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# Literature Review on Real-Time Dashboard Systems in Healthcare and Education

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***Abstract***

*Real-time dashboards are revolutionizing data analysis and visualization within education and healthcare, highlighting the realms of online learning analytics and emergency medicine. Such systems maximize decision-making power, efficiency of workflows, and awareness in real time. The literature review below explores diverse methodologies, benefits, and pitfalls, and presents suggestions for potential avenues for research in the future. Growing access to data and advancements in visualization and analytics technologies have given rise to powerful dashboards that support better situational awareness and timely interventions. This review considers the design elements, implementation methodologies, and assessment techniques applied for developing real-time dashboards across healthcare and educational contexts. The review detects strengths and limitations, common challenges, and future research opportunities. The aim is to present an all-around view of existing real-time dashboard systems, which will lay the ground for more useful applications in these essential fields.*

**Keywords:** Real-time dashboards, data visualization, healthcare analytics, emergency medicine, online learning analytics

## INTRODUCTION

The use of dashboards in healthcare and education has greatly increased, particularly in emergency medicine and online course learning analytics. Dashboards support important real-time visualization of data, which leads to enhanced decision-making, efficient workflow, and situational awareness. The current literature review provides an overview of studies conducted on dashboard systems, evaluating methodologies used, weaknesses and strengths, and areas requiring further research.

Real-time dashboards are revolutionizing data visualization and analysis across sectors, with vast implications for decision-making in fast-changing environments [1–3]. The present literature review is concerned with the application of real-time dashboard systems in two significant sectors: healthcare and education [4–6]. Increased availability of data in such domains, along with the development of data analytics and visualization technologies, has driven the production of advanced dashboards with the objective of enhancing situational awareness, enabling timely intervention, and overall results [7].

We examine the design guidelines, implementation approaches, and evaluation methods employed to build real-time dashboards in healthcare environments such as emergency rooms,

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as well as learning environments such as online courses and teacher apps. This review discusses the strengths and limitations of current systems, recurring problems, and promising avenues for future work. By integrating results from pertinent research, we aim to present a thorough summary of the state of the art in real-time dashboard systems for healthcare and education, opening the door to more efficient and influential applications in these vital areas.

## LITERATURE REVIEW

Real-time dashboards have emerged as critical tools for enhancing data visualization, analysis, and decision-making, particularly in the domains of healthcare and education. Their ability to provide immediate insights into dynamic environments has propelled research into their design, implementation, and impact.

In healthcare, real-time dashboards assist clinicians by aggregating patient data, monitoring emergency department activities, and supporting public health surveillance. Khairat *et al*. emphasized the role of dashboards in improving the quality of care and clinician satisfaction [1]. Similarly, Elshehaly *et al.* proposed QualDash, which enables adaptable visualization for healthcare quality improvement, highlighting the need for customizable, user-centered designs [4]. Zhuang *et al*. further developed a framework to evaluate healthcare dashboards, focusing on usability and decision-making support [5].

Yoo *et al*. conducted a five-year case study of an autonomous emergency department dashboard, demonstrating its ability to enhance situational awareness and reduce clinician mental workload [8]. However, limitations such as a small sample size and limited generalizability were noted.

In education, real-time learning analytics (LA) dashboards aim to improve teaching practices and student outcomes by providing insights into learner behaviors and engagement. Nguyen *et al*. developed TEADASH through an iterative Design Science Research approach, emphasizing the importance of co-designing dashboards with end-users (teachers) [9]. Despite positive feedback, challenges in achieving sustained teacher adoption and the need for continuous iteration were identified.

Hasnine *et al*. introduced a dashboard that uses computer vision and deep learning techniques to detect online learners' affective states, allowing instructors to intervene promptly [10]. While innovative, the system faced limitations in validating emotion detection accuracy and assessing its impact on academic performance.

## COMPARISON OF APPROACHES

The associated papers present a range of approaches to designing and evaluating LA dashboards. A teacher-facing dashboard (TEADASH) was developed and refined iteratively in one study through Design Science Research (DSR) based on teacher feedback. The systematic review methodology of another study, which reviewed existing dashboards to identify best practices and create a checklist for future dashboard development, is the opposite of this iterative process. The visual design components of dashboards were also the focus of another study, which highlighted the importance of proper and transparent representation of data for optimal usability and understanding. Another study examined the utilization of real-time data and automatic feedback systems, specifically with a focus on the use of computer vision and machine learning methods automatically to identify the affective states of online students. Finally, a series of studies examined dashboard use across a variety of environments, including public health and emergency care, showing the technology's flexibility and applicability across disciplines.

## A COMPARATIVE ANALYSIS OF DASHBOARD IMPLEMENTATION

The current review consolidates highlights and limitations of five studies on design, implementation, and evaluation of dashboards across several fields, such as emergency medicine, education,

 

cryptocurrency visualization, and public health. The research employed diverse methodologies, pointing to the intricacies of developing and accessing dashboards.

The investigation of a real-time autonomous emergency department (ED) dashboard demonstrated effective long-term adoption (five years) and overall positive user ratings, as evidenced by a "OK-to-Good" System Usability Scale (SUS) score [8]. The small sample size and single ED setting of the study restrict the generalizability of the findings. Whereas the dashboard enhanced situational awareness and diminished mental workload, perceived information quantity was less than its quality, suggesting further improvements in information presentation.

The TEADASH study based on Design Science Research (DSR) highlighted the necessity of iterative design and collaboration between teachers in designing effective teacher-oriented dashboards [9]. The iterative process, involving several design cycles and feedback loops, generated a tailored dashboard to the needs of teachers and learning designs. Yet, small study size with only five courses at two universities restricts generalizability of the results. In addition, the research found a discrepancy between projected and realized teacher adoption, stressing the necessity of continuous assessment and adjustment subsequent to the first design phase.

The study of a real-time learning analytics dashboard for the automatic recognition of affective states of online students introduced a new method for monitoring learner attention and engagement by fusing computer vision and deep learning [10]. The feedback mechanism in real time of the system facilitates timely interventions. Nonetheless, the research has shortcomings, such as limited rigorous assessment of academic performance and accuracy of emotion detection. It is further validated with conventional methods like Geneva Emotion Wheel, and a test on its effect on the learning outcome.

The research on data streaming architecture for visualizing cryptocurrency temporal data effectively proved the possibility of real-time visualization through a lambda architecture [11]. The dynamic updates yielded useful insights into cryptocurrency price movements. The assessment was mostly visual, with no quantitative accuracy or usability measurements. The narrow scope, which only addresses cryptocurrency data, restricts the applicability of the findings to other types of data and visualization needs.

Lastly, the research on integrating and visualizing a public health dashboard showed the possibility of integrating different sources of data (social media, web searches, etc.) for real-time surveillance of public health [12]. The interactive dashboard facilitated easy monitoring and analysis of public health events. Nonetheless, the system was in its initial alpha stage, with little evaluation and possible data availability limitations. More research and strict testing are needed to establish its efficacy in actual public health settings.

In summary, these studies exhibit dashboards' capabilities in various fields and also illustrate the difficulties in designing, implementing, and assessing them. Future studies need to overcome issues of sample size, generalizability, stringent evaluation approaches, and the integration of user feedback during the course of development. More thorough comprehension of users' needs and situational aspects is needed to build useful and effective dashboards.

## RESEARCH GAPS

Several research gaps emerge from the analysis of the related documents. Additional research is required to improve the generalizability of findings across various educational contexts and student populations.

1. Long term studies are essential in determining the long-term effect of LA dashboards on teacher practice and student learning results.

 

**Table 1.** Summary of literature findings on dashboard visualization.

| Study | Study Objectives | Dashboard Design and Features | Implementation Context | Evaluation Methods |
|---|---|---|---|---|
| [8] | Develop and evaluate a real-time autonomous ED dashboard | Real-time, automated, geographical layout, patient-level alerts, real-time summary data. | Emergency Department (ED) setting, integrated with existing hospital information system (HIS). | Situation Awareness Index, questionnaire based on Situation Awareness Rating Technique. |
| [9] | Design and develop TEADASH using DSR; evaluate its impact on teaching and learning | Teacher-facing, co-designed with teachers, visualizes student activity data (e.g., forum participation, quiz scores). Iterative design. | Five courses from two Swedish universities, integrated with Canvas LMS. | Iterative design cycles with teacher feedback, interview, and informal observations during course deployment. |
| [10] | Develop a real-time LA dashboard for automatic detection of online learners' affective states. | Real-time, automated emotion detection (facial expressions, eye movements), engagement and concentration levels, student clustering. | Online learning environment integrated with web conferencing tools (Zoom WebEx). | Academic performance, accuracy of emotion detection, user feedback (Geneva Emotion Wheel). |
| [11] | Visualize real-time cryptocurrency price changes using a data streaming architecture. | Real-time multiline and line charts; dynamic updates. every minute; uses C3.js and Tableau. Data from multiple cryptocurrency websites. | Web application; data sourced from multiple cryptocurrency websites. | Visual inspection of dynamic updates; video demonstration of functionality. |
| [12] | Develop and evaluate a public health dashboard integrating diverse data sources. | Web application (HTML5/JavaScript); integrates diverse data sources (social media, online searches, etc.); visualizes epidemiological data. | Public health surveillance; integrates data from various sources, including social media and online searches. | Simulations using 2009 swine flu outbreak data; future plans for more rigorous evaluation. |
| [13] | Recommend business strategies using Power BI dashboard visualizations of financial data. | Power BI dashboard; features not explicitly detailed, but likely includes charts, graphs, and interactive elements for financial data analysis. | Atliq Hardware, a consumer electronics company, specific details on data sources and data volume are limited. | Analysis of dashboard outputs and their contribution to business decision-making. |

2. The ethical implications of data privacy, security, and possible biases during data analysis also need more consideration. Studies ought to examine how teacher capacity, institutional support, and the usage of LA dashboards are correlated.
3. Data-driven best practices in visual design for LA dashboards need to be established keeping in mind diverse data types and user needs. In order to make LA dashboards more effective, their embedding in certain pedagogical styles and learning principles should be further researched.
4. Lastly, more research is required to develop and implement efficient automated feedback systems in LA dashboards, considering teacher preference and student requirements.
5. Development of standardized assessment frameworks for LA dashboards is another significant topic for future research.

Table 1 provides the summary of the literature reviewed in a clear and concise manner for better understanding.

## CONCLUSION

This review of the literature illustrates the increasing interest in applying LA dashboards to enhance teaching and learning. Although current research informs us about different facets of dashboard design, implementation, and assessment, considerable gaps in research exist. Closing these gaps is urgent to ensure LA dashboards are developed and successfully implemented to promote equitable and effective

 

teaching and learning practices. There should be future research on the development of robust evaluation frameworks, the resolution of ethical issues, and the examination of how dashboards could be integrated into pedagogical approaches in order to optimize their potential in enhancing educational outcomes. Guidelines and best practices for visual design, data representation, and stakeholder communication will also be essential in facilitating the systematic and successful application of LA dashboards across education.

**Declaration of Interest**

The authors declare that there is no conflict of interest regarding the publication of this manuscript.

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NA.

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