HCI Strategies for Informing the Design of a Teacher Dashboard: How Might Real-Time Situational Data Determine the Potential for technological Support in the Classroom?

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Abstract. As AI Technologies become more prevalent in the classroom, there has been an increased interest in teacher dashboards in fields such as computer science and the learning sciences. While extensive research has highlighted potential metrics of interest for teacher dashboards, little work has prioritized the interactivity of the teacher and dashboard in conjunction with students and other responsibilities. There is little knowledge of educators' availability to pay attention to a dashboard when working with students, often under time constraints and various levels of stress. Accordingly, there is a need for stronger HCI research integration during the design and development of teacher dashboards. Specific methods targeted at end-user experiences can inform and validate future iterations by defining what navigation and information teachers consistently utilize based on their priorities in the classroom. To bridge the gap between an ideal dashboard and ideal teacher-dashboard integration, the aim of this research was to design a 1 button, simplified dashboard that seeks the answers to questions best answered in real-time, in-situ contexts, such as when a teacher needs or wants assistance. Dashboard-Zero is a simple and customizable model of a teacher dashboard, inspired by the Staples "easy" big red button, that acts as an input device for gathering situational data to frame the user story during design and development of the teacher dashboard. The goal of Dashboard-Zero is to supplement and validate surveys and interviews at early stages of design.

Keywords: HCI, teacher dashboard, storytelling, UX design, UX research, co-design, Dashboard-Zero.

1 Introduction

The direction towards AI has, at this point, grabbed the attention of all fields, from the social sciences to STEM to fine arts. This is no less true for the learning sciences. Based on the rising standards for STEM education in primary and secondary schools, it is becoming increasingly difficult for educators to meet these growing expectations while maintaining an effective learning environment. There is a need for technological support for teachers in scaffolding their students in STEM practices [4].

Teacher dashboards for facilitating learning in the classroom have been extensively researched for decades [12]. There are a number of possible dashboard metrics that can support teacher orchestration, such as status of on and off task discussion, task progress, and task completion for individual, group, and whole class settings. By co-designing with partnering schools and teachers, researchers in the computer sciences and learning sciences have included the end-user in each step of the design process [7]. With the intention of being teacher-centric at all stages of dashboard design, researchers have strategized interviews and surveys based on each iteration of the interface designs [9]. They have used these interviews and surveys to inform the metrics to measure for display, as well as the visual components displaying said metrics. However, there are limitations to relying only on survey and interview data during dashboard design.

Although extensive research has highlighted potential metrics of interest for teacher dashboards, little work has prioritized the interactivity of the teacher and dashboard in conjunction with students and other responsibilities. There is a lack of research considering educators' ability to pay attention to a dashboard while attending to the intensive tasks involved with classroom orchestration. There is a need for stronger HCI research integration during the design and development of teacher dashboards that takes these time pressures and task complexities into account. Specific methods targeted at end-user experiences can inform and validate future iterations by defining what navigation and information teachers consistently utilize based on their priorities in the classroom. To bridge the gap between an ideal dashboard and ideal teacher-dashboard integration, the aim of this research is to design a 1 button, simplified dashboard that seeks the answers to questions best answered in real-time, in-situ contexts, such as when a teacher needs or wants assistance. 'Dashboard-Zero' is a simple and customizable model of a teacher dashboard, inspired by the Staples "easy" big red button, that acts as an input device for gathering situational data to frame the user story during design and development of the teacher dashboard. The goal of Dashboard-Zero is to supplement and validate surveys and interviews at early stages of design.

2 Background and Literature Review

2.1 Lack of HCI Integration in Early Stages of Design

The data informing the direction of a design and development of a product should be the foundation on which every piece stands. Ez-Zaouia [5] has defined a process framework by which teacher dashboard design should be followed. It encompasses four iterative steps: (1) Situate, (2) Ideate, (3) Develop, and (4) Evaluate. The first step, Situate, is where the research for this paper is focused. It states the importance surrounding the phenomena that goes into building a digital or physical artifact. It describes the situations and stories that make up the domain space. It is these stories that inform the rest of the process. Hence, initial research lays the foundation on which the teacher dashboards are built. The data and analysis of dashboards are crucial, and must be explored from various perspectives, with every detail in mind.

User interviews and surveys should be expanded on for several reasons. The questions asked of interviewees must be strategically written and ordered without bias or a push towards a specific answer. Researchers may subconsciously be prone to priming teachers to answer questions in a way that already aligns with their vision or expectations [8]. As humans, bias is almost impossible to avoid. Teachers, as well, must put themselves in a position to honestly answer each question, which is a challenge. The way they interpret each question is influenced by many external factors, such as their mood or a recent experience that came to mind. To avoid human error, researchers' questions would best be answered in real-time, when the situation is current, and the answer is instinctual. There is great potential for integrating technology in order to collect real-time data for dashboard design.

2.2 Methods of Early Design in HCI

When it comes to designing the user experience of a teacher dashboard, much of the work is done before development begins, in the Situate stage [5]. According to Ez-Zaouia [5], this stage includes the phenomena surrounding the situation relevant to the product, such as facts, tasks, activities, and values. The process begins with figuring out the users' needs, then understanding where the product fits into their "story." This story is the key to understanding the big picture, and informs further design, development, and implementation of the user experience. In the design of teacher dashboards, the teacher's story should be at the forefront of every decision. Interdisciplinary research, especially, can benefit from the utilization of storytelling as a basis for understanding the user as well as in building credibility for the design [1]. Uncovering the user's needs followed by a detailed user story informs the user flow, metrics, and navigation of the dashboard. This includes initial interviews as well as outside research on what has been done, what has worked, and what has not. The pursuit of the user's story is crucial for a successful design.

2.3 Storytelling as a Means for Informing Design

A story involves true human attributes, emotions, and processes in the design of a product. It helps to hold the designers and researchers accountable for creating a product for "human." A story paints a picture that helps to inform how and where the product fits in, not vice versa. The details used in crafting user stories are very important and should be backed up by valid, unbiased data. Surveys and initial user interviews do not hold strong enough data to inform an entire technological system. They induce biases, rhetorical situations, and are informed by external measures. Predicting future actions involves making guesses which can cause errors in judgment [8]. Survey and interview data have a high chance of being skewed. They are not uninformative or useless, however. There is a need for further initial user research that supplements and validates interviews and surveys. By asking questions in the form of in-situ prompts, interviewees answer questions instinctively, without a push towards a specific answer or idealized situation. It is more reliable and realistic; this is where Dashboard-Zero is useful.

2.4 Related Work

BROMP. The Baker Rodrigo Ocumpaugh Monitoring Protocol (BROMP) 2.0 is a method for gathering quantitative student-affect data in order to obtain ground truth labels for Educational Data Mining research [10]. Trained researchers individually assess each student in real time and determine their engagement or affect with a momentary time sampling method. This means that the student's engagement is recorded for every twenty seconds of an activity [2]. BROMP supports automated intervention and teacher reporting as well as data-mining models used to inform constructs.

Similar to BROMP, Dashboard-Zero is a method for gathering quantitative data in real-time. Its extensive use has proven the need for gathering data in-situ. The design, like Dashboard-Zero, seeks to determine the user's states holistically with great attention to detail. While BROMP requires extensive training and certification on the coded model for researchers to determine student emotions, Dashboard-Zero allows the user (teacher) to answer based on a single prompt. The proven track record of BROMP suggests the need for a holistic approach to real-time quantitative data gathering.

Lumilo Co-Design Case Study. In this case study, the LATUX workflow was used for the co-design and development of Lumilo, a real-time wearable learning analytics tool for teachers working in AI-supported classrooms [7]. The LATUX workflow was a set of phases that each encompassed a unique research methodology to inform the design of Lumilo. The designers of Lumilo believed that the co-design of Learning Analytics (LA) technology needed to include stakeholders from the very beginning. Including users after a first prototype was already too late; by then the pedagogical goals had already been decided on [7, 11]. This is a principle Dashboard-Zero was designed for, as well.

Like Dashboard-Zero, LATUX emphasizes the importance of storytelling to inform design. Early in the co-design process, methods for directed storytelling helped to shape the goals of Lumilo before its inception. They also included various design activities such as card sorting and semi-structured interviews with teachers [7]. Dashboard-Zero recognizes the importance of the early design stages, and seeks to accomplish what LATUX did for Lumilo in a real-time, efficient manner.

3 Inspiration Behind Dashboard-Zero

Storytelling is a key element to building a robust design. However, past and current methods of producing these stories are not meeting the standards they could be. Dashboard-Zero has the potential to amplify the outcomes of initial user-oriented design by backing theories with more detail-oriented and unbiased data. It presents questions in the form of simple prompts, allowing the users to build their stories. Before describing Dashboard-Zero, we first describe the inspiration behind the design.

3.1 Inspiration for Design

Researchers from the University of Wisconsin at Madison in conjunction with other Universities in the NSF AI Institute on Student-AI Teaming conducted a participatory design study for a teacher dashboard based on interviews done with teachers in the Madison area in November of 2021. The inspiration for Dashboard-Zero came from the design process used to conduct this study [3]. The goal of the study was to identify key metrics to include as features in a teacher dashboard. To ensure relevant information was being displayed, researchers included teachers in their co-design through a set of interviews regarding a mid-fidelity prototype of potential interface options. The researchers followed a user-centered design approach to inform their design decisions. The Feigh et. al [6] Adaptive System Framework, based on the three AI processing states of sensing, assessing, and acting, framed their research questions. The acting state includes the user-interface, which is what the teacher interacts with. The interviews with teachers sought to discover what content to show, when to show it, who should see certain information, and how the information should be shown.

A navigable set of screens were reviewed by each teacher who participated in the study. Their review was followed by a set of questions regarding the who, what, when, and how framework. For example, to address the "when" question, teachers were asked "Would you use this information before, during, or after class?". While the teachers' responses were excellent for informing future iterations of the teacher dashboard design, the answers would have benefited from real-time data that includes the actual classroom context, versus only relying on rhetorical scenarios.

By having questions answered in real-time in classroom situations, a breadth of knowledge can be discovered related to the realities of the classroom in order to optimize the dashboard's user experience. By reducing the load of interview questions to a single factor, simplifying the way each question is answered, and having them answered in-situ, implementing Dashboard-Zero into the classrooms would have answered many of the interview questions while also accounting for contextual impacts of the classroom. Further, it would have provided a prompt for an unbiased real-time, situational answer.

Dashboard-Zero (iPad/tablet) could be given to each of the teachers before the school day with a prompt for clicking the button. To prove or discover the most important research question, "will a teacher dashboard be useful," the first prompt would have been, "Click every time you need more information regarding what is happening in each student group to move forward in the lesson efficiently." From there, supplemental interviews regarding the physicality of carrying a dashboard and what exactly teachers were experiencing each time they "clicked" would provide data to consider in the next steps of building the dashboard.

4 Dashboard-Zero

This paper proposes a method for gathering qualitative and quantitative situational data at early stages of design. With the goals of exploring the domain space from every angle, and of informing every detail of the design, the proposed method

incorporates a simple technology that supplements, validates, and potentially replaces early surveys and interviews in a co-design process. Dashboard-Zero is a one click input-only application that stores click counts and their timestamps as an indicator of a significant moment in a class period or time of day. It also acts as a placeholder for a future dashboard in terms of a physical handheld device as a "feeler" for teachers. Throughout the school day, teachers will click the button each time they find themselves in a particular situation (as specified by a prompt provided by the researchers). For instance, at a very early stage in design, the researcher may ask the teacher to "click when you wish you knew more about each group's progress but could not address all of them." This simple prompt informs further questions and decisions about the situations in which a group progress metric would be relevant, how often the situations arise, and why the situations should be explored in greater detail. On the other hand, another early prompt regarding the physical carrying of the tablet would be, "click each time this dashboard is distracting or taking away from your time with students." Throughout the design process, prompts can continue to be made more specific to answer sub questions and find overlapping data. If researchers noticed the teacher clicking frequently when students were doing group work at the beginning of a new lesson, the next prompt could, for example, be "click each time you are unsure of the specific parts of a new lesson to re-address for more student understanding." Prompts should be decided by researchers at every stage in order to best inform their research questions. To further investigate, recordings of class periods could be reviewed by researchers with the teacher in order to ask more about why they clicked when they did. Dashboard-Zero is useful in making the co-design process more efficient and detail-oriented by getting the internal state of each teacher involved. It builds the foundation for each user story vital to the design of a teacher dashboard. This paper proposes the design of Dashboard-Zero.

Dashboard-Zero is an intentionally limited dashboard for understanding teachers' thoughts and processes in the classroom domain. It informs a more robust design plan because it gathers honest feedback and data in real-time and in the correct context (in-situ). By reducing the load to a single factor, each research question can be explored in greater detail. Supplemented by classroom recordings, teachers are prompted to click a button each time they experience a specific emotion, situation, or challenge. With the in-situ data, researchers can go back and study the contexts surrounding each time the prompt was relevant as well as review the internal feelings with the teachers.

4.1 Technical Definition

Dashboard-Zero is a one-screen, one-button application that stores input "click" data. Each time the button is pressed, a timestamp is logged, and the count of "clicks" is increased by an increment of one. In the case of an accidental "click" there is an option to delete it in the interface immediately. Physically, Dashboard-Zero embodies the size and feel of carrying a dashboard around the classroom. It forces users to have it on hand and pay attention to it when relevant, which is essential to the embodiment of a teacher dashboard. Hence, Dashboard-Zero helps to answer physical implications of teachers having an extra artifact to pay attention to in a class period and throughout

the school day. For researchers, it gathers real-time data based on a prompt that answers questions to inform metrics and the situations in which they arise.

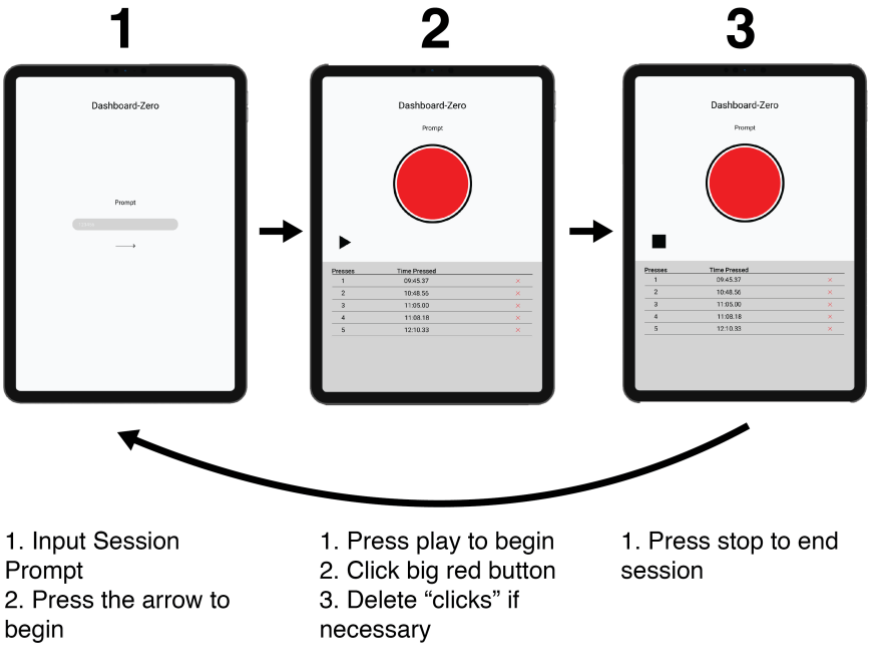

Fig. 1. The design of Dashboard-Zero was done in Figma, with the intent of passing on to a development team to incorporate into their research software. Above is the interface as seen by teachers while using it. This was intentionally designed as a very simple and customizable dashboard, so that research teams can adjust it to their needs

Depending on the research team, data will be logged in their system (Google Sheets is a simple option otherwise) automatically based on the prompt. Data will not include deleted “clicks.”

Data:

- Prompt
- Press count
- Time pressed

5 Limitations, Future Work, and Conclusion

Dashboard-Zero is limited in that it can only be used to its fullest potential if it is supplemented by classroom recordings. It does not take any microphone or video data of its own. Additionally, while there is a strong argument for the potential of Dashboard-Zero to be used in initial studies for teacher dashboard designs, there is a lack of "active" evidence of its benefit. Dashboard-Zero should soon be implemented into classrooms gathering data for an AI device that informs the metrics for the dashboard. These classroom sessions must be recorded, and Dashboard-Zero will act as a supplement for interpreting the data gathered, and framing the user story during dashboard design.

Dashboard-Zero also holds significant potential in other domains, such UX research for B2B and B2C applications. Exploration into how a single-red-button interface could be used in various testing scenarios, including UX research and design of IT solutions and interfaces (mobile or for web), has many opportunities in both academia and industry domains. The goal is to explore this theory further both in the teacher dashboard and other designs.

Teacher dashboard design holds strong ties to AI and learning science research. However, it lacks in HCI research. Creative HCI methods can help to inform the designs of teacher dashboards by building a strong foundation of user-experiences and user stories. This theory has been proven by extensive research using BROMP and the Lumilo case study. Dashboard-Zero provides a novel method for initial design practices and a new perspective on the integration of HCI research in the development of teacher dashboards and beyond.

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