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Teaching for cognitive activation: Outstanding mathematics teaching in a Nordic context

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Abstract (300 words)

The aim of the study was to enrich empirical understandings of teacher-student interactions in mathematics lessons with a high-level of cognitive activation in a Nordic context. Cognitive activation is claimed to consistently emerge as a crucial component of teaching quality. It involves both the cognitive challenge of tasks and the level of student engagement in classroom discourse. Although some studies have found cognitive activation to be positively linked with student achievement gains, research is scarce in developing empirical understandings of how teachers engage in teacher-student interactions that create potential for cognitive activation. This study builds on a Nordic video database of 40 mathematics classrooms from Iceland, Denmark, Sweden and Norway. Two lessons from each country were identified where the teacher offered students rich opportunities for cognitive activation as indicated by high classroom observation scores in two elements: intellectual challenge and classroom discourse. These eight lessons were translated and transcribed. The teacher-student interactions were then analyzed using reflexive thematic analysis.

Preliminary findings showed both similarities and differences in teacher-student interactions in the lessons. Contrary to what some might expect, the teachers engaged in considerable direct, explicit instruction and explanations to the whole class. However, explicit instruction was commonly interspersed with student input through student "prompting", such as to state solutions, explain how or why, or share understandings with other students. Rapid transitions between these two "modes of teaching" were common in these lessons. The instructional format of the lessons was not devoid of what may be described as "traditional mathematics teaching" – parts of some lessons included procedural exercises and examples on a whiteboard. However, toward the end of the lessons, the focus tended to shift toward more cognitively activating tasks. This study contributes richer empirical understandings of cognitive activation which are vital to apply research results to teacher training and development.

Extended summary (1000 words, excluding reference list) Include introduction, theoretical background, methods, aims, preliminary findings/findings, results, theoretical and education significance, relevance to the QUINT ambition and the reference list.

Introduction

Cognitive activation has been both conceptualized and operationalized in several different ways. In its most basic terms, cognitive activation is defined as all features of teaching quality which cognitively activates students (Neumann et al., 2012). Indicators of cognitive activation may involve the cognitive challenge of tasks or the level of student engagement in classroom discourse. Cognitive activation has been measured both by directly rating the tasks that students are set to solve, such as on class tests (e.g., Kunter & Voss, 2013), and by rating lesson segments using observation frameworks (e.g., Pianta & Hamre, 2009). Some studies have found cognitive activation to be positively linked with student achievement gains (Klieme et al., 2001; Krauss et al., 2020; Lipowsky et al., 2009). However, research is scarce in developing empirical understandings of how teachers engage in teacher-student interactions that create potential for cognitive activation, particularly in lower secondary mathematics. In a video study on early science education, the most common interactions underpinning cognitive activation involved challenging questions, while instructional dialogue was the rarest type of interaction (Kotzebue et al., 2020). The current study aims to contribute to these empirical understandings under the research question: What exemplifies teacher-student interactions in lower secondary mathematics lessons considered outstanding in cognitive activation in a Nordic context?

Theoretical background

Cognitive activation is claimed to consistently emerge as a crucial component of teaching quality and is one of the “German Three Basic Dimensions” of teaching quality (Kunter et al., 2013; Praetorius et al., 2018). In an analysis of 12 observation frameworks, Praetorius and Charalambous (2018) defined cognitive activation in terms of three teaching practices: (1) selection of appropriately challenging tasks and use of mathematically rich practices, (2) facilitation of cognitive activity, and (3) support of meta-cognitive learning from cognitively activating tasks. The theoretical foundation of the concept lies in both the application of cognitive science to educational situations and (socio)constructivist theories of learning. The primary theoretical assumptions are that to activate students cognitively, i.e., teach for understanding, the teacher must: (1) in the constructivist view, engage students in cognitive conflicts through challenging problems and questions, and (2) in the socio-constructivist view, invite students to participate in classroom discourse and communicate their ideas to develop conceptual understanding (Praetorius et al., 2018).

Methods

The study builds on a Nordic video database of 40 mathematics classrooms from Iceland, Denmark, Sweden, and Norway. Each lesson had been scored by trained observers in the mathematics-adapted Protocol for Language Arts Teaching Observations (PLATO; see Grossman, 2019). For this study, specific lessons were identified where the teacher offered students rich opportunities for cognitive activation by considering the PLATO scores for intellectual challenge (IC) and classroom discourse (CD). The “top two” lessons in these elements from separate classrooms from each country were selected, for a total of eight cognitively activating lessons from eight separate classrooms. The chosen lessons (beside lessons from Iceland) were transcribed and translated by Nordic research colleagues. The research colleagues also provided contextual information as well as confirming mutual understandings of instances of ambiguity, furthering the credibility of results. The teacher-student interactions were analyzed with reflexive thematic analysis (Braun & Clarke, 2022). Both the video-recorded lesson data and translated lesson transcripts were used in the analysis. Each

interaction was coded with regard to its educational meaning. Clusters of codes were used to generate themes with meaningful contribution toward understanding the nature of teacher-student interactions in these highly cognitively activating lessons.

Aims

The aim of the study was to enrich empirical understandings of teacher-student interactions in mathematics lessons with a high-level of cognitive activation in a Nordic context.

Preliminary findings

Preliminary findings showed both similarities and differences in the teacher-student interactions in the lessons. Contrary to what some might expect, the teachers engaged in considerable direct, explicit instruction and explanations to the whole class. However, explicit instruction was commonly interspersed with student input through student "prompting", such as to state solutions, explain *how* or *why*, or share understandings with other students. Rapid transitions between these two "modes of teaching" were common in these lessons, which instigated a feeling of diversity and variation. Students were frequently given opportunities to explain their understanding before the teacher provided feedback or explained further, inviting student's *asserting mode* instead of *accepting mode* (Mason & Johnston-Wilder, 2006).

Many teachers also engaged in "connection-making" interactions. These interactions aimed both to connect the tasks to student's previous experiences or daily lives, and to draw connections between mathematical concepts and methods. This can be interpreted as an effort to move students toward relational understanding of mathematics. The notion of "withitness" was also richly observed; commonly checking student progress, keeping students on task, and checking on student feelings (e.g., "are you tired?" and "how did it go yesterday?").

The instructional format of the lessons was not devoid of what may be described as "traditional mathematics teaching" – parts of some lessons included procedural exercises and rules/examples on a whiteboard. However, toward the end of the lessons, the focus tended to shift toward more cognitively activating teaching. Some of the highest scoring lesson segments involved structured group activities (games) where students took on an explicit pre-determined role in the social environment (e.g., secretary who writes, professor who explains) which shaped the interactions that took place. This particular result invites further questions on the potential role of theater/drama in developing teaching practices with high-level cognitive activation.

Theoretical and education significance

Continued developments of empirical understandings of cognitively activating interactions is crucial to apply the promising research results on cognitive activation to teacher training and professional development. Richer empirical understandings may (or should) inform theoretical development.

Relevance to the QUINT ambition

The QUINT ambition is to produce new insights into what characterizes teaching quality in Nordic classrooms. Building on video and transcript data from QUINT's LISA Nordic video database, the aim of the study was to explore in what way teachers interact with students that contributes to the lesson's high level of cognitive activation potential.

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