Teachers' Knowledge of Fraction Arithmetic with Measured Quantities

Sheri E. Johnson
University of Georgia

Merve Nur Kursav
Michigan State University

Abstract: *A national sample of 990 middle grades teachers completed a knowledge assessment aimed at measuring teachers' knowledge of fraction arithmetic using measured quantities. Utilizing a simple measurement of the percentage of items answered correctly, middle grades teachers scored significantly different based on their undergraduate major. These findings reveal the importance of developing instruction for undergraduates focused on developing their multiplicative reasoning with measured quantities, especially fractions.*

Keywords: Mathematical knowledge for teaching, Fractions, Multiplicative Reasoning

The skills of multiplicative reasoning are important because their development can greatly influence success for students in later mathematics (Beckmann & Izsák, 2015). Common Core (2010) stresses the importance of reasoning with fractions as measured quantities. Middle grades teachers are required to reason multiplicatively using fractional amounts with designated units, and researchers have developed instruments to measure this specific content knowledge needed for teaching (Izsák, Jacobson & Bradshaw, in press; Jacobson & Izsák, 2015; Izsák, Jacobson, de Araujo & Orrill, 2012). The present study investigates how undergraduates with different majors who become middle grades teachers perform on a knowledge assessment of reasoning with fraction multiplication of measured quantities. Based on a sample of 990 middle grades teachers, undergraduate engineering majors scored higher on average than any other major, although this was not deemed statistically significant due to the small number (n=23) and variability. Mathematics majors had mean scores significantly higher than teachers who reported the category of "Other". Izsák et al (in press) reports similar results. Since Business and other STEM majors comprised approximately a quarter and the "Other" category included almost half of the participants, the data were recoded into different categories (see Table 1).

Table 1. Frequency of undergraduate majors

Undergraduate Major	Counts	Percentage
Business or STEM	256	26%
Elementary Education	240	24%
Mathematics Education	169	17%
Other	325	33%
Total	990	100%

At least one of the undergraduate majors has a statistically significant mean score according to a one-way analysis (p-value of less than 0.0001). Furthermore, a Tukey-HSD analysis reveals that teachers with an undergraduate major of Elementary Education and "Other" scored significantly lower than those with a Business or STEM degree. Teachers with an undergraduate degree in Mathematics Education cannot be differentiated from other majors. Middle grades content of multiplicative and proportional reasoning with fractions in context continues to be difficult for many people beyond their K-12 and college education. Business and STEM majors require more advanced mathematics than other majors and it follows they would have more opportunities to apply these skills across a wider variety of contexts and develop mastery.

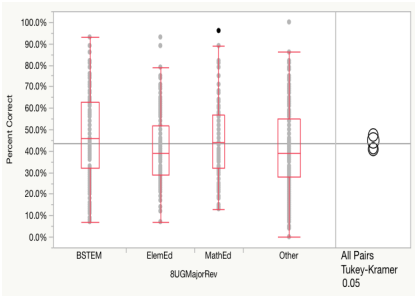

Figure 1

These findings reveal the importance of developing a deep understanding of multiplicative reasoning with measured quantities, especially fractions. Implications are especially important for the undergraduate teaching of our future teachers, who should possess a more robust understanding of this content in order to scaffold their future students learning.

References

Beckmann, S., & Izsák, A. (2015). Two perspectives on proportional relationships: Extending complementary origins of multiplication in terms of quantities. *Journal for Research in Mathematics Education*, *46*(1), 17-38. doi: 10.5951/jresematheduc.46.1.0017.

Izsák, A., Jacobson, E., Bradshaw, L. (in press) Surveying Middle Grades Teachers' Reasoning About Fraction Arithmetic in Terms of Measured Quantities. *Journal for Research in Mathematics Education*.

Izsák, A., Jacobson, E., de Araujo, Z., & Orrill, C. H. (2012) Measuring mathematical knowledge for teaching fractions with drawn quantities. *Journal for Research in Mathematics Education, 43*(4), 391–427. doi: 10.5951/jresematheduc.43.4.0391.

Jacobson, E., & Izsák, A. (2015). Knowledge and motivation as mediators in mathematics teaching practice: The case of drawn models for fraction arithmetic. *Journal of Mathematics Teacher Education, 18*(5), 467-488. doi: 10.1007/s10857-015-9320-0.

National Governors Association Center for Best Practices & Council of Chief State School Officers. (2010). *Common core state standards for mathematics*. Washington, DC: Author.