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Learning Dashboards

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ABSTRACT: This article explores how information visualization techniques can be applied to learning analytics data to help teachers and students deal with the abundance of learner traces. We also investigate how the affordances of large interactive surfaces can facilitate a collaborative sense-making environment for multiple students and teachers to explore these learner traces together.

KEYWORDS: Learning analytics, data visualization, interactive surfaces, collaboration

1. MOTIVATION

Learning analytics can help researchers understand and optimize (human) learning and the environments in which it occurs (Siemens, & Long, 2011) by collecting relevant user traces and using these data for self-improvement. However, capturing learner traces scales up quickly and often generates an abundance of data that should be presented in a meaningful way for both teachers and students. Whereas educational data mining (Wolff, Zdrahal, Nikolov, & Pantucek, 2013) can be used to identify problematic students and send warnings to both teachers and students, this black box nature can lead to trust issues, and does not allow users to explore the data used to make decisions. In our research, we therefore investigate how information visualization techniques can be applied to allow both teachers and students to explore the data themselves in a meaningful and efficient way, while not overwhelming them.

2. THEORETICAL BACKGROUND

Visual dashboards present large amounts of data in a way that supports exploration by both teachers and learners (Verbert, Duval, Klerkx, & Govaerts, 2013). Existing learning dashboards present data such as artefacts produced, social interactions, resource usage, time spent, and exercise results (Verbert et al., 2014). These data can be presented in many ways (e.g., histograms, bubble charts, etc.) (Silius, Tervakari, & Kailanto, 2013). In practice, most dashboards consist of basic bar and line charts or scatterplots. A key research question in our work is to investigate more innovative visual representations that can help the user explore the large amount of data in an interactive way, presenting an overview combined with actionable information for self-improvement.

Furthermore, existing learning dashboards focus on medium-sized, desktop computer screens. Few cases are specifically designed for tablets (Martinez Maldonado, Kay, Yacef, & Schwendimann, 2012) or large displays. To the best of our knowledge, no examples exist of learning dashboards deployed on devices such as interactive tabletops and whiteboards. Our second research question is to investigate if and how we can use affordances of interactive surfaces to enable multiple students and teachers to explore the collected user data together, which in turn can lead to collaborative sense-making (Isenberg, Elmqvist, Scholtz, Cernea, Ma, & Hagen, 2011).

3. METHOD

Our methodology is a design-based or user-centred research (Wang & Hannafin, 2005; Gould & Lewis, 1985; Kelly, 2004). This methodology relies on 1) early focus on users, 2) empirical measurement via prototypes designed and implemented, and 3) iterative design. We evaluate our solutions following a user-centred rapid prototyping approach, where we rely on paper prototypes to gather initial feedback on early ideas and then gradually develop more functional digital prototypes in rapid iteration cycles. Prototypes have been deployed in realistic settings with real users such as inquiry-based learning environments, where students generate large amounts of artefacts (hypotheses, discussions, field data, etc.) and courses for engineering students at the KU Leuven.

Evaluations of each iteration consist of semi-structured interviews, activity tracking, live recording, and questionnaires to evaluate usability, importance of functionality, perceived motivation, awareness, usefulness, and effectiveness. Participants typically include expert users (i.e., researchers in the fields of learning analytics, information visualization, and human–computer interaction) and intended target users (teachers and students). On average, we included 22 students per evaluation between the ages of 20 to 25 who used our dashboards in a real course setting.

4. RESULTS

To tackle the question of visual representations that can help the user deal with the abundance of data, we looked at badges as an abstraction of the data, which help the awareness of important activities, course goals and the progress of students (Charleer, Klerkx, Odriozola, & Duval, 2013). By adding activity count visualizations, powerful filtering methods, and access to the actual content, teachers understand the class achievements and activities better (Charleer, Santos, Klerkx, & Duval, 2014b). The "overview first, zoom and filter, then details-on-demand" technique (Shneiderman, 1996) streamlines the workflow, presenting first an overview, visualizing both quantity of activity and social interactions between students. From this overview, the user can drill down to actual content (Charleer, Santos, Klerkx, & Duval, 2014a).

Results of our user studies indicate that presenting the data in a collaborative interactive setting, results in interesting discussions among students (Charleer, Klerkx, Odriozola, & Duval, 2013). In addition, the screen estate of large displays helps compare activity and achievements of students, and was considered valuable to discuss and evaluate class activities with both teachers and students (Charleer, Santos, Klerkx, & Duval, 2014b). Creating visual representations of learner traces that take advantage of the affordances of large interactive surfaces (e.g., multi-touch, multi-user interaction, screen estate) will present many new challenges, which we hope to tackle to create our collaborative sense-making environment for learning analytics data.

5. CONTRIBUTION TO LEARNING ANALTYICS

We have found that “zoom + context” visualizations can help deal with the abundance of learner traces. Using technology such as interactive tabletops and whiteboards, we can create a collaborative sense-making environment to support teachers, students, and researchers to explore and discuss the data. By supporting Tin Can API and proprietary APIs, our open-source dashboards will be freely available for anyone to deploy on most learning analytics datasets.

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