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# The Influence of Note-taking on Mathematical Solution Processes while Working on Reality-Based Tasks

It is known that dealing with reality-based tasks require special linguistic competencies (Leiss et al., 2019), which contradicts the ubiquitous assumption that mathematics and language are two fundamentally different and clearly separable scientific fields. Although there is a large amount of available research on the topic, Strohmaier et al. (2023), Ufer et al. (2020) and Peng et al. (2020) describe in their meta-analysis that it would be premature to draw a conclusion about the kind of connection between mathematics and language.

## Theory

Numerous empirical studies have shown that the translation process between reality and mathematics while working with reality-based tasks is associated with cognitive barriers (Galbraith & Stillman, 2006). The formation of an adequate situation model from the task text, which is the prerequisite for correctly solving reality-based tasks, challenges many students and depends heavily on various individual linguistic abilities (Strohmaier et al., 2023) - especially reading comprehension (Leiss et al., 2010; Pongsakdi et al., 2020) and reading strategy application (Schlager, 2020; Schmitz & Karstens, 2022; Schukajlow & Leiss, 2011).

A promising reading and solution strategy for overcoming the difficulties described above is note-taking (Graham et al., 2020; Rogiers et al., 2020; Rovers et al., 2019; Samuelstuen & Bråten, 2007; Schukajlow et al., 2012; Wienecke et al., 2023)

## Research Questions

However, differentiated analyses of the design of notes and the specific influence of note-taking on the solution process represent a research desideratum, which is addressed in the present study:

- RQ1: Which characteristics of note-taking are exhibited by students during the solution of reality-based tasks?
- RQ2: What personal characteristics are associated with the creation of solution-process-related notes in reality-based tasks?
- RQ3: In addition to personal and language characteristics, to what extent does taking notes explain additional variance regarding to the solution of reality-based tasks?

In: P. Ebers, F. Rösken, B. Barzel, A. Büchter, F. Schacht & P. Scherer (Hrsg.),
*Beiträge zum Mathematikunterricht 2024.*
*57. Jahrestagung der Gesellschaft für Didaktik der Mathematik.* WTM.
https://doi.org/10.37626/GA9783959872782.0

## Method

The data on note-taking and text comprehension were collected as part of the VAMPS project1 using a within-subject design. 424 students (47.0 % ♀, 50.6 % ♂, 2.4 % non-binary) in grades 7 to 10 at a cooperative comprehensive school in Lower Saxony generated 1272 responses by completing 3 tasks each in a paper-pencil survey. The different types of notes that were generated while working on the reality-based tasks were considered in the evaluations both as dependent (RQ2) and independent variables (RQ3, AV: task solution). In addition to the tasks, a Cloze test, a subject test on the mathematical content areas of the tasks and a socio-demographic questionnaire were used to record covariates. The paper-pencil test was administered on a single school day in 26 classes. To avoid class effects, different test booklet versions were randomly distributed among the participating classes. After a brief test instruction, each student had 85 minutes to complete the booklet individually.

Each one of the 3 focused tasks consists of an item describing a reality-based task stimulus. The stimulus was followed by a question about interest and prior knowledge. After that, there are 9 reading questions designed to provide information on how easy or difficult it was to understand the task stimulus, which was varied according to Heine et al. (2018). At the end of the double-sided page the task should be solved.

## Results

Overall, notes were taken unprompted for just under a third of the tasks completed (RQ1). In percentage terms, it can be seen that, contrary to expectations, underlining is not the most frequently used form of note-taking (RQ1). One fifth of the tasks tended to be solved using the strategy of writing out the relevant data (RQ1). About a quarter frequently used strategy is the use of structuring features (RQ1). Regarding the influence of personal characteristics, the strongest significant correlation was found with socioeconomic status(RQ2). Regarding the influence on the technical solution (RQ3), the coefficients of a Generalized Linear Mixed Model show that notes are a significant predictor for the correct solution of reality-based tasks, controlling mathematical and linguistic profiency. If text comprehension is added as a possible predictor, text comprehension and making helpful notes remain significant in addition to inner-mathematical and linguistic competencies. The

1 The data collection and analysis described here was conducted as part of an interdisciplinary project funded by the German Research Foundation (DFG-project no. 417017613, project leader: Dominik Leiss, Knut Schwippert, Timo Ehmke, Lena Heine, and Dietmar Hoettecke).

model fit was tested with a conditional $R^2$(Nakagawa et al., 2017) and the Akaike information criterion (Burnham & Anderson, 2004), and it was found that the models that include note-taking are better than those without notes. As a result, it can be seen that different forms of note-taking have different influencing factors that affect the solution process differently and that further analysis is therefore required in this area.

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