

## **Three types of cognitive activation in mathematics education: a qualitative-reconstructive video analysis.**

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### **Abstract**

Cognitive activation is treated as one of the three basic dimensions of teaching quality (Klieme et al., 2009) and was recently included in the MAIN-TEACH model according to Charalambous and Praetorius (2020). The dimension has been empirically examined in a variety of studies, in different school subjects, and across different school types (Praetorius et al., 2018). So far, cognitive activation has been operationalized predominantly as an offering brought into the classroom by the teacher. However, little is known about how these cognitively activating stimuli are processed interactively between the teacher and the students in the classroom.

In the study videos from 9th grade mathematics classes on the topic of quadratic equation from the TALIS-video study in Germany were analyzed regarding their cognitive activation. The qualitative-reconstructive Documentary Method (Asbrand & Martens, 2018; Bohnsack, 2021) was used to investigate how cognitive activation is interactively produced and processed in the classroom.

In the talk, the reconstructed types are presented with respect to the handling of cognitive activation. The first type '*activation for reproduction*' can be described by an instructivist understanding of teaching by the teacher, in which activating impulses predominantly stimulate the students to reproduce knowledge. The second type '*activation to unsystematic trying*' is characterized by a mediating understanding of teaching. Impulses are characterized by the fact that they cannot be processed with the existing prior knowledge of the students. The last type '*activation to construction*' is characterized by a constructivist understanding of teaching on the part of the teacher and impulses are developed in a co-constructive process by the students in cooperation with the teacher.

## **Extended summary**

Cognitive activation, along with classroom management and constructive support, is one of the three basic dimensions of teaching quality (Praetorius et al., 2018). The dimension recently was included in Charalambous and Praetorius (2020) MAIN-TEACH model of instructional quality. Instruction is supposed to be cognitively activating primarily when it focuses on understanding and reasoning, when it provides challenging content and tasks, and when it connects to learners' prior knowledge and experiences (Klieme, 2019). Theoretically, the construct is grounded in cognitive and social constructivist and learning theories (Piaget et al., 1985; Vygotsky, 1978).

While individual studies provide empirical evidence for sufficient construct validity or predictive validity of cognitive activation (Kunter & Voss, 2013; Lipowsky et al., 2009), numerous studies exist that do not support this (Fauth et al., 2014; Pauli et al., 2008) and highlight theoretical as well as methodological challenges of the construct. In addition, the results of various video studies show that, first, agreement between external observers is usually weak and, second, scores for cognitive activation tend to be low compared to other dimensions of instructional quality (Bell et al., 2020).

The (instructional) theoretical underpinnings and empirical approach to cognitive activation in the classroom continue to be the subject of lively debate in empirical educational research (Praetorius & Gräsel, 2021). Capturing and assessing cognitive activation, especially in observational studies, poses several problems. The biggest problem is the unobservability of a student's actual cognitive activation. In addition, the black box problem remains: The view into the students heads remains closed, so that a direct cognitive activation cannot be observed anyway. For this reason, observational studies can only infer the potential for cognitive activation (Klieme, 2019), e.g., the extent to which the teacher designs the learning environment to facilitate students cognitive activation. Another problem seems to be the strongly teacher-centered perspective in the assessment of cognitive activation.

This study tests a new approach to observing cognitive activation. The analyses presented here follow an understanding in which instruction is seen as an interaction of 'offer' and 'use'. These 'offer-use' models (Vieluf et al., 2020) assume that the offers often induced by the teacher (e.g., in the form of tasks or questions) must be used by students in order to have an effect on them (e.g., in the form of learning gains). According to this understanding of offer and use, the offer structured by the teacher constitutes the condition for the possibility of use by the students but

does not determine it. According to this conception, the question of whether and how the offer is used also depends on the characteristics of the students and on contextual factors.

The aim of this study is to take a closer look at the processes of cognitive activation in the classroom using a research approach to analyze classroom interactions (Asbrand & Martens, 2018) to provide an empirical basis for describing cognitive activation. The analyses are based on videos from the TALIS-video study in Germany. Individual subsequences are selected from the videos of a total of 50 teachers, which were recorded twice in the teaching unit of quadratic equations in mathematics classes and analyzed qualitatively-reconstructively. The sequences selected in this way are analyzed using the documentary method by Bohnsack (2021), which was extended by Asbrand and Martens (2018) to a method specifically developed for the analysis of instructional videos. The documentary method has proven to be particularly suitable for capturing learning and competence acquisition processes (Martens & Asbrand, 2009).

By analyzing several video sequences, three different types could be reconstructed that describe different ways of dealing with cognitive activation. The main framework that shapes these types is the design of the cognitive activating impulse by the teacher and the processing of this impulse by the students. Furthermore, the handling of the students' prior knowledge plays a central role in the description of the three types. The types are framed by different attitudes of the teachers, such as the understanding of teaching, and the attitudes of the students towards the completion of tasks. The first type '*activation for reproduction*' can be described by an instructivist understanding of teaching by the teacher, in which activating impulses predominantly stimulate the students to reproduce knowledge. Specifically, in these sequences' problems are often induced by the teacher that is not addressed as such by the students themselves. The second type '*activation for trial and error*' is characterized by a mediating understanding of teaching. Impulses are characterized by the fact that they cannot be processed with the existing prior knowledge of the students. The problems posed by the teacher are always worked out in cooperation with the teacher. The last type '*activation for construction*' is characterized by a constructivist understanding of teaching on the part of the teacher and impulses are developed in a co-constructive process by the students in cooperation with the teacher. The students make assumptions that are taken up by the teacher in the discourse.

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