# Collaborative Research: Enhancing Middle Grades Students' Capacity to Develop and Communicate Their Mathematical Understanding of Big Ideas Using Digital Inscriptional Resources

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## Project Overview

Building on prior research and development, this project explores two broad hypotheses about how use of digital inscriptional resources can improve middle school students' mathematical understanding:

- Development and communication of mathematical understanding is enhanced through the use of inscriptional resources for constructing meaningful records of student thinking
- Evidence for conceptual growth of mathematics becomes more sophisticated over time when students purposefully reflect on their inscriptional work at key points in the development of big mathematical ideas

## Inscriptions

Inscriptions are representations of student thinking that exist on paper or the computer screen, such as written text, graphical displays, tables, equations, diagrams, maps, or charts.

Because inscriptions exist in material form, students can use them to develop, communicate, and retrieve their understandings in social classroom settings.

## Research Goals

- Investigate how student thinking made visible through the use of digital inscriptional resources;
- Investigate the kinds of student inscriptions that are registered, talked about, and manipulated in collaborative settings; and
- Investigate growth in students' conceptual understanding of big mathematical ideas over time through the use of digital inscriptional resources

## Methods

This project follows **Design Research** methodology.

**Systematic:** Data is methodically collected, analyzed, coded, and interpreted throughout the project.

**Flexible**: Data and findings are used throughout the development process to inform product design and theory about student learning and engagement.

**Collaborative:** Design of the product is the result of collaboration amongst researchers, practitioners, curriculum developers, and programmers.

**Iterative:** Work is the result of repeated rounds of design, testing, and analysis to inform future work.

## Data Sources

- Student Surveys
- Teacher Interviews
- Classroom Observations
- Videos of Classroom Sessions
- Screencasts of Student Computers
- Analytics of Student Interaction with the Software

## Iterative Development Plan: Project Timeline

Year 1: Development and testing of prototype with a few problems → Feedback and modification → Year 2: Field test a connected sequence of problems → Feedback and modification → Year 3: Pilot testing with connected units in limited classrooms → Feedback and modification → Year 4: Field Testing multiple units in a variety of classrooms

## Early Stage Digital Platform

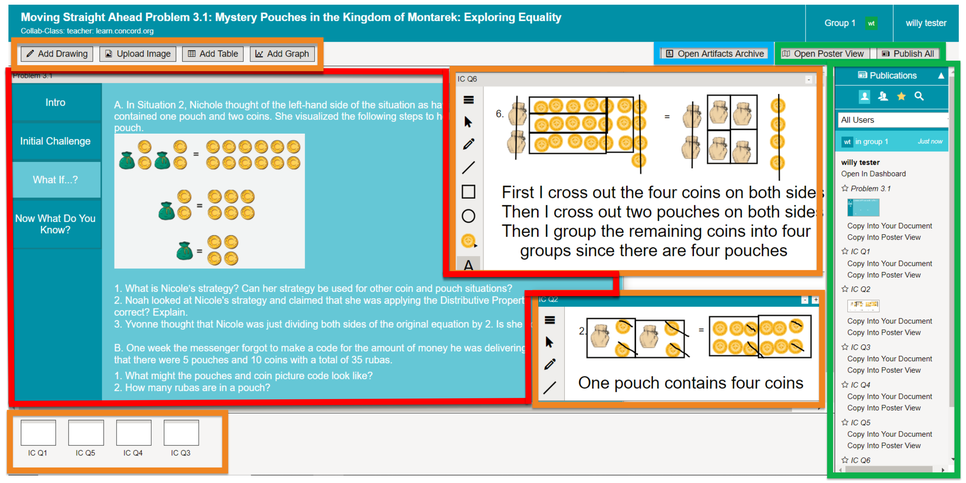
The **problem presentation** shows contextual background of a problem and associated questions. It can be moved or minimized to control screen space.

The **work space** is the digital environment where inscriptions are created. It is comprised of individual and collaborative group spaces, and it comes equipped with a flexible variety of representational tools. Instantiations of the work space can be moved or minimized to control screen space.

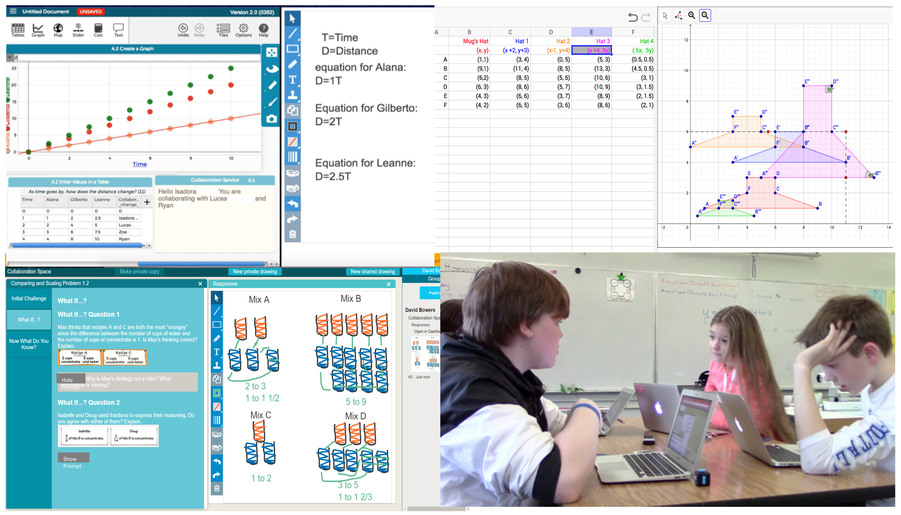
The **publish and poster view** allows for sharing and collaboration across the entire class. An annotation tool is included to allow students or teacher to draw on top of work that has been published to the poster view.

The **artifacts archive** collects all published artifacts that the user has access to, from across all classes and activities. This allows teachers and students to reference prior work or copy it into the current activity. Further development will offer more options for artifact archiving, organization, and retrieval.

The **learning log** is the home of students' individual reflections, capturing key elements of their learning. Building from the artifact archive, the learning log is currently in progress and will span across multiple problem lessons.




## Collaborative Inscriptions in the Digital Space




## Preliminary Findings

**Preliminary analysis of student surveys has indicated:**

- The digital platform was generally helpful in their collaborative work
- Some technical difficulties occurred while students were using the digital platform

**Preliminary analysis of teacher interviews has indicated that the digital platform has potential to support:**

- Student collaboration and engagement in mathematics
- Students to simultaneously express and manipulate multiple representations
- Students to see growth over time through recorded snapshots of student thinking

## Questions We Are Thinking About

**Inscriptional Storyline:** How can we meaningfully convey the story of how an inscription is planned, constructed, modified, interpreted, presented, and critiqued? How and when will students capture and annotate the work of others?

**Learning Log:** How will students determine what inscriptions to save? What is the curation process? How will the process help students develop their mathematical understanding over time?

**Teacher Resources:** How will real-time access to student workspaces support the teacher's role in the classroom? How can technology support the teacher's ability to examine student growth over time?

**Analytics:** What are useful software-generated analytics for examining student learning and engagement in mathematics?

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