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An Activity Theory approach to surfacing the pedagogical object in a primary school mathematics classroom

Abstract

This paper develops a methodology for using Activity Theory (AT) to investigate pedagogical practices in primary school mathematics classrooms by selecting object-oriented pedagogical activity as the unit of analysis. While an understanding of object-oriented activity is central to Activity Theory (AT), the notion of object is a frequently debated and often misunderstood one. The conceptual confusion surrounding the object arises both from difficulties related to translating the original Russian conceptualisation of object-oriented activity into English as well as from the different interpretations of the object currently in use within two contemporary approaches in activity theory. This paper seeks to clarify understandings of the object by exploring notions of object oriented activity. To this end, the paper traces the historical development of the object through Leontiev (1978; 1981) and Engeström's (1987; 1999) expansion of Vygotsky's original triadic understanding of object oriented activity. Drawing on Basil Bernstein's (1996) notion of evaluative criteria as those rules that transmit the criteria for the production of a legitimate text, the paper goes on to elaborate a methodology for using AT to analyse observational data by developing the notion of "evaluative episodes" as pedagogical moments in which the pedagogical object is made visible. Findings indicate that an evaluative episode can serve as an analytical space in which the dynamism of an activity system is momentarily frozen, enabling one to model human activity in the system under investigation and, hence, in this study, to understand pedagogy in context.

Introduction

A flurry of recent publications indicates that Activity Theory is proving a useful tool for studying work settings (Engeström, 2001); product design (Hyysalo, 2005); collaborative activity (Nardi, 2005); studies in creativity (Daniels & Leadbetter, 2005); drama games with children (Brostrom, 1999); educational interventions (Lim & Hang, 2003; Seitamaa-Hakkarainen, Hakkarainen, Bollstrom-Huttunen, Engeström, 2005) and even the workings of a law court (Engeström, 1997). Activity Theory (AT) offers a potential framework with which to transcend archaic dualist notions that either reifies mind or society as the ultimate 'cause' of human behaviour. With its focus on situating mind in context, contemporary AT indicates that one cannot study agency or psychological questions in general, outside of the context in which these questions are meaningfully animated. Figure 1 represents a contemporary view of an activity system, which activity theorists take as the prime unit of analysis (Engeström, Miettinen, & Punamaki, 1999; Engeström, 1987). This unit of analysis allows one to situate developmental processes in context. What one can see from figure 1 is that the *subject* acts on the *object* in order to transform it using *mediating artefacts*

Figure 1: An activity system (Engeström, 1987: 75)

in order to arrive at an *outcome*. In turn, the subject's position and engagement with the activity is influenced by the rules of the context, his/her community and division of labour.

Most activity theorists today agree that the basic characteristic of an activity system is its object orientedness (Kaptelinin, 2005; Leontiev, 1978; Engeström, 1987; Hardman, 2005). Kaptelenin (2005) indicates that the object of activity is what imbues the activity with sense and meaning, allowing for a "structured understanding of otherwise fragmented pieces of evidence" (5). In fact, it makes no sense, really, to talk of an activity that is not directed at an object; what indeed could an object-less activity look like, one wonders? Hence, identifying what object is being worked on within a specific context, will help to illuminate the activity system as a whole. However, tracking the object represents something of a challenge as it is notoriously difficult to apprehend due in part to the conceptual fuzziness surrounding the notion of the "object" (Foot, 2002). This confusion arises both because of the vagaries of translation and because the two current versions of AT come at this notion of the object in subtly different ways. Much has been written about the notion of the object in AT; an entire edition of *Mind, Culture and Activity* (12, 1, 2005) is dedicated to this thorny issue. I do not seek to re-invent these debates or even to elaborate them in much depth. This paper deals with a very specific empirical problem; how does one track an object in a classroom (a very complex system indeed, suffused with unseen power and control relations) in the absence of a direct intervention? In a bid to illustrate how one might track the object of pedagogical activity in a mathematics classroom, this paper sets out to understand the notion of object oriented activity. The first part of this paper deals with developing an understanding of what object-oriented activity *is* and the second part develops a methodology for tracking the object of pedagogic activity as it is constructed in the context of mathematics lessons.

What is object-oriented activity?

All activity is directed towards something that exists objectively in the world. For Jonassen et al (1999) the object is the primary focus of the activity system.

> The subject of any activity is the individual or group of actors engaged in the activity … The object of the activity is the physical or mental product that is transformed … Tools can be anything used in the transformation process. … The use of culture-specific tools shapes the way people act and think… Tools alter the activity and are, in turn altered by the activity. The activity consists of goal-directed actions that are used to accomplish the object-tasks, actions and operations that transform the object. (1999: 161)

The notion of the object is not restricted to material objects; socially and culturally determined properties also have an objective existence and can be studied with objective methods (Miettinen, 1997; Bannon & Bodker, 1991). This almost dual nature of the object (as both material and ideal) has led to some confusion and conceptual 'fuzziness' in methodological attempts to 'track' the object. The confusion arises primarily in how this notion is used in contemporary versions of AT. For Leontiev, the object of any activity is that thing that drives the activity, what he refers to as the "motive" of the activity (1981). In a well argued article uncovering the conceptual gaps in understandings of the notion of

object, Kaptelinin (2005) illustrates that for Leontiev (1978), the object of activity is predominantly the "object of individual activity" (9). Leontiev's psychological framework suggests that:

> "Human psychology is concerned with the activity of concrete individuals that takes place either in conditions of open association, in the midst of people, or eye to eye with the surrounding object world- before the potter's wheel or behind the writing desk. Under whatever kind of conditions and forms human activity takes place, whatever kind of structure it assumes, it must not be considered as isolated from social relations, from the life of society" (1978, p. 51).

For Leontiev then, all activities are social, even those carried out in apparent isolation; however, the focus is on "concrete individuals" engaged in individual activity. While Leontiev's work does not discount the possibility of collective activity (and indeed, Engeström (1987) makes a good case for reading his work as a move towards collective activity) it appears that his framework was designed for explicating individuals' activities. Given the profoundly psychological focus of Leontiev's concept of activity as essentially individually motivated, this understanding of activity could not easily be applied to fields outside of psychology that deal with supra-individual activities (Kaptelinin, 2005). Education is a field that deals very much with collective rather than individual activity. As a field of study, education requires that one is able to situate the subject of study within a wider context[1], highlighting community membership, rules of interaction and issues related to division of labour in order to more fully understand the complexities of learning and teaching. This more elaborated picture of context is provided by Engeström's model of activity represented in figure one above.

While Engeström has built on Leontiev's hierarchical model of human activity, he has extended Leontiev's view of the object to incorporate not only motive but also the problem space towards which the activity is geared. For Engeström (1987), activities are collective phenomena that unfold over time. Individuals can carry out actions oriented towards goals only within the wider arena of a collective, object oriented activity. For him, the object is more than merely the motive driving the activity. The object is "the raw material or problem space at which the activity is directed and which is moulded and transformed into outcomes" (Centre for Activity Theory and Developmental Work Research, n.d.). Moreover, resonating with Cole's (1996) articulation of artefacts, Engeström and Escalante suggest that:

> "Objects do not exist for us in themselves, directly and without mediation. We relate to objects by means of other objects … this means that objects appear in two fundamentally different roles: as objects (*Gegenstand*) and as mediating artefacts or tools. There is nothing in the material makeup of an object as such that would determine which one it is: object or tool. The constellation of the activity determines the place and meaning of the object" (1996: 361-362).

This understanding of the object draws heavily on the Marxian notion that the object of thought (*Gegenstand)* cannot be understood independently from object oriented practical activity (*Objekt)* (Marx & Engels, 1970; Roth, 2004). Whereas for Leontiev the object of activity is related to motive, the object of activity, for Engeström is related to production (Kaptelenin, 2005). Moreover, pointing to a contextual elaboration that is analytically

1 There is some conceptual fuzziness surrounding the notion of 'context' as it arises out of debates that stretch across sociology, anthropology and cultural psychology (Cole, 1996). For my purposes I draw on Cole's (1996) notion of context as that which "weaves together". Interested readers are referred to this seminal work in cultural psychology for an in depth discussion in which Cole illustrates how the notion of context is elegantly captured in Engeström's elaboration of an activity system.

absent from Leontiev's work, this quote highlights the need to focus on object construction in the context of an activity. It is only possible to distinguish between the object of an activity and material artefacts in the "constellation of the activity" (Engeström & Escalante, 1996:362).

For this paper, I draw on Engetrom and Escalante's (1996) understanding of the object. This however, is not without its own challenges: Engeström's work is a predominantly intervention-oriented form of action research and surfacing the object of an activity becomes the focus of change laboratories where contradictions emerge and the object of the activity becomes visible. My own study does not utilise change laboratories; nor indeed, do I maintain an interventionist stance. I have, therefore, had to develop a method for eliciting the object of a classroom activity in the absence of intervening in that activity. My own journey to surface the object of the activity I am interested in (viz: pedagogic activity) is two fold: First, as the object is connected to the motive behind the activity, and as it is the subject's motivation that drives this, I have interviewed the teachers to ascertain the motives driving their actions within a classroom. However, I am acutely aware that investigating teachers' motives for their goal directed actions do not necessarily give one insight into the object still-to-be-constructed in activity. As I see it, there are two problems with basing an analysis of the object of the activity solely on interview data; the first and most obvious obstacle relates to the fact that interviewees might not in fact have direct access to their motivation for acting and the second reason, related to the first, goes to the notion of the object as being constructed in activity, rather than a-priori. So first, the teachers may not be aware of their motives for acting and second the teachers' intended motives may differ from what actually happens in the classroom. Consequently, I track the actual object of the lesson by analysing pedagogic activity in what I have called evaluative episodes, spaces that are capable of uncovering the object as it emerges in activity (Hardman, 2005).

The study

The study underpinning this article investigated pedagogical activity in primary mathematics classrooms. The focus of the study, then, is on teachers rather than on students. Through detailed analyses of teachers teaching, interviews with teachers and students, classroom observations and analysis of students' productions (such as workbook or board work), the study set out to investigate pedagogy in a mathematics classroom. An exploratory case study design was employed in order to best investigate pedagogical activity. The sample comprised four previously disadvantaged[2] primary schools in the Western Cape region of South Africa. Four grade six classes (153 children) and four grade six mathematics teachers participated in the study. The decision to focus the analytical lens on mathematics classrooms was driven both by the crisis faced in mathematics education in South Africa[3] as well as by the more pragmatic concern with situating the study within a context in which the participating teachers taught. Two schools were located in urban areas and two were located in rural farming districts. Eight lessons differing in length from one hour to one hour and forty five minutes were video recorded and serve as the primary observational data set. The video

2 'Disadvantage' is a relative term; these schools were historically systematically disadvantaged in terms of access to human and material resources under Apartheid. Post-Apartheid South Africa has given these schools potential access to better resources; they are still, however, relatively poor schools with students drawn almost exclusively from the working class and in many cases, from the working poor and unemployed.

3 South African was placed last (out of 38 countries) in the Third International Mathematics and Science Study (TIMMS) (Martin et al, 2000).

data were examined for evidence of evaluative episodes, disruptions in the pedagogical script where the teacher makes visible the evaluative criteria required for students to produce a legitimate text. The novelty of this method requires a detailed discussion of what these evaluative events are as well as outlining the theoretical roots of these episodes.

Operationalising evaluative episodes

An evaluative event is a coherent classroom activity where the teacher elaborates the evaluative criteria required to produce a legitimate script. These episodes are marked out because they represent *disruptions* in the pedagogical script; that is, they indicate a break in the flow of the script where the teacher is called on to *restate* and make explicit the requisite evaluative criteria in response to student productions. The reference to 'disruptions' and 'restatement' of content draws on the body of knowledge that has developed out of Flanagan's (1954) definition of critical incidents as "a classroom episode or event which causes a teacher to stop short and think" (33) as well as Goodwin's (2001) understanding of these events as turning points in the lesson "where the teacher's utterances influence the shape and tone of the subsequent interaction" (11). So the evaluative episode represents a break in the flow of the lesson and my use of this concept derives predominantly from work done around notions of critical incidents. In this way, then, an evaluative episode is a device for selecting data to analyse it in depth. However, what demarcates an evaluative episode as an event in which the object of the lesson is surfaced, lies in *what* is restated during these events; that is, the essence of this event is to be found in the evaluative criteria that it explicitly highlights. It is in the foregrounding of these rules that one is able to track the object of the episode. The restatement of the evaluative criteria in the episode provide us with a microcosm of the object of the lesson as a whole by highlighting what it is that the teacher and students are working on in the lesson.

I draw heavily on Bernstein's (1996) notion of evaluative criteria in order to elucidate those rules that highlight the object in these episodes. For Bernstein: "Evaluation condenses into itself the pedagogic code and its classification and framing procedures, and the relationships of power and control that have produced these procedures" (1996:18). Evaluation, then, provides us with a window into the teacher's epistemic assumptions regarding what mathematics *is*; it provides a window, if you like, through which to view pedagogical activity as well as teachers' motives for acting. For Bernstein (1996) *evaluative* rules are those rules that transmit the criteria for the production of legitimate texts, behaviour and relations. In a sense, these rules are *psychological tools* that the teacher supplies the children with (Karpov, 2003). These rules are 'framed' to greater or lesser degrees depending on the amount of control exercised by the teacher. For Bernstein "framing refers to the degree of control teacher and pupil possess over the selection, sequencing, pacing and evaluation of the knowledge transmitted and received in the pedagogical relationship" ((1975:88). Framing refers then to relations within boundaries (Morais, Neves &Pires, 2004). When a teacher makes the evaluative criteria explicit, when he/she gives reasons for why an answer is right or wrong, we can say that the teacher makes these rules visible and that the rules are strongly framed, because they are explicit. When the student oversteps or challenges these invisible boundaries the teacher is forced to re-assert the boundary making visible the previously invisible rules of engagement. In short, then,

evaluative criteria communicate the object[4] to be constructed by illuminating how one arrives at a legitimate text[5]. These episodes are 'sparked' off in the following two ways:

Questions:

- *Teacher question*:

1. The teacher checks whether students understand by asking a question *and* when not receiving a satisfactory reply, the teacher then typically goes on to repeat what has already been covered (Extract 1). That is, by checking understanding the teacher discovers that students have not acquired the requisite rules and, rather than moving on, the teacher takes this as an opportunity to restate the core issues.

Extract 1*: *The teacher's question opens up an evaluative episode

The teacher has been explaining the function of denominators. he is about to move onto new work (a task) and as he hands out pieces of paper he asks students if they have any questions. Wayne's question illustrates that he has not yet acquired sufficient understanding about the denominator's function and the teacher takes the opportunity to begin to restate these criteria.

1) **Teacher:** Questions
2) **Wayne**: explain the denominator again sir.

Evaluative episode opens

3) **Teacher:** Right, explain the denominator again**.**
4) Come let's go further**.**

In extract 1 the teacher's question in line 1 elicits a question from Wayne which the teacher then goes on to deal with at some length.

2. **In response to students' task engagement**: A second way in which episodes can be sparked off is when a teacher intervenes in students' task engagement because they are not evidencing an appropriate engagement with the task. He/she then takes the opportunity to model appropriate task engagement.

***Extract 2**: Evaluative episode provoked by students' incorrect production*

The class has just finished working out some problems. Kim's group is feeding back to the class. The teacher notices that Kim's answer is incorrect and sees this as an opportunity to restate the rules that underlie multiplication of fractions, which were discussed at the beginning of the lesson.

1. **Kim**: (4/9 x5/3) Ok, so I divided 9 by three
2. and 3 by 3

Evaluative episode

3. **Teacher:** ok, must we stop Kim there?
4. Hmm? Must we stop Kim there?
5. Is Kim doing the correct thing?

In extract 2 above the teacher intervenes (line 3) when she sees that Kim is incorrect. She uses the space opened here to elaborate rules related to simplification and the multiplication of fractions. As we shall see, evaluative episodes are disruptions in the pedagogical text, where the teacher notices that students

4 In these episodes my reading of the object can be likened to Engestroms (1987) notion of the object unit as that "chunk of the object handled and moulded by the subject at a time…Once identified the object-unit thus provides a strategic lens or magnifying glass through which the inner movement of the activity system becomes visible"

5 Note, however, that in severely dysfunctional classes, one may not be able to find evaluative episodes at all as these episodes indicate a level of teacher responsivity that would be lacking in a context where the teacher's main function was to manage behaviour and the students' main function was to rote learn (for an example of dysfunctional classrooms, see Hoadley, 2002; Jacklin, 2005).

have not demonstrated the requisite grasp of the evaluative rules already covered by the teacher.

While in extract one and two it is clear that the evaluative rules here relate to mathematics, and in fact, the object of these two episodes is essentially the development of students' mathematical understanding, it is not correct to assume that evaluative rules relate solely to subject matter content: where a teacher stops the flow of the lesson in order to restate behavioural rules that serve to manage interpersonal interactions the evaluative rules here would be behavioural and the object might turn out to be curriculum coverage. There are two points here; the first is that an evaluative episode might surface an educational, behavioural or another type of object and second, only by studying the constructed object in the context of a pedagogical activity (in this instance an evaluative episode) can we determine whether something is an object, a tool or even a rule. To sum up then, evaluative episodes are disruptions in the pedagogical script which are initiated in response to students' apparent lack of or misunderstandings around the focus of the lesson. Evaluative episodes communicate the object to be constructed (the intended object of acquisition). As the episodes make visible the invisible; they are moments when the object of the lesson can be surfaced. An evaluative episode ends when the focus shifts and when the teacher moves onto the next topic. These episodes are characterised by a degree of flexibility in terms of the teacher altering the sequence and selection of content in order to address students' apparent lack of understanding. In these episodes the teacher manipulates selection of the content and tasks at the level of micro selection in response to students' interventions.

Extract 3: *Mediating mathematics understanding in a classroom*

Merryvale[6] Primary: Evaluative Episode 1

The following transcript is drawn from Merryvale Primary School, a small farm school situated in a farming district 123 kilometres outside of Cape Town in the Western Cape, South Africa. Students have just begun to work with fractions. The transcript is taken from the second lesson in a series of lessons on fractions. Yesterday students learnt 1) that fractions had two parts, a numerator and a denominator and 2) that fractions have different names, such as common or equivalent fractions. The teacher has just been explaining to students what the function of the denominator is. He does this by first using an apple to illustrate notions of 'parts of the whole'. He is about to move onto the next task. The transcript which follows is divided into 2 segments, the pre-focus segment, which situates the evaluative episode in context and the evaluative episode. The evaluative episode forms the basis for a detailed analysis of teacher/student interaction around a shared object. A key to the symbols and codes used in this extract are found in Appendix 1.

6 All names mentioned in the article are pseudonyms.

Teacher/student talk	Actions	Activity Theory elements Tools; Object; rules; division of labour [DOL]
Pre-focus segment **1. Teacher:** Good, I am going to give everyone a piece of paper.	*Teacher has a bundle of plain white paper in his hand and is about to hand them out to the children*	
2. I want that page…	*Teacher looks up from the papers he is holding and asks a question*	
Is there anything that you don't understand?		
3. Something that I must help you with?		
4. That is the denominator's job.		
5. **Jan**: numerator sir?	*Puts up his hand to ask a question*	
6. **Teacher:** Sorry?		
7. What does the numerator do?		
8. The numerator just tells me how many parts there are.		
EPISODE 1 **Evaluative episode: the relationship between parts and a whole** 9. Question?		**Tool: Q3** **DOL** teacher asks questions; students answer
10. **Wayne**: explain the denominator again sir.	*Puts up his hand.*	**Tool: Q1** Tacit behavioural rule- put up your hand to ask a question.
11. Teacher: Right, explain the denominator again**.**		**Object=** children's understanding of denominator
12. Come let's go further**.**	*Teacher walks over to the bag of apples he has and selects another apple to cut.*	**Tool:** knife & apple everyday artefacts **DOL** teacher models answers; students observe and respond.
13. Now, what is this?	*Holds up apple. Reference to the everyday- children's understanding of parts of an apple.*	**Tool:** Q1 & Knife & apple Everyday knowledge
14. Students: whole		**R**
15. Teacher:: whole.		**E**
16. And I cut him exactly, exactly, in how many parts?	*Teacher cuts apple using the knife.*	**Tools:** Q1& Knife & apple Everyday knowledge- cutting/ parts/sharing
17. How many parts are there?		**Tool:** Q1
18. **Students**: two		**R**
19. **Teacher:** now, my denominator tells me how many parts I have divided my whole into	*holds up parts*	**Tool**: I1 & apple Math rule: denominator's function Linking everyday knowledge of parts to mathematical rule.

20. In this case, it's two.	*holds up parts*	**Tool:** I1 & apple Linking everyday to abstract **Tool**: Q1	
21. So my denominator in this case will be?			
22. **Students**: two			
23. **Teacher:** two.		**E**	
24. And now I' m going to cut him further.	*puts apple back together and begins to cut it again*	**Tool:** Knife and apple	
25. Again, exactly, exactly.	*Cutting apple and talking to himself as he does so.*		
26. Let's pretend it's exactly	*(Smiling). Looks up and continues cutting*		
27. **Walter**: Into a quarter		**R**	
28. **Teacher:** must [cut] him exactly, exactly.	*Nods. Still cutting.*	**Tool:** Knife and apple	
29. and I cut him up	*cuts apple*		
30. In how many parts?	(*cuts apple- holds up pieces*)	**Tool:** Q1 & apple	
31. **Students**: Four		**R**	
32. **Teacher:** And if you look carefully, how many pieces?	*holds up pieces*	**Tool:** Q1 & Apple Everyday, empirical knowledge	
33. **Students**: four		**R**	
34. **Teacher:** four pieces.		**E**	
35. This piece, he is my	*holding up a piece*	**Tool:** Q1 &Apple Everyday empirical linked to abstract: four pieces= quarter. **R** **E**	
36. **Students**: quarter,			
37. **Teacher**: quarter			
38. **Teacher:** you are clever			
39. You are clever!	*(smiling)*		
40. But these four pieces show me, if I put them together, they are my whole.	*Puts pieces together again*	**Tool:** I1 & apple **Math rule**	
41. But I want to know, what is my denominator?		**Tool:** Q1	
42. and my denominator is going to tell me into how many parts		**Too**: I1 **Math rule**	
43. **Students**: parts		**R**	
44. **Teacher:** parts I have cut him into and it is		**Tool:** Q1	
45. **Students**: four		**R**	
46. **Teacher:** four.		**E**	
47. and Bokaas told us very nicely that denominator stands		**Tool:** Q1	**Math rule**
48. **Students**: under		**R**	
49. **Teacher:** under.		**E**	
50. Denominator tells us how many parts we have.	(*goes up to the boy- Wayne- who asked the question and shows him the 4 pieces of apple*)	**Tool**: I1 & Apple **Math rule**	

51. Ok now Wayne?	*(Wayne nods)*	**Tool:** Q3	
52. I could cut him further, but that would be difficult.			
53. I give Wayne	(*gives him a quarter*)	**Tool:** Q1 & Apple	
54. **Students**: a one		**R**	
55. **Teacher:** one of what?		**Tool:** Q1	
56. **Students**: the whole.		**R**	
57. **Teacher:** I give him one of the four parts.		**E** **Tool:** Apple	
58. so he sits with one of the four pieces	(*writes on the board a 4 and then 1 over it- ¼*)	**E** **Tool:** blackboard	
59. And I sit with?	*holds up his piece*)	**Tool:** Q1	
60. **Students**: 3		**R**	
61. **Teacher:** 3 of the pieces	*writes ¾ on the board*	**E** **Tool:** Black board	**Math rule: parts and wholes** Linking everyday empirical pieces of apple to abstract representations of fractions. Move from concrete to abstract.
62. and if I take my three and I put the other piece with it then I have	*puts the pieces together*	**Tool:** Q1	
63. **Harvey:** your whole		**R**	
64. **Teacher:** my whole.	(writes *on board: ¼ ¾ =*)	**E** **Tool:** Black board	
65. come let me put in a plus [*¼ + ¾]*	*Writes ¼ + ¾ =*	**Tool:** I1 & blackboard	
66. then I have 4/4	*Writes 4/4 next to the sum*		
67. and then my numerator and denominator are the		**Tool:** Q1	
68. **Students**: the same.		**R**	
69. **Teacher:** good.		**E**	
70. Good.	*episode ends and teacher goes on to discuss work covered in the previous lesson*		

Analysis of the evaluative episode

One of the most powerful aspects of Activity Theory is its dynamic nature, which enables one to capture the complex and dynamic interactions that characterise classroom interactions. However, this dynamism is potentially mystifying for the researcher intent on capturing pedagogic activity; something that begins life as a rule in an activity system is destined in time to become a tool, or even perhaps and object, depending on the context. Consequently, one is always aware that change is certain within a system and one should therefore anticipate fluidity over time. In order to "freeze" interaction in time and develop a picture of the classroom activity system, evaluative episodes provide a window into the dynamic system.

In the pre-focus segment in excerpt three above, it is clear that the teacher is about to

move onto a new task (line 1). However, before carrying on with the lesson, he checks whether students' have understood the lesson so far. A feature of evaluative episodes of this type is that they are sparked by the teacher checking students' understanding (asking a "checking" question: line 3). Generally, if students do not evidence sufficient understanding, the teacher will then restate the evaluative criteria, opening up an evaluative episode. Note, however, that in this episode Mr M does not take up Jan's question (line 6) in any depth; he merely gives Jan a brief answer, without illustrating why the numerator functions as it does. This portion of the dialogue is not an evaluative episode, precisely because the teacher does not use the space created by Jan's question to elaborate the functioning of the numerator. This is to be expected in this instance, however, because the teacher is focused on developing students' understanding of the denominator, not the numerator. He has spent eighteen minutes explaining what the denominators' function is and it is this understanding that he seeks to refine. It is only when he is called on to restate this explanation (line 10) that the evaluative episode begins. The evaluative episode is an episode, then, in which repetition of previously elaborated evaluative criteria feature. This is not to suggest that an evaluative episode is nothing more that a re-statement of what has just been said. In fact, in this episode, the teacher uses the space opened by the episode to introduce something he has not done before in the lesson, namely, the graphic representation on the board of a fraction (lines 58, 61, 64, 65, 66). However, restatement of the evaluative criteria is a *central* feature of an evaluative episode. An evaluative episode, a rupture in the pedagogical script, provides us with a unique space in which to develop a picture of the activity system of the lesson as a whole. Faced with the students' lack of understanding, the teacher is called on to make the rules of mathematical engagement explicit. These rules (evaluative criteria) communicate the object under construction.

Tools

In this episode, the teacher makes use of a variety of mediating artefacts to elaborate the denominator's function. Some are material tools, such as an apple, a knife, chalk, and the blackboard while others, such as questions and instructions in mathematics are slightly less tangible tools. In extract three, the teacher relies heavily on a concrete object (in this case an apple) to illustrate the relationship between parts and a whole (lines 14, 17, 20, 21, 24, 25, 26, 28, 29, 30, 32, 41, 50, 58, and 64). He moves from using the concrete object (the apple) to representing the parts of the whole on the black board (64, 65, and 66). His primary material tools in this episode, then, are the apple (which he cuts using a knife) and the blackboard (which he uses to represent the abstraction he has been discussing in concrete form). Both these tools are used to illustrate properties of fractions with the purpose of developing students' understanding of fractions. By manipulating these tools to uncover the properties of the denominator (literally, to illustrate the denominator's "job", line 4) it is clear that the teacher is concerned here with developing students' understanding of fractions, specifically their understanding of what the denominator's function is. One of the most prevalent tools used, however, is the teacher's talk. In this episode the teacher uses mathematical instruction (lines 19, 20, 21, 40, 42, 50, 65, 66) and questions (lines, 10, 13, 16, 17, 21, 30, 32, 35, 41, 44, 47, 53, 55, 59, 62, 67) to instruct students in mathematics, and to verify or check their understanding (lines 9, 51). The teacher uses talk and material tools, such apples, to illustrate his discussion around the notion of the denominator. While cutting the apple, the teacher engages students in a question and answer session (lines 16-25). Note how he incorporates definitions (line 19)

with the physical act of cutting the apple. He repeats the same process of cutting the apple and asking cueing, closed questions (lines 25-51) until he is satisfied that Wayne (the student who asked him to repeat his explanation) understands the work (line 51). Closed questions in this episode serve two functions: the first function they serve is to open interaction by cueing students' verbal engagement and the second function they serve (such as, for example, in lines 17, 21, 30, 35) is to reference students' everyday understandings of cutting things into pieces. So in lines 16 and 17 the teacher taps into students' everyday, empirical understanding when he asks how many pieces of the apple he has in his hand. Note how in lines 19-24 the teacher links the students' everyday understanding of pieces of a whole to the abstract mathematical concept (denominator's function) he is teaching. Again in lines 53 to 64 the teacher moves from the students' everyday empirical understanding to the abstract concept he is teaching. This is especially evident in line 64 where the teacher moves completely away from the everyday by representing the apple pieces in a fraction on the board. The use of questions as scaffolds coupled with feedback and mathematical definitions, serve to *mediate* or guide students' engagement with the abstract fractions the teacher ultimately draws on the board. Had the teacher begun his explanation by representing fractions on the board, one might argue that he would have "lost" many of the students along the way.

Object

What is it that the teacher and students are working on in this episode? Throughout the episode, the teacher makes certain evaluative criteria visible, such as in line 20 where he outlines the mathematical rule that states that the denominator indicates how many parts a whole is divided into. This rule will ultimately help children to develop an understanding of fractions. This is a rule only in this particular context, however, as the teacher is trying to develop students' understanding of fractions. Once students' appropriate this rule and mobilise it to solve problems, it will become a tool for them. In this episode, however, this remains a rule for the successful production of a legitimate mathematical text, rather than a tool. What is clear from the episode is that the teacher is concerned with getting students to understand the denominator's function. The object that the teacher is working on then, is the development of students' understanding of fractions. One of the tenets of Activity Theory is that an object is a collective one. What evidence do we have from the episode that children share this object? The first, most obvious evidence is provided by Wayne's (line 10) question, indicating that he does not understand what the denominator's function is. Further, his question illustrates that he *wants* to know more about the topic. That is, Wayne wants to develop his own understanding of fractions. The rest of the class also appear eager to engage in developing their understanding, as evidenced by the frequent choral answers to questions relating to the topic (lines 14, 18, 22, 31, 33, 43, 45, 48, 54, 56, 60, 63, 68).

Rules

While some rules in the lesson are overt (such as mathematical rules like those contained in lines 19 and 50) other rules are tacit, such as putting up your hand to ask a question (line 10). In this episode, we can distinguish between mathematical rules and behavioural rules. While the mathematical rules are very clear, the behavioural rules are less so. The teacher does not have to discipline the children and manages the episode through praise (line 38 and 39) rather than by reference to overt disciplinary techniques. The teacher's manner is relatively easy going and affectionate. The relative dearth of language serving an overt

disciplinary function might be explained by the fact that these students are grade 6 learners who have been in school for six years and, consequently, it would appear, that the students have internalised certain routines and disciplinary norms; they are able to control their own behaviour without the teacher having to tell them what to do. What is also clear from the question and answer format of instruction is that the instructional context in this episode demands certain ways of acting (such as putting up one's hand to ask a question or providing a choral response to certain questions). It is quite possible that children are well behaved because they have internalised what Foucault (1977) would call the 'normative' gaze. The point to be made, here at least, is that the instructional context, rather than the teacher's verbal cues exerts control over students' behaviour in this episode.

Division of labour

It is clear in this episode that while the teacher dominates talk time, students have at least some access to the unfolding dialogue (25 % or ¼ of the *overall* talk time is utilised by students[7]). Most of the students' talk time is taken up with answering (94 % of the students' talk) rather than asking questions (6 % of the students' talk). It is the teacher's task to ask questions (n= 18; 38 % of the teachers talk) and the students' task to answer these questions. Students' use talk in this episode to fulfil the role of 'respondent' (94 %), a secondary role that talk helps them to fill is as enquirer (6 %). For the teacher, questions are used to mediate student engagement, rather than to assess students' knowledge. In lines 16-25 where the teacher guides students' answers while cutting the apple, he uses questions here as prompts to develop understanding, rather than to test what students already know. Moreover, he uses cutting the apple as a tool to guide students towards the point he is making: viz. the relationship between parts and a whole. As these closed questions form 31 % of the *overall* dialogue in the class and as these questions are guiding or mediating questions, the teacher uses these questions as well as the apple to fulfil the role of '**mediator**'. The use of the apple and closed questions as tools to guide students' engagement and facilitate their interaction in the episode tells us that the teacher's role here is not merely to direct behaviour or even to instruct children in a didactic way. Rather, how he uses these tools tells us that his role is one of mediator. The difference between the role of mediator and instructor lies in the nature of interaction between teacher and student, rather than solely in the teacher's tool use. This mediating role requires the teacher evaluate the students' responses, giving them access to appropriate mathematical ways of knowing, providing them with the rules with which to arrive at a legitimate mathematical text. The use of structured instruction (28 % of the teacher's talk; see for example, line 19) and evaluation of students' responses (22 %) together with questions to guide engagement, to make visible the criteria for successful engagement in understanding fractions is a further characteristic of the mediator role in this episode. There is a clear asymmetrical power relation in this episode with the teacher determining what counts as meaningful mathematical knowledge and the student responsible for acquiring and reproducing this knowledge.

Knowledge

The central conceptual relationship being worked on in this episode is that between parts and a whole. The teacher elaborates this relation with reference to the students' everyday lived experience and to the more abstract school based concepts. The teacher makes use of everyday objects (in this instance an apple)

7 This percentage is calculated by coding teacher and student utterances, adding them together to derive a total and calculating an average.

to develop students' understanding of fractions, specifically of the relationship between parts and the whole. He begins his explanation, in fact, by using this artefact before moving onto more abstract representations of fractions (line 58). Children in this classroom are extremely familiar with apples as the school is located in an apple farming district of the Western Cape, South Africa, and most of the students' parents who have some form of employment are employed on these farms. By connecting subject matter knowledge (mathematical concepts) to the children's empirical experience (everyday concepts) the teacher makes these concepts more meaningful and personal and creates the motivation for subject matter learning (Hedegaard, 1998). That children are indeed motivated to learn in this instance is born out by Wayne's question as well as the students' choral responses to the teacher's questions. There is a clear linking between the students' everyday understanding of sharing pieces of an apple and the more sophisticated understanding of what a fraction actually is and how it can be represented. By working from the empirical to the theoretical and back again, the potential exists here for teacher to make the scientific concept meaningful while still maintaining the distinction between the different types of knowledge.

Community

The community in this activity system is that group of people who share an object, in this instance, developing children's understanding of fractions. In this episode, the community comprises the students and the teacher. While a wider community exists outside of the school (such as the Western Cape Education Department, who will also share this object to a

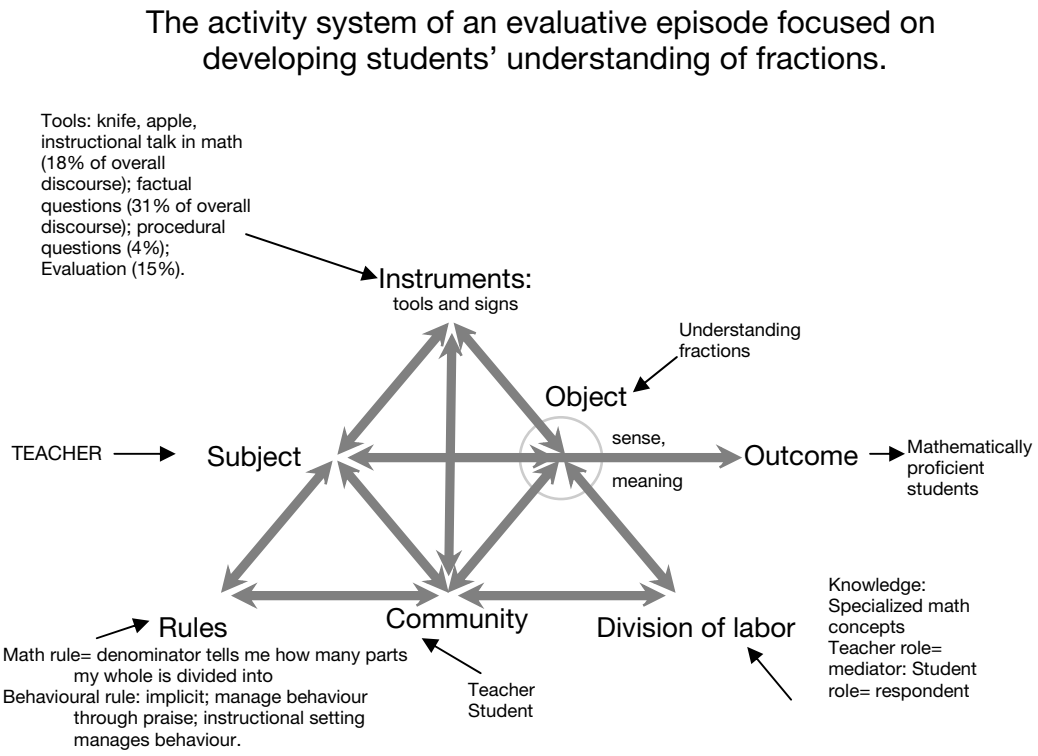

Figure 2: Graphic representation of evaluative episode: Mediating meaning

greater or lesser degree) I have chosen to focus my analytical lens on only those participants who are obviously involved in this episode. As the teacher makes no use of textbooks or worksheets in this episode, I have also excluded curriculum specialists from the community of this particular episode. This is not to ignore the obvious impact the wider community has on the teacher's decisions regarding what object is to be worked on. However, this influence cannot be garnered from this episode.

For ease of reference, it is useful to represent this evaluative episode graphically, as an activity system as in figure two below. As noted previously, activity systems are dynamic and subject to change; however, when focusing on an evaluative episode, we are able to briefly freeze this dynamic system in order to focus an analytical lens on the object of the episode.

Conclusion

This paper began with two aims; the first was to provide an understanding of object oriented activity and the second was to develop a method for studying the object of activity as it develops in a classroom. It is the latter aim that forms the focus of this paper. This aim was motivated by the need to understand pedagogic activity and, hence, to be able to study the object of a complex system, such as a classroom, at the micro level of teacher/student interaction in a lesson. In this paper, I have argued for the use of AT as a tool for analysing observational data at the level of the classroom by elaborating the notion of evaluative episodes as those pedagogical moments in which the previously invisible rules of engagement are made visible, which in turn, surfaces the object of acquisition. Findings indicate that evaluative episodes provide a window into the unfolding activity system of the classroom, a microcosm if you will, of the overall system. By enabling the researcher to temporarily freeze the unfolding system, evaluative episodes allow us to construct a model of activity in the mathematics lesson. The small scale nature of this research (only four schools participated) militates against making generalisations across contexts in relation to what the activity systems of mathematics lessons might look like. This is not the purpose of this paper; rather, this paper seeks to illustrate a method for investigating classroom level observational data using Activity Theory by focusing on analytical events that I have called evaluative episodes.

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Appendix 1

Categories for the Analysis of Discourse

The analysis is carried out at two levels. At the first level evaluative episodes are identified in the data. At the second level each utterance (defined as a unit of speech that is capable of being meaningfully understood on its own) is categorised according to the categories outlined below. Utterances were divided into two groups: questions and statements. Some questions were difficult to categorise as such as they did not elicit answers nor were intended to do so (such as a rhetorical question that the teacher might answer him/herself). These questions where no responses were elicited were categorised as statements (Myhill & Duncan, 2005). Statements were categorised as those utterances that did not elicit a response.

Tool	**Definition**	**Codes**
Teacher talk: Instruction	Mathematical instruction	I1
	Task work- procedural (literally how to do a task- the actions required to meet the task goal)	I2
	Computer skills	I3
Teacher talk: questioning.	Closed (factual questions to which the teacher knows the answer: single response items)	Q1
	Probes (teacher stays with same child asking further questions; invites child to articulate their understanding/explain their thinking)	Q2
	Verification (teacher checks whether students' understand)	Q3
Teacher talk: Evaluation	Teacher assesses students' responses	E
Regulating students' behaviours (Management)	Time management	R1
	Discipline	R2
Student:	Response	R