

MathFlowLens Teacher Dashboard: Using Learning Analytics to Gain Actionable Insights About Strategic Thinking in Mathematics

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ABSTRACT: This **practitioner report** presents the iterative development and real-time integration of the MathFlowLens (MFL) dashboard, a data analytics and visualization tool for mathematics teachers that helps identify their students' strategic thinking and problem-solving pathways. Development by researchers was guided by a co-design process where middle school teachers provided mockups, feedback and usability data that were analyzed and turned into new analytics and features that met their instructional needs. Focus groups provided insights into the design of a new data visualization component that allows teachers to see each individual student's problem attempts and their complete process of solving a problem from start to finish, as well as an integration into the Graspable Math (GM) platform. Results from two classroom studies will help identify the ways that the integrated dashboard tool can provide teachers with real-time actionable data, prompting questions, and support to better facilitate mathematical discourse in the classroom about students strategic thinking.

Keywords: strategic thinking; mathematics teaching; problem solving; actionable feedback; teacher dashboard

1 INTRODUCTION

In a math classroom focused on strategic flexibility, teachers should value the variability in how their students are approaching problems. If teachers have an understanding of their students' diverse thinking strategies, they become better equipped to assist and instruct them (Carpenter et al., 1989). Two key elements of problem solving that can be garnered from student work are their strategic thinking processes (the steps taken to solve a problem; Star & Newton, 2009) and productive persistence (learning from failure and reattempting) These processes are useful for a teacher to be able to identify as each provides different insights into aspects of a student's conceptual understanding and engagement which can be used to inform current and future instruction.

Our prior work used pathfinding algorithms on openly accessible action-level log data from 1,649 students who solved math problems in a learning platform as a part of a previously conducted large scale randomized controlled efficacy study (data available: Ottmar et. al, 2023; Woodrow et al., 2023). Four distinct types of problem-solving pathways were identified: optimal, suboptimal, dead-end/exploratory, and incomplete pathways. Sequential network visualizations were then created based on the identified classifications to present these distinct procedural pathways to teachers. The predictability of these classifications on students' later performance was established for three facets of mathematical knowledge: conceptual knowledge, procedural knowledge, and procedural flexibility (Pradhan et al., 2025; Pradhan et al., 2024).

2 CO-DESIGNING THE MATHFLOWLENS DASHBOARD WITH TEACHERS TO PROVIDE STUDENT ATTEMPT AND PROBLEM LEVEL ANALYTICS

MathFlowLens was developed through a co-design process working alongside mathematics teachers to solicit feedback and design ideas (Thompson et al., 2025; Pradhan et al., 2025; Rua, 2025). During the co-design process, teachers sketched out their requested dashboard designs and features on paper and identified ways that they thought that analytics could be used to better support their classroom instruction. These efforts resulted in a fully-functional prototype that used the pathway classifications to provide a set of prototype data analytics and visualizations that gave teachers step-by-step and summary information about their student's student mathematical strategies, attempts, and engagement to better assist teachers with identifying their students' strategic thinking and mathematical understanding when solving problems (Figure 1).

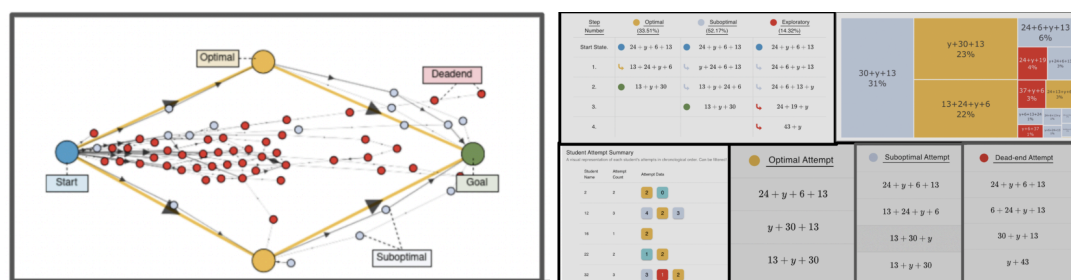


Figure 1: Left: The Graph Diagram showing all attempt pathway and categorizations. Top Middle: Teacher preview of 3 sample student strategies. Top Right: Tree map of the various student first steps. Bottom Left: Student attempt summary and categorizations of each attempt. Bottom Right: Student solving steps for each attempt type.

Teachers completed follow up surveys to provide more feedback on what additional features would make the dashboard more usable and feasible for their classroom. Results showed that teachers spent a lot of time examining the overall graph diagrams, noting the variability in how their students were thinking about and solving problems. Teachers also used these diagrams to identify common patterns and clusters in their data to see more generally how a majority of their students arrived at the solutions, to identify difficult concepts to reteach, and to change their instructional focus for discussions to strengthen understanding. Others saw use for the tool at the individual level to trace how a particular student worked through a problem for one-on-one intervention and differentiation.

3 REAL-TIME ANALYTICS IN CLASSROOMS: INTEGRATING MFL INTO GRASPABLE MATH

Since prior prototypes were tested with only a small number of teachers in the lab, we integrated its components within GM (graspablemath.com) to provide a real-time use case for teachers to test out the MFL dashboard with their own students and classrooms (Figure 2). GM was selected as the proof-of-concept platform for integration as it is a widely used free online teacher and student platform that provides teachers with tools to a) assign their own problem sets to students, b) monitor student progress, and c) receive live updates, strategy visualizations, and summarized data on their students' mathematical problem solving. GM is also an effective interactive algebra learning platform that utilizes perceptual learning and helps learners strengthen their mathematics skills by transforming mathematical expressions between equivalent states (e.g., $3 + 2$ to $1 + 4$) in any way

that is mathematically permissible. Each step that students take and the errors they make from the state to end state for each problem attempt is recorded in the log data and can be analyzed by our tool as an individual path. The integrated dashboard takes all student attempts into account, including those that were unsuccessful, which are important in understanding how a student worked through and struggled with a particular problem.

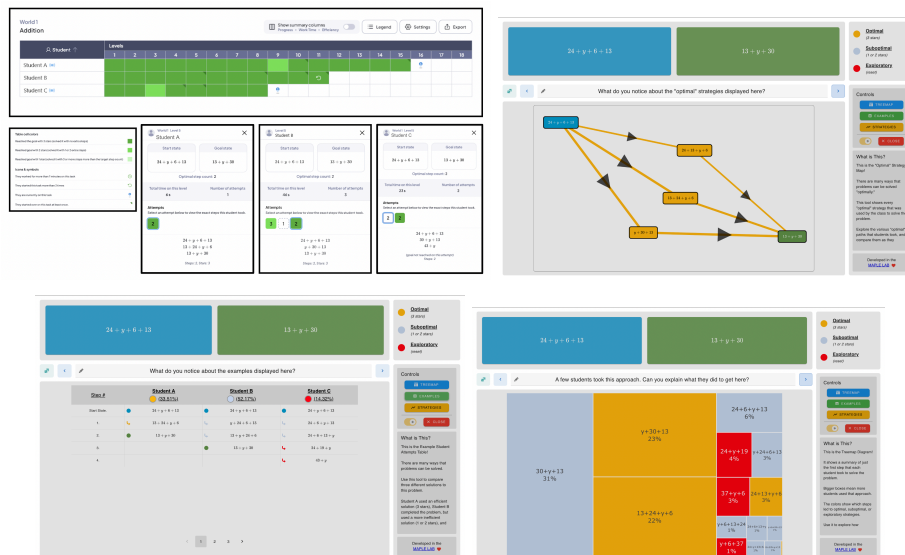


Figure 2: Dashboard integration into the Graspable Math platform. Top Left: Teachers can see summaries of their classroom progress and problem-solving efficiency. Different colors and icons indicate different problem-solving behaviors. Here we show three students' individual attempts and steps that they took to solve the problem. Top Right: MFL Classroom Presentation Mode showing Optimal Strategy Pathways an question prompts. Bottom Left: MFL Classroom Mode showing three sample student strategies by classification. Bottom Right: MFL Classroom Mode showing the state and frequency of all students' first steps.

The GM platform combined with the MFL data analytic and visualization components in the teacher dashboard make it easier for teachers to detect patterns and identify individual problem-solving strategies for each student, attempt, and the class as a whole. The MFL tool also provides a present feature that shows specific tree map diagrams (% of students who took a particular first step), sample student variable strategies, and all optimal pathways taken for their class, and provides a number of prompting questions for teachers to pose to students during instruction about the shown data and visualizations. These are intended to shift the classroom conversations during instruction from correctness of student answers towards an attention to the efficiency and variability in students' mathematical strategies and engagement.

4 NEXT STEPS: EXAMINING HOW TEACHERS CAN USE MFL FOR CLASSROOM CONVERSATIONS ABOUT STUDENT STRATEGIES

With these real-time analytics and visualizations being integrated into GM, our research team is currently conducting two studies in classrooms with teachers to better understand how teachers use and interact with the real-time data analytics and visualizations presented in the MFL tool. We are currently working with a total of 20 teachers who are using different components of the GM and MFL

dashboards to monitor more than 1,000 students from 40 classrooms. Participating teachers will complete surveys about their experiences and provide information about what additional training, supports, or feedback they need to effectively use GM and MFL presentation tools in their classroom. Focus groups, classroom visits, and observations will also provide insight into the ways in which teachers interpret and act upon the different levels of data presented in the tool when instructing their students in real time. Together, this research will help us learn how we can better design- and teachers can best use- digital tools to understand students' mathematical strategic thinking, facilitate discourse in the classroom, and implement more effective data-based interventions.

5 CONCLUSION

During our presentation at LAK2026, we will give a demonstration of the real-time GM and MFL dashboard components as well share findings from our two ongoing studies. We will also provide challenges and insights to the community into how working alongside practitioners at every stage of the design and development process can improve our tools and broaden our understanding of how learning analytics can be made more implementable and actionable for teachers in real-world classroom situations. Lastly, we will discuss ways in which we can generalize this approach to other educational technology tools. **Disclosure:** The authors have no conflicts. **Acknowledgements:** The research reported here was supported by an IES Efficacy and Replication Grant (R305A180401), ED/IES SBIR Grant (91990024C0017) and an NSF CAREER Grant (2142984) to Worcester Polytechnic Institute.

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