiences to date reveal that DSB is reasonable, and depict the potentials and possibilities that the method can offer to the design of mass lectures. Although we have applied the method over the course of several semesters, a limitation is that the Action Research project is still ongoing, which might lead to further adjustments of the method as well as the lecture. The novelty of our method is that it integrates service engineering thinking in the design of educational services, an area which has, thus far, been dominated by didactical thinking only. DSB provides a bridge between efficiency oriented thinking for service design and provision, and didactical theory. Additionally, DSB provides principles that inform design. Design is a creative procedure which can be informed by principles and patterns that guide the engineer in deriving new solutions (Alexander 1973; Schermann et al. 2009).

As for the outcome of DSB, the re-designed course, the main goal of our measures was to increase interactivity, the quality of learning materials and accordingly overall satisfaction and learning success. With regard to interactivity and satisfaction, the results of the questionnaire suggest that we accomplished our goals. All in all, the students' rating increased over the course of the semesters. While we cannot clearly distinguish between possible effects of our different measures, we can conclude that the measures altogether had a positive impact on students' satisfaction. In this context, it is also notable that most aspects that we did not target with our measures, e.g., the course difficulty or attainability of the instructor, do not differ significantly. This indicates that the improvements stated before indeed result from our measures and not from some external uncontrolled influences. The rating of the instructor is an exception, as his overall rating increased drastically, which was probably caused by his individual learning curve over time. As a limitation of our research, we have to take into account that this factor may have also influenced the overall satisfaction rating.

An interesting fact is that the perceived effort students put into the course significantly increased, especially in those semesters when new learning materials were being introduced. This might indicate that usage of the additional learning materials also led to more effort for the students. The additional effort might also be one reason for possible increases in learning success. Another striking fact is that perceived own participation decreased during WT 2009/10 and 2010/11. One possible reason might be that, due to different learning materials and the live stream, students missed out on some of the face-to-face lectures, thus perceiving that they had participated less in class than they could have. It increased again during the last WT. A possible reason for this increase is the re-designed tutorials which supposedly were much more engaging than those used previously, but this is conjecture.

With regard to actual learning success, we can conclude only that students performed significantly better in WT 11/12 than in the previous semester. However, the clear increase in overall satisfaction is also a weak indicator for a possibly higher learning success, as satisfaction and learning success are often correlated to some extent (Eom, et al., 2006). This, however, is still a much discussed question. Overall, the measures taken indicate that we have improved our learning service significantly.

Taking a look at the necessary resources, both the in-class assignments and the learner-created self-assessment do not demand much additional effort. To start a poll, the instructor needs only to enter multiple-choice items. The peer assessment activity is completely conducted by the students without any input by the instructor. Choosing the best items to upload to the LMS is a task performed once a week and takes only a few minutes. The most resource demanding task is the forum which is moderated once a week for about an hour. The graduate assistants post comments or answers on an irregular basis. These efforts, however, are reasonable, since all actions can be conducted in a fixed time span.

## Conclusion, Limitations and Outlook

In this paper we presented the DSB method to analyze and re-design learning services, especially large scale lectures, with reasonable resources. We summarized key requirements for successful learning services and common problems in large scale lectures. We then developed several principles to guide the process of re-design. We applied these principles to a large scale IS lecture and evaluated the resulting lecture with regard to learning success and satisfaction. Results indicate that after each iteration, the re-

designed learning service achieved a higher quality. Still, the results are subject to several limitations. We evaluated the outcome of our DSB method, i.e., the course as a whole. These results do not necessarily prove the quality of the method itself. Any improvements in service quality may result from the different concepts we developed, not necessarily from the overall method. Second, since this is an Action Research project, different external factors might have flawed the data, e.g., differences between the students, slightly changed contents of the course, etc. Third, we tested DSB in only one setting, an IS course at a German university. Thus, results are not necessarily adaptable to other target groups.

Despite these shortcomings, the results do indicate that the method worked for our case. Thus, we will refine it further during the next semesters and will also use it to improve other lectures. Currently, there is still not much incentive for students to sustain their learning. Instead, we perceive that many students tend to learn mostly during the last weeks of the semester when the date of the exam approaches. Thus, we will have to find ways to keep students more engaged throughout the whole semester. There is also still much potential left for further peer activities, especially outside the classroom. We want to expand the forum to a real Virtual Learning Community, but we will need tools to help instructors supervise the community or individual learning groups. We anticipate that this may be one of the core design tasks in our research project for the near future.

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