**Introduction**

INK-12 is investigating how pen-based wireless technology can support teaching and learning mathematics in elementary school. **Pen-based interaction** enables creation of inscriptions, e.g., writing, sketches, graphs, which are critical in math, where content is expressed using both text and drawings.

**Wireless networking** enables student work to be communicated among teachers and students, supporting formative assessment and classroom discussion.

Using our Classroom Learning Partner (CLP) software, students use a digital pen to create and annotate representations using CLP tools. CLP **interprets** the representations when possible, and students and teachers **share** the student work.

CLP tools enable students to be creative, while at the same time providing representational structure that supports machine interpretation. Stamps, arrays, and division templates are examples.

**Research Questions**

1. How can technology that allows young students to both draw and use representational tools support learning the concepts of multiplication and division?
2. How can technology that enables a teacher to view and share student work with her class support students’ learning?
3. What role can machine interpretation of student work play in facilitating the teaching and learning of multiplication and division?

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**Model of Interaction**

**Stamps**

Students create their own replicable images by drawing on a “stamp.” Creating representations with multiple copies of identical groups can support students’ understanding of multiplicative relationships.

**Arrays**

Students create and manipulate arrays to help them solve multiplication and division problems. Arrays can be divided into regions, cut into smaller arrays, and snapped together.

**Division Templates**

Students use a division template to help them represent and solve division problems. They snap in arrays that represent multiplication of factor pairs, and the division template keeps track of the accumulating size of the arrays, number of groups, and remainder.

**Machine Interpretation**

AI techniques can help teachers view and select student work for class discussion, an often overwhelming task. Answers involving stamps can be interpreted and grouped: After students enter how many things are counted on the stamps, CLP determines that both of these examples are correct representations for 7 groups of 5.

**Smart Sorting**

Based on teacher tags or machine interpretation, the teacher can sort student work, e.g., according to remainder errors, “interestiness,” independence, or correctness.

**Class Discussion**

On a progress panel, an envelope shows teachers which pages students have submitted. Using a tag, teachers “star” work of interest.

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**Interactive Ink Inscriptions in K-12**

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