Which textual features are difficult when reading and solving of mathematics tasks?

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Despite the digital revolution much of the mathematics practiced in schools is still tightly bound to two-dimensional texts. This emphasis on text is neither surprising, nor inadequate, since mathematics has developed through a long history with the use of written text, consisting of natural language, mathematical notation and images. Texts are also important in written tests, since reading the text is part of the assessment. If the text is hard to read, that difficulty can be relevant as part of assessing the communicative competence in mathematics. Crucial is however whether potentially difficult textual features are part of what the assessment aims at. This issue is investigated in the current study, using a synthesis of statistical results and qualitative analyses of task text.

Keywords: Mathematics task, text, reading, difficulty.

A critical question is where to draw the line between necessary and unnecessary reading demand and how to judge which textual features that are irrelevant for assessment of mathematics and therefore should be avoided. In the current study this aspect of reading demand is addressed through a mini meta-analysis of four studies where different textual aspects in task text are analyzed in relation to task difficulty (solution frequency) and task reading demand. The theoretical starting point for the current research is an understanding of language as an essential part of mathematics. It has been argued theoretically that the understanding of a mathematical object develops as the student develops her discourse on that object (see e.g. Sfard, 2008). This understanding of mathematics discourse as part of what mathematics is, is in line with the theoretical interpretation of the statistical measure for demand on reading ability (DRA) used in the studies included in the mini meta-analysis conducted in the current study. DRA is a measure of the unnecessary reading demand in a mathematics task, and within this interpretation lies also an assumption of some kind of reading demand that is relevant in mathematics tasks (see also Dyrvold, Bergqvist, & Österholm, 2015).

The purpose of the study is to contribute to the knowledge about which textual features in tasks that are demanding and whether that difficulty is a mathematics relevant difficulty. The research questions are: i) what conclusions can be drawn regarding reading demand in mathematics tasks in relation to textual features?, and ii) how can the conclusions based on statistical analyses be interpreted in relation to a qualitative analysis of mathematics task text with a high reading demand?

The study consists of a mini meta-analysis and a qualitative analysis of the results of the meta-analysis. Only four studies are included in the meta-analysis but even such a small meta-analysis can contribute to the development of knowledge since con-
clusions that would not be possible to draw without such an analysis are likely to be a result of the analysis. The qualitative analysis has a systemic functional perspective (Halliday & Matthiessen, 2004) and includes also images and mathematical notation.

The meta-analysis focuses on textual features in relation to two quantitative measures; task demand on reading ability (DRA) and task difficulty Results in relation to the two dependent variables (difficulty and DRA) are relevant to interpret together since they explain different difficulty aspects, where DRA can be seen as one part of the difficulty aspect. The measure DRA is obtained through a principal component analysis (PCA) on students’ results on PISA reading and mathematics tasks. The result of the PCA is several components that explain different parts of the results on the tasks. The components are statistically disjoint, and therefore the DRA represent demand on a reading ability that is not part of a mathematical ability (see also Dyrvold et al., 2015). Every PISA mathematics task obtains through the analysis a loading value on that component, a value interpreted as the tasks DRA.

The results reveal several features of the natural language that distinguishes tasks with a high DRA, but also that the images are more tightly integrated with the sentences in tasks that have a low DRA but are difficult to solve. For task with high DRA, on the other hand, the sentences are knitted together through the Themes (the topic of the sentence) and Rhemes (what is presented in relation to the theme) something that is not as pronounced in task with low DRA (Theme and Rheme are explained by e.g., Halliday and Matthiessen, 2014). One example of that is can be found in the following sentences. The Themes are underlined. “The sculpture is a half circle with the radius 2m. The half circle is inscribed in a square.” Those sentences represent a linear progression since the Rheme of the first sentence becomes the Theme of the next sentence. A thorough example analysis will be presented in the poster.

The results from the meta analysis reveal other features than the natural language that are related to difficulty but not to DRA and the textual analyses contributes to the interpretation of these results. Tasks with high DRA may be composed in the same way as those with low DRA when it comes to presence of natural language, images, and symbols but for tasks with a low DRA the references between the natural language and images or symbols are of a different kind. In summary, the textual analyses reveal features of the text in tasks with high DRA that enlighten what the high reading demand may stem from.

References

