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The solving of problems and the problem of meaning

The case with grade eight adolescent students

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The problem of loss of meaning in schooling and teaching-learning of mathematics is explored in a study with adolescent students at two grade eight classes in Sweden with five frames of reference: deploying CHAT theoretical perspectives, incorporating student agency and identity, conduct of an action strategy, the design of meaningful mathematical tasks and the situatedness of these in local contexts of classroom and school. Exemplary of second-order action research, the conduct of five mathematical tasks enables reformulating the situated social practice in the classrooms, evidencing overt display of student identity in the fifth and final task. The addressing of problems posed by students in this open-ended task e.g. What is your favorite sport? Have you tested smoking? allows students to combine mathematical knowing and a sense of achievement, along with their selves as perceived in their local contexts. The inclusion of problems/mathematical tasks related to students' self is thus sought for in the curriculum of mathematics for adolescent students.

Key words: CHAT, situated learning, mathematical tasks, action research, agency and identity

ZDM: C70 - Teaching-learning-processes; D40 - Teaching methods and classroom techniques

Introduction

This paper explores the recognised problem of loss of meaning in schooling and teaching-learning of mathematics by drawing upon five frames of reference: the deploying of cultural-historical and activity or CHAT perspectives, the bringing forth of student agency and identity in their learning, the conduct of an action strategy to affect change, the conduct of mathematical tasks in succession and the situatedness of these in local contexts of classroom and school. Prior research in each of these areas serve as relevant points of departure. First, del Rio & Alvarez (2002) argue student interest as the most significant aspect that could bring about change, given
that students are found to be deeply dissatisfied with schooling. Drawing on CHAT perspectives, which I elaborate in the next section, they seek student participation in activities that have meaning, include action and emotion and provide for the development of students' identity. Second, Grootenboer & Jorgensen (2009) argue student agency and identity depend upon providing task opportunities, wherein a sense of achievement can be had by drawing upon prior mathematical knowledge by them. They refer to Boaler (2003) who seeks classroom practices that allow for interchange of agency of students with that of the discipline of mathematics. Third, Altrichter et al. (1993) characterise action strategies as co-ordinated actions taken in local contexts of classrooms, aimed at improving educational quality. The conduct of any strategy, they say, proceeds with no expectation of preconceived or immediate results. Fourth, the conception of mathematical task and activity conducive to perspectives that are adopted in this study follow Watson & Mason who argue:

> Task in the full sense includes the activity which results from learners embarking on a task, including how they alter the task in order to make sense of it, the ways in which the teacher directs and redirects learner attention to aspects arising, and how learners are encouraged to reflect or otherwise learn from the experience of engaging in the activity initiated by the task. (Watson & Mason; 2007, p 207)

Finally, the design of such mathematical tasks and ensuing activity in my study follows Lave (1990) who points to mutually constitutive nature of students learning and their social and cultural world asserting “what is to be learned is integrally implicated in the forms in which it is appropriated, so that, for example, how math is learned in school depends on its being learned there” (p. 310).

Taken together, the above arguments underpin conduct of an action strategy in collaboration with two teachers Greta and Marcus (All names are pseudonyms) in their Grade eight classrooms. This strategy was made up of five mathematical tasks conducted in succession, wherein each subsequent task was designed after conduct of the prior. It was in such conduct that Greta and Marcus' students evidenced an overt display of identity in the fifth and final task, which was open-ended and lent voice to the agency that they encountered as individuals in their respective classrooms. Shedding light on the search of meaning by students of schooling (Rio & Alvarez, 2002) the conduct of mathematical tasks as action strategy (Altrichter et al., 1993) allowed for interchange of agency between students and the mathematics they were learning (Boaler, 2003). It was by incorporating social and cultural aspects prevalent in their local contexts (Lave, 1990)
that led the final task to allow students to pose problems, the pursuit of which enabled them to combine mathematical knowledge with a sense of achievement (Grootenboer & Jorgensen, 2009). What nature of agency and identity did students display when provided opportunity to pose meaningful problems in an open-ended mathematical task, within an action strategy, is the research question.

**Theoretical underpinnings**

Under ongoing exploration, CHAT perspectives perceive education as a process of simultaneous enculturation and transformation, alongside development of understanding and formation of minds and identities. Conducive to turbulent times such as ours, Wells & Claxton (2002) highlight three features that have bearing on my study. First, the role of cultural tools and artefacts which mediate understanding and afford means with which to know and share wisdom accumulated in any culture. It is learning to appropriate cultural and conceptual resources and the use of these with others, that provides for a learning that leads human development (Vygotsky, 1978). Second, they point out that values, goals and willingness of people who collaborate while using cultural tools and artefacts need not either be the same or coincide, thus providing opportunities for both enculturation as well as transformation. Finally, CHAT they stress is concerned not only with cognitive development but also of a person's mind and spirit as a whole. Any understanding of other's thought processes they stress needs to include one's interest, affect, emotion and volition. It is by drawing on these views that del Rio & Alvarez argue against fragmented approaches in education and favour the conduct of personally significant and socially meaningful activities:

> In meaningful practical activities, the object and purpose of the activity are apparent, the result of the action is contingent and feedback is immediate. When the activities are also productive, the results merge into a product that strengthens participants' identity and sense of self-efficacy. The produced artifact also becomes an external, stable symbol of the processes involved in producing it. (del Rio & Alvarez; 2002, p 64)

It was also the case that Greta and Marcus' classrooms and school were located in an industrial area, where at the time of conduct of the study there was considerable discussion in the press of possible closure of industry and possible loss of jobs for parents of students at the school. It followed that participation by Greta and Marcus' students in classroom activities depended on the manner in which mathematics was available for their appropriation in these local contexts of their

school. In agreement with Grootenboer & Jorgensen (2009) and with relevance to students learning in their local contexts, Lave (1990) also points out that routine instructional practices of classrooms could alienate learners, who would alternately gain from a curriculum designed for practice in which students are active agents. It was these arguments that formed backdrop to the design of the five-task action strategy which privileged active participation of students, moving attention away from a normative attention to their textbook. Lave (1992) has further highlighted the hypothetical nature of mathematical word problems in curricula which leave students, she says, to look upon everyday mathematics negatively by implication. Lave therefore argues for students' ownership of problems in a dilemma motivated manner in classroom activity, as is the case with problems encountered in everyday life. As outlined in the next section the design of five successive tasks enabled students to voice such concerns and address issues as faced by them in their respective classrooms.

CHAT perspectives significantly argue in addition that social practices produce not only knowledge but also participant identities, constituted through active relations with their social world. Students' identity Stetsenko (2010) argues is real work, in which their self is born and enacted in the activities that they participate. Human subjectivity and thinking she clarifies is a threefold process in which cultural tools and artefacts are provided through teaching, their use learnt by students, which in turn provides opportunity to transform their life's agendas. Such a view underpins the interchange of agency of students and mathematics (Boaler, 2003) its being situated in local contexts (Lave; 1990) and underlines providing for meaningful activities (del Rio & Alvarez 2002). With pedagogical implications of CHAT in mind, Stetsenko specifies teaching-learning to be:

organized in ways where knowledge is revealed: (a) as stemming out of social practice - as its constituent tools; (b) through social practice - where tools are rediscovered through students' active explorations and inquiry; and (c) for social practice - where knowledge is rendered meaningful in light of its relevance in activities significant to students, that is, where knowledge is turned into a tool of identity development. (Stetsenko; 2010, p 13)

**Methodology and methods**

CHAT perspectives premise practical activities in which individuals participate, use cultural tools, gain agency, develop identity and transform their social world as comprehensive unit of

analysis. These activities as Vygotsky (1978) argued are simultaneously object, tool and result of any study. The units of analysis in my study is thus participation of students in each of the mathematical tasks that constituted the action strategy deployed, where such conduct was a result of collaboration that Greta and Marcus and myself had come to agree upon. On my approaching their Rektor and seeking a grade seven for study at their school I was offered a grade eight instead, since this grade had demanding parents voicing concerns about the quality of their children's schooling. I visited Greta's class which was organised for regular students and later Marcus' class organised for more basic students. In Greta and Marcus' school offering specialised training in sports and music, it was also the case that Greta's class had the presence of a handful of boys who trained professionally for hockey. In a year ahead interview Greta mentioned that within instruction their presence demanded inordinate amount of her time and classroom space. While I deliberate my drawing upon cultural studies to theorise these concrete circumstances elsewhere (Gade, 2012) I now turn to perspectives that informed the design and conduct of the five mathematical tasks in succession.

Altrichter et al. (1993) outline action strategies as falling in an action research paradigm wherein questions about everyday work are asked so as to study and improve teaching-learning. Recognising the need to draw on situated theories that can inform action, they acknowledge too that social situations are complex and cannot be changed by any single action. They thus suggest criteria that could guide any sequence of actions that form an action strategy including (1) planning (2) acting and observing (3) reflecting and (4) replanning. Encouraging flexibility in one's approach with also not expecting predetermined results, Altrichter et al. importantly seek inclusion of voices of all stakeholders during design and conduct. It was to gather these voices in my study that I adopted narrative inquiry which led me to ascertain the experiences that Greta, Marcus and their students had in their local contexts. Alasuutari (1997) argues narrating in everyday life as a phenomenon to be studied in its own right, since the selves of individuals are not mere object in a physical world but importantly constructions lived by in existing social realities. Such manner of attention to these accompanied by my other observations of students' complaints about being tired, listening to music or being playful to avoid instruction lead me to surmise their lack of interest in mathematics or loss of meaning in school, or both, in agreement with del Rio & Alvarez (2002). In addition to drawing upon narrative inquiry I considered
students' working in groups as pedagogical aim in my study. This followed Vygotsky's dictum that peer interaction is the leading activity amongst adolescents, instrumental in the development of their self-consciousness (Karpov, 2005). Designing my tasks for such conduct I was careful to have instructional content area also in mind, to avoid burden from conduct of the action strategy. Such manner of action, inclusive and not independent of stakeholder voice, is termed second-order action research (Elliott, 1991). I now offer background to the tasks, of which I dwell only upon the fifth one in detail within data and discussion.

I premised the design of my first task on the possibility that students may be resentful of using their textbooks, given that many of them seemed to display disinterest. I turned to non-routine tasks such as those from the Känguru competition (http://ncm.gu.se/kanguru) and asked students to find area and perimeter of figures shown alongside Task 1 in the Table below:

<table>
<thead>
<tr>
<th>Task 1</th>
<th>Task 2</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Figure 1" /></td>
<td><img src="image2" alt="Figure 2" /></td>
</tr>
</tbody>
</table>

The conduct of Task 1 involved students first discussing their solutions in their respective groups, followed by their sharing these at the whiteboard with their classmates. This provided opportunity for student peers to observe and listen to alternate solutions and was indicative of initiating group work in Greta and Marcus' classroom culture. With intention of verifying my premise of students' possible aversion to the textbook I retained the goal of finding area and perimeter in group work in Task 2, yet offered figures that were from a textbook (Channon et al., 1970, p. 174). The conduct of this task strengthened my earlier premise, since I found the more basic students in Marcus' class to have difficulty in attempting this task. I was informed by Marcus that he found them struggling with their attempts, with one of them even coming up to me, expressing disappointment with facial expression and reporting "We need help." I surmised this feedback of students to come with a sense of their being let down by me, as their attempts at Task 1 may have given them a sense of hope in meeting the demands of mathematics expected of them. I thus reverted to everyday contexts while designing Task 3 and chose to work with maps taken from Internet search engine Google. Offering three maps that showed directions from the city centre (1) to their school (2) to a nearby town and (3) to the country's capital, I asked
students to calculate the scales that were used in each map, in their respective groups. Being highly relevant to the experience of each student the conduct of this task was met with a lot of interest, with students asking if they could measure distances as the crow flies as well as taking pride in greater accuracy of scales that they calculated. Encouraged by such responses, I based Task 4 on various containers they encountered in their everyday and asked students to first estimate and then calculate their volume. This task was in fact better received by more basic students in Marcus' class, who felt no hesitation in guessing the volume in terms of number of dice or milk packets say, where those in Greta's class were cautious and wanted to be accurate in their estimation. My combined observation of such evidence of agency in students prepared ground for their acting with emotion in their final task, set in the topic of statistics.

**Data – The fifth task**

With marked reformulation in students' agency in Greta and Marcus' instructional practice via the conduct of the first four tasks, I decided to give their students greater voice in the fifth task. It was with this in mind that I designed Task 5 to be open-ended and gave them opportunity to pose their own problems. In conducting this task myself, Greta and Marcus gave the following instructions (1) Work in groups of two or three (2) Decide on a question/pose a problem of your own choice (3) Collect data from other groups in the classroom and (4) Display your results in a column graph or pie chart. The sense of excitement displayed by students in either class while attempting this task was palpable. Greta, Marcus and me observed students groups to first formulate questions and then seek data from other groups towards addressing their problem,

which understandably incorporated a sense of ownership. I present examples of students' questions and graphs below.

<table>
<thead>
<tr>
<th>Question</th>
<th>Graph</th>
</tr>
</thead>
<tbody>
<tr>
<td>Which month were you born?</td>
<td><img src="image1.png" alt="Bar graph" /></td>
</tr>
<tr>
<td>What is your favorite genre of film?</td>
<td><img src="image2.png" alt="Bar graph" /></td>
</tr>
<tr>
<td>What brand of cellphone do you own?</td>
<td><img src="image3.png" alt="Pie chart" /></td>
</tr>
<tr>
<td>What is your favorite colour?</td>
<td><img src="image4.png" alt="Pie chart" /></td>
</tr>
<tr>
<td>What is the country you have most travelled to?</td>
<td><img src="image5.png" alt="Bar graph" /></td>
</tr>
<tr>
<td>What brand of four wheelers does your family own?</td>
<td><img src="image6.png" alt="Bar graph" /></td>
</tr>
<tr>
<td>How much does you get as monthly pocket money?</td>
<td><img src="image7.png" alt="Bar graph" /></td>
</tr>
<tr>
<td>How many brothers and sisters do you have?</td>
<td><img src="image8.png" alt="Bar graph" /></td>
</tr>
</tbody>
</table>

The eight graphs I present evidence the variety of problems that the majority of students in Greta and Marcus' class sought solutions to. However two particular solutions stood out against this
norm and overtly expressed students' self or identity as experienced by them in the social practice of their classroom. The first of these which asked *What is your favourite sport?* was pursued in Greta's class in which boys playing hockey were present. As mentioned earlier on, it was the presence of these boys that demanded a lot of attention both symbolically and in reality within Greta's instruction. The second which asked *Have you tried smoking?* was pursued by a group in Marcus' class. This later group consisted of Alba who smoked cigarettes and was a regular student enrolled in Greta's class in the beginning of the year. At the time of conduct of this task Alba had moved, or may have even been asked to move to the more basic group in Marcus' class, leading to possible feelings of her resentment. I was aware that Alba's habit worried Greta, who as her teacher felt she was unable to do anything beyond speaking about it with Alba's parents. I argue that students responses to these two questions were real and meaningful to them in their local contexts, as was any interpretation of these as researcher also was. By overtly addressing self and identity, I argue that student groups in either class utilised Task 5 and demonstrated, or voiced as it were, that hockey was not the most favourite sport and that it was a large majority of students who had tried smoking. That this seemed to be the case can be seen from the first graph where hockey is represented by only four students with the football, curling, handball, badminton, basketball, riding and innebandy represented by the majority. Alba's graph showed too that more than three quarters, or 77% of students in her class had tried smoking, something that she had a history of being singled out for alone.

![What is your favourite sport?](image1)

![Have you tried smoking?](image2)

**Discussion – The fifth and final task**

I consider most student responses to the fifth and final task as quite normative, as can be expected in any Grade eight, except for the overt display of students' self and identity in the last two cases I report above. Central to the five frames of reference deployed in this paper I discuss implications
of these graphs in their reverse order. It was drawing upon Lave (1992) that I first shifted focus away from students' textbook, which ultimately resulted in the last two solutions and problems posed as being meaningful to their selves in the social practice of their classroom, addressing dilemmas they faced within. Such problems designed specifically for their classroom practice, I argue, resulted in students not feeling alienated, voicing concerns and dilemmas being faced in their social reality (Lave, 1990; Alasuutari, 1997). Such overt display of self and identity was representative of how students learning and their social world were mutually constitutive. The participation of Greta and Marcus' students also exemplified Watson & Mason's (2007) notion of activity that surrounded a mathematical task, within which it was that students displayed visible shifts in their agency. Greta and Marcus' guidance in conduct of these was no less significant as in speaking native Swedish they were able to seek engagement of students in each and every task. In fact the overt display of self and identity in the fifth and final task was neither anticipated nor planned. Following Altrichter et al. (1993) our actions taken to change and improve educational quality was not a single one, but many successive actions that vitally took stakeholder voice into account. This study thus evidences how it is possible to bring about greater student engagement both in classroom teaching-learning and the discipline of mathematics. A visible representative of interchange of student agency and mathematics in particular, were exemplified by the two graphs about students' favorite sport and their attempts at smoking (Boaler, 2003). It was via these two graphs that student groups showcased their combining a sense of accomplishment with their mathematical knowledge (Grootenboer & Jorgensen, 2009). Following CHAT perspectives, the fifth and final task was not only a cultural tool and artefact whose use students were being enculturated into, but also one they were transforming as means of expressing self, identity and their very being (Wells & Claxton, 2002). Finally the design and conduct of tasks based upon the loss of meaning in mathematics and schooling that del Rio & Alvarez (2002) alluded to, was a viable strategy that led to greater agency and resulted in students voicing their selves and their identity. These actions were those that became personally significant and socially meaningful. My drawing on voices grounded in social practices within local contexts, lent finally to the immediacy and nature of change that any second-order action research, it is argued, has potential to bring about (Elliott, 1991).
In conclusion

My attempt to address the problem of loss of meaning in schooling and the teaching-learning of mathematics in and through my study has led to an approach situated in the social realities of local contexts of classroom and school. Towards any resolution of this issue I have found it imperative to take all stakeholders voices into account. Besides Greta, Marcus, their students and their Rektor, at Greta's request I agreed to meet parents of students at their parent-teacher meeting. My rationale for agreeing to this was based on the ethical need for the practice of educational research to stand up to societal scrutiny. Towards this, my drawing upon situated stakeholder narratives was means with which to not only make personal sense of how these were situated, but also how my study itself was to be situated in wider society. Narratives, following Alasuutari (1997), are phenomena which enable research to attend to how individual selves became personalities in social realities. Towards this, attention in my study to activities that accompanied the mathematical tasks (Watson & Mason, 2007) provided opportunity for Greta, Marcus and me to direct as well as redirect various aspects of these very realities. Not achieved by a single action, as Altrichter et al. (1997) rightly point out, the incidence of this was possible only by a sequence of tasks in which the importance of allowing for group work is also noteworthy. Following Vygostky, I argue that it was such manner of conduct that gave students many an opportunity to not only develop self-consciousness, but also its display as self and identity (Karpov, 2005). Such an holistic approach to solving problems, inclusive of the social being and emotions of students, is I find often overlooked in cognitive studies of problem solving. In light of Stetsenko's (2010) arguments that student identity is real work, born and enacted in activities being participated, my study shows how students' identity was born out of their social practice, through social practice and for the social practice that locally prevailed. It was successive changes brought about in instructional practice via conduct of an action strategy, that the tasks and ensuing activities became meaningful for Greta and Marcus' students (Rio & Alvarez, 2002). Based on my study, I thus seek inclusion of problems and/or tasks related to students' self in mathematics curriculum for adolescent students. Not allowing for such opportunities, would risk leaving learner as well as that which is learnt unchanged and unaltered in education.
References


