Learning from Errors: Combining correct with incorrect worked modelling examples

This experimental study investigates the incorporation of errors into example-based learning, which is promising, yet insufficiently established. Previous research found mixed results on cognitive performance. In addition, there is a knowledge gap regarding the effect of errors on engagement and self-efficacy, and regarding the relation between learning from errors and self-regulation. This study aims to investigate the use of errors in example-based learning by combining the field of worked examples and modelling examples (resulting in *worked modelling examples*), by combining incorrect with correct examples, and by incorporating multiple design principles. It investigates the effect of the combination of correct and incorrect examples on engagement, self-efficacy, and task performance; and the relation between self-regulation and task performance. Two conditions were compared, one with correct and incorrect worked modelling examples (the C-I condition), and one with only correct worked modelling examples (the C-C condition). The examples were designed in the form of videos, which instructed on adding fractions. Important design components were the use of visual representations in addition to symbolic representations, and the provision of explanations.

82 Fifth grade participants (mean age 11.2 years) started with a self-efficacy and self-regulation questionnaire, followed by a pre-test to measure knowledge on fractions. Next, three pairs of video examples were provided, which were alternated with practice. Video logs recorded how much of the videos was played (i.e., engagement), and practice was used as a measurement. Next, the self-efficacy questionnaire was administered again. To assess knowledge on adding fractions, an immediate post-test was administered. This test was repeated a week later (delayed post-test), followed by a transfer test to assess more complex knowledge. Reliability tests revealed satisfactory to excellent scores on all questionnaires and performance tests. The real-world classroom setting and the random assignment of participants to conditions in each class contributed to the validity of the study.

For both conditions, log data revealed high engagement. The C-I condition had significantly higher play rates on several comparisons. The higher engagement in the C-I condition might be explained by the motivating and activating effect errors can have. Self-efficacy increased considerably, especially in the C-C condition. This might have been a result of the provision of a correct solution after each example in the C-C condition. Performance outcomes showed substantial increases in both conditions from pre-test to practice, and to the immediate and delayed post-test. Presumably, the deliberate design of the examples has accounted for these results. Self-regulated learning was positively related to performance in the C-C condition, but this was not substantial in the C-I condition. This unexpected finding calls for more investigation on the relation between self-regulation and learning from errors. Furthermore, future research can look deeper into what factors contribute to engagement, and into the effect of the combination of correct and incorrect examples on cognitive performance and on self-efficacy. This study contributes to the field of example-based learning and learning from errors, by revealing the positive effects of the combination of correct and incorrect worked modelling examples.