Reflecto: A Teacher Reflection Tool Leveraging Multimodal Learning and Teaching Analytics

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Abstract. Prior research has found that teacher reflection is important for both teachers' professional development and students' learning, but frequent, effective reflection faces many obstacles. Could an analytics-based reflection tool help address these barriers? Reflecto is a novel teacher-facing tool designed to support teachers in reflecting (after-the-fact) on their classroom practices during sessions when students are engaged with intelligent tutoring systems. Whereas many teacher analytics tools support real-time decision-making in class, Reflecto aims to promote teacher agency through out-of-class teacher-initiated, data-driven exploration of possible trends in their classroom practice. Unlike many other analytics tools, it combines learning analytics and teaching analytics.

Keywords: Teacher Reflection Tools, Multimodal Learning Analytics, Teaching Analytics, Teacher-student Interaction

Demo Video: https://youtu.be/hfwNe_FfRW4

Overview of the Reflection Process Supported by Reflecto. When students use AI-based tutoring software for self-paced practice, teachers are very busy monitoring the class and supporting students beyond the software's capabilities. This task is challenging – might data-informed reflection help teachers improve? Reflecto, designed through user-centered design with teachers [2,4], supports post-class reflection by allowing teachers to explore multimodal classroom data. Reflecto was built within CTAT+Tutorshop [1], leveraging 1) data about the teacher's location and movement through the classroom, captured by Pozyx sensing technology every second and processed to identify student visits [3], and 2) intelligent tutoring system log data, augmented with detectors for idle behavior, struggling, and hint abuse. During reflection activities, the teacher selects one or more *trends* to explore, analyzes multimodal classroom data to see to what degree the selected trends are present or absent in their own classroom practices, thinks about possible reasons for deviations from desirable trends and/or for adhering to trends that, on reflection, are not desirable, and sets intentions for improved classroom practices. Teachers control their

exploration, with Reflecto offering minimal suggestions for filtering or sorting the data based on the chosen trends.

Focus Panel Teachers start with reviewing a list of eight potential classroom trends such as "I keep my visits short" or "I attend to struggling students" (Fig. 1). These trends, informed by user-centered design research with teachers, reflect desirable classroom practices *or* practices to avoid. The trends are meant to capture what teachers might find important as they monitor and help a class of students engaged in the tutoring system. Teachers can rate the trends in terms of desirability ("How desirable is this?") and personal alignment ("How true of me is this?"). They select one or two trends to focus on as they explore Reflecto's data.
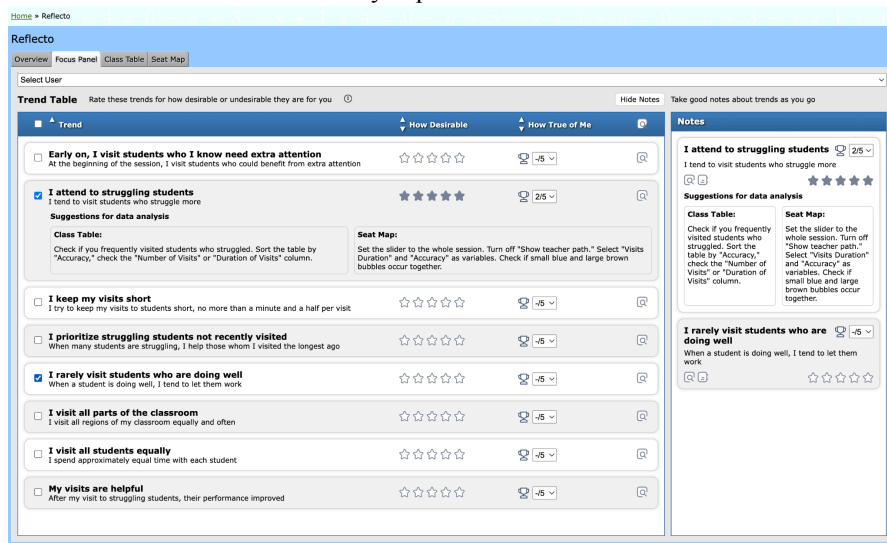

Fig 1. Focus Panel, which shows trends, derived from user-centered research with teachers

Fig 2. Class Table, which shows students' learning analytics and teacher's visit analytics

One of Reflecto's two main data displays is a **Class Table** panel (Fig. 2) which shows analytics about students' learning, metacognitive and behavioral states, such as

number of problems solved, time worked, accuracy, idle time, misuse time, consecutive errors. It also displays teacher-student interaction analytics such as visit count and visit duration. To dive deeper, teachers can access detailed visit-level analytics and compare students' analytics for before and after visits. Teachers can sort the table based on any analytic (e.g., to explore correlations between variables ("I attend to struggling students")).

A second data display, the **Seat Map** (Fig. 3), offers a spatial-temporal visualization of the same analytics, superimposed on an actual classroom seat map. The teacher can select one student analytics and one teacher visit analytic on a classroom layout, and track their movement through visit heatmaps or directed path lines, within a specific time intervals of their interest. These affordances make the Seat Map a powerful tool for identifying spatial patterns in teaching and learning, such as which areas of the classroom received more teacher attention or which students were most visited, (e.g., such as trend: "I visit all parts of the classroom").
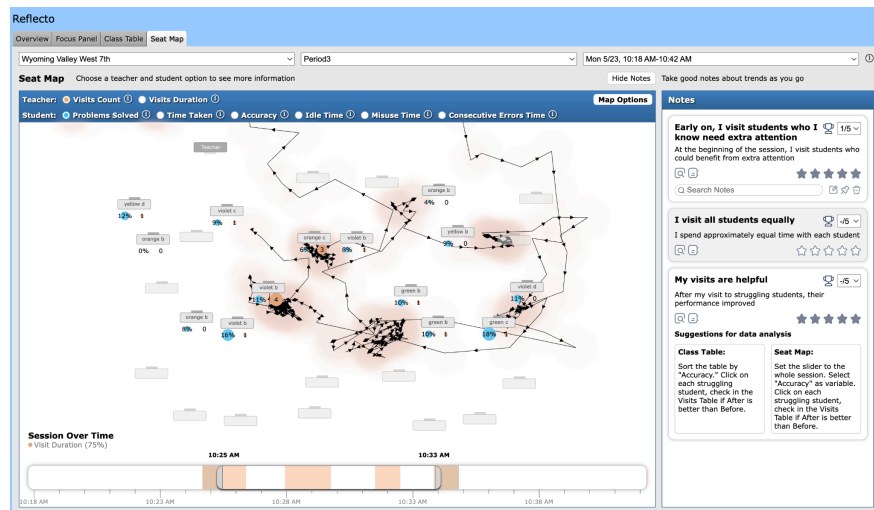

Fig 3. Seat Map Panel, that shows spatial-temporal visualization of classroom analytics

References

1. Aleven, V., Borchers, C., Huang, Y., Nagashima, T., McLaren, B., Carvalho, P., Koedinger, K. (2025): An Integrated Platform for Studying Learning with Intelligent Tutoring Systems: CTAT+TutorShop. arXiv preprint arXiv:2502.10395.
2. Karumbaiah, S., Borchers, C., Falhs, A.-C., Holstein, K., Rummel, N., Aleven, V.: Teacher Noticing and Student Learning in Human-AI Partnered Classrooms: A Multimodal Analysis. In: Proceedings of the 17th International Conference of the Learning Sciences - ICLS 2023.
3. Shou, T., Borchers, C., Karumbaiah, S., Aleven, V.: Optimizing Parameters for Accurate Position Data Mining in Diverse Classroom Layouts. In: Proceedings of the 16th Interactional Conference on Educational Data Mining, pp 310-317 (2023).
4. Yang, K.B., Borchers, C., Falhs, A.C., Echeverria, V., Karumbaiah, S., Rummel, N., Aleven, V.: Leveraging Multimodal Classroom Data for Teacher Reflection: Teachers' Preferences, Practices, and Privacy Considerations. In: European Conference on Technology Enhanced Learning (EC-TEL 2024), pp. 498–511 (2024)