

FORMULA: Fostering-related Diagnostics in Mathematics including Reading

Foerderbezogene Diagnostik in Mathematik inklusive Lesen

INTRODUCTION

- Target group: Transition from primary to secondary school (grade 4 + 5)
- Problem: 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
- 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

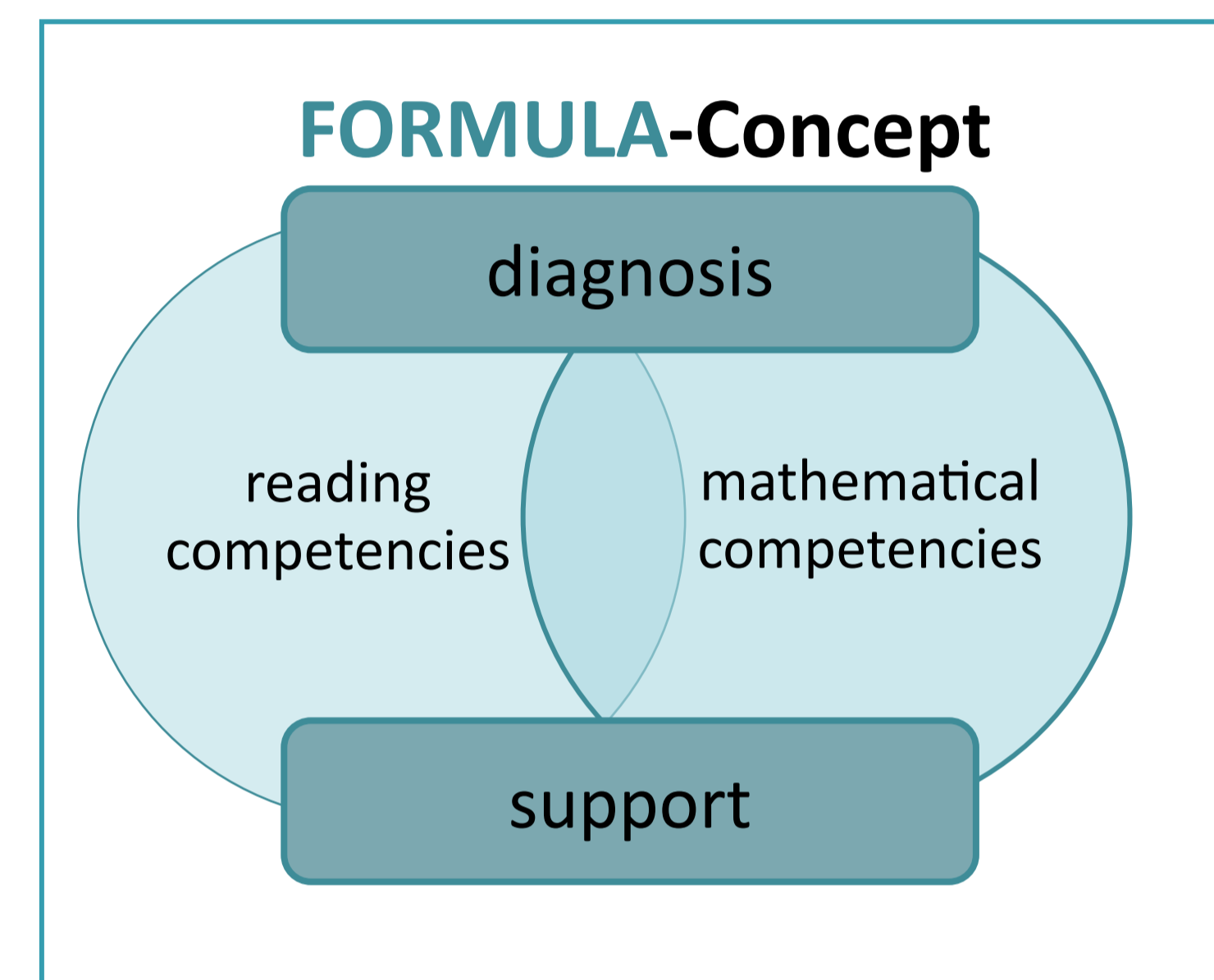
GOALS

- First goal: Exploration of relationships between the mathematical participation of students in inclusive education and their reading skills and how these can be combined
- Second goal: Development of a valid, supportive diagnostic tool → used to assess reading and mathematical competencies as well as their interconnections

THEORETICAL BACKGROUND & STATE OF RESEARCH

- Results of 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 higher hierarchical reading processes (19% below proficiency level 3; Hußmann et al., 2017)
- 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)
- Reading comprehension is regarded as a key skill in all subjects, including mathematics (Borasi & Siegel, 2000; Grimm, 2008)
- Word problems combine both reading and mathematical skills and have shown to pose a difficulty for many students (Verschaffel et al., 2000)
- On mathematical level, the following characteristics can be an obstacle: type and number of operations (Reusser, 1997), seriality of numbers (Franke & Ruwisch, 2010) & additional information (Daroczy, 2015)
- There are also many linguistic features that can cause difficulties in understanding, e.g. passive voice or subordinate clauses (Abedi et al., 2001)

research questions	methods	expected results
1) How do students' learning processes proceed? What difficulties do they face and what kind of potentials do become visible? (learning processes)	design-oriented developmental research approach, e.g. cyclic sequential design experiments, eye-tracking	Detailed results concerning the correlation between mathematical competencies and reading comprehension
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)		
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



DIAGNOSTIC DESIGN FOR WORD PROBLEMS

SIMPLE EXAMPLE

Ali's purchase

Ali buys 40 cups for a party. There are 8 cups in a box.

seriality: is given (40:8)

level of complexity: one-step

level of information: essential information

number range: natural numbers

computing effort: low

ANALYSIS CHARACTERISTICS

linguistic characteristics

Word level

- technical terms
- phrasal verbs
- prefix verbs
- nominalization
- compound word
- keywords

Sentence Level

- prepositions
- cohesion funds
- hypotactic sentence structures
- passive
- genitive

mathematical characteristics

- seriality in the sequence of numbers for the calculation
- level of complexity
- level of information
- number range: natural numbers
- computing effort: low

COMPLEX EXAMPLE

Ali's purchase

A class party is planned soon. Ali gets 15 euros from his mother for it. Ali sets off for the supermarket because a total of 40 drinking cups are needed. While shopping, Ali pays 2 euros for 8 cups.

seriality: not given

level of complexity: multi-step

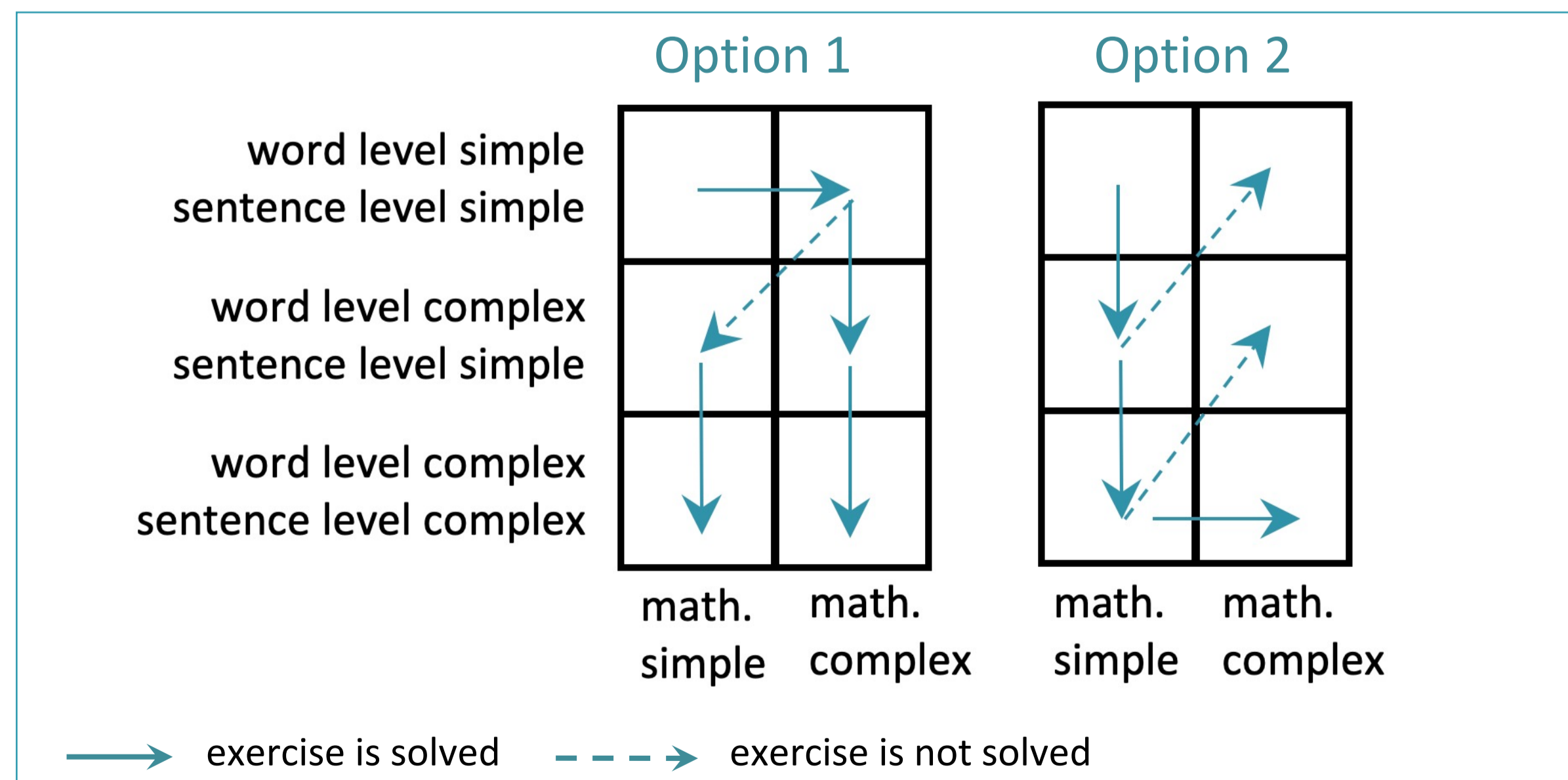
level of information: additional information

number range: natural numbers

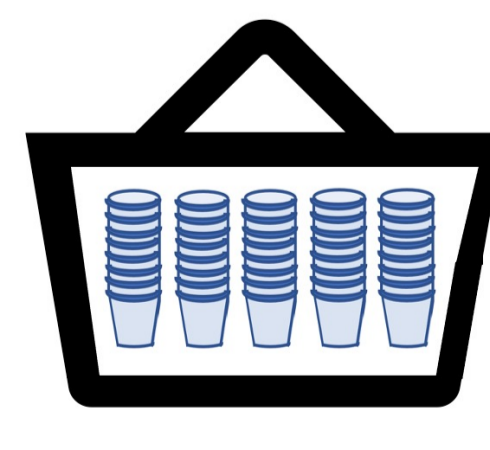
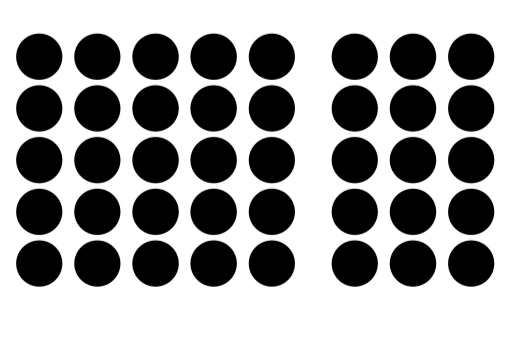
computing effort: low

DIAGNOSTIC PROCESS

Each child goes through one option in this process. Prior to this, reading and operational comprehension are assessed separately in individual tests.



EXERCISE FOR DIAGNOSTIC

reading comprehension	reading comprehension & mathematical competencies	mathematical competencies									
Point out what you remember in your own words.	Paint a picture of the text.	a) Write a question after reading the text. Underline in the text.									
Which words do you not understand? Mark them.	Does the picture match the text? Tick off.	b) What do you need for your calculation?									
Is the sentence correct? Tick.	 	c) Calculate the result. Write an answer.									
<table border="1"> <thead> <tr> <th>Sentence</th> <th>Correct</th> <th>Incorrect</th> </tr> </thead> <tbody> <tr> <td>Ali buys 40 drinking cups for a birthday party.</td> <td></td> <td></td> </tr> <tr> <td>...</td> <td></td> <td></td> </tr> </tbody> </table>	Sentence	Correct	Incorrect	Ali buys 40 drinking cups for a birthday party.			...			<p>Ali has too little money to buy the drinking cups.</p> <p>Is Nick right? Calculate and give reasons.</p>	
Sentence	Correct	Incorrect									
Ali buys 40 drinking cups for a birthday party.											
...											

LITERATURE

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