Project title: Images of Numeracy
Researcher: Drs. K. Hoogland
Period: 2010 – 2016
PhD Research: ESoE
Promotor: Prof. Dr. K. Gravemeijer & Prof. Dr. B. Pepin
Co-promotor: Dr. A. Bakker (Utrecht University)

Problem:
The aim of this research is to contribute to the body of knowledge on (alternatives for) word problems in mathematics education. Word problems are predominant in the mathematics classrooms in teaching students and in assessing students’ ability to solve problems from everyday life. Research on word problems, however, reveals a range of difficulties in their use in the mathematics classroom. In our research we took an alternative approach: we designed image-rich numeracy problems as alternatives for word problems. Our prediction is that students score better on image-rich problems as an indication that the difficulties that occur in using word problems are diminished by this change in representation of the problem situation.

Summary:
The effect of changing the representation of the problem situation in word problems on students’ performance is still under-researched. Research on solving mathematical word problems suggests that students may perform better on problems with an image-rich, more authentically represented problem situation than on word problems. Therefore we needed a validated instrument to measure this effect. The instrument to measure this effect was designed and validated by experts and executed in a test run with over 7,000 participants. In a follow-up study the prediction that students perform better on image-rich problems was tested in a randomized controlled trial with 31,842 students, aged 10 to 20, from primary and secondary education.

A probit model was used to analyse the effects of the manipulated variable – descriptive versus depictive problem situation – against the background or non-manipulated variables (such as school type, grade level, gender, ethnicity, and age). The conclusion was that students scored significantly higher on problems with a depictive representation of the problem situation, but with a very small effect size ($d = 0.09$). The chance of a fictitious participant answering an item correctly increases by around 2 percentage points, which is a relevant effect comparable with effects of family background or gender.