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Support-Related Diagnostics in Mathematics Including Reading - FORMULA

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Introduction

The project *Formula* is funded by the German Federal Ministry of Education and Research. It aims to explore the relationship between the mathematical participation of students in inclusive education (in transition from primary to secondary school) as well as their reading skills and how these can be combined. The overall goal is to develop a highly valid, supportive diagnostic tool that can be used to assess reading and mathematical competencies as well as their interconnections. In combination with the associated remediation this is called the *Formula-Concept*. In this way, the project *Formula* responds to a problem of many already existing diagnostic and remediation instruments: They exclusively focus on subject-specific competencies and are neither linguistically appropriate nor linguistically sensitive.

Theoretical Background

Research findings confirm the connection between linguistic and mathematical skills - even for students with learning difficulties and developmental disabilities (Mann Koepke & Miller, 2013; Martin & Mullis, 2013). Students' language competencies are essential for the development of mathematical understanding and are considered as a predictor of learning growth (Prediger et al., 2019). Reading comprehension is regarded as a key skill in all subjects, including mathematics (Borasi & Siegel, 2000; Grimm, 2008). Reading promotion is a necessary component to be taught not only in language lessons but in all subjects. Moreover, this can be important for learners with special needs in particular.

As most recently shown by the empirical studies PIRLS 2016 and TIMSS 2019, a significant proportion of children in Germany at the end of primary school show both below-average mathematical competencies (25% below proficiency level 3; Selter et al., 2020) as well as an insufficient level in hierarchically higher reading processes (19% below proficiency level 3; Hußmann et al., 2017). However, it is unclear how reading skills affect the development of mathematical competencies and which relevance lower- and higher-hierarchical reading processes play in this context.

Research design

In our project we are addressing five research questions using a combination of a research design approach and an intervention study (see Table 1).

Table 1: Connections between research questions, methods and expected results

research questions	methods	expected results
1) How do students' learning processes proceed? What difficulties do they face and what kind of potentials becomes visible? (learning processes) 2) What does a supportive diagnostic concept and design look like? (design) 3) What are the local theories about the relationship between mathematics and reading competencies? (theory)	design-oriented developmental research approach, e.g. cyclic sequential design experiments, eye-tracking	detailed results concerning the correlation between mathematical competencies and reading comprehension
4) How do reading and mathematical competencies influence each other during the mathematical learning process? (relation math + reading)	pre-post interventional study	individual strategies of students, obstacles, potentials
5) How do teachers in elementary and secondary education use the Formula-Concept in their mathematics lessons to integrate reading promotion? (teaching profession)	design-oriented developmental research approach, survey	conditions for a sustainable transfer

The knowledge aims concern the differential evaluation of the competencies of reading and mathematics competencies. However, this is related to the presentation and meaningful context of mathematical tasks. Therefore, appropriate combined support measures for mathematics and reading should be developed, distinguishing between representational and contextual tasks. Tasks from the BASIS-MATH 4-+5 (Moser Opitz et al., 2016) are further developed and specified with regard to the competencies considered in this project. The resulting diagnostic tool will be pre-tested in individual sub-areas on smaller samples first (on average $N=60$ /item), then piloted as an overall diagnostic tool ($N=150$). Additionally, students' reading comprehension will be assessed at the word, sentence, and text levels with help of the diagnostic test ELFE II (Lenhard et al., 2017).

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