Using interactive items in arithmetic problems to help Grade 3 students shift from intuitive to arithmetic-based strategies and create mental representation.

Abstract

In 2014, 32% of Grade 3 students in fundamental schools in Luxembourg failed to attain the minimum required skill level in mathematics; rising from 30% of students in 2015, as measured by the Ep.Stan examination, a standardized assessment of students at national level. These results have been rather stable since 2011, suggesting that almost 1 in 3 students in grade 3 do not possess the mathematical skills they would need to successfully progress in school. Most students in this bottom tier of performance in mathematics are also found to have low scores in reading skills in the German language (these students also tend to be recent arrivals with a low socio-economic profile) (Martin et al 2014), which as we will see has a compounding effect on their mathematics performance.

At the beginning of grade 3 in the fundamental schools in Luxembourg, students begin to delve into the skills needed to solve arithmetic wording problems. That students encounter more barriers to perform highly in the resolution of arithmetic wording problems than in those problems presented in a numeric form is however a well-known fact (Reusser 1990). The needed skills are not only mathematical, but well-developed skills in reading the language are needed, to solve an arithmetic wording problem (LeBlanc & Weber-Russel 1996). Both conditions do not allow the low performing students, who also perform less well in Ep.Stan, to succeed.

The purpose of this PhD study will be to measure the impact on the test results from Ep.Stan of the grade 3 students by letting students learn on wording problems that require intuitive strategies at first, up to those needing a more arithmetic strategy through interactive animated items in the digital learning environment MathemaTIC.

References:


Research Questions

The following research questions were advanced to guide this study:

- Do grade 3 students’ skills in resolution of arithmetic wording problems improve in the national testing Ep.Stan after the use of the designed learning environment?
- Can the progress of the skill levels of resolution of arithmetic wording problems already been measured during the use of the designed learning environment?

Item Structure

According to Brissiaud and Sander in 2010 on strategies students use to solve the arithmetic wording problems, students rely on the situation described in the wording. There are types of wording problems which could be solved by intuitive strategies (SI problems) and others that would prerequisite more arithmetic knowledge (CC problems). So depending on how the wording problem is presented to the student and the chosen numbers, the strategy and the needed arithmetic knowledge differ (Brissiaud & Sanders 2010).

Beside the arithmetic skills, the language skills, reading and comprehension of the wording problem are necessary to create a mental representation of the described situation, which is vital to find the strategy to solve it (Reusser 1990). In agreement with these researches, ways to improve the skills of solving word problems could be the training of the students on the different types of problems, from SI problems to CC problems, and to support students in creating a mental representation of the described situation.

Study Design

This PhD is a design-based research (Collins et al 2004) and will therefore be divided in different phases of testing, analysing data and remodelling the design during the study according to the results obtained from the data collection. Grade 3 students will take part in the EpStan 3.1 in November 2016. Based on the results of EpStan 3.1, the researcher will choose a representative group of 20 classes of students who will work during on MathemaTIC from January 2017 to July 2018. Between June and November 2017 the researcher will redefine the design taking in consideration the use of students and teachers, based on qualitative data from students and teacher interviews and collected logdata in MathemaTIC. After the redesign and second period of use in 2018, the same students will take part in the EpStan 4.1 in 2018. A comparison will be carried out between the students who have been using MathemaTIC and those in a control group, to measure a possible increase of the skill levels from the students who used MathemaTIC. Before the first use in class in 2017, during the redesign in 2017 and at the end of use in 2018, usability testing will be carried out in an Human-Computer-Interaction Laboratory through the concurrent and retrospective think-aloud-protocol (Kuusela & Paul 2000). This to get data on the first choices students made in the different wording problems and the use of the main interface.