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Approaching the challenges of assessing academic rigour in mathematics instruction in Iceland

Abstract (300 words)

For mathematics teaching to be considered of good quality, it is necessary to uphold a certain level of academic rigour. In the PLATO framework, intellectual challenge captures „the academic rigour of activities, assignments and teacher questions“ as part of the instructional domain of disciplinary demand (Grossman, 2019, p. 32). One of the challenges that arise when analysing this teaching quality element from video is when students are working individually on problem sets in textbooks, either in silence or with indistinguishable chatter. This textbook-work instructional pattern is the most common one in mathematics classrooms in Iceland, both according to our classroom video data and previous reports on the lower and upper secondary level (Jónsdóttir et al., 2014; Þórðardóttir & Hermannsson, 2012). It is a challenge to assess academic rigour in classrooms where activities and assignments are not made explicit in whole-class instruction, but strictly referred to as numbered problems in textbooks. In order to provide a more holistic assessment of the quality of intellectual challenge, not only must the teacher questions be analysed from the video data, but also the tasks themselves that students are set to be solving in the lesson. Frameworks exist both for analysing what has been called the “cognitive demand” of mathematical tasks (Stein, 2009) and the types of reasoning that students engage in when justifying their answers (Lithner, 2008). Introducing these additional frameworks for further analyses, that consider activities and assignments separately from video data, can supplement their occasional absence in teachers’ instruction as observed from classroom video and thereby provide a more multi-layered approach to the quality of academic rigour. I would welcome a discussion of the strengths and weaknesses for this approach for a more thorough and reliable measure of the quality of academic rigour in the classroom.

Extended summary (1000 words, excluding reference list) introduction, theoretical background, methods, preliminary findings/findings, results, reference list.

For mathematics teaching to be considered of good quality, it is necessary to uphold a certain level of academic rigour. In the PLATO framework, intellectual challenge captures „the academic rigour of activities, assignments and teacher questions“ as part of the instructional domain of disciplinary demand (Grossman, 2019, p. 32). Within PLATO, the score for intellectual challenge is advanced when teacher and student questions are more challenging than the activity as initially presented, and degraded when questions and comments are less challenging, such as when a teacher walks through to an answer directly without asking questions or requiring student thinking.

One of the challenges that arise when analysing this teaching quality element from video is when students are working individually on problem sets in textbooks, either in silence or with indistinguishable chatter. This textbook-work instructional pattern is the most common one in mathematics classrooms in Iceland, both according to our classroom video data and previous reports on the lower and upper secondary level (Jónsdóttir et al., 2014; Þórðardóttir & Hermannsson, 2012). In some cases, the video data shows little or no explicit instruction from the teacher to the whole

class, with instruction taking the form of short "teacher-student conferences" when a student asks for assistance. Even though students may be involved in higher-order thinking processes in constructing their solutions, it is not easily captured on video with a classroom-wide lens for this type of instruction. Given these constraints, how can the teaching quality element of intellectual challenge be more thoroughly and reliably measured?

A key factor in moving toward learning goals of activities, from curricula or textbooks and to the students, is via the instruction from the teacher. The teacher can make a low-challenge task require higher order thinking by asking students to justify their answers and explain their solutions. The teacher can also make a high-challenge task less demanding. In addition to teacher questions, the PLATO manual also includes both activities and assignments as part of the objects of analysis for intellectual challenge. Therefore, a researcher faces a real "intellectual challenge" when assessing academic rigour in classrooms where activities and assignments are not made explicit in whole-class instruction, but strictly referred to as numbered problems in textbooks. In order to provide a more holistic assessment of the quality of intellectual challenge, not only must the teacher questions be analysed from the video data, but also the tasks themselves that students are set to be solving in the lesson.

Frameworks exist both for analysing what has been called the "cognitive demand" of mathematical tasks and the types of reasoning that students engage in when justifying their answers. In Stein's framework (2009), tasks are divided into four categories, two of low cognitive demand and two of high cognitive demand. In the author's previous study on Icelandic textbooks in upper secondary schools, over 80% of tasks score as low cognitive demand, which makes it up to the teacher to advance and uphold the mathematical rigour of the activities should they be considered challenging (Sigurjónsson, 2014). For the current QUINT research ambition, the tasks in each classroom should be analysed separately. Lithner's (2008) framework divides types of student reasoning into two categories: creative reasoning and imitative reasoning. For the lessons that do include student reasoning, it would be interesting to investigate what kinds of reasoning students really engage in when they justify their answers to the teacher.

Introducing these additional frameworks for further analyses, that consider activities and assignments separately from video data, can supplement their occasional absence in teachers' instruction as observed from classroom video and thereby provide a more multi-layered approach to the quality of academic rigour. The weakness to this approach is that it still does not measure what students notice and direct attention to when working silently. That cannot be done without specifically analysing student work, e.g. by strapping cameras on students' heads with visual sensors – as actually has been done with teachers in a recent study (Haataja et al., 2019). However, its strength is that it does measure the cognitive demand of tasks or assignments that the teacher chooses for the students to engage in (and could also identify the tasks that the teacher chooses not to engage in). Therefore, I argue this approach more reliably measures academic rigour by specifically analysing the quality of assignments and activities, that PLATO indeed does consider as part of intellectual challenge.

I would welcome a discussion of the strengths and weaknesses for this approach for a more thorough and reliable measure of the quality of academic rigour in the classroom. I find it important for a video study such as LISA Nordic to align its theoretical approach to the diverse classroom data at hand. More broadly speaking, the patterns that emerge in video data may be difficult to detect by the pre-determined protocols, and it is possible that these patterns become hidden because of a certain cultural difference that the protocols fail to consider. A possible scenario is that the added meaning in these hidden patterns is limited, such as if the inexplicit instruction found in the Icelandic data

simply fails to uphold academic rigour. Obtaining such a result will likely require a more multi-layered analysis to the data at hand than PLATO alone can provide.

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