

# Designing a Student-Facing Learning Analytics Dashboard to Support Online STEM Practices

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**ABSTRACT:** Despite the potential of learning analytics dashboards (LADs) to support learners' needs for autonomy, little research has been conducted on designing LADs to support student autonomy. In this paper, we reported the process of designing a student-facing LAD that offers students' autonomy support by providing necessary information for students to set their own goals and choose learning activities that are aligned with their goals. A leaderboard was also integrated into the LAD to promote student motivation. Reeves's (2006) design-based research model was adopted to develop the LAD. The final version of the LAD was presented, and the significance of the work was discussed.

**Keywords:** learning analytics dashboard, STEM, online learning, autonomy

## 1 INTRODUCTION

A learning analytics dashboard (LAD) or learning dashboard is "a single display that aggregate different indicators about learner(s), learning process(es) and/or learning context(s) into one or multiple visualization" (Schwendimann et al., 2017, p. 37). Research on student-facing LADs is particularly promising due to its potential to support students' autonomy and help learners become more self-regulated (Bodily & Verbert, 2017; Yoo, Lee, Jo, & Park, 2015). However, researchers suggested that there is a lack of actionability in current student-facing LAD design (Verbert et al., 2020). To address this concern, this study focuses on designing a LAD that prompts student to autonomously set their goals and choose appropriate learning activities.

## 2 LITERATURE REVIEW

### 2.1 Research on STEM Fluency

This study was conducted within an established online training program for STEM learning called STEM Fluency. This online program, built upon research-validated principles and methods including computer-based training with feedback, mastery-based training, distributed and interleaved practice, and multiple representations (Mikula & Heckler, 2017), is to improve undergraduate student mastery of essential STEM skills (i.e., basic procedural skills) via explicit practice. Research on STEM Fluency training has showed some positive results in enhancing both the accuracy and fluency of student essential skills (Heckler & Mikula, 2016; Mikula & Heckler, 2013; Mikula & Heckler, 2017). However, when students were given the freedom to choose what skills to practice in STEM Fluency after they completed the assigned tasks, most students chose to practice the skills that they were good at instead of those they needed to improve. To address this problem, this paper reports the attempt to design

and develop a student-facing LAD that provides students process-oriented feedback and prompts that help students make choices that are more beneficial to their learning.

## 2.2 LADs and Student Autonomy

Research on LADs is still at its early stage (Schwendimann et al., 2017), and little research has been conducted on LADs and student autonomy support. Although LADs were designed help learners better monitor their learning activities, limited attention was given to support student autonomous decision-making during the learning phases such as planning and control (Valle, Antonenko, Dawson, & Huggins - Manley, 2021). Our research directly addresses the research gap by designing a student-facing LAD that offers students' autonomy support and guides students to make well-informed learning choices on their own.

## 2.3 Research on Leaderboards

One concern about the implementation of student-facing LADs is the low usage of LADs from students (Bodily, Ikahihifo, Mackley, & Graham, 2018). To address this potential issue, we decided to incorporate a leaderboard, a popular gamification feature, into the LAD design. Research on the integration of gamification features into LADs has been limited. According to Sahin and Ifenthaler (2021), only 8 out of 76 studies on LAD include gamification features. In our study, a leaderboard was chosen because research on educational use of leaderboards has shown that, in general, leaderboards have a positive impact on participants' learning and motivation (Kalogiannakis, Papadakis, & Zourmpakis, 2021). It is expected that integrating a leaderboard into LADs may provide additional motivation needed for learners to use the information on LADs to improve their performance.

## 3 METHOD

The design and development of LAD follows the guidelines of design-based research (DBR) (Wang & Hannafin, 2005). We employed Reeves's (2006) DBR model which comprises four phases: analysis, solution, testing and refinement, and reflection. These phases overlap and proceed in a cyclic manner, with activity in previous phases often influencing activity in later phases. After several rounds of reiteration, we arrived at the version presented in Figure 1.

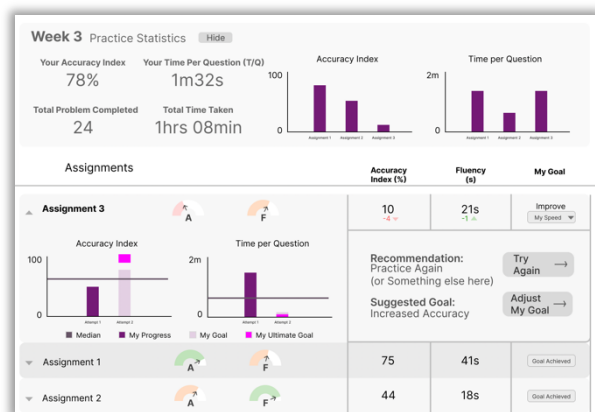


Figure 1. Final version of the LAD design

## 4 SIGNIFICANCE OF THE STUDY

This project is significant because it is one of the first few attempts to explore ways to design LADs to support learners' autonomy. The significance of the study also lies in the following aspects. First, the design of the LAD addresses the lack of actionability in current LADs design (Verbert et al., 2020) by incorporating actionable items into the LAD. Second, a gamification element, leaderboard, is integrated into the design of the LAD to create a strong support for learners' motivation. Finally, based

on studies of the LAD, additional research will be conducted to examine learners' metacognitive strategies and decision-making, which are not well studied in LADs research (Sahin & Ifenthaler, 2021).

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