A lens on two classrooms: Implications for research on teaching

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This paper uses the Teaching for Robust Understanding framework (Schoenfeld, 2013) as an analytic lens on episodes of mathematics teaching from two different countries. This lens highlights differences in teaching approaches across the two settings and draws attention to the need for further interrogation of how culture, curriculum and values inform teaching practices. It also has implications for research practices as it shows that the theoretical frameworks and methodological tools that are used in research are not value free or culturally neutral.

Keywords: Research frameworks, culture, international, mathematics teaching.

Introduction

My motivation in writing this paper is to address some of the questions that were raised in TWG19 at CERME10. I hope to contribute to discussions on methods used to conduct research on mathematics teaching. I have a particular interest in how research frameworks are used by different communities. At CERME10, I presented a view of research frameworks as theoretical frameworks or methodological tools which 'frame' or structure a coherent set of understandings about a theme (Nic Mhuirí, 2017). In this paper, I use the Teaching for Robust Understanding (TRU) framework (Schoenfeld, 2013) to analyze segments of mathematics lessons. I raise questions about how culture, curriculum and values inform teaching practices and how research frameworks reflect this (or not). I conclude by considering the implications for research practice more generally.

Theoretical Framework

I situate my work in the sociocultural perspective where learning is conceived as transformation of participation in social practices (e.g., Lerman, 2001). From this perspective, a classroom community can be understood as a community of practice (CoP) (Wenger, 1999). The CoP theory developed from research on apprenticeship contexts. Critics argue that it does not offer a theoretical base for formal teaching where teachers are accountable for learning outcomes (e.g., Goos & Bennison, 2008). Attention to teacher as agent for educational and social change (Cochran-Smith & Lytle, 2009) is necessary to envisage how new practices might come to be established within the community. Notwithstanding student agency and the influence of the wider sociocultural context, the teacher is assumed to have agency, and generally some authority, in choosing actions which shape the practices of classrooms, i.e., "the repeated actions in which students and teachers engage as they learn" (Boaler, 2002, p. 113). However, teaching is more than simply a collection of practices. Following Biesta and Stengel (2016), I recognize teaching as relational, intentional and purposeful. Firstly, teaching implies a relationship between the person teaching and the one being taught. The teacher also has a role to play in 'relationally bridging' student and subject (Grootenboer & Zevenbergen, 2008). While learning may occur, in the absence of teaching, teaching is considered to be intentional as teachers deliberately aim to teach their students. Furthermore, education is a "teleological practice where the question of what education is *for* can never be evaded" (Biesta & Stengel, 2016, p. 33, original emphasis).

Biesta and Stengel contrast 'purpose' with the more concrete 'aims' which a teacher might endeavor to achieve. They describe the purpose of education as concerned with justification for engaging in teaching and consider 'purpose' to be normative and indicative of what is 'educationally desirable' (2016, p. 31). They identify three important domains of educational purpose: qualification; socialization; and subjectification. Qualification is understood as connected with "the transmission and acquisition of knowledge and skills" and socialization is understood as "the way in which through education we become part of existing cultures and traditions and form our identity" (Biesta & Stengel, 2016, p. 26). Subjectification is "an educational orientation concerned with the ways in which human beings can be subjects in their own right, rather than objects of the actions and activities of others (2016, p. 21). It is difficult to argue with Mosvold and Hoover's (2017) contention that "while there are other important aims of education, teaching is centrally about supporting the learning of subject matter" (p. 3111). However, Biesta and Stengel maintain that such aims should be articulated in relation to the domains of educational purpose.

The view of education proposed by Biesta and Stengel centralizes teacher agency as it highlights the role of teacher judgment. In every activity, teachers make (tacit) judgments about the balance between the three domains of educational purpose. This has connections with Schoenfeld's (2015) theory of teachers' decision-making. He maintains that for a well-practiced activity like teaching, decision making is a function of teachers' knowledge, resources, goals, beliefs and orientations. His model of in-the-moment decision making offers a fine-grained lens on teacher judgments. By situating such judgments in the broader field of the three domains of educational purpose, Biesta and Stengel's philosophy facilitates consideration of the bigger picture. It raises questions about how society, culture and curriculum shape teachers' orientations and how beliefs about educational purpose influence everyday decision-making.

Methodology

The data was collected by international researchers for different purposes. It was shared amongst TWG19 members who had expressed an interest in engaging in the analysis of common data at CERME10. Four pieces of data were shared, three of which contained video clips. I focused only on the video data which consisted of episodes from an American, a Greek, and a Norwegian classroom.

I will use the TRU Framework (Schoenfeld, 2013) for analysis. This framework consists of five dimensions: *the mathematics; cognitive demand; access to content; agency, authority and identity; uses of assessment*. *The mathematics* involves the disciplinary concepts and practices made available for learning. *Cognitive demand* aims to capture the extent to which students have opportunities to engage in 'productive struggle'. *Access to content* addresses the extent to which activity structures support the active engagement of all students. *Agency, authority and identity* refers to the extent to which students have opportunities to instigate and contribute to discussions in ways that contribute to their agency, mathematical authority and to the development of positive identities. *Uses of assessment* relates to how classroom activities elicit student thinking and subsequent interactions respond to those ideas. Schoenfeld (2013) describes his goals in the creation of the framework as being concerned with identifying a relatively small but 'complete' number of categories of classroom activities for observation, i.e., no other categories or dimensions are thought to be necessary for analysis. This claim of ‘completeness’ was the main reason for choosing to use the framework as a methodological tool. The TRU framework can be used for evaluation purposes but I aim only to highlight important issues and to interrogate the process of analysis itself.

The TRU approach to classroom observations separates or parses lesson by the nature of the activity structure that occurs: *Whole class activities* (including *topic launch, teacher exposition,* and *whole class discussion*); *small group work; student presentations;* and *individual student work*. Each episode should be relatively short but ‘phenomenologically coherent’ (2013, p. 617). The TRU framework contains detailed rubrics for all five dimensions across each of these activity structures. It might be considered that these activity structures are relatively unambiguous and should be easily recognized across international classrooms, e.g., individual work or small group work. However, issues of curriculum and culture should not be ignored (Andrews, 2011). For example, the activity structure ‘*topic launch’* would seem to have strong connections to the ‘Launch-Explore-Summarize Teaching Model’ used in the US based Connected Mathematics Project Curriculum (https://connectedmath.msu.edu/). The extent to which this model of instruction is recommended by, or embedded in, other jurisdictions internationally is questionable. It is also possible that other important activity structures exist locally that are not captured in the TRU framework (c.f., Clarke et al., 2007). Despite these concerns, it was possible to categorize the data using the TRU activity structures so it was decided that it was appropriate to proceed with analysis.

To some extent the data was ‘pre-parsed’ as only selected elements of the lessons were shared. There were a variety of activity structures in evidence across the different classroom. The activities in the Greek classroom were conducted in a whole class setting with some elements of teacher exposition and whole class discussion. The activity structures in the Norwegian classroom involved a whole class topic launch, small group work/individual work and a series of student presentations. The activity in the US classroom centered on a single student presentation. Given the constraints of this paper, I decided to focus on the student presentations across the US and the Norwegian data. An overview of the data is shown in table 1.

US Data	Norwegian Data
Summer program for 5th graders. Majority low SES participants. Experienced teacher recognized as expert (Professor Deborah Ball, University of Michigan) Video clip (c. 3 minutes) and contextual information.	Small group (5 students) primary teaching. Experienced teacher recognized locally as expert Video clip (c. 21 minutes) with English subtitles and transcription.

Table 1: Overview of data

Overview of video content

In the US video, a student presents a solution to a task concerning what fraction is marked on a number line. She gives the incorrect answer of 1/7. Her justification is that there are seven equal parts shown on the number line. The teacher invites students to question her reasoning.

In the Norwegian example, the teacher gives the students the task of figuring out what year the King was born. In effect, students have to compute 2017 – 80. After about 5 minutes, the teacher asks students to present their solution methods. These are summarized below.

- *Presentation 1*: 80 – 17 = 63, 2000 – 63 = 1937. The calculations were carried out using the standard algorithm even though the procedure has not yet been taught for higher number ranges. The teacher models the students' thinking on an empty number line and also models the algorithm.
- *Presentation 2*: 2000 – 80 = 1920; 1920 + 17 = 1937. The calculations were done mentally but recorded in vertical format at the board.
- *Presentation 3*: 2017 – 80 = 1937 using standard algorithm.
- *Presentation 4:* 1900 + 20 = 1920; 1920 + 17 = 1937. Teacher questioning appears to aim to expose reasoning.
- *Presentation 5:* The first student complains that she did not have a chance to write her method (standard algorithm) on the board. Teacher invites her to do this.

Results

Due to space limitations the full TRU framework rubric for student presentations is not presented here. Instead, under each heading, I give a brief overview of all levels with a full description of the most relevant levels (in italics). I then present an analysis of relevant classroom events.

The Mathematics

Level 1 (answers without reasons) and Level 2 (procedural mathematics with no expectation of reasoning) do not apply in either case. Level 3 is described as follows: The Mathematics presented is relatively clear and correct AND either includes justifications and explanations OR the teacher encourages students to focus on central mathematical ideas and explaining and justifying them.

In the US classroom, explanations were given by the presenter Aniyah but the mathematics was incorrect. The teacher encouraged other students to ask questions but not to evaluate (i.e., agree or disagree with) her solution. Toni questioned why she chose one-seventh. Lakeya questioned her choice of 1 for the numerator. Dante's question is unclear but may also be targeting the numerator. The focus on justification and key mathematical ideas would place this at level 3 of the rubric.

In the Norwegian classroom, the mathematical reasoning was correct and the explanations were generally clear (level 3). Where this was not clear (e.g., presentation 4), the teacher asked clarifying questions. In presentation 5, the student inverted the numbers when writing the standard subtraction algorithm. She appeared to recognize her own error and the teacher said he understood her thinking. He appeared to value reasoning above procedures. All presentations can be described by level 3.

Cognitive Demand

Level 1 (familiar facts and procedures) does not apply to either case. Level 2: Presentation offers possibilities of conceptual richness or problem solving challenge, but teaching interactions tend to 'scaffold away' these possibilities, resulting in a straightforward or familiar focus on facts and procedures. Level 3: The teacher's hints or scaffolds support presenters and/or class in 'productive struggle' in building understanding and engaging in mathematical practices.

In the US classroom, the mathematics was cognitively demanding for the presenter Aniyah and perhaps for others, e.g., Dante. Other students were invited to ask questions and in this way possibly provide support for Aniyah. The extent to which these interactions were ‘productive’ for her and/or other students is not obvious on completion of the clip. Level 3 most closely describes this extract but it was the classroom community, rather than the teacher, that was providing the scaffolding.

The task in the Norwegian classroom was of appropriate challenge. One student solved it quickly but others needed more time and one student did not come to a correct solution. In presentation 1, the student was clear in her ideas but this transitioned quickly to teacher explanation. The second student presented a mental method. Again, the teacher took responsibility for explaining this. No scaffolding occurred in presentation 3. It might be considered that a more challenging example of the standard algorithm had been addressed in presentation 1. This might explain why the teacher did not dwell on this example. The teacher’s questions in presentation 4 appeared to attempt to scaffold the presenter and clarify her ideas. Across all presentations, the focus remained on student thinking rather than procedures. However, the teacher’s actions are closer to level 2 than to level 3. While presenters did not often need the teacher’s support, his input may have the effect of ‘scaffolding away’ the opportunities for students to build their own understanding of each other’s ideas.

Access to Mathematical Content

*The descriptions for this dimension refer to teacher-presenter conversations (**C**) and whole class discussions (**W**). Level 1 (no support (**C**) or significant disengagement (**W**)) and level 2 (ineffective scaffolding (**C**) or uneven participation without teacher action (**W**) do not apply. Level 3: Teacher supports presenters if needed (**C**) or the presentation evolves into whole class activity in which the teacher actively supports broad participation and/or what appear to be established participation structures result in such participation (**W**).*

The US classroom was very much orientated to the whole class situation (**W**). Not all students contributed to this discussion but the teacher deliberately orchestrated whole-class consideration of Aniyah’s idea. This is indicative of level 3 of the framework.

In the Norwegian classroom, the interaction was between the teacher and each presenter in turn (**C**). The teacher asked clarifying questions. Some questions might be considered to be dual-purpose in that the other students might have benefitted from them. However, the discussion never ‘evolves into whole class activity’ (**W**) and the students were not explicitly asked to comment on each other’s ideas or to make connections across suggestions. It is hard to match this with TRU framework descriptions as for teacher-presenter conversations (**C**) level 3 still refers to active supporting of presenters (which was only necessary in presentation 4).

Agency, authority and identity

Level 1 (presentation constrained by teacher questions) does not apply. Level 2: Presenters have the opportunity to demonstrate individual proficiency but the discussions do not build on student’s ideas. Level 3: Student presentations result in further discussions of relevant mathematics or students make meaningful reference to other students’ ideas in their presentations. (To qualify as an idea what is referred to must extend beyond the tasks, diagrams etc. that is referred to)

In the US classroom, Aniyah's presentation appeared to launch some classroom discussion of meaningful mathematics. This would place it at level 3 of the framework. It can be argued that students such as Toni take on an evaluative role. She acts as a mathematical authority and demonstrates agency. Such activities are envisaged to contribute to positive mathematical identity. The nature of Aniyah's experience is less clear and at the end she chooses to sit down rather than continue presenting/defending her idea. It is necessary to track participation over a longer period before one can make any claims about identity or agency (Nic Mhuirí, 2014).

The Norwegian classroom can technically be considered at a level 3 but while students are the source of ideas, they are not the source of discussion. Talk is teacher-led at all times. Student contributions are reformulated and explained by the teacher presumably for the purposes of ensuring others understand. Consequently the teacher retains mathematical authority. He also 'rates' the solution strategies of two students. After presentation 3, he first praises the girl who used the standard algorithm. Then he compares it to the previous presentation, saying "But his way to do it, I'd say, uses a method that's easy to calculate in your head. Really smart." By implication, the solution using the standard algorithm in a number range students have not officially been taught yet, is positioned as not as 'smart.' This hierarchical positioning of solutions, and by implication students, does not occur anywhere else but it does speak to issues of identity and authority.

Use of Assessment

Level 1 (reasoning not pursued) and level 2 (specific student ideas not utilized) do not apply. Level 3: In presentation and discussion, the teacher solicits student thinking and responds to student ideas by building on productive beginnings or addressing emerging misunderstandings.

The US classroom episode is aligned with the level 3 description and might be considered formative assessment in action. The teacher is activating the other students to respond to Aniyah's misunderstanding. It would be necessary to see how this plays out to judge whether the strategy is effective for Aniyah and other students.

In the Norwegian classroom, the teacher emphasizes student thinking. In presentation 1, the teacher uses the student's ideas as a launch to model her solution on an empty-number line and to model the standard subtraction algorithm. This episode might be considered to 'build on productive beginnings' (level 3). Levels of understanding were not generally made explicit in the classroom dialogue. The teacher posed a question which explicitly sought to assess students' understanding just once. It is possible that in this small group the teacher could closely observe indications of student (mis)understanding. Late in the episode, (c. 18 minutes) a student explained that he had attempted to solve the task using the standard algorithm but had gotten an incorrect answer. It remains unclear whether he learned how to complete this correctly from the class dialogue.

Discussion

On an evaluative level, the short US video scored higher on the dimensions of the TRU framework than the Norwegian example. The analysis showed differences in the extent to which agency was devolved to students. This devolution was carefully orchestrated by the teacher in the US classroom. Student presentations never evolved into whole-class discussion in the Norwegian setting. All interactions were funneled through the teacher and it was never explicitly stated that the students should attempt to understand each other's reasoning though this may have been an implicit teacher expectation. Such norms were possibly well established in comparison to the US summer school where the teacher was working to establish norms. Indeed, when the Norwegian students were working on developing solutions, they displayed some annoyance that one of the participants indicated the answer before all had completed working. In one of his only explicit directions, the teacher gave the following instruction: "A good tip right now is not to trust that one sitting beside you […] you can only trust yourself. Think for yourself and trust yourself." This appears to emphasize individual effort and indicates an expectation that all students should be able to devise a solution independently. Individual thinking, including errors, was valued in the US classroom but the teacher also seemed to be trying to set an expectation that the community should support the individual in making sense of mathematics. It might be argued that particular forms of socialization and subjectification (Biesta & Stengel, 2016) were being actively pursued by the US teacher.

The extent to which certain forms of socialization and subjectification are interwoven into the TRU framework warrants further attention. The framework presents a leveled or hierarchical positioning of various teacher practices that is not value-free. For example, in the Access to Mathematical Content dimension, two different participation structures are recognized: teacher-presenter conversations and whole-class involvement. In the Norwegian classroom, it appears that teacher-presenter conversations occur for the benefit, but without the involvement, of the whole-class. This participation structure is not recognized by the TRU framework but has some similarities to Andrew's (2011) discussion of the 'implicit didactics' of Finnish classrooms where teachers' extended conversations with a competent child in a whole-class setting appeared to be a common feature. These embedded, but unspoken, expectations raise particular challenges for researchers.

Any research lens is informed by the values of the researcher and the research tradition from which the lens is drawn. Often what is valued by a lens remains implicit and unexplored. In this case, the disconnection between the TRU framework and the Norwegian classroom highlights something about the lens itself. This disconnection also raises questions about culture, and whether it is suitable to use a framework developed in one environment to analyze teaching in a different context where conceptions of expert practice may be quite different (Clarke et al., 2007). The aim of this paper however was not to compare teachers (or contexts) but to explore some of the challenges of conducting research in mathematics education. Limitations to this research include the length of the US video and the outsider-status of the researcher in relation to both contexts. The analysis of the Norwegian data was conducted with an English transcript and it is likely that particular nuances of language and meaning have been lost in translation. However, this brief analysis does draw attention to the need for further interrogation of how culture and values inform teaching practices and research frameworks.

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