

# Understanding learning at a glance: An overview of learning dashboard studies

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## ABSTRACT

Research on learning dashboards aims to identify what data is meaningful to different stakeholders in education, and how data can be presented to support sense-making processes. This paper summarizes the main outcomes of a systematic literature review on learning dashboards, in the fields of Learning Analytics and Educational Data Mining. The query was run in five main academic databases and enriched with papers coming from GScholar, resulting in 346 papers out of which 55 were included in the final analysis. Our review distinguishes different kinds of research studies as well as different aspects of learning dashboards and their maturity in terms of evaluation. As the research field is still relatively young, many of the studies are exploratory and proof-of-concept. Among the main open issues and future lines of work in the area of learning dashboards, we identify the need for longitudinal research in authentic settings, as well as studies that systematically compare different dashboard design options.

## Categories and Subject Descriptors

K.3.1 [Computers and Education]: Computer Uses in Education; H.5.2 [Information interfaces and presentation]: User interfaces

## General Terms

learning analytics, educational data mining, information visualization, dashboards, systematic review

## 1. INTRODUCTION

Visual displays are critical to sense-making as humans can process large amounts of data if presented in meaningful ways. A current major challenge in the field of education is how data coming from learning platforms can be made actionable by analyzing and presenting it in ways meaningful to different stakeholders [4]. Learning dashboards build on

research in information visualization, learning analytics and educational data mining. Although these fields are still relatively young, their explosive growth already provides enough literature to justify a systematic review. Indeed, several reviews of learning dashboards already exist, although they only focus on small case studies and contrasting selected examples (see, for example [5]). Thus, this paper provides a systematic literature review of research on learning dashboards. The research questions addressed by this study are:

- *RQ1*: In which contexts are learning dashboards applied?
- *RQ2*: What are the characteristics of learning dashboards developed so far, including their purpose, indicators presented and technologies used?
- *RQ3*: How mature are such efforts on learning dashboards, in terms of their evaluation?

## 2. METHODOLOGY

When conducting the review (following the guidelines proposed by Kitchenham and Charters [2]), we selected five main academic databases relevant for Technology Enhanced Learning: ACM Digital Library, IEEE Xplore, Springer-Link, Science Direct, and Wiley. Google Scholar was also used in order to detect potentially relevant 'grey literature' (technical reports and other publications outside of classic academic publishing channels). The search string used was: *dashboard AND ("learning analytics" OR "educational data mining" OR "educational datamining")*. Hence, the review focuses specifically on *dashboards* ("a visual display of the most important information needed to achieve one or more objectives; consolidated and arranged on a single screen so the information can be monitored at a glance" [1]), rather than visualizations in general. The literature search was conducted on 21st August, 2015.

A total of 246 papers were obtained from the aforementioned databases; additionally, the top 100 results from GScholar (from a total of 989) were added to the analysis. Each paper was reviewed by two researchers to determine if it was out of scope, of low credibility, or of low quality. After this filtering, 55 papers were analyzed in detail (see list of papers here <https://dx.doi.org/10.6084/m9.figshare.2066793.v1>).

## 3. RESULTS

### 3.1 Types of contributions

While many of papers (39 papers; 71%) described the implementation of a specific learning dashboard, only 3 papers

presented a theoretical proposal or a framework. Interestingly, the definition of 'dashboard' was addressed in just 4 papers (7%), being different in each one of the cases.

### 3.2 Learning Context

When considering the context where dashboards were applied (RQ1), we identified different target users, learning scenarios, educational levels and pedagogical approaches discussed in the papers.

**Target users.** Teachers (41 papers; 75%) and students (28 papers; 51%) are clearly the main users of the dashboards, although administrators and researchers also appear in some cases.

**Learning scenarios.** 50 papers (91%) targeted formal learning while the rest of the papers either addressed non-formal learning or they did not specify the type of learning.

**Educational level.** 29 papers (53%) addressed university settings and 17 (31%) did not specify the learning context.

**Pedagogical approach.** Although the papers often did not refer to a specific pedagogical approach (31 papers; 56%), there is a noteworthy appearance of computer-supported collaborative learning (7 papers; 13%), blended (5 papers; 9%), and online learning (4 papers; 7%).

### 3.3 Learning Dashboard Solutions

To answer RQ2 (regarding current dashboard solutions), we analysed the (1) purpose of the dashboard, (2) types of data sources used, (3) platforms the data was retrieved from, (4) indicators and (5) visualizations presented in the dashboard.

**Purpose.** We distinguished 3 types of dashboard purposes: self-monitoring (28 papers; 51%), monitoring others (39 papers; 71%) and administrative monitoring (1 paper; 2%). Three papers (5%) did not explicitly state a purpose for their dashboard.

**Types of data sources.** The majority of papers (47 papers; 85%) mentioned logs as their data source for the dashboard. Learning artefacts were the second most frequently used data source (16 papers; 29%), followed by information explicitly asked from the users (7 papers; 13%), institutional databases (5 papers; 9%), physical user activity (4 papers; 7%) and external APIs (3 papers; 5%). Finally, 4 papers (7%) did not specify the used data source.

**Platforms.** The solutions, presented in the reviewed papers, relied in total on data coming from 51 distinct platforms, of which 38 papers each mentioned a different platform. Moodle was the most prominent platform being used in 18% of the papers.

**Indicators.** From the paper review we obtained over 200 different indicators, which we categorized into 6 groups: learner, action, content, result, context, and social-related indicators. Regarding the subject, most of the papers presented indicators about individuals (47 papers; 85%), followed by indicators related to whole classes (25 papers; 45%), small groups (8 papers; 15%), or large ones such as MOOCs (5 papers; 9%).

**Visualization type.** The most popular five are bar charts (33 papers; 60%), line graphs (24 papers; 44%), tables (21 papers; 38%), pie charts (15 papers; 27%) and network graphs (10 papers; 18%).

### 3.4 Evaluation

The maturity of current learning dashboard solutions, in terms of evaluation presented in the papers (RQ3), is rather unequal: the majority of papers (58%) contained no evaluation whatsoever. Most papers used mixed methods for the evaluation (15 papers; 65% of the evaluations), as opposed to purely qualitative or quantitative evaluations (four and two instances, respectively). In total, ten papers gathered evaluation information from teachers, while 19 papers targeted students. Surprisingly, most of the evaluations (74% of the 23 papers that had evaluations) addressed general constructs such as usability, usefulness or user satisfaction, while very few studies actually looked at (and provided evidence for) the impact of these technologies on *learning* (e.g., [3] did not find statistically significant effects).

## 4. IMPLICATIONS AND FUTURE LINES OF WORK

The review reveals a lack of an agreed and shared dashboard definition. Thus, we propose the following definition: a learning dashboard is a single display that aggregates multiple visualizations of different indicators about learner(s), learning process(es) and/or learning context(s). Additionally, we have identified certain trends and gaps that may lead to future lines of work. For example, more than half of the papers focused on university settings, which highlights a need for learning dashboard studies in other settings, such as K-12 and non-formal settings. Regarding the data sources, the reviewed papers retrieved data mainly from logs and only a few used external APIs, physical user activity or institutional databases. With the development of distributed and ubiquitous learning, it will become a must to aggregate complementary data sources. The field still lacks comparative studies among different dashboards or dashboard design options as well as empirical studies on the long-term impact and affordances of learning dashboards, especially in terms of *learning gains*.

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