VISUALIZING STUDENT PROBLEM SOLVING

Yvonne Chen and Eleanor O'Rourke

Research Problem

Design new methods of visualizing student problem-solving data both to help teachers assist students effectively during class and allow teachers to monitor aggregate student performance.

Motivation

Importance of Student Data

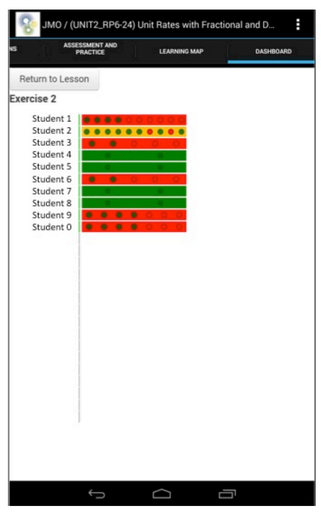
Prior research shows that teachers can benefit from having access to student data, particularly when data is accessed in real time. Yet while there are clear benefits to exposing student data, little research explores methods of effectively visualizing it. Our work targets this gap in the literature.

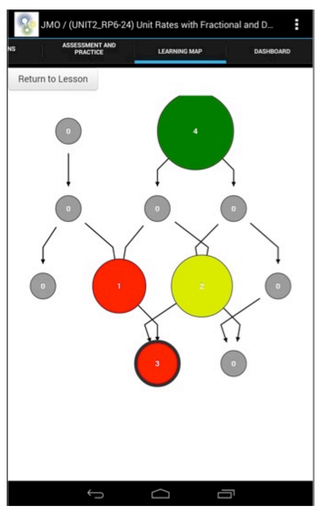
Enlearn

We partnered with Enlearn, a non-profit company founded to develop tablet-based adaptive problem-solving software for K-12 classrooms. We display real data from Enlearn students.

Enlearn's Initial Visualizations

Enlearn evaluated two visualization designs with teachers, but found that neither was effective in the classroom. This was in large part because the information provided by the visualizations did not match teacher needs. Designing effective visualizations is challenging because teachers are extremely busy during class time. Teachers need visualizations that are both easily glanceable and that provide actionable information.





Approach

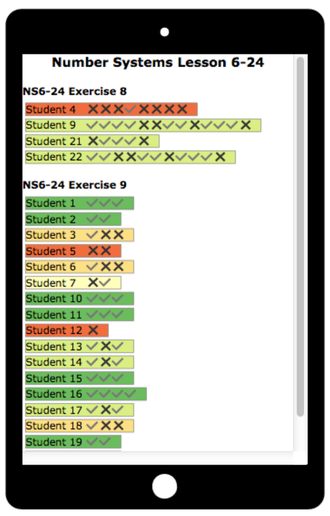
Problem Characterization

We developed a set of design guidelines based on the data visualization problem faced by teachers:

- Visualizations must provide actionable information.
- Visualizations must show data for individual students.
- Visualizations must display concept-level information.

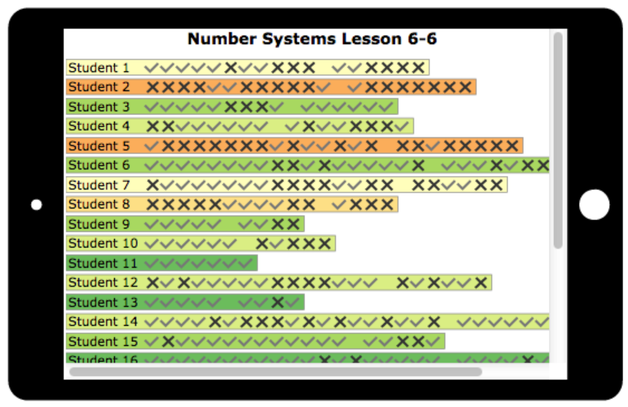
We created two separate visualizations to expose student problem-solving data for teachers.

Concept Visualization

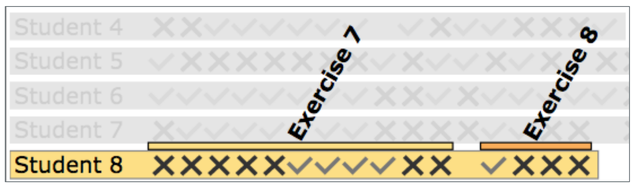


This visualization is designed to help teachers determine which students need help in the present moment. Students are grouped by the concept that they are currently working on. The background color of each student bar indicates how well the student is performing on that concept. This will help teachers quickly decide which students currently need assistance.

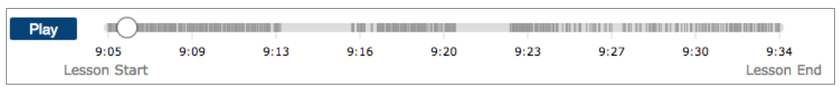
Aggregate Visualization



The aggregate visualization gives teachers a high-level overview of how each student performed over the course of the lesson. The background color of each student bar represents aggregate performance across all concepts. Clicking a student shows detailed concept-level information.



Simulating Real-Time Data

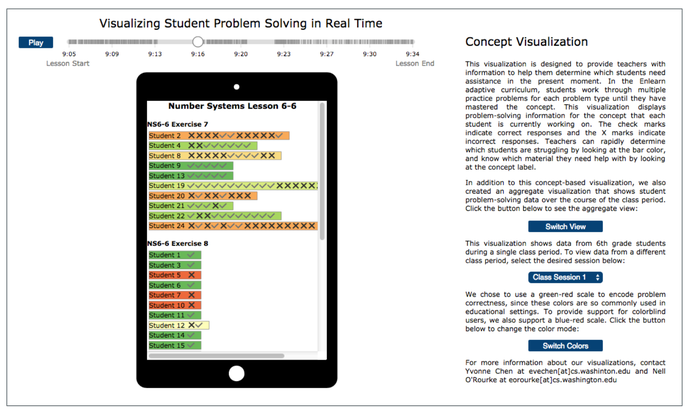


To simulate real-time data streaming of problem solving, we use data collected from students last fall. Our timeline can be played and brushed so we can quickly see what the visualizations would look like in various real-time scenarios. Lines on the timeline are visual information scent cues, showing where problem-solving actions occur. While we included the timeline for our benefit as designers, it may also be a valuable tool for teachers to play back their lessons after class.

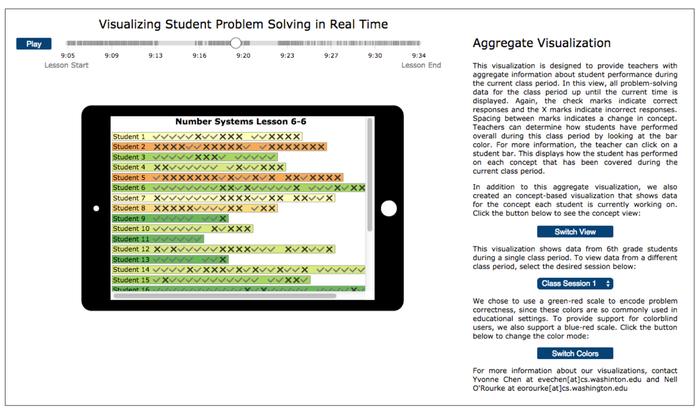
Color Design

By default, we use a red-green color scheme to indicate problem correctness, since these colors are so common in educational settings. We also provide an option that allows colorblind users to switch to a red-blue color scheme.

Results



Screenshot of the Concept Visualization



Screenshot of the Aggregate Visualization

Contributions and Future Work

This work makes contributions at multiple levels of Munzner's nested model for visualization design: a characterization of the data visualization needs of classroom teachers, a data abstraction for representing student data grouped by concept, and two new visual encodings for displaying student problem-solving data both streamed in real time and played back after the fact.

While we made significant progress in developing visualization techniques for this problem domain, we have not formally evaluated our solutions with our target users. Through Enlearn, we aim to pilot these visualizations with teachers in the classroom.

Yvonne Chen
evechen@uw.edu
homes.cs.washington.edu/~evechen

Eleanor O'Rourke
eorourke@cs.washington.edu
homes.cs.washington.edu/~eorourke