

**Design Research on Mathematics Education:  
Investigating The Progress of Indonesian Fifth Grade Students' Learning on  
Multiplication of Fractions With Natural Numbers**

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*Abstract*

This study aimed at investigating the progress of students' learning on multiplication fractions with natural numbers through the five activity levels based on Realistic Mathematics Education (RME) approach proposed by Streefland. Design research was chosen to achieve this research goal. In design research, the Hypothetical Learning Trajectory (HLT) plays important role as a design and research instrument. This HLT tested to thirty-seven students of grade five primary school (i.e. SDN 179 Palembang).

The result of the classroom practices showed that measurement (length) activity could stimulate students' to produce fractions as the first level in learning multiplication of fractions with natural numbers. Furthermore, strategies and tools used by the students in partitioning gradually be developed into a more formal mathematics in which number line be used as the model of measuring situation and the model for more formal reasoning. The number line then could bring the students to the last activity level, namely on the way to rules for multiplying fractions with natural numbers. Based on this findings, it is suggested that Streefland's five activity levels can be used as a guideline in learning multiplication of fractions with natural numbers in which the learning process become a more progressive learning.

**Keywords:** multiplication fractions with natural numbers, measurement (length) activity, design research, Hypothetical Learning Trajectory, model of, model for.

**Abstrak**

Penelitian ini bertujuan untuk menginvestigasi kemajuan belajar siswa dalam mempelajari materi perkalian pecahan dengan bilangan bulat melalui lima tingkatan aktivitas berdasarkan Realistic Mathematics Education (RME) yang diusulkan oleh Streefland. Design Research dipilih untuk mencapai tujuan penelitian ini. Dalam design research, lintasan belajar (Hypothetical Learning Trajectory) memegang peranan penting sebagai desain dan instrumen penelitian. Lintasan belajar ini diujikan pada 37 siswa kelas lima Sekolah Dasar (yaitu, SDN 179 Palembang). Hasil penelitian menunjukkan bahwa aktivitas pengukuran panjang dapat menstimulasi pengetahuan informal siswa dalam mempartisi untuk menghasilkan pecahan sebagai level pertama dalam tahapan pembelajaran perkalian pecahan dengan bilangan bulat. Selanjutnya, strategi-strategi dan alat yang digunakan oleh siswa dalam mempartisi secara bertahap dikembangkan menjadi matematika yang lebih formal dimana garis bilangan digunakan sebagai model dari

(model of) situasi pengukuran dan model untuk (model for) penalaran yang lebih formal. Garis bilangan dapat membawa siswa menuju tingkat aktivitas akhir, yaitu dalam perjalanan menuju aturan perkalian pecahan dengan bilangan bulat. Berdasarkan temuan-temuan yang didapatkan, dapat disimpulkan bahwa pembelajaran siswa mengenai materi perkalian pecahan dengan bilangan bulat dimana proses belajar lebih progresif berkembang melalui tingkatan yang berbeda-beda.

**Kata kunci:** perkalian pecahan dengan bilangan bulat, aktivitas pengukuran panjang, design research, lintasan belajar.

### *Introduction*

Researches have identified major problems with current learning methods for teaching fractions. The first dealt with a syntactic (rules) rather than semantic (meaning) emphasis of learning rational numbers, where the learning processes often emphasize technical procedures in doing fraction operations at the expense of developing a strong sense in students of the meaning of rational numbers (Moss & Case, 1999). This problem leads to algorithmically-based mistakes, which result when an algorithm is viewed as a meaningless series of steps so that students often forget some of these steps or change them in ways that lead to errors (Freiman & Volkov, 2004).

In learning multiplication by fractions in Indonesia, most of the students are required to master the procedures and algorithms. They just need to memorize formulas and tricks in calculation to solve the problems. However, we do not know whether the students know and understand the meaning of the procedures and algorithms lay behind it.

Secondly, one of the reasons points out as to why the mathematical notion of fractions is systematically misinterpreted because fractions are not consistent with the counting principles that apply to natural numbers to which students often relate (Stafylidou & Vosniadou, 2004). Focus on the multiplication in counting principles, in multiplying natural numbers, the product is larger than the factor. On the other hand, in multiplying fractions, the product may either be higher or lower than the factors. The fact that multiplication by fractions does not increase the value of the product might confuse those who remember the definition of multiplication presented earlier for natural numbers.

Considering the two aforementioned issues, it seems to be necessary to remodel mathematics teaching and learning, especially in domain multiplication fractions with natural numbers. Therefore, we conducted a design research that developed a sequence of activities referred to Realistic Mathematics Education (RME) approach.