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STUDENTS' MEANING MAKING IN A COLLABORATIVE CLASSROOM PRACTICE AS INITIATED BY TWO TEACHERS
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This paper reports the nature of classroom practice that afforded students' meaning making at an upper secondary mathematics classroom in Norway. The participation of both teachers and students in the collaborative classroom practice they jointly establish is outlined. A longitudinal and person-in-practice view sheds light not only on the meaning producing foreground that was initiated, but also the nature of its growth. An artefact of instructional practice of two teachers Olaf and Knut is thus evidenced. In this there is opportunity to appreciate mathematical content, pedagogy and students' thinking in an integrated manner – making such knowledge useful and usable by practising as well as prospective teachers of mathematics.

INTRODUCTION
Drawing upon a year-long doctoral study at an upper secondary mathematics classroom, I report on one of four themes found grounded in my data (Gade, 2006). These themes emerged in response to my research question – Within a collaborative teaching-learning practice in the mathematics classroom, how do artefacts and activity mediate: meaning making in participation, consolidation of meaning made, development of problem solving know-how, and cooperation in problem solving. In reporting on the first of these themes, I describe the nature of classroom practice that was initiated by Olaf and Knut who shared teaching in the class I conducted my study; and whose prior objective it was to have their students cooperate in small groups within instruction. I label the classroom practice they established jointly with their students as a collaborative one, since it provided students opportunity to cooperate not only with each other in their groups, but also with students from other groups. At times groups of students presented solutions to tasks they had cooperated upon to other groups in the classroom. I explore how such practice was conducive to students meaning making in relation to the mathematics being demanded of them.

LITERATURE REVIEW
The need to attend to practices in mathematics classrooms has been recognised in PME and wider literature (e.g. Seeger et al., 1998; Boaler, 2003; Forman, 2003; Morgon, 2009). Socio-cultural-historical and activity or CHAT perspectives have also enabled classroom research to move beyond claims about individual cognition alone. A larger analytical zoom and holistic understanding has enabled research to inform a person-in-practice view of students and their teachers (Lerman, 2001). A relational view of mathematics, students, teachers and material aspects of practice has...
in turn led to insight about the nature of participation and negotiation of meaning that is capable of leading to greater knowing in classrooms. Greeno (2003) has argued that such a situative view has consequences, not only for what students learn but the kind of learners that students become. Attending to changes in patterns of discourse, it has also become possible to address critical aspects in mathematics education, especially those inherent in the complexities of everyday classrooms. The study of any sphere of practice which provides experience and enables students to bring forth their intention and foreground their personal meaning making has thus been argued for as desirable (Skovsmose, 2005). The demand to understand mathematical content, pedagogy and students' thinking in an integrated manner has also been recognised (Silver, 2009). Such practice-based knowledge has potential, Silver points out, to be useful and usable by practising and prospective teachers, as well as in professional development. Though the theoretical benefits of such knowledge have been recognised, it is time Silver argues, to reap these benefits in empirical terms. I respond to this demand by reporting on the nature and growth of an instructional practice that Olaf and Knut initiated and steered in my study.

THEORETICAL FRAMEWORK

CHAT perspectives offer constructs that enable appreciation of the participation of individuals in practices. Built upon Vygotskian assumptions, which are fairly broad and under current scrutiny, these perspectives consider the social environment as the provider of cultural tools and resources that mediate psychological processes and determine development. Resting upon innate biological functions, such psychological processes identified as higher mental functions, are mediated by cultural tools and resources. CHAT perspectives thereby analyse how higher mental functions emerge and became functional in individuals. These perspectives premise human engagement in practical activity as the means by which individuals transform themselves, at the same time as they are transforming external reality (Steksenko 2004). Analysis of various activities in which individuals objectify their psychological processes as they participate, thus forms methodological basis. Participation as unit of analysis in my study is informed also by Rogoff (2003) who distinguishes this unit with individuals' actions such as remembering or planning, where transformations in these are dynamic and indicative of participation in cultural practices. Laying emphasis on relationships rather than transformations Lave (1993) identifies participation, in addition, with relations entered into in local social practices. Her emphasis on relationships is not on those entered into between participants and their contexts, but on those relations that contextualise the way people act both within and across those very contexts.

Participation with meaning of individuals in either a cultural or social conception is guided further by Bruner (1996) who argues that the role of culture in general and education in particular, is the idealisation and consolidation of personal meaning into academic forms. In treating education as embodiment of culture and not a preparation for participating in one, Bruner says it is thus demanded of pedagogy to select ways of negotiating the academic meaning that is to be made. Teachers and students are
thereby treated as if they had intentional states and considered as acting with purpose. Extending Bruner's arguments, Olson (2003) has singled out the need for teachers to make timely decisions within instruction so as to bring together students' minds as well as various cultural tools and available resources. In particular Olson draws attention to the formation of joint intentions between teachers and students in practice - characterised by their sharing a common vocabulary and the eventual taking over of responsibility by the students of their own learning. In adopting a person-in-practice (Lerman, 2001) and situative (Greeno, 2003) view of the mathematics classroom, it is my intention to evidence the nature of one such practice steered by Olaf and Knut. In this I outline how their students transformed themselves within instructional activity (Stetsenko, 2004) and formed joint intentions with their peers and teachers through participation (Olson, 2003). I turn to methods adopted for studying such participation which resulted in students taking over responsibility of their own learning.

METHODS

The principal means with which I investigated Olaf and Knut's classroom practice was ethnographic. Such a stance not only drew upon my experience as a teacher but also became a way to embed methods that were necessary for studying various other units of analysis found necessary in my study. Enabling me to bring ground to figure such an approach was question driven, wherein I could match evolving models about teaching-learning with events that transpired in subsequent practice (Weisner, 1996). Of the three specific methods I utilised – field notes, survey response by students to group-tasks, and transcriptions of problem solving conducted with student groups; I now explain my collection of field notes that informed participation as unit.

I made field notes as a participant observer during the length of data collection. This enabled me to appreciate Olaf and Knut's bilingual instruction in Norwegian and English of 32 students seated in 8 small groups. Making field notes enabled me to record not only that discourse which transpired in English, but also make additional notes about material aspects that accompanied teaching-learning. Inclusive of who was speaking, from which group and whether one was stationed at their desk or blackboard, I obtained a thick description of actions, events and cultural artefacts that constituted instructional practice (Geertz, 1973). The corpus of data collected was thus naturally occurring and included my interpretation of the experience of teachers, students and myself (Silverman, 2001). While I draw extensively on field notes in this report, I acknowledge having arrived at current interpretations with multiple levels of triangulation by deploying units of analysis other than participation as well. When Olaf taught alone at the beginning of the academic year, I made notes by seating myself to one side of his classroom. Upon Knut joining teaching duties, which coincided with commencement of the second chapter of the textbook, I sat beside one particular student group. This enabled me to view classroom teaching-learning as much as was possible from that group’s point of view. I sat with a new group with every subsequent chapter of instruction and report in this paper from events that transpired in the first three chapters.
RESULTS AND DISCUSSION

I sketch the nature of classroom practice established within my larger study in three sections. First, when Olaf taught alone, next when he and Knut initiated group work, ending with students' discussion and formalisation of rules for group cooperation.

**A single teacher**

Olaf began instruction with the chapter titled *Number Understanding* while stationed near the blackboard. With his students seated in groups around tables they had pulled together, Olaf's proximity to his students and their workings was restricted. Beyond greeting students on the first day of instruction Olaf began his instruction as below:

Olaf: Turn to page 14 ... there are some rules in the box

Olaf: [A while later] If you have a problem, box first, partners next, then me.

The very brief exchange above is indicative of the nature of relationships that Olaf was forging with his students in his classroom. Aware of talk that could arise when students worked in groups, Olaf was guiding the manner in which his students were to speak with each other and seek guidance when in doubt. The rules in the box that Olaf drew attention to, demonstrated how one could obtain equivalent fractions and how one could reduce a fraction to its simplest form. Olaf's drawing the attention of students to these rules had a two-fold purpose within classroom practice. First, these rules reminded students of procedures they would have been familiar with even prior to his classroom. Second, Olaf signalled his intention of having students utilise rules even before seeking assistance from peers in their group or even him. It was with such advice that Olaf embedded classroom practice with his intentions (Olson, 2003). Being new to his classroom, Olaf's students were now participating in an instructional practice that he was laying out. Their making of meaning in mathematics was made between the cultural resource of the textbook, their peers and him (Greeno, 2003). The participation of Olaf and his students was therefore not independent, but anchored in a specific kind of classroom practice that Olaf had initiated.

**A team of teachers**

There were several changes in classroom practice when Knut joined teaching at the commencement of chapter *Equations and Proportionality*. In line with their stated objective of having students cooperate in groups, Olaf and Knut conducted two tasks *When Together* and *How Heavy* in consecutive sessions of teaching-learning. The tasks and sample solutions evidenced in Table 1 are indicative of two aspects. First, that the use of diagrams in the two tasks was different. Where in the first, the given diagram was used to cooperate, by the second, students had to provide a diagram or equation in order to cooperate. Second, group cooperation was also different. Where in the first, cooperation was initiated by Olaf and Knut, by the second, students took for granted and consolidated group cooperation. It was in the conduct of these tasks that Olaf and Knut realised their objective of having students cooperate in small groups, which was to become the norm of instructional practice in the classroom.
The changes in classroom practice just outlined changed the participation of Olaf, Knut and their students in four distinct ways. First, corresponding to changes in the manner students worked with say diagrams, I record Olaf and Knut noticeably work as a team and complement each other while say teaching at the blackboard. These transformations corresponded to their continued participation in the changing practice (Rogoff, 2003). Second, Olaf and Knut's students also had opportunity to bring forth personal meaning and knowledge they had prior to participation in this sphere of practice (Skovsmose, 2005). Third, in privileging the use of a simple equation by one student group, Olaf and Knut led their students to utilise forms of societal knowledge that were acceptable beyond the context of the classroom (Lave, 1993). By this Olaf and Knut guided various versions of meaning students had about balancing to greater academic forms, as was the case with a simple equation (Bruner, 1996).

**Group cooperation is formalised**

From students in my study being asked to turn to a particular page in the beginning of the year, their manner of participation gained far greater freedom by the third chapter *Scale factor in similar figures*. Illustrating one such instance, I relate how Olaf both accepted and acknowledged the accuracy of personal meaning made by Levi - which was independent of the one Olaf was discussing with Levi's other classmates.

- Olaf: What is the scale factor of the side?
- Jan: Three
- Tove: Three
- Levi: Or one by three [Belonging to the group I was sitting beside]
- Olaf: What is the scale factor of area?
- Researcher: [Records Olaf to extend this discussion with Levi's other classmates in relation to the scale factor of area, as well as that of volume]
Olaf: So you were right Ulrik ... So if you have the volume of one of them we can calculate the value of the other

Levi: What if we do it the other way? [Persisting to question Olaf]

Olaf: If we know volume of the larger we find the volume of smaller

Olaf: [Demonstrating correctness of Levi's scale factor on the blackboard]

Olaf: Good question [Addressing and accepting Levi's version of scale factor]

My sitting beside Levi's group allowed me to observe and record how Levi's version of scale factor was independent of the one being discussed by Olaf with the whole class. While Olaf and Levi's classmates were working with a numerical value of three as scale factor, Levi was working with its reciprocal. In presenting the above extract I evidence the manner in which Levi pursued Olaf, seeking to ascertain the correctness of his version of scale factor - one which Olaf accepted and demonstrated as accurate on the blackboard. From offering explicit instructions with regards to how students were to make meaning in the first chapter, by the third chapter Olaf acknowledged the personal meaning that Levi had independently made. Illustrative of the kind of timely decisions that Olson (2003) said a teacher needed to make within one's own instructional practice, my final extract shows how Olaf was working with one version of scale factor as cultural tool (with Jan, Tove and Ulrik) and its reciprocal as another acceptable cultural tool (with Levi). In guiding the utilisation of different forms of academic meaning (Bruner, 1996) and the formation of corresponding higher mental functions (Stetsenko, 2004) Olaf's role by this time in practice had now shifted from being custodian, to arbitrator of alternate kinds of mathematical meaning being made by his students. By the end of this chapter, Olaf and Knut also had all students groups discuss arguments and counter-arguments in relation to working in small groups, so as to formulate ways in which such manner of working was best possible. I present guidelines that the eight student groups together agreed upon in Table 2:

1. Everyone must be treated with respect
2. Everyone must contribute
3. All ideas must be considered by the group
4. Everyone must be aware of what transpires before the group moves ahead
5. Everyone must be able to present the work of the group
6. Everyone must ask the others in the group before seeking help from the teachers

Table 2: Students guidelines in relation to group cooperation

Put up in large letters on their pin-up board these rules became part of the new norm in instructional practice. In Olaf and Knut thereafter encouraging students from across groups to present their group work either at the blackboard or to each other, I witnessed classroom practice to progressively became a collaborative one.
CONCLUSION

With participation as unit of analysis it has thus been possible to appreciate a person-in-practice view of the classroom (Lerman, 2001). Such analysis viewed the efforts Olaf and Knut made to guide the meaning being made by students within their sphere of practice (Greeno, 2003; Skovsmose, 2005). There was opportunity for either, to participate in the intentions of others (Olson, 2003). Olaf was first seen establishing his own intentions. With Knut he then guided the sharing in groups of the meaning students were making with their peers, affording opportunity for them to participate in their own as well as others intentions. Finally, Olaf's student Levi had occasion to externalise the meaning he had personally made. This was representative, more generally, of independent meaning making by students and coincided with a shift in responsibility to them for their own learning. I summarise the growth of the instructional practice that Olaf and Knut so initiated as follows:

<table>
<thead>
<tr>
<th>Chapter number and topic</th>
<th>The collaborative practice</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: Number Understanding</td>
<td>Establishment by the teacher of his intentions</td>
</tr>
<tr>
<td>2: Equations and proportionality</td>
<td>Participation by students in their and other's intentions</td>
</tr>
<tr>
<td>3: Scale factor in similar figures</td>
<td>Participation by students with independent intention</td>
</tr>
</tbody>
</table>

Table 3: Nature of growth of Olaf and Knut's classroom practice

A person-in-practice study has had two implications for my ongoing research. First, based on opportunities that students had for imitation, I have since shown how a zone of proximal development or zpd was formed when students cooperated as well as collaborated within such an instructional practice (Gade, 2010). The corresponding development of higher mental functions resulted in students becoming independent. Second, analysing day-to-day material practices in relation to meaning making has provided me with researcher strategy that is conducive to the conduct and sustenance of action research (Gade, 2011). While I respond in this report to Silver's (2009) call of the need for empirical examples of practice-based studies, I also illustrate how the mathematical content taught; pedagogy and students' thinking were interrelated in one such practice. I thereby underscore the need to recognise classroom practices in general and the role that these may have in the meaning being made by teachers and students in particular classrooms. Towards this, I have argued for the benefits of one such practice that two teachers Olaf and Knut had instituted in my study.

References


Gade

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