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# Observation is hard: The challenges involved in developing a shared understanding of classrooms

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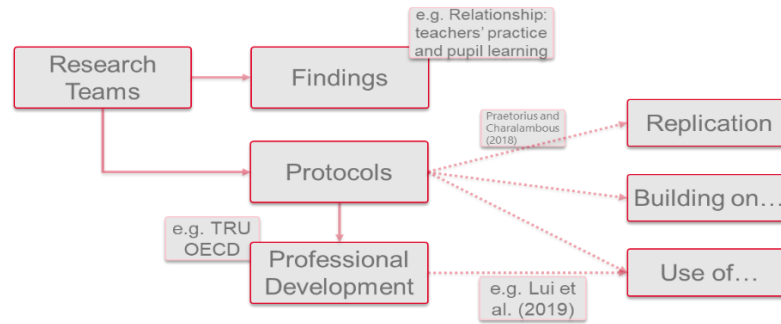
*Mathematics classrooms are widely recognised as complex and dynamic, with interactions occurring with an intricate combination of cultural, social and mathematical facets. A wide range of observation protocols have been developed, often with the aim of improving teaching and student outcomes. However, these are often high-inference instruments, so use by those outside of the development team is problematic. This paper seeks to contribute to the debate as to how researchers can build on prior studies through the application of a previously developed observation framework to a shared data set of a class video and transcript. The purpose and structure of the Orchestration of Mathematics Framework (OMF), developed for a classroom-based video study, is outlined, with the underpinning conceptualisations of teaching signposted. A 17-minute section of a lesson is then analysed in order to illustrate the affordances and limitations of the OMF.*

*Keywords: Classroom techniques, classroom observation, teacher response.*

## Introduction

Building a shared understanding of how to interpret classrooms is a complex undertaking. Since Wiliam and Bartholomew (2004) argued that teachers' classroom activities are weakly theorised, a range of observation frameworks have been developed (e.g. Ingram et al., 2020; Schoenfeld, 2013). These vary in purpose, from research through to professional development for teachers, but also in structure, content, and focus. For example, different conceptualisations of effective teaching has led to different categories in observation rubrics. There have been efforts to compare frameworks (e.g. Praetorius & Charalambous, 2018), but with language used in different ways, it is not always clear to those outside of the research team as to how the theoretical considerations have been operationalised.

Observation protocols often use high-inference instruments, evidenced by the high level of training needed for observers. Many frameworks seek to capture the quality of instruction (Praetorius & Charalambous, 2018), but notions of high-quality teaching are often embedded within these high-inference components rather than explicitly operationalised (Liu et al., 2019). Within this complex landscape, the Orchestration of Mathematics Framework (OMF) was developed for a classroom-based video study (Baldry, 2019). The rationale, at that time, for adding to rather than building on prior protocols was two-fold. First, accessing and understanding published protocols was problematic, for the reasons outlined above. Second, the focus on quality of instruction appeared to obscure the earlier stage of developing a better shared understanding of what was happening in the mathematics classroom. In particular, a key goal was to find ways to notice and describe teachers' pedagogical moves and the relationships to the mathematics made available to students. However, this development perpetuated the same fundamental issue, that of the OMF being difficult to use by those not directly involved in the design or implementation. By illustrating the analysis of a lesson extract, this paper aims to provide a mechanism to discuss the OMF that provides insights into its structure and affordances, and thereby ameliorate some of these accessibility issues.



**Figure 1: Outputs from observational studies**

As a research community, there have been observational studies where findings have been the principal output (figure 1), offering insights such as the links between professional development initiatives and changes in classroom practice, or between teachers’ practice and student learning (e.g. Liu et al., 2019). On other occasions, observation protocols have been developed and shared, with both ‘research level’ and ‘practitioner level’ rubrics published, such as TRU (Schoenfeld, 2013) and OECD Global Teaching Insights (Ingram et al., 2020). However, Praetorius and Charalambous (2018), amongst others, have argued that we can only enhance our understanding of the field if we can replicate, build on and use prior research; at the moment this remains problematic. With limited access to the often iterative development of categories, combined with inconsistencies in language use, it is usually difficult to ascertain how theoretical considerations in different protocols have been established and operationalised. Restricted access to datasets on which protocols were developed and/or applied usually compounds this situation, removing the possibility of a common reference point through which a shared understanding might be developed. Here a dataset, comprising of a video of a lesson extract and transcript, has been made accessible to a CERME TWG, allowing any analysis to be seen alongside the dataset.

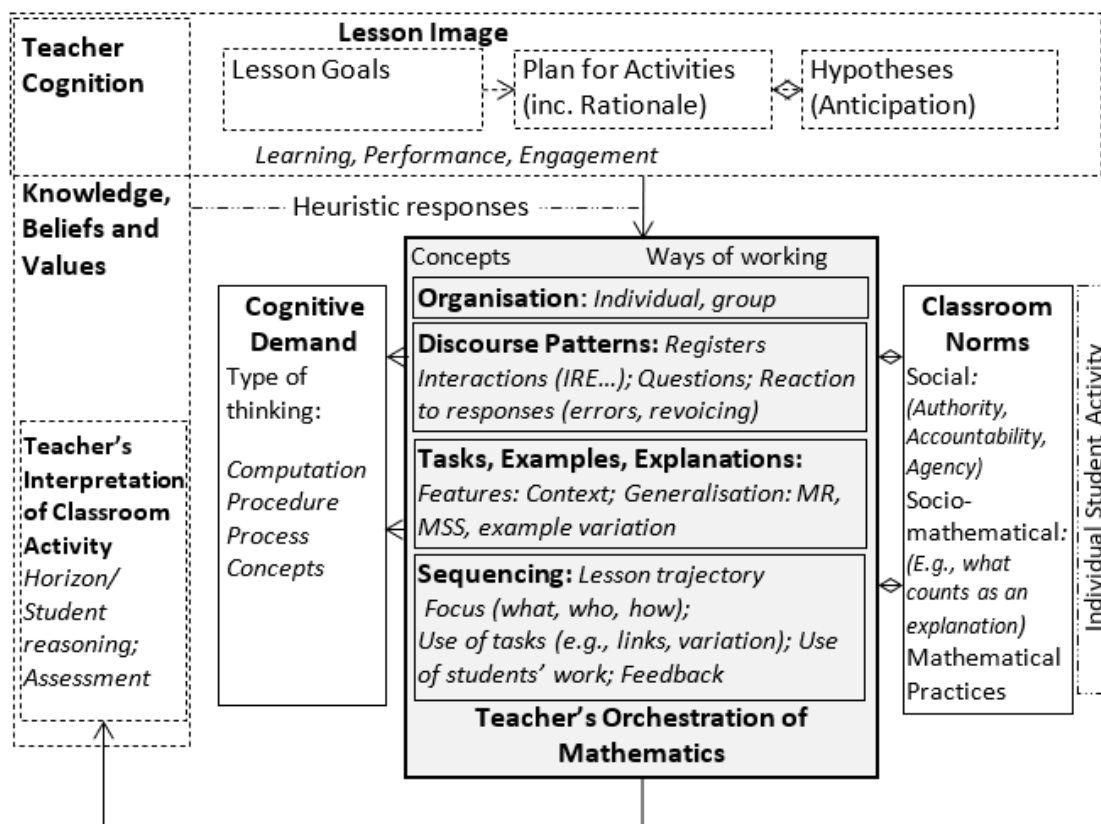
The purpose here is to draw on this accessible dataset to provide greater insights into how theoretical perspectives in the OMF are drawn on and applied, with the aim of facilitating a critical discourse about the framework from both a conceptual perspective and its operationalisation. The ultimate goal being the enhancement of opportunities for a wider use of this framework by others.

### **Orchestration of Mathematics Framework (OMF)**

The OMF was developed to capture those elements of teachers’ practice that play a key role in shaping the mathematics made available to students. This was developed through a review of prior research, integrated from the perspective of the teacher and developed through a classroom-based video study (Baldry, 2019). The focus was on the observation of any ‘typical’ lesson, with the goal to notice and describe pedagogical activities that can offer insights into the students’ experience of mathematics.

The overarching structure draws on Simon’s (1995) teaching cycle of teacher’s knowledge, hypothetical learning trajectory (teacher’s learning goal, plan for activities and hypotheses about learning) and assessment. This cycle starts before the lesson and continues throughout, with teacher assessment prompting review and adjustments. The ‘heuristic’ connection has been added to recognise the role of intuitive reasoning, which is the influence of pedagogical scripts, built up through experience, have on classroom decision-making (Watson, 2019). With research identifying

that some teachers focus on performance and/or engagement rather than learning (Amador & Lamberg, 2013), hypothetical learning trajectory has been replaced by the broader term of ‘lesson image’ (Rowland et al., 2015, p. 75). The Teachers Orchestration of Mathematics (TOM), the shaded section, represents the teachers’ in-class activities, added to capture pedagogical moves.



**Figure 2: Orchestration of Mathematics Framework (OMF)**

The other two aspects of the OMF are cognitive demand and classroom norms. The mathematics that is made available to students through those activities in the shared space of the classroom is denoted by cognitive demand, which categorises activities into levels, based on the type of thinking they have the potential to elicit (Boston & Smith, 2009, p. 122). Activities that require computational or procedural approaches being classified as low cognitive demand, with those that focus on more generalizable processes or mathematical concepts, as high cognitive demand (Stein et al., 2008). Classroom norms offers a way to interpret classroom interactions, marking events as typical or atypical, and allowing identification of what is considered mathematically legitimate in that context (Cobb et al., 2001). For example, social norms signpost where authority to determine ‘correctness’ resides and socio-mathematical norms indicate what counts as a mathematical explanation.

However, teachers’ pedagogical activities are many and varied, and as previously discussed are too complex to submit to an undisputed categorisation. Prior research has indicated that classroom discourse and task selection, combined with the management of the lesson trajectory, are significant factors (e.g. Stein et al., 2008). Classroom organization is included to provide contextual information. Each of these dimensions, however, is a large field of its own, with many theoretical perspectives that could be brought to bear. For example, discourse patterns can be analysed at varying grain size, with

consideration of interactional patterns as well as language used. Specific features, such as the handling of errors (Ingram et al., 2015), have also been researched. Within the sequencing dimension, variation theory, with the notion that learning requires discernment stimulated by variation set against invariance (Marton & Pang, 2006), can be used to analyse questions used and their sequence, but this is far from the only perspective that could be used. Whilst it is argued that, taken together, the OMF offers a way to build a picture of the classroom, based on the features as they occur and interact in the course of a teacher’s normal practice, the complexity and interconnectedness of so many concepts is a key barrier in communicating the conceptualisation and operationalisation of the OMF.

### Analytical Approach

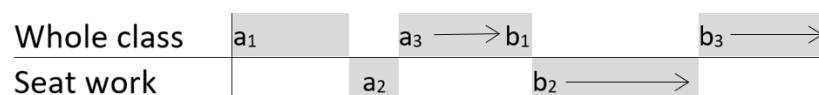
Transcripts are the starting point for the analysis, with classroom talk split into three categories: talk as mathematics, considered as the verbalization of mathematical thinking, including the mathematical focus and level (recall, computation, procedure, process or mathematical concepts – aligned to cognitive demand); talk about mathematics, which includes reference to the nature and learning of mathematics, and ways of working mathematically; talk about students, which includes motivation, engagement and what constitutes an effective student. The nature of the dataset then governs which aspects of the OMF become the focus of the analysis. Here, a 17-minute video of part of a Norwegian lesson and associated transcript in English were made available. Consequently, the analysis focused on aspects of the Teachers’ Orchestration of Mathematics (TOM), described in more detail below.

In terms of discourse patterns, the structure of talk is grouped by type of interaction, with two main categories of turn-taking and monologues. A common turn-taking pattern is teacher initiation (usually a question), followed by a student response, which is evaluated by the teacher (IRE). The evaluation is often implied by the teacher’s next move rather than explicitly stated, but understood as established classroom norms. For example, repetition or an immediate transition often signals that the student response meets the teacher’s requirements. In terms of sequencing, the regulation of the lesson trajectory, or steer, is considered in terms of direction establishment and maintenance in relation to a topic or focus, with features classified as launch, direction, redirection or the exploration of student reasoning. Regulation is also considered in terms of level, as to whether actions reduce the complexity of the mathematics, focus on implementation or draws attention to mathematically significant aspects (simplifying, processing, conceptualising).

### Lesson Analysis

#### TOM: Organisation

Students were seated in pairs and were writing on mini-whiteboards. Pair work appeared to be encouraged during seat-work with the teacher stating “talk together”. Whole-class interactions and seat work were interleaved across the 17 minutes of the lesson extract. During the seat-work the teacher circulated and talked to pairs of students.



**Figure 3: Whole class – seat work timeline**

## **TOM: Tasks**

In the first whole class episode the teacher spoke and led question and answer exchanges about the role of percentages, such as “When do we see it in our daily life?”. The penultimate question was “If you buy a new jacket, and you get a discount of seventy percent, how many percent do you have to pay then?”. Finally, question **a** was posed at  $a_1$ , which the students worked on in the first seat-work episode ( $a_2$ ). Solutions to this question were discussed in the second whole-class episode ( $a_3$ ). This pattern was repeated for question **b**.

**a:** There is a shirt, and that shirt costs five hundred kroner. But you, lucky you, you are getting a discount of twenty percent. How much do you have to pay for that shirt?

**b:** The case is that there is a very nice beanie that you really want to buy. It costs three hundred kroner. But since it is close to easter, the beanie is on sale at a reduced price, so you are getting a discount of thirty-five percent. How much do you have to pay then?

Multiple solution strategies were possible with these percentage problems, though the percentage discounts of 20% and 35% made calculations via 10% a viable option. Whilst approaching problems via an initial calculation of 10% may have been introduced in earlier lessons, the students were not directly prompted towards a particular solution strategy here, such as through modelling of similar questions beforehand. During whole class discussions ( $a_3$ ,  $b_3$ ) different solution strategies were reported by students; all bar one had finding 10% as the first step. The one non-10% approach was the only student report not pursued as far as completion, and the possibility of alternative approaches was not raised; this indicates that the 10% approach aligned with the teacher’s lesson image.

## **TOM: Discourse**

As most exchanges focussed on articulating particular steps in percentage questions, the majority of classroom talk was ‘talk as mathematics’. Question and answer sequences were the most common form of interaction, with IRE patterns dominant. For example, during  $a_3$ , the following exchange contain extended IRE sequences related to questions about  $a_1$  (lines 49-59):

- 45 Teacher: Do you see what is written on student C’s whiteboard? Can you tell us?  
46 Student C: Erm, Twenty percent is the same as one-fifth.  
47 Teacher: Why is it so?  
48 Student C: Because, if you take twenty five times you get one hundred.  
49 Teacher: Okay. So you used the fact that you know twenty percent is one-fifth... If you all look at Student D’s whiteboard, then you see that it looks completely different... How did you think?  
50 Student D: I was thinking like on takes five hundred and divided by ten, which is fifty..  
51 Teacher: You took five hundred divided by ten. Why did you do that?  
52 Student D: Because. That it was we have learned to do, so....  
53 Teacher: What did you find then?  
54 Student D: Because then I get fifty  
55 Teacher: Yes, but when you divided by ten, what kind of percentage did you find then?  
56 Student D: Fifty. Fifty percent? Erm,... ten, ten percent  
57 Teacher: Correct  
58 Student D: And then, erm, I multiplied by eight because it is eighty percent up, erm, what we are buying is eighty percent  
59 Teacher: Yes. So you were searching for what you should pay? And multiplied it with eight, to find out how much you should pay.

Lines 45-49 relate to the only example where finding 10% was not the first step. In line 47 the teacher extends the exchange using 'why' to initiate, and the student responds with their explanation (line 48). In line 49, the teacher offers an evaluation and then reframes the student explanation as a fact; after a pause, the teacher moves onto another student without completing the question.

At the end of line 49 the teacher initiates an exchange by asking another student to report on their whiteboard. In line 50 student D responds, describing their calculation. The student's interpretation of the teachers' subsequent repetition and a why (line 51), in terms of whether their response was 'correct'/acceptable, draws on classroom norms. In some classrooms, this repeat/why pattern would indicate an 'error'/unacceptable response (Baldry, 2019); here the student attempts an explanation (line 52), indicating an a follow-up request for a further explanation communicates at least a partially acceptable response has been made. This 'why' extends the IRE sequence, with student D offering an unspecific response in line 52. Subsequently, the teacher shifted the focus from the unanswered why to what was found (line 53); this returned the interaction to the implementation of the procedure. In line 55, the teacher offers a direct positive evaluation of the student response in line 54, but the follow-up question indicates there were elements missing in comparison to the teacher's preferred response. In terms of the question set, 50 kroner represented 10%. In line 56 the student responded by initially repeating 50, then added percentage; the teacher's body language (standing still, looking directly at the student, no affirmation such as nods), and with no verbal response after the 'fifty percent', seemed to provide the feedback that an error had been made. In contrast, the 'ten percent' was evaluated immediately and explicitly by the teacher (line 57), and the student continued with their reporting in line 58, which included a rationale as to why they were finding eighty percent. In line 59, the teacher offered a direct evaluation and rephrase the student's explanation.

### **TOM: Sequencing**

The teacher controlled the lesson trajectory, regulating the mathematical focus and level through questions set for seat-work and questions asked in whole-class episodes. The teacher predominantly maintained the focus on calculation steps, at a procedural level. The teacher also directed progression through the steps in the solution with the particular questions asked. The teacher drew attention to the fact that students' whiteboards looked different (line 49), but there was no comparison or evaluation of the different solution strategies, or a consideration of alternatives not presented by the teacher or students. The teacher circulated during seat-work and interacted with all pairs of students. The lesson transcript for these interactions is only partial, but indicates that the teacher was aware of the students' solution strategy before the subsequent whole class reporting and discussions. Two similar questions were chosen, but both the percentage reduction and the value were changed so connections between the questions may have been less visible to the students.

### **Classroom Norms**

The dominance of IRE interactions, combined with the teacher's rephrasing or reframing, placed the teacher as the arbiter of correctness with responsibility for explanations. There was one occasion where the teacher asked if other students understood a rephrased student contribution:

- 151 Teacher: Did you all get that? You thought that thirty-five percent is one-half of seventy, so then I can find seventy percent first

152 Student F: I did not understand why one should multiply by seven?

After the teacher rephrased a student explanation (line 151), student F's response indicated they were responding to the previous student's explanation about multiplying by seven, and held sufficient accountability for their own understanding to ask. In terms of socio-mathematical norms, it appears that articulation of steps in the calculation process are expected as mathematical explanations.

### **Cognitive Demand**

The majority of classroom talk was about particular steps in a procedure, and was classified as low cognitive demand (computational or procedural). However, multiple solution strategies were possible and students had the opportunity to select their approach and were exposed to different approaches with the same (correct) answer. Consequently, the talk as mathematics shared in the classroom was indicative of low levels of cognitive demand, but there was the potential for students to engage in higher cognitive demand through their own consideration of connections between the examples and the underlying processes and concepts. In terms of the mathematics made available to students, they could have successfully engaged with the tasks without any press to move beyond the procedural. However, the lesson continued beyond the 17 minutes of the video, and it might be the case that the latter part of the lesson gave the students more explicit exposure to higher levels of cognitive demand.

### **Conclusion**

The wider purpose here is to contribute to a better shared understanding of observation frameworks. This narrative has outlined the analysis of a 17-minute lesson episode, but relatively few aspects of the full analysis can be reported here. Whilst this runs the risk of an oversimplified view of both the lesson extract and the OMF, the availability of the dataset alongside this analysis, albeit limited to one CERME TWG, is a small but important step towards greater transparency in the conceptualisation and operationalisation of observation frameworks. If others have also analysed this dataset, more direct comparisons of frameworks may be possible, with complementary, compatible and contradictory elements of the respective analysis all providing stimuli for a more nuanced debate. Whilst the current difficulties in obtaining open access datasets is recognised, if the affordances of this type of shared approach are demonstrated, it is hoped that this will prompt wider access being part of future research design, so we can all more effectively build on the work of others.

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