Developing 4th Grade Students’ Multiplicative Thinking
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Introduction
Many individuals recall “learning” multiplication by memorizing facts with the use of timed tests, drills, and flash cards. However, simply knowing multiplication in this way try to move their students rapidly toward determining answers at the expense of insightfully helping them reason about the meaning of multiplication (King & Bay-Williams, 2015). In doing so, students may not develop the ability to derive answers using strategies understanding and known facts. Additionally, students who “learn” multiplication by rote memorization may not realize multiplication has multiple meanings and applications (Walasse & Gumps, 2015).

Students who have “learned” multiplication in this way often do not what they have memorized and lack the ability to regenerate a forgotten fact (King & Bay-Williams, 2015). Such individuals lack of knowledge likely to hinder their ability to solve real-world word problems (Walasse & Gumps, 2015). According to research, if students have a functional conceptualization of multiplication and have the ability to flexibly derive solutions using various strategies, they are likely to be able to recognize a forgotten fact and use multiplication to solve problems in the real-world (King & Bay-Williams, 2015).

Purpose:
To explore the way in which students think about multiplication and, to intervene to help them develop their multiplicative proficiency and a functional conceptualization of multiplication.

Research Question:
How can students’ multiplicative proficiency be developed for multiplication?

Theoretical framework
Conceptualization of Mathematical Proficiency
Mathematical proficiency can be conceptualized by the five components of procedural fluency, strategic competence, adaptive reasoning, number sense, and productive dispositions. It can be categorized into the following three levels (p.25-26).

SC: Students can use strategies such as decomposition, doubling, and halving, but lack the ability to use more efficient algorithms. They are unable to recognize patterns in numbers and struggle with abstract mathematical concepts.

PF: Students can use strategies such as decomposition, doubling, and halving, but lack the ability to use more efficient algorithms. They are unable to recognize patterns in numbers and struggle with abstract mathematical concepts.

CU: Students can use strategies such as decomposition, doubling, and halving, but lack the ability to use more efficient algorithms. They are unable to recognize patterns in numbers and struggle with abstract mathematical concepts.

Methodology
Participants and Procedure
- Participants: Grade 4 students
- Sessions: 20 sessions, 10 per Semester
- Purpose: To help each student make progress along the trajectory and towards multiplicative proficiency in mathematics.

Empirical Teaching and Learning Trajectory

CSM 3.OA.3
- Represent multiplication with objects, arrays, and area models.
- Understand how to break down the objects and use the partial products. He demonstrated SC, PF, and CU weaknesses. She wrote a story problem and assessed what the student could do, but only the student who student demonstrated SC, PF, and CU weaknesses. Megan demonstrated SC, PF, and CU weaknesses. Using her area model, she demonstrated how to make brownies. She was able to explain her answers using the partial products.