Characterizing fraction addition competence of preservice teachers using Rasch analysis

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Research topic and theoretical framework

Norwegian preservice teachers (PSTs) produce lower scores on tests of prerequisite mathematical knowledge than other student groups, and fractions is a particularly difficult topic (Bjerke et al., 2013; Ánestad et al., 2014). The low mathematical competence in turn poses a hindrance to acquiring didactical competence from courses in mathematics education.

Several theoretical frameworks for mathematical competence emphasize the role of representations and transformations between representations (e.g. Niss & Højgaard, 2011). If the target and source representation are the same, this transformation is called a treatment, whereas it is called a conversion if they are different (Duval, 2006). For example, a calculation in the symbolic representation is a treatment of the mathematical object, while graphing a function from a table is a conversion. Conversions between representations have been suggested to be a common source of incomprehension for students, where the direction of the conversion could substantially affect the perceived difficulty of a mathematical problem (Duval, 2006). As a step towards understanding and strengthening PSTs’ competence with mathematical representations, we ask:

What characterizes PSTs’ competence in representations of fraction addition as they enter mathematics education, and how does their competence develop through teacher training?

In this poster, we report on the development of a Rasch measurement scale for answering these questions, and present quantitative and qualitative results from a group of PSTs at the beginning of their teacher training. By using Rasch analysis we will obtain an invariant measurement scale ensuring that the results can be compared confidently over a time period. Furthermore, this approach provides insight into the dimensionality of competence in representations of fraction addition.

Method

A Rasch instrument including 18 items on fraction addition was developed. The items concerned the transformation between symbolic and two kinds of diagrammatic (area and number line) representations of fraction addition. Data was collected from a group of 98 first-year PSTs who had not yet had instruction in fractions in their mathematics education courses. The group therefore reflects a wide range of experiences with fraction representations from classrooms across the country. The student answers were analysed qualitatively and scored according to pre-defined criteria developed in a pilot study.
**Result and discussion**

First-year PSTs were highly competent at solving fraction addition problems in the symbolic representation register. At the same time, there was large variability in the PSTs’ competence in converting addition problems between the symbolic and diagrammatic representation registers, where conversion from symbolic to diagrammatic form was the most challenging.

Principal Component Analysis (PCA) of the instrument indicated two potential dimensions, or *contrasts*, in the data. The first contrast separated items according to which diagrammatic representation was involved (linear vs area model). The second contrast separated the items according to the direction of conversion between symbolic and diagrammatic representations, which could be considered a subdimension of the instrument. This can be interpreted as saying that competence in representation of fraction addition should be measured using more than one variable.

We conclude that competence in fraction addition was a multidimensional construct for the group of first-year PSTs. The PSTs’ high level of competence in the fraction addition procedures did not necessarily transfer to representing fraction addition in a diagrammatic model, and producing diagrammatic representations was more difficult than interpreting diagrammatic representations, likely reflecting a difference in experience with the different kinds of conversion. These quantitative results were reflected in the qualitative analysis. The coding and scoring process showed that although many of the students that performed well on the area model tasks tended to apply part-whole interpretations to the number line. These results lend support to the theory that different aspects of competence in a single concept can be developed independently (Usiskin, 2015).

The present study provides a foundation for investigating whether different representation registers of fraction addition, and transformations between these, become increasingly associated towards a coherent concept as PSTs progress through the teacher education program.

**References**


