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Accounting for Situated Experience in Socio-cultural-historical Inquiry Bakhtinian Utterance in a Mathematics Classroom

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This paper discusses two cases of instruction from within a mathematics classroom, in which the situated experience of participants is informed using Bakhtinian utterance as analytical construct. The first illustrates situatedness and shared reference between teachers and students in the social speech of the classroom, with reference to the generic ‘When we multiply, we add’ in the teaching-learning of exponents. The second discusses the sharing of experience and the shaping of reason by students solving a problem as a group, in relation to a graph depicting the movement of an elevator between two floors where the word ‘stop’ is used to both convince and be convinced by the other. Located within a socio-cultural-historical study and accounting for the materiality of language in which individual intention, meaning and experience is populated, a Bakhtinian analysis enables access to both individual and collective thinking. This approach in turn informs the nature of active knowing in the teaching-learning of mathematics and its authoritative word.

Introduction

Of the many analytical constructs that inform the functioning of teaching-learning in mathematics classrooms, the issue of talk or communication has received recent attention. A greater need to understand the tool-kit of discourse has been argued for to appreciate the relationship between language and knowing which thus far may have been taken for granted. The theoretical and methodological challenges in adopting such an approach has begun to be informed by socio-cultural-historical perspectives in providing a basis for dealing with the materiality of everyday instruction. In this paper I report from my classroom study wherein an emphasis on the role of artefacts, both physical and intellectual, in understanding teaching-learning led me to appreciate the role of materiality in mediating various actions of participating students and teachers (Gade, 2006). Adopting a Bakhtinian perspective in unison provided insight in particular to the externalised and spoken aspect of the larger discourse constituted in the classroom. In the construct of utterance one had not only a sensitive index of social change reflecting the progression of teaching-learning, but an epistemic basis for claims about the situated experience of participating students and teachers within instruction. In presenting the two cases that illustrate this approach, I first outline the nature of my socio-cultural-historical study and related view of the mathematics classroom as a particular kind of cultural practice. I then present two cases, the first illustrating situatedness and shared reference between teachers and students within teaching-learning and the second the sharing of experience and the shaping of reason by students as a group. After discussion about the insight such analysis provides about the classroom teaching-learning of mathematics, I conclude with the benefits of analysing situated experience of individuals with Bakhtinian utterances.
Socio-Cultural-Historical Inquiry in the Mathematics Classroom

One emphasis laid in my classroom study from within which I report is the role of artefacts in the teaching-learning of mathematics (Gade, 2006). The artefacts that I identified and classified for this purpose included physical artefacts like the blackboard, calculator and notebooks and intellectual artefacts like algebraic symbols, notations and mathematical signs of convention. Analysing the role of artefacts led me to analyse various physical and intellectual actions of both teachers and students mediated by these within the teaching-learning of mathematics. Though primarily a medium for visible display the blackboard for example, was also a forum for discussion amongst various groups of students that constituted the collaborative practice established in the classroom. As in the case of exponents that I discuss in this paper, algebraic signs mediated not only the intellectual activity that such notation denoted but also formed the basis for a generic form of social speech that was shared within teaching-learning. An attention to actions mediated by artefacts in everyday instruction thus paved way to analysing the materiality of communication that was situated within the classroom.

Two perspectives inform analysis about the nature of situated communication or discourse. Firstly, in line with a language based theory of learning Wells (1999) recognises the nature of dialogue amongst those who participate as central towards the emergence of knowing. He qualifies the nature of such knowledge construction to be a collaborative process in which various modes of actions like representing, recognising, hypothesising and concluding are involved. Wells argues also that although knowing is necessarily individual, its purpose and fullest realisation is in its socially-oriented creation generated in concrete practices. The second perspective that informs analysis of the nature of situated discourse is offered by the construct of utterance which according to Bakhtin (1986, 1994; Holquist, 1990, Vološinov, 1973) is inherently double-voiced, serving both speaker and listener in anticipating and presupposing the other. In being the materiality in which the situatedness of participants is experienced, Bakhtin premises utterances as the basis for claims that can be made about individual and collective thinking. In being able to account for the intention and experience of those participating, Bakhtinian utterances hold promise of insight into the nature of dialogue and the shaping of meaning that Wells argued as leading to active knowing.

Drawing upon Bakhtin and with reference to mathematical instruction in particular, van Oers (2001) portrays classroom teaching-learning as a specific kind of practice wherein both teachers and students participate with differently conceived roles. The teacher argues van Oers, is responsible for the enculturation of mathematics by the apprenticing or initiating his or her students into the more formal mathematical community. In such a scenario the role of students is one of gaining membership and exhibiting a particular manner of thinking or participation to gain membership within that community. The protracted discourse between teachers and students is thus recognised by van Oers as essential towards constituting a practice in the classroom, that is acknowledged as a mathematical one. The nature of situated and shared social speech towards this end, he adds, involves processes of both contextualisation and decontextualisation. Bringing the above mentioned perspectives to bear in analysis, I now turn to discuss the case of exponents followed by the case of an elevator within the classroom teaching-learning of mathematics.

The Case of Exponents and Bakhtinian Utterance

This case relates to whole-class discussion between teachers and students in my study, while attempting questions from the textbook relating to the multiplication and division of exponents. Prior to the incidence of this discussion in teaching-learning, Olaf the
teacher had derived the rule related to the adding of powers of exponents when they were to be multiplied and of subtracting the powers of exponents in case they were to be divided. At the time of occurrence of this case Olaf was urging his students to apply the rules that they had derived earlier.

In the extract I offer relating to the case (Figure 1) I first draw attention to Olaf’s utterance in event 4, ‘When we multiply we …’ to which he receives a students response in event 5 of ‘Add’. The discussion in events 6 to 11 thereafter, show Olaf making sure that his students can recall the meaning mediated by the exponential notation in terms of other topics in mathematics like fractions and decimals that the students would have dealt with prior to the topic of exponents being currently discussed. Within instruction, Olaf then turns to discuss a question of his choice from the textbook. His utterance in event 14 of ‘What do we do when we divide …’ now elicits the response in the next of ‘Subtract’ from another student. In reply to the response of his students which he seems satisfied with, Olaf summarises his instruction by offering ‘Subtract because we have division’ by which he articulates the basis upon which he, as a teacher, is accepting their responses.

I view the two pairs of utterances ‘When we multiply, we …’ ‘Add’ and ‘What do we do when we divide …’ ‘Subtract’ between Olaf and his students as illustrative of a stylis-

<table>
<thead>
<tr>
<th>Event</th>
<th>Person</th>
<th>Utterance</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Olaf</td>
<td>Anything you’d like me to explain or do before we go on</td>
<td>$2^3 \times 2^{-4}$</td>
</tr>
<tr>
<td>2</td>
<td>Olaf</td>
<td>We apply the rules we know before</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Olaf</td>
<td>When we multiply we …</td>
<td>$2^3 \times 2^{-4}$</td>
</tr>
<tr>
<td>4</td>
<td>STD1</td>
<td>Add</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Olaf</td>
<td>We can do more …</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>STD2</td>
<td>Fraction</td>
<td>$\frac{1}{2}$</td>
</tr>
<tr>
<td>7</td>
<td>Olaf</td>
<td>Zero point five</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>RES</td>
<td>Notes Olaf wait for explicit equivalence of the exponent, fraction and decimal forms of representation</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Olaf</td>
<td>I want to do c</td>
<td>$(\text{Referring to Q1.33(c))})$</td>
</tr>
<tr>
<td>10</td>
<td>Olaf</td>
<td>((Q1.33(c) Calculate))</td>
<td>$\frac{3^{-2}}{3^{-3}}$</td>
</tr>
<tr>
<td>11</td>
<td>STD</td>
<td>Subtract</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Olaf</td>
<td>Subtract because we have division</td>
<td></td>
</tr>
</tbody>
</table>

Figure 1
tic or generic discourse in a Bakhtinian sense. With specific reference to the multiplication of exponents, these pairs refer to arithmetical operations to be performed on powers corresponding to their respective bases which as utterances both anticipate and presuppose the other utterance. Outside of referential meaning to the multiplication of exponents that they denote, these utterances may even seem contrary to everyday experience and carry the risk of being considered as mathematically incorrect. The existence in my study of shared social speech as illustrated by this case, is indicative also of the nature of training by which Olaf is initiating his students. Following van Oers, this nature of apprenticeship is indicative of the kind of participation and thinking that Olaf is asking of his students towards his acceptance of them into formal mathematical practices. With reference to multiplication and division of exponents the nature of shared social speech by which the participation of his students is guided, is indicative also of the kind of decontextualisation that is needed on their behalf to carry out multiplication and division of exponents. The existence of shared social speech or semantic potential between Olaf and his students illustrated by the pair of utterances referred to in this case, seem to exemplify also the meta-contracts of communication that Rommetveit (1974) draws attention to, which he says lend and endorse meaning to the nature of communication that has so transpired.

From a Bakhtinian perspective the pair of utterances ‘When we multiply we ... add’, ‘… when we divide ... subtract’ both express a particular intentional position on behalf of the teacher and elicit a particular responsive position within teaching-learning by his students. As utterances they finalise not so much the grammatical form that is required of formal sentences but rather the idea behind the nature of operations to be performed with respect to multiplication and division of exponents. Following Bakhtin, Dannow (1991) argues that such nature of stylistic discourse enters experience and consciousness in close connection with each other, having the potential of being mastered as fluently as native language. In Olaf initiating his students into choosing not simply a lexicon but a generic mode of expression, he is constraining the nature of speech that his students would use. In so doing he draws attention to two aspects simultaneously – that arithmetical operations are to be carried out on the powers of exponents and not their bases, and that these arithmetical operations differ in either case of multiplication or division. By way of intonation and the manner in which he allows his students to complete his uncompleted utterances, Olaf chooses a strategy by which his students respond and participate in a way he thinks is both appropriate and advantageous. As argued by Bakhtin these utterances do not reflect the situation being experienced by them, but come into existence and represent in words a particular situation and view of the world. These utterances thus simultaneously serve Olaf, his students and the cultural practice of mathematics.

The Case of an Elevator and Bakhtinian Word

Unlike the case of classroom instruction above, my second case refers to the solving of a problem by a group of students and relates to two graphs that were presented to them in a problem solving task (Figure 2). The task instructed “You will be given two graphs A and B. The graphs relate to the motion of two different bodies. One of the graphs describes the motion of an elevator traveling between two floors. The other graph describes the motion of a ball thrown up in the air and caught on its return. Which of the two graphs given to you shows the movements of the elevator and ball mentioned above and why?” As part of their problem solving task the students were also asked “Refer to the graph labelled B and explain what may be happening at points marked P, Q and R that were marked at the beginning, middle and end of the line drawn in the graph.”
In relation to the two questions mentioned above I present two extracts. In the first extract the group of students Anja, Egil, Lea and Stine attempt to distinguish between the two graphs given to them.

03:59 RES 37 That is A and that is B
Stine 38 Elevator
Lea 39 Hmm, hmm … and that’s the ball
Anja 40 And that’s the ball
Egil 41 No, that’s the ball that’s the ball because it starts fast and mm mm
((referring to graph A))
Egil 42 --arh if you throw up a ball it will go up like this … this you know
Egil 43 --and it will kind of stop like this
Anja 44 On the ground?
Egil 45 On the top
Egil 46 On the top and then it will fall down again
Anja 47 (Inaudible))

04:37 Egil 48 It says here … ball thrown up in the air
Egil 49 You throw it and it sort of stops and falls down again
Egil 50 So I think this is the ball definitely
Egil 51 And because that … arh the elevator will increase in speed
Anja 52 -- and stop
Egil 53 It’ll stop and then it’ll go up again

05:00 RES 54 What do you think? Is it OK?
Many 55 Yes, ya

In the second extract that follows, the students identify points P, Q and R in graph B.

07:32 Egil 119 So Graph B then
RES 120 Ya
Anja 121 OK the P is when it’s on the first floor
RES 122 So what about P, Q and R
Egil 123 Well, here it increases arh an elevator well is similar to the car it will start and it goes faster and faster…
Egil 124 And then it will stop and then it will arh …
Lea 125 ((Inaudible)) it will slow down
Egil 126 Ya
RES 127 So P is when you say it is starting?
Egil 128 Ya … and Q is …
Stine 129 [When it is at the top]
In turns 37 to 41 at the beginning of the first extract, where the students are identifying which of the two given graphs is either that of an elevator or the ball there is evidence of disagreement between Anja and Egil as to which of the two graphs depicts the motion of the ball. In turns 41 to 43, Egil relates his experience with a ball thrown up in air and how it will come to a stop. In my arguments it is usage of the word ‘stop’ that I wish to trace. Not only is the word ‘stop’ a word that is traded between Anja and Egil, its usage as I now elaborate is one that refers to different contexts on different occasions. To Egil’s use of the word stop in turn 43 ‘And then it will stop and then it will arh …’ Anja wants to know where it is that the ball will stop. By turn 49, Egil’s use of the stop in ‘You throw it and it sort of stops and falls down again’ refers to the general and accepted fact that any ball will stop when it is thrown up in the air. By turn 51 when Egil is now referring to the motion of elevator between two floors and saying that the elevator will increase in speed, it is Anja who completes Egil’s utterance in turn 52 by saying that it is the elevator that will stop. This usage of the word stop refers to the elevator and not the ball as before. Finding Anja to agree that it is the elevator that will stop Egil’s now ‘borrows’ Anja’s usage and reference of the word stop to add in turn 53 that ‘It’ll stop and then it’ll go up again’. Within this extract it is only in this and last usage of the word stop that Egil and Anja agree upon what it is that is stopping.

The usage of the word stop between Anja and Egil resurfaces in the second extract when as a group the students are identifying what may be happening in reality corresponding to the points P, Q and R at the beginning, middle and end of the line in graph B. Anja identifies point P in turn 121, as representing the elevator being on the first of the two floors between which it is traveling. At this point and explaining the motion of an elevator in real life, in turn 123 and 124, Egil calls upon the experience that all of them would have with a car speeding up and eventually stopping. In response to Egil and wanting to clarify what could be happening after the elevator stops, Anja asks ‘Stops and then’ in turn 131. Egil then clarifies in turn 132, that the elevator had to slow down in order to stop at the next floor. Taking cue from Egil, Lea another student in the group now shares in turn 133 her experience of an elevator coming to a stop by varying her pitch from a lower one to higher one and another from a higher one to a lower one to represent an elevator actually stopping. She offers her sound representing the stopping of the elevator in turn 141 again, which she verbalizes as ‘Doying!’ to match Egil’s use of the word stop in turn 140. In addition to the first extract where the word stop refers to the motion of either ball or elevator, the word stop in the second extract is now supplied with another meaning and personal experience by Lea, of how an elevator comes to a halt or stops in reality. In this manner the word(sound) stop(Doying) is possessed by neither of the students and is borrowed from each other in a Bakhtinian sense, suffused with
meaning and traded back and forth amongst the group in order to both convince and be convinced in turn by the other.

I argue that the words ‘stop’ and later the sound ‘Doying!’ as words allowed the students in the group to share their individual perspectives, enabling them to negotiate differing positions in solving the given problem. The two extracts illustrate the struggle in the voicing of their personal experiences, allowing insight into how each of them attempted to stride between the real world in which their experiences resided and the world depicted in the problem. These words are intentionally and strategically deployed with their meaning and intent recreated and renegotiated on each occasion. Incorporating contextual meanings as well as behavioral accompaniments like throwing their pencil cases up in the air to represent the motion of the ball, these words become a mode of apprehending and interpreting the world and its objects and concepts. Following Bakhtin the private experiences of the students is informed by the authorship of the word they were using while in communication with each other. Their discourse lies as Danow (1991) points out at the intersection between their own self and the others in their group or between self and not-self. In co-being, co-creating and co-authoring utterances and words in their attempts at solving the problem as a group, there is no unique meaning being striven for as the contexts the words refer to in reality are limitless – underscoring Bakhtin’s dictum that there is never a first word nor a last. In addition it is through their utilisation of words that the students gain entry to formal mathematical culture.

The Classroom Teaching-Learning of Mathematics

Accounting for the situated experience of teachers and students in either a group or classroom with Bakhtinian utterance as analytical construct thus seems to provide insight into how one individual can initiate another to participate in the formal mathematical community, revealing the intentions of either speaker in the process. Such manner of situated analysis informs us of two vital aspects of enculturation in addition, firstly what nature of discourse between teachers and students qualifies their participation in the teaching-learning of mathematics in a classroom and secondly, which of these acts exemplifies those processes which when taken together constitute a cultural practice that could be considered as mathematical. The two cases I present illustrate that classroom teaching-learning conceptualised as that of apprenticing and gaining membership into a formal community is governed by active participation in a particular kind of discourse. The pedagogical attributes of such a practice lie in the opportunities provided for both individual and collective thinking in relevant activities, through the utilisation of social conventions of speech and power relationships by both teacher and his students towards specific goals that the teacher has in mind. Following Bakhtin, the authoritative word in teaching-learning is authoritative in two ways – in the teacher using his authority and in the students authoring the words they use with individual intent. Either usage is directed or addressed to another person or self with specific intent, towards eliciting the other’s response. The communication that brings about such participation is as Linell (1998) argues not single-voiced but through words and dialogical, very much presupposing another.

It is whilst adopting a historical methodology and a socio-cultural-historical approach that I present the two cases from within the complexity of classroom instruction in my study. Yet the importance of the two cases I discuss is based on theoretical interpretation which views utterances as the material medium in which the situatededness of participants is being experienced in and not the means of representing that experience. Following Bakhtin, my recognising every utterance as being double voiced, serving two speakers simultaneously and expressing two different intentions at the same time, allows me to treat them as a window to the socio-ideological context of instruction that the teacher and students were participating in. Beyond the gaining of such insight the promise of such an
approach lies as well in addressing questions related to the nature of plurality in perceptions that were shared amongst students, to what purpose they were used by the teacher, which social conventions were addressed, as well as the active nature of situated discourse which contributed to greater knowing. I contend that the possibility of making these aspects explicit informs how talk and discourse is critical not only for individual and collective thinking but also for research in teaching-learning of what Bakhtin argued was the authoritative word of mathematics.

Bakhtinian Utterance and Word as Analytical Constructs

I conclude this paper by drawing attention to four features that I found exemplified in my study.

- The first of these informs the nature of meaning that was shared between both teacher and students in either of the cases I discuss. The teachers utterance ‘We can do more’ in my first case, where it was the students who offered the decimal and fractional equivalents of the exponent being discussed, was illustrative of Bakhtin’s contention that an utterance served both speakers – the teacher and the students in co-authorship. The varied usage of the word ‘Stop’ by the students in the second case illustrates how, far from belonging to any one individual a word was co-authored in the group in collective experience as well.

- The second feature relates to the nature of social speech that prevailed. Following Bakhtin and in the generic sequence ‘When we multiply we –’ ‘Add’ one is alerted to the presence of a socio-ideological context between the teacher and his students at a particular point of time in instruction. At a later time in instruction such manner of speech may not even be spoken and may even be taken for granted. In a similar manner, the use of the ‘Doying!’ as another way of expressing the word ‘Stop’ is indicative of the presence of shared situated experience amongst the students. Brought into dialogue to meet this very purpose, its use outside of the problem being solved may not even be understood for lack of adequate reference.

- In the third feature I deliberate upon the nature of powerful insight that the Bakhtinian utterance provides. In the sequence ‘We can do more …’ ‘½’ and ‘0.5’ one has access to the social norms that were accepted by both students and their teacher in the classroom, wherein the fractional and decimal equivalents of exponents would henceforth and in all probability be treated as accepted convention. In the second case, attention to use of the words ‘Stop’ and ‘Doying!’ provide access to the plurality in perception these words could refer to. In the first extract the same word ‘Stop’ refers to various and different contexts in reality, where by the second extract two different words ‘Stop’ and ‘Doying!’ refer to the same reality.

- In my final feature I refer to understanding about teaching-learning that one has access to with Bakhtinian utterances. The first case enables me to illustrate that it was the presence of both teacher and student as individuals who were answerable to the environment in the classroom, that created the opportunity for either of them to author different words and utterances. For such authorship and participation, the extracts in the second case illustrate how each person drew upon individual experience and contributed personal meaning.

Situated experiences, either within the context of a mathematical problem or within the classroom instruction of mathematics, when analysed as Bakhtinian utterances therefore seem to offer four benefits. In the first, they are means with which to account for concrete experiences lived in the present as well as in the past. In the second, they provide access to the ideological and social aspects that drench the cultural practices in which individuals participate. In the third, they are both a mode with which to apprehend and interpret ones
experience in reality. Finally, they are an active means by which to share meaning in the collective endeavor of human knowing.

References
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