Reading mathematical exercises: preliminary results

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0. Introduction

The Portuguese Ministry of Education (ME) has pointed out as one of the major reasons for the lack of success in mathematics evaluation the difficulties of basic school students in reading and comprehending the examinations' texts. However, these declarations were never rigorously justified, since until the present, no studies revealed the reading behaviours of the subjects while processing mathematical exercises. Studies in this area (Hegarty, Mayer and Green 1992; Thompson 1992) point out mainly to factors associated with mathematical competence.

This study particularly focuses on mathematical exercises resolution by subjects attending the three basic school levels and it is part of a larger research project on reading comprehension of words, sentences and texts that is taking place at the University of Lisbon.

1. Experiment Methodology

Test Material

Exercises used as experimental stimuli have been selected from the full set of national examinations (from 2000 till 2007) and were unimodal (only text) and bimodal (text and image).

Exercises cover different areas which are defined by the national mathematical educational programs:

- *numbers and operations, shapes and space, measures and dimensions (4th year);*
- *numbers and calculus, statistics and probabilities, proportionality (6th year);*
- *numbers and calculus, statistics and probabilities, algebra, geometry (9th year)*

These exercises require the following aspects of mathematical competence:
concepts and procedures, **reasoning**, **problems solving** and **communication**.

Method

Each exercise (see Figure 1) was presented on a computer screen followed by the respective possible answer (see Figure 2). Participants had to read the exercise text and press a certain button if the answer was true or another button if the answer was false.

Time spent reading the exercise text and the answer was registered with *E-Prime*. The accuracy of the answer was also registered.

Figure 1. Examples of the exercises, from the examination test, presented.

Figure 2. Examples of the answers provided.

Participants

95 subjects, aged 9 to 15 years, attending the last levels of the basic cycles in national Portuguese public schools, distributed according to three different levels: 1st level ; 2nd level; and 3rd level.

2. Results

All the exercises were classified considering the following **variables**:

- ✓ Thematic Domain
- ✓ Mathematical Operation Type
- ✓ Number of words on the exercise text
- ✓ Number of words on the answer text
- ✓ Number of images on the exercise text
- ✓ Number of images on the answer text

These variables were contrasted to the **participants' behaviour variables**:

- ✓ Time spent on the exercise text
- ✓ Time spent on the answer text
- ✓ Number of right answers.

First cycle results

There are statistically significant positive correlations between the time spent on the exercise text and the number of words ($p < 0.05$), and between the time spent on the answer exercise and its number of words ($p < 0.01$).

Second cycle results

No correlation of the extension of the text and reading time was found. However, there is a positive correlation between the time spent on the answer text and its number of images, i.e., the higher the number of images in the answer, the higher the time spent on it. More interestingly, there is also a positive correlation between the number of right answers and the number of words of the answer text.

Third cycle results

In this cycle, there are statistically significant positive correlations only between the time spent on the exercise text and the number of words ($p < 0.01$). We find in the same Thematic Domain the best and the worst results. For instance, in *statistics and probabilities,* participants achieve 93% in one exercise and 17% in another.

3. Conclusions

The extension of the exercise text and of the answer influences the time spent on reading and solving the problem, it does not necessarily make the resolution of the exercise harder. In other words, the difficulties in mathematical problems solving, and, consequently, **the high level of unsuccess in this area of knowledge, does not seem to be due to the exercises extension (at least in number of words).**

The Mathematical Operation Type and the Thematic Domains are also determinant for the exercise resolution. In all cycles, but with more evidence in the first one**, *numbers and operations is always the domain with the* highest number of right answers**.

In face of these results, we will look, in further analyses, into correlations between linguistic complexity of the exercises texts (not always very well controlled) and the dependent variables (time spent on exercise text and on answer text, and accuracy of answer) analyzed in this experiment. Besides, we will also contrast the eye movement's data collected while solving the exercises with the exercise characteristics and with the exercises linguistic complexity.

4. References

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