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MANAGING THE MASSES – DEVELOPING AN EDUCATIONAL DASHBOARD FOR LECTURERS IN LARGE-SCALE LECTURES

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Abstract

The article presents a method to the development of a dashboard for large-scale lectures (more than 100 students) based on information derived from educational IT-applications, which play an increasingly important role in the field of university education. Via mobile devices, IT-applications enable students to interact with lecturers as well as their fellow students in large-scale settings, e.g. forum or chat. From a service perspective, lectures can be enhanced by the real-time provision of relevant and useful data. However, data created by the use of IT applications is not yet systematically used to support lecturers' tasks, i.e,. by providing contents in a well-defined course setting. Feedback comes in the guise of information gathered through the adoption of said devices, e.g,. on what students have understood and which students are intellectually engaged. We are thus in the process of developing a dashboard, which collects information during the lectures to support lecturers' increasing interaction. We collected design requirements based on experts' testimonials and relevant literature. These have led to a mock-up which we designed according to literature and expert requirements. We introduce our planned steps to validate the proposed design guidelines through the implementation and evaluation of a proof-of-concept prototype dashboard.

Keywords: dashboard design, interaction, task technology fit, large-scale lectures

1 Introduction

Universities in Germany face increasing numbers of students, especially due to the situation of double graduation classes in recent years. Rising numbers of learners in the auditorium and an unfavourable lecturer-students-ratio up to 100 students per lecturer are quite common situation at German universities (Schallert, Budka et al., 2008; Leidenfrost, Strassnig et al., 2009). Such large-scale lectures are characterized by pronounced anonymity and suffer from a lack of social exchange between the students and the lecturer. Results are insufficient learning outcomes and unsatisfied students.

Nevertheless, social exchange has a positive effect on the learning outcome and positively affects learners´ and lecturers´ course satisfaction (Moore, Masterson et al., 1996). By being actively engaged in the learning process, students will get a deeper understanding of the content (Evans and Gibbons, 2007). To ensure the engagement of the students, the lecturer has to adapt the educational service and react to a broad variety of possible situations (i.e. situations specific to the learner and the learning content) during classes in order to improve the service delivery (Wegener, Bitzer et al., 2011). The usage of IT allows communication in large-scale lectures, which heretofore was impossible due to the adverse circumstances of large-scale lectures, and enhances the social exchange between learners and lecturers. Thereby, IT can facilitate the lecturers´ task as IT data helps to arrive at a more appropriate solution in a certain situation (Arunachalam and Daly, 1996). IT enables lecturers to collect students´ information, not only demographic data, but also data which helps the lecturer to intervene in the learning/teaching arrangement. Since the data collection is getting complex very quickly, a systematic and centralised use of the data seems to be reasonable; hence this study puts forth a method to develop a dashboard to identify and use IT data, which helps to increase the interaction in large-scale lectures. Considering scientific results and lecturers' requirements, we develop a proof-of-concept dashboard prototype.

The paper is structured as follows: We first introduce performance dashboards and ways to design and display information in a dashboard. Then we present our design concept and theoretical foundation. The following describes the specification of our method, and then we introduce the application of our mock-up. Finally we explain the next steps for the evaluation of the proof-of-concept prototype.

2 Related Work and Problem Awareness

Eckerson (2011) states that a performance dashboard "enables organizations to measure, monitor, and manage business performance more effectively". He describes a performance dashboard as a full-fledged business information system, which has a business intelligence and data integration infrastructure as a basis.

Although dashboards seem to be highly accepted and widely used in companies all over the world, there is not much research conducted on the systematic dashboard development. (Yigitbasioglu and Velcu, 2011) stated that there are abundant textbooks and articles on dashboards in the business press (eg. (Few, 2006); (Kawamoto T. and B., 2007)). Nevertheless, only a handful of studies can be found in academic journals (DeBusk, Brown et al., 2003; Pauwels, Ambler et al., 2009; Yigitbasioglu and Velcu, 2011).

Overall,(O'Donnell and David, 2000) identified three general perspectives which can be considered relevant from a dashboard design perspective (Yigitbasioglu and Velcu, 2011): 1.) feedback given by information systems 2.) type of presentation format being used and 3.) the amount of information load. The level of necessary interaction and feedback is determined by the task the user has to fulfill (Goodhue and Thompson, 1995). It comprises the information which is displayed as well as the frequency of information provision. This also includes graphical aspects (Vessey, 1991) and the amount of information presented to the user (O'Donnell and David, 2000).

So far, we could identify one method for a systematic dashboard development. Unfortunately, the method considers perspectives mentioned above inadequately. The method by (Pauwels, Ambler et al., 2009) consists of five stages on the dashboard development in a business context, with a strong focus on the information in the dashboard. One can argue that this exclusive focus on the information included in the dashboard considers user tasks implicitly. However, neither (Pauwels, Ambler et al., 2009) nor others (e.g. (DeBusk, Brown et al., 2003; Wind, 2005) have addressed specific representation or information load issues in their research. Since these aspects significantly determine the success of the dashboard (Yigitbasioglu and Velcu, 2011), current methods lack a consideration of relevant aspects of dashboard design.

To sum up, the challenge of dashboard design is to deal with highly context-relevant design requirements. First and foremost, the specific data which fits the requirements of the task has to be identified. Furthermore, the representation of that data has to be designed, depending on the characteristics of the task and the specific user requirements. In addition, the information load has to be balanced, influenced by the complexity of the task and the usability of the dashboard.

Therefore, we present a method for dashboard design in the context of large-scale lectures, considering requirements of users for their specific task, the characteristics of learning services and technological possibilities created by the increasing use of IT in German universities.

3 Design Rationale and Conceptual Framework

Grounding IS-design in existing research increases the inter-subjectivity of design artifacts (Walls, Widmeyer, & Al., 1992). Design research can be considered as prescriptive research which aims to improve IT performance (Simon, 1981). The goal of design science research is "to develop technology-based solutions to important and relevant business problems" (Hevner, March et al., 2004). Within the design process there are two main tasks: 1.) develop / build, i.e. the development of theories and the building of artifacts and 2.) justify / evaluate, i.e. proving the initial theories or originally built artifacts using various methods (March and Smith, 1995). They stated further that the design process results in four possible types of artifacts, constructs, models, methods or instantiations.

In the present case we are developing a dashboard design method which helps to rectify the lack of interaction in large-scale lectures. (March and Smith, 1995) defined a method as a "set of steps (an algorithm or guideline) used to perform a task." Furthermore, the design rationale is determined by the task-technology fit by (Goodhue and Thompson, 1995). They postulated that performance impacts of IS artefacts are determined by the fit between task and technology characteristics.

Within the task-technology fit the task describes an action which is performed to transform inputs into outputs. The primary focus of tasks is on comparisons or identification of trends or totals (Yigitbasioglu and Velcu 2011). Tasks can be split into spatial and symbolic tasks.(Goodhue and Thompson, 1995) stated that spatial information design is well suited for tasks that require identifying and understanding relationships and for making comparisons. Representing information in a table reflects a symbolic task which is more adequate for tasks that require the extraction of specific values and combining them into an overall judgement (Vessey, 1991; Vessey and Galletta, 1991; Umanath and Vessey, 1994). Furthermore, (Goodhue and Thompson, 1995) defined technology as parts of computer systems (hardware, software, and the data) provided to assist users in their tasks. The technology characteristics are determined by functional features, e.g. the representation type (graph vs. tables) or presentation format flexibility, and visual features, e.g. use of a single page for the dashboard or sparing use of colours (Yigitbasioglu and Velcu, 2011).

Overall, the challenge is to systematically design dashboards which fit to user tasks in terms of information load, presentation format and functional features. More specific, in the present case, design aspects have to be derived from the large-scale lecturer's requirements.

4 Specification of the Method

According to Pauwels et al., the first step to design a dashboard is to *identify the right dashboard information* (Pauwels, Ambler et al., 2009). As the supported task is complex, the consideration of domain knowledge is very important (Khatri, Vessey et al., 2006). Hence, we extend Pauwels' method in the first stage. Since the collection of information about the interaction between user and dashboard, as well as the exact data representation is important for the use of the dashboard (O'Donnell and David, 2000; Yigitbasioglu and Velcu, 2011), we integrated those perspectives into our method.

Stage two according to Pauwels et al. is to *populate the dashboard* with data. It can be realized by using currently available or combining existing metrics. Populating the dashboard is anything but trivial (Pauwels, Ambler et al., 2009), nevertheless information gathered in stage one has to be used to integrate the data in a user-friendly and task-adequate way. After the dashboard prototype has been developed, the evaluation marks the end of this stage.

In the third stage the *relationship between the dashboard items* will be realized to get a deeper knowledge of the field of application and to develop the dashboard into a decision-support system (Pauwels, Ambler et al., 2009).

In the following stage, *forecasting and scenarios,* the dashboard model is used to plan scenarios and budget settings (Pauwels, Ambler et al., 2009). In the case of our educational dashboard method the lecturer is supposed to collect and construct-information on students' learning behaviour to analyse specific instructions during and after the lesson.

The fifth and last stage according to Pauwels et al. is the *connection to financial consequences,* and it is presented with business-related information. This state is transferred into connection to learning outcomes. The evaluation might be quite challenging in an university context.

Stages	**Basic method (Pauwels, Ambler et al., 2009)**	**Extensions / changes in the lecturers' dashboard method**
1	Identify the right dashboard information	Identifying dashboard information, including dashboard items, visual and functional aspects
2	Populate the dashboard	Populating the dashboard with information, including prototype development, evaluation and implementation
3	Relationship between the dashboard items	Analysing relationships between the items, including iterative improvement of the dashboard items considering the user task
4	Forecasting and scenarios	Data usage to connect data on items to specific actions and reactions
5	Connection to financial consequences	Connection to learning outcomes

Table 1. Comparison of the stages of dashboard development method

5 Application of the Method

The first stage of the method includes the identification of relevant dashboard information for the lecturers' task. Hence, the first step was to define the lecturer's task in a manner which could help to define the most appropriate dashboard items. Afterwards, considering the design perspectives of (O'Donnell and David, 2000), three questions were examined: 1.) Which kind of information do we need? (feedback), 2.) What kind of design do we want? (presentation format) and 3.) How much information can we handle? (information load). Therefore, we initiated a workshop with eight lecturers with experience in large-scale lectures. This workshop was based on research results on focus group design (Greenbaum, 1998).

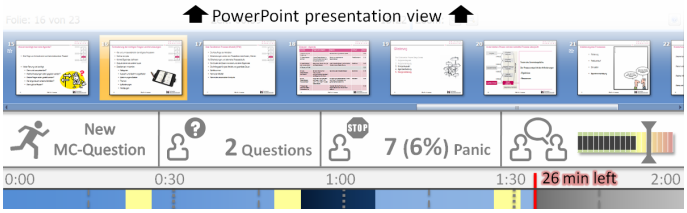
In teaching settings it is the lecturers´ task to impart knowledge to the learners. Drave (2000) stated that interaction is more essential than the content for the knowledge transfer. Learning is described as an interactive group process in which the participants actively construct knowledge and extent the knowledge through the exchange of ideas among themselves (Richardson, Swan 2003). Interaction in teachings scenarios is an essential fact not only for the satisfaction of learners and lecturers but also for learning success (Alonso et al. 2009, Hardless et al. 2005). (Evans and Gibbons, 2007) show that interaction increases the depth of learning and comprehension. However, interaction itself is synonymous with learning activities including exchange between learners and lecturer (Moore, 1989; Schrum and Berge, 1997). Defining the task accordingly, the workshop participants decided to focus on a certain aspect of their task, the lack of interaction in their large-scale lectures.

The workshop participants identified relevant dashboard items, discussing the most relevant and decided on a total amount of five items. Furthermore, the participants defined them in terms of their objective, their function within the lecture and their design. Table 2 shows a detailed presentation of the five dashboard information items as result of our focus group workshop.

Name	Objective	Function	Design
Panic Button	Immediate feedback when someone is not understanding content	Students can press a button which gives a signal to the lecturer	The panic button is integrated into the students application set
Noise Indicator	Automated feedback on the noise level within the class room	Microphone records the noise level in the classroom	A graph shows a normalized development of the noise level during the lecture.
Anonymous Questions	Collecting anonymous questions, which can be answered by the lecturer right away	Students can enter a text within their application set, which will be send to the lecturer right away	A red icon is flashes when students have questions; they will be collected in a separate window at the dashboard.
Multiple-Choice-Questions	Empowering the lecturer ask and analyze MC-Questions	Lecturer can test the understanding right away and activate students	The button is located in the dashboard and allows the lecturer to pose questions which will be visible on the students application set.
Time bar	Structuring the lecture	Shows possible timeslots for activating elements to improve students interaction	The time bar displays various, coloured pre-defined sections of the lecture and elapsed time.

Table 2. Summarized presentation of the information for the lecturer dashboard.

The second stage of our method contains the population of the dashboard. The workshop results showed that lecturers prefer to obtain all relevant information for the lecture on a single screen. Thus we added the presentation slides and the additional information around the slides into the lecturer dashboard. In this way the lecturer is still able to view and control the presentation and use his notes but is furthermore able to monitor the information about the current setting.



Picture 1: Mockup screenshot

Based on Olivia et al. (2004) a clear and simple design for a mock-up of the dashboard was chosen to reduce non-data pixels and visual complexity. Each piece of dashboard information was depicted in its

own area and characterised by a simple, recognizable and distinguishable symbol. To keep the design simple only basic information is represented on the dashboard. The lecturer can access additional information by pointing at the area of the metric as suggested by Few (2006). The lecturer can determine boundaries for the metrics. When one or more metrics exceed the predefined boundaries, the symbol of the metric is highlighted in red to alert the lecturer, as suggested by Yigitbasioglu and Velcu (2011).

Since, our paper represents a research in progress, we cannot at this point report any findings for the other stages. However, the evaluation of the mock-up can be considered as the next logical step and might help to evaluate the usefulness of the method so far.

6 First Evaluation and Outlook

Design science research mandates that the intended (and unintended) impact of the design artefact needs to be scientifically evaluated to show utility, quality and efficacy (Hevner et al. 2004). Therefore, the following value proposition is made:

The use of the artefact supports the development of dashboards in the context of large-scale lectures. Therefore (1) it is helpful to increase interaction in the large-scale setting, i.e. interaction between students and lecturers, and (2) it enhances learning success and student satisfaction.

We chose a cross-examination approach to double-check our results in terms of the developed IT-tool (dashboard) and the process which led to the tool (dashboard development method). In total, eight lecturers will evaluate the artefact after the introduction of the tool. First of all, since the dashboard introduction is critical in terms of the acceptance of the lecturer and the technological infrastructure, we can only evaluate a few settings in the university context which will use the lecturer's cockpit. So far, we expect that the dashboard will be used in eight large-scale lectures, with attendance ranging between 150 and 250 students. For this reason, we chose a descriptive evaluation method, i.e. qualitative interviews in a field study setting for a proof-of-concept. (Zelkowitz and Wallace, 1998) classify this as an observational method to validate technology. Based on a semi-structured interview, we are interviewing dashboard users about task-technology fit, considering feedback, presentation format and information load. Four of the lectures cover business administration content, two cover juridical topics and two linguistic topics. Additionally, we are conducting guided interviews with subject-matter experts about the different stages and contents (Ahlemann and Gastl, 2007). We intend to ask the lecturers on the activity set for each stage, including task and technology development. To this end a prototype will be developed and evaluated in various large-scale lectures by eight lecturers. Finally, we are conducting an empirical study on the perceived interaction before and after the introduction of the dashboard. This will be tested with around 150 students of a large-scale lecture in an introductory information systems course.

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