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Expanding the foci of activity theory: accessing the broader contexts and experiences of mathematics education reform

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In this paper, we consider our use of activity theory to examine empirical data from a study of reform in England – the implementation of the mathematics strand of the Key Stage 3 Strategy in two schools. Our concerns are largely methodological – we consider the aspects of reform that more traditional activity theory methods and foci were able to theorise – questions related to ''what'' had changed, and then consider those aspects that were left aside – participants' experiences of reform and the influences of broader dominant discourses relating to mathematics classroom practices. We then go onto show how concepts related to the notion of ''boundaries'' – boundary objects and boundary crossing can be used within an activity theoretical frame to theorise the gaps. We conclude by detailing the ways in which this expansion of foci adds to our understandings of policy implementation.

Keywords: activity theory; boundary crossing; boundary object; Key Stage 3 Strategy; mathematics education; reform

Introduction

Activity theory (Engeström 1987), predicated on the Vygotskian notion that all intentional human action is goal-directed and tool-mediated by cultural artefacts or tools, has received increasing attention within educational research including mathematics education research over the last decade. The largely individual-focused Vygotskian research has been expanded to embrace collective, institutional activities and their development in much of the current research, with the activities themselves forming the central unit of analysis. This attention is also part of the extension of activity theory from its developmental base in studies of workplace learning and change, into studies of learning and change in more formal educational settings.

At the same time, studies in education have brought critique of activity theory, specifically the argument that the focus on the specificities of changes within activity systems has tended to leave out discussion of how the broader cultural context constrains the directions available for change and the artefacts available to effect change (Daniels 2004). Daniels suggests in his paper that activity theory still needs to develop ''handles'' to grapple with these questions and uses Bernstein's (2000) analyses of the modalities of cultural transmissions to fill this gap.

In our view, activity theory's stress on changes in specific activities also tends to leave aside discussions of participants' experiences of change. This contrasts with the extensive sociological research base on educational reform, where teachers' and

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learners' experiences of change are considered alongside the changes in practice and their impact as integral features of how policies are interpreted into practice (e.g. Gewirtz, Ball, and Bowe 1995; Woods et al. 1997).

In this paper, we argue that both of these aspects – the constraining (or affording) role of broader cultural discourses, and participants' experiences of change – can be accessed from within activity theory, firstly by expanding the foci of methods used to collect data, and secondly shifting the foci of concepts used to analyse data. This argument emerges from an empirical study of education policy implementation in England undertaken by the first author (Venkatakrishnan 2004). In-depth interviews with key agents (an atypical feature of studies informed by activity theory), followed by an analysis rooted in the concept of "boundaries" between practices[1] provided mechanisms, theorized jointly in this paper, for opening up and explaining the broader constraints on, and experiences of reform.

We begin this paper with a brief outline of activity theory, its current incarnations, and the research methods commonly associated with the theory. We also introduce the concepts related to the "boundaries" between practices.

Our story of reform was located in two mathematics departments in the early stages of their interaction with an English national policy initiative, the mathematics strand of the Key Stage 3 (KS3) Strategy. This policy was directed towards improving the teaching and learning of mathematics in the early secondary phase of schooling (students aged 11–14). The two departments began this interaction process with very different prior models for organizing mathematics teaching and learning, associated closely with the different resources they used. These contrasts were considered in relation to the policy's advocacy of relatively singular models for improving classroom practice. These are briefly detailed, as are the pre-existing forms of classroom practice in the two schools.

The process of interaction with the policy began in training meetings led by a local "consultant" and attended by participating mathematics departments' "numeracy coordinators". In the meetings, activity focused on disseminating and discussing different aspects of policy-advocated practice, with a view to orienting departments towards trialling, taking-up and integrating these practices into their departmental organization. Engeström (1999) suggests that within these sites of coordination in which changes in practice, and therefore new activities, are the explicit object, the following kinds of data collection methods can drive a fruitful exploration of how changes in practice become conceptualized:

> We typically videotape a series of team meetings and interactions at work and analyse transcripts of these interactions as our prime data. This approach enables us to conduct very detailed data-driven analyses of the discursive processes, practical actions, and mediating artifacts that are employed in the step-by-step production of an innovative solution or idea. (p. 377)

In our study, the first author observed the progress of these meetings, keeping fieldnotes of the topics covered and materials used, of the discussions and responses around these topics, and of informal conversations with the numeracy coordinators from the two focal schools and the consultant leading the training. The analysis of this data allowed us, as Engeström (1999) notes, to develop a picture of pre-existing practices in the two departments, their differing priorities for change, and the differing "practical actions" taken to trial and initiate changes in the two focal departments.

However, this analysis left largely un-theorized, other aspects of our data – contrasts in the profiles and experiences of the two coordinators key amongst these. In order to explore these questions, we expanded our data collection to include semi-structured individual interviews with these coordinators, asking questions that probed both their selections of policy artefacts and their experiences of interaction with the policy context. This expansion of data collection methodology and focus within the data collection led us into further questions about the ways in which the topics put up for discussion within the training meetings were also constrained within the policy context, coalescing much more readily with the pre-existing organization of practices and priorities for change of one coordinator than for the other. The range of data sources that we used therefore, formed an important part of the story of interaction with the policy that we were able to tell, and is briefly summarized.

In the body of the paper, we detail the contrasting experiences of the numeracy coordinators from the two schools – Evenscroft and Bradstone (all names in the paper are pseudonyms), and then present our activity theoretical analysis of these contrasts, building in questions about the "encircling" of issues for discussion within the policy context and the broader arena of dominant practices in mathematics education. In the concluding section, based on this analysis, we argue that using concepts related to boundaries provides handles within an activity theoretical frame for accessing both participants' experiences of effecting changes in practice, and for analysing the ways in which the directions of change may be constrained within the broader context.

Activity theory

As stated at the start of this paper, activity theory rests on the assumption that all intentional human actions are goal-directed and tool-mediated. Vygotsky (1978) represented this central tenet in his well-known triadic arrangement of subject–tool–object, shown in Figure 1.

Leont'ev (1981) extended the notion of individual mediated action to collective activities, bringing with this expansion, the notion of community-based "rules" (routines, or "taken-as-shared" norms of practice), and a "division of labour" within which tasks and status/power may be differentially distributed across the community being studied. Engeström (1987) depicted Leont'ev's extension to collective activity in an enlarged triangular form (see Figure 2), which he labelled as an "activity system".

Engeström defines activity systems as communities engaged in activities which share common goals. [More complete definitions of the key loci within activity

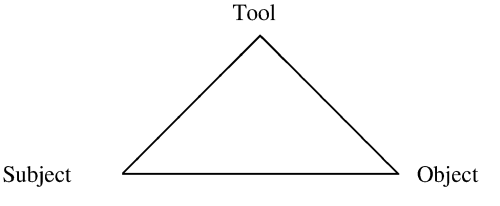

Figure 1. Vygotsky's (1978) model of mediated action.

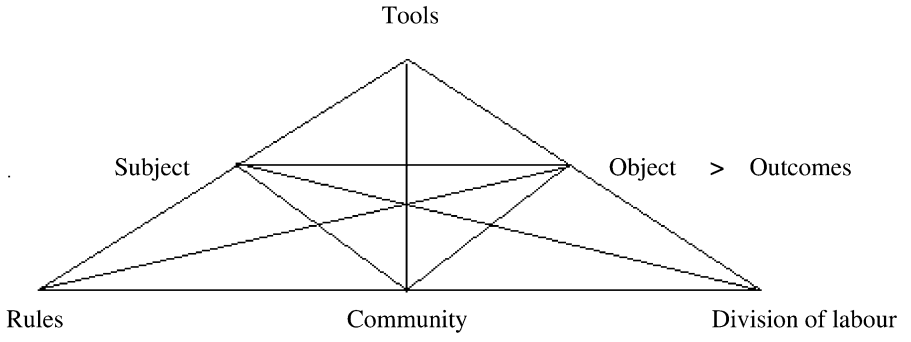

Figure 2. Engeström's (1987) model of an activity system.

systems can be found in Engeström (1993)]. Recent empirically-driven shifts to accommodate dissonant perspectives and non-coincident goals, and the need to theorize coordination between these perspectives, have led to the idea of multiple, interacting activity systems, represented minimally in Figure 3.

We found this representation particularly useful for considering the two departments' interaction with the policy context. One triangle was used to depict the activity system structured by the policy training meetings, within which the policy appointed "consultant" worked with representatives from local schools, with the aim of disseminating information and supporting take-up of policy-advocated practices; the other triangle was used to represent departmental activity focused on integrating the policy in the midst of their organization of practice at that time. Coordination between these two systems was sought within the activity systems of each school, although the two departments differed in terms of the aspects of policy that they focused upon as useful within this coordination.

As stated earlier, studies using this model of interacting activity systems have used concepts related to "boundaries" (Wenger 1998) to theorize the ways in which differing perspectives can be coordinated in the context of interaction. Boundaries can be viewed as the discontinuities of practice between activity systems. Within the context of our study, we were able to look at the models of organization of practice in the two departments in comparison to the (relatively singular) models of practice advocated in the policy (detailed in the following section). In studying processes

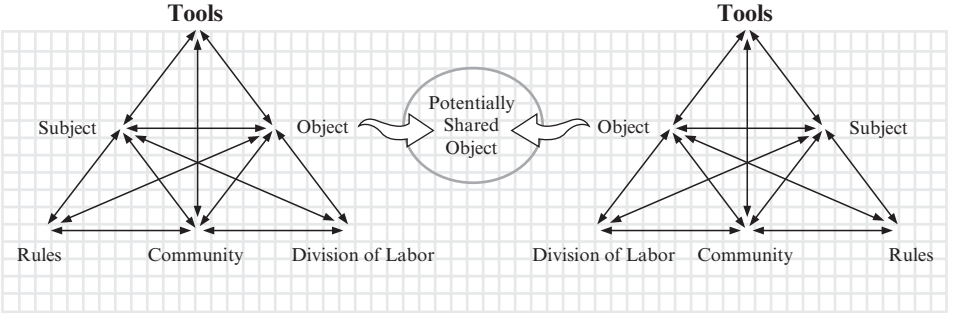

Figure 3. Engeström's (2001) model of interacting activity systems.

where some coordination of perspectives was sought, Star and Griesemer (1989) introduced the notion of "boundary objects" – tools that could be used as starting points for coordinating the perspectives of participants from multiple communities who came together with some shared aims:

> Boundary objects are objects that are both plastic enough to adapt to local needs and constraints of the several parties employing them, yet robust enough to maintain a common identity across sites. They are weakly structured in common use, and become strongly structured in individual site use. (Star and Griesemer 1989, 393)

This construct provided a useful way of thinking about the policy tools that were suggested within the training meetings for use to improve classroom practice. Wenger (1998) cautioned against viewing all such discussion prompts as boundary objects, arguing that such tools had the potential to become boundary objects if, and only if, they were taken up as such by the subjects acting as intermediaries between different communities as a means of bridging between their respective practices. Changes could then be related to "boundary crossing" (Suchman 1994) activities, activities through which boundary objects were taken up and incorporated into practice. Moreover, our data suggested that boundaries were co-constituted by structural and experiential realities, enabling us to link macro-level considerations of dominant discourses of mathematics education practice and micro-level subjective practices, priorities and experiences.

The interaction between the two activity systems comprised by practice in the training meetings and departmental practice required an understanding of the goals and resources that were located within each system. In the following section, we summarize key aspects of the mathematics strand policy – policy aims, the mechanisms offered to help to achieve these aims, and the ways in which these mechanisms represented changes to the pre-existing landscape of practice within mathematics education in English secondary schools. After this, we briefly detail the two school contexts, and the contrasting organizations of mathematics teaching and learning that they employed.

The policy context

The wider study out of which this paper emerges was concerned with the impact on classroom practices of implementing the mathematics strand of the KS3 Strategy, a policy launched nationally in English secondary schools in September 2001, aiming to "transform standards in the early years of secondary school" (Department for Education and Employment 2001, Foreword). The KS3 phase covers the early years of secondary schooling (Years 7, 8 and 9). The two focal schools entered this policy context through their participation in one of 15 KS3 numeracy pilot projects, begun in 1999, which preceded the main policy launch. Key facets of the local numeracy pilot and the mathematics strand policy were:

- Structure
  - three-part lessons in mathematics comprised of mental/oral starter, main activity, plenary
- Curriculum
  - specific learning objectives, set in "Yearly teaching programmes"
- Pedagogy
  - predominant use of interactive whole-class teaching; "pace"

- Remediation
  - "catch-up" programme for Year 7 students who had failed to achieve "target" levels in Key Stage 2 mathematics tests
- Professional development programme for teachers
  - led by consultants recruited in each education authority and funded through the policy budget to demonstrate and disseminate policy-advocated practices

In order to locate this policy within a historical trajectory and to understand the areas in which reform was sought, an analysis of the policy's documentation was undertaken drawing in the findings from other research writing on this policy and its highly similar primary-level predecessor, the National Numeracy Strategy, and from previous large-scale attempts at reform within mathematics education (detailed in Venkatakrishnan, 2004). These analyses pointed to an increased prescription of both the curriculum and of pedagogic practice (Brown et al. 2000), a shift to foregrounding the collective needs of groups of learners over the individual learner (Askew et al. 2001), and to an increased emphasis on teaching, with much less of an overt stress on learning (Perks and Prestage 2001; Tanner et al. 2002). Our two focal schools were selected with these shifts in mind.

The two schools

The focal schools – Evenscroft and Bradstone High Schools – were located within one local education authority, and therefore the two departments attended the same local training meetings and worked with the same consultant. Both schools served highly disadvantaged intakes (a little over 50% of the school roll in both schools were eligible for free school meals in comparison with a national average at that time of 16%, eligibility for free school meals being one of the most commonly used indicators of socio-economic disadvantage within schools in England). On other student background indicators though – ethnicity and gender key amongst these, the two schools differed greatly from each other. Evenscroft had an even gender profile in comparison to Bradstone's roll and focal cohort, which were both about two-thirds male; also, students from an "Indian" background were the largest subgroup in Evenscroft (27% of the focal cohort), whilst the largest subgroup at Bradstone were "White" (34% of the focal cohort; ethnic categories drawn from the categories used by the English Department of Education and Employment).

A key contrast between the two schools though, related to differences in their organization and practices of mathematics teaching and learning. Prior to policy implementation, Evenscroft used "setting" (placing students in differentiated groups based on their prior mathematical attainment) and whole-class teaching across KS3, using a differentiated text-book scheme. Mathematics lessons usually followed a teacher-led format involving an initial teacher exposition followed by students' working individually from similar textbook exercises. This kind of routine has been widely documented within mathematics lessons, described as "chalk and talk" or "direct instruction" models of practice. Whilst therefore, Evenscroft's intake was atypical in many respects, the resources and routines of classroom activity within their mathematics lessons were in common use, aligning with dominant forms of practice in secondary school mathematics classrooms.

Bradstone used a workcard-based individualized learning programme called SMILE (Secondary Mathematics Individualized Learning Experience) across KS3 prior to their implementation of the mathematics strand. Students were taught in mixed-ability groups, with individualized work supplemented with some whole class teaching on "core" topics. Students within any class worked on a range of topics at a range of levels at any one time. Teachers would set each student an individual "matrix" of tasks – usually made up of 10 tasks – to work through. As each task was completed, the student would correct his/her own work using the answer books provided by the scheme. On completing these tasks, the teacher would ensure that this work was satisfactory before allowing the student to proceed onto short tests relating to that set of tasks, which would then be marked by the teacher. The teacher's role in these classrooms was therefore to support the work of individual students, organize the availability of a range of appropriate resources, monitor, and where necessary, record progress. Classwork in SMILE lessons at Bradstone was not "led" by the teacher; students worked individually and sometimes collaboratively on tasks, and they were allowed to move around the classroom to pick up the SMILE cards, resources and answer books as needed. Given the prevalence of more "traditional" teaching approaches within mathematics education (Boaler 1997), there was strong evidence for considering Bradstone's teaching as "going against the grain" (Cochran-Smith 1991). Whole-class teaching, the model advocated within the mathematics strand, was emphatically not the dominant form of practice therefore at KS3, although the department did use whole-class teaching and setting in Years 10 and 11.

These differing models of departmental practice prior to policy implementation were viewed as critical parts of the activity systems that the policy training meetings focused on impacting upon, initially through discussions and trialling of policy-advocated "tools", amongst these, the three-part lesson structure and the curricular format presented in the policy documents.

Prior to presenting and analysing the contrasts between the two coordinators' approaches to policy implementation that were witnessed in the early stages of interaction with the policy, we briefly detail the data sources used.

Data sources

The data that we draw upon within this paper was collected between 1999 and 2001. In the first year of the pilot (1999–2000) the pilot meetings, led by the policy consultant involving six local schools, were focused on disseminating information about the policy. This involved sharing "exemplar" video clips of policy-style practice, discussing specific aspects of practice related to the policy, and asked school representatives at the meetings to take ideas away to trial across their mathematics departments. At the end of this first year, decisions on how to more formally implement the policy for September 2000 were taken, and put into effect with the Year 7 cohorts starting their secondary school careers. Our data sources for this period were drawn from:

- HV's attendance at the local policy meetings, in which fieldnotes were taken of the discussions that took place, and policy documentation, (some produced by the local consultant and other documentation that was produced centrally), was collected.

- Semi-structured interviews conducted with Beena Charan, Evenscroft's head of mathematics and numeracy coordinator, Eesha Lakhani, Bradstone's numeracy coordinator and one of the mathematics teachers, and Keely Horsham, the local policy consultant.

Based on these data sources, we now detail the contrasts in actions taken by Beena and Eesha, and their experiences in the local training meetings.

The numeracy coordinators' activities and experiences

Within the training meetings, we observed from the very early stages, contrasts in the ways in which the two numeracy coordinators interacted with the policy. Beena, Evenscroft's coordinator, spoke very positively about the policy within these meetings, and was clear about the shortcomings of practice in her department that she felt needed addressing:

> I think the Strategy [referring to the mathematics strand policy] is really good. Teachers just can't carry on doing the same old thing because it just doesn't work. … I think staff have to plan their lessons a lot more as well. You can't just go into a lesson and say "Right, Page 53 of the textbook, Questions 1–20" because it doesn't work any more. You've got to *plan* your lessons and you've got to think of an oral and mental starter and a plenary and what you are going to do in the middle. So it breaks up the lesson a lot more as well.

Over the course of the first year, Beena invited the consultant in to her school to share the policy rationale for three-part lessons, demonstrated the use of mental starter activities, purchased resources that supported these activities, and monitored her department's take up of three-part lessons through a round of observations. Through her feedback on the kinds of actions being taken within her department, Beena attained a high profile within the pilot meetings, and was praised by the consultant for her ability to find time and creative ways of moving her department's teaching forward.

Beena's participation therefore was characterized by enthusiasm for the pedagogic forms advocated within the policy, and trialling of the tools that she felt would allow teachers to move towards more active teaching styles.

Eesha, Bradstone's numeracy coordinator, indicated very different experiences of interaction with the policy in the local meetings. Whilst she stated that she liked much of what the policy offered, her department's use of individualized learning – (the only secondary school in the area using this model) – made it difficult for her to contribute to discussions about classroom teaching, which took whole-class teaching to be a "natural" backcloth to these practices. Her response when it was her turn to contribute was often simply to say: "Well we use SMILE so we don't do that", to which the consultant would nod and then move on to the next person. In spite of these more limited openings to participate, Eesha did put together a booklet of mental starters which her department trialled, and like Beena, put a departmental numeracy policy in place too. These changes were largely focused on aspects of mental skills and numeracy, a priority confirmed subsequently by Bradstone's head of mathematics, rather than the wide-ranging emphases on pedagogy and curriculum suggested within the mathematics strand policy documents, and reflected in the training meetings.

Beena and Eesha differed from most of the other department representatives at these meetings in their reporting of department-wide, rather than individual trialling of specific practices. In spite of collective moves in both departments, Eesha's comments reflected a sense of a lack of progress, of personal and departmental deficiency, in terms of policy implementation:

> I always feel so behind at those meetings, like I really haven't done anything at all.

This contrasted starkly with Beena's confident sense that her policy dissemination methods were moving the department's teaching forward:

> in our [curriculum] meetings I would share that with the rest of the department. And slowly people started taking it on board, and then last year [the pilot year] when I went round into people's lessons, the focus was the oral and mental starters. We just did oral and mental starters, you know before because it leads on – yes. And then, every lesson I went in to see, that was the main focus. And I saw people doing it so that was good.

These contrasting experiences and profiles were interesting for two reasons. Firstly, the changes in profile had been effected within the locale of the training meetings; outside this forum, both schools stood at similar, low positions in relation to the local education "market" (Gewirtz, Ball, and Bowe 1995), hovering in the lower reaches of the local "league tables" of examination performance. Secondly, neither "profile", nor "enthusiasm" related in a direct way to the "degree" of later implementation of the policy. In spite of Beena's confidence and positive response within the training meetings (and position of authority within her department), both departments effected a partial implementation of the policy, with Evenscroft taking on board the pedagogical forms presented within the policy texts, and Bradstone incorporating the organizational forms and timeframes within the policy's curriculum (Venkatakrishnan and Brown 2004).

In the analysis that follows, we begin by noting the aspects of change that we were able to "capture" and theorize using the approach outlined by Engeström (1999). We then summarize what was omitted and present our analysis of these facets of change from an activity theoretical perspective.

Analysis

Interacting activity systems, with Engeström's research approach

Initial overviews of the contrasting profiles attained by Beena and Eesha in the policy training meetings pointed to exhibitions of agency on Beena's part, and structural constraints in Eesha's case which limited her room to participate. This initial contrast though, also served to highlight the fact that the pre-existing organization of practice in Evenscroft worked to afford, or support, Beena's willingness to trial policy-advocated practices, and that Eesha instigated changes within her more limited room for manoeuvre. The use of the model of interacting activity systems coupled with Engeström (1999) research approaches allowed for a nuanced analysis of this combination of structural aspects and agency. The notion of differential access to power within activity theory's "division of labour" provided a handle that could take on board the effects of Beena's more authoritative position as head of department in mandating change; the clash between Bradstone's use of individualized learning and the tacit acceptance of whole class teaching as a backcloth norm of operation in the training meetings could be interpreted as a clash

of ''rules''; and the differing goals or local priorities that figured within the aspects of the policy that were formally incorporated could be represented as a clash of ''objects of change''. A summary of the key loci of activity theory based on the actions taken by the two coordinators, is presented in Table 1.

This model worked well to explain the inter-systemic overlaps and contradictions that figured within the actions taken by the two coordinators – the ways in which a combination of local priorities for change interacted with existing organizations of practice and the policy's offering of new ''tools'' for use in classrooms. In the language of interacting activity systems, it was Beena's combination of favourable position within the departmental system and the organization of activity in her department that allowed for mathematics strand practices to be trialled. Her agreement with the tools offered within the policy to move pedagogy forward in ways that she perceived as desirable, opened up the possibilities for her to report back frequently to the pilot project on the broad range of aspects of the policy that she had been able to trial across her department. In doing so in the early stages of the introduction of the policy, she was able to carve a position for herself as being at the leading edge of managing implementation around ''shared objects'' as suggested in the interacting activity system model (see Figure 3). For Eesha though, Bradstone's use of individualized working rendered plenaries and lesson planning along policy lines meaningless to the way learning was organized. Additionally, these aspects were difficult to trial without substantial changes to the main activity within lessons. Eesha did trial some of these activities in her own lessons, but did not have the authority to insist that this was done across the department. Reciprocally, such moves were not seen as a priority within her department. The numeracy focus was possible to incorporate in the mental starter format, whilst retaining the basic structure of individualized working. In instigating the trials of these activities Eesha

Table 1. Coordinators' responses set in an activity theoretical frame.

	Departmental activity system		
Activity theory loci	Evenscroft	Bradstone	Policy training meetings activity system
Subject	Beena	Eesha	Keely
Tools	Key Maths	SMILE	Starter activities; curriculum model; planning model; interactive resources, etc.
Object	Pedagogy	Numeracy focus	Improving teaching and learning through use of suggested tools
Community	Maths department and students	Maths department and students	Representatives from participating schools
Rules	Whole class teaching; setted grouping	Individualized learning; mixed ability grouping	Whole class teaching; three-part lessons
Division of labour	High authority	Lower authority	Emerging hierarchies of profile through varying degrees of participation

did therefore exploit the more limited affordances open to her, framing her objects around what was achievable.

We were able to get to this point using the approaches suggested by Engeström and Middleton, but at this stage, had left untouched the very different experiences of participation and perceptions of the changes effected of the two coordinators in the training meetings. In order to explain these experiences, we found that in Eesha's case particularly, we had to use an individual interview, and use probes focused on finding out about her perceptions of the policy, and further detail on her experiences of interaction. This expansion of the focus of our study into participants' experiences of change represented a shift away from mainstream activity theoretical studies, with their more exclusive focus on analysing the technologies of change. The concepts of boundary objects and boundary crossing, introduced earlier in this paper, were useful within our theorizing of these contrasting experiences.

Expanding the focus of activity theory

We noted earlier that boundaries between activity systems could be viewed in terms of the discontinuities in practice between them, and that the aspects presented for discussion in the training meetings could be viewed as potential boundary objects. In the context of our study, we were interested in the ways Eesha and Beena constituted the boundaries and boundary objects between practice in their departments and the proposed practices of the training meetings. We also wished to explore the ways in which their positions within the interacting activity systems combined with their perceptions of the boundary object to impact upon the extent to which they were able to initiate changes that could qualify as boundary crossing.

Eesha's comments on aspects of the mathematics strand that she was unable to trial at Bradstone pointed to the fact that for her, the critical boundary between Bradstone and the policy agenda was constituted by the advocacy of whole-class teaching on the policy side set against individualized teaching at Bradstone. By virtue of her "position" and the other contrasts outlined in Table 1, she appeared to judge herself and feel judged in relation to her inability to "cross" this specific boundary, in spite of spanning the divides on other aspects – the numeracy focus within the policy in particular – successfully.

Beena also represented the boundary between pilot and Evenscroft practices in pedagogical terms, but for her the boundary object was "interactive teaching" set against what she viewed as more inactive teaching practices in her department. Her authoritative position within Evenscroft, pre-existing practices at Evenscroft that afforded incorporation of "tools" such as the three-part lesson without necessitating changes to their existing tools and rules of practice, and her strong agreement with securing this goal, resulted in actions taken over the course of the year to address this issue – presenting the rationale for more structured lessons in departmental meetings, purchasing resources that encouraged a more active style of pedagogy, and then monitoring the use of mental/oral starters through a round of observations. This trajectory of actions acted as a means of making progress on the boundary object, and became the beginnings of the boundary crossing initiatives between the school and the pilot. The ways in which the actions taken by the two coordinators relate to the concepts of boundary, boundary objects and boundary crossing are summarized in Table 2.

Table 2. Aspects and activities that constituted boundaries, boundary objects and boundary crossing for the two coordinators.

	Beena	Eesha
Pilot/department boundary	Interactive/inactive teaching	Whole class/individualized teaching
Boundary object	Interactive teaching	Whole class teaching
Boundary crossing	Departmental trials of mental/oral starters, purchase of interactive resources and structured lessons	Not attempted

Thus, whilst both coordinators instigated changes, Beena's positive experiences and Eesha's negative experiences could be understood in terms of actions (in the former case), and lack of actions (in the latter case) that constituted "boundary crossing".

The analysis of boundary objects also highlighted questions about the kinds of aspects of practice that were presented for discussion in the training meetings, several of which operated with whole class teaching as an underlying "rule". One possible argument for this position was to ascribe it to a rigid adherence to the policy framework, but Keely Horsham, the local consultant leading the meetings, stressed within her interview that she did not feel tied to the policy agenda – a sentiment reflected in the flexibility offered to participants to adapt policy tools as they chose to fit in with departmental priorities. This suggested that whole-class teaching occupied a somewhat different position within these debates – as a backgrounded, underlying norm of practice upon which discussions could take place relating to, amongst other aspects, curriculum planning, three-part lessons and assessment models – occupying the role of foregrounded potential boundary objects. Wider survey evidence from secondary mathematics education in England supported this latter view of whole class teaching as the "natural" form for mathematics teaching, pointing to the widespread use of this model (Ofsted 1998). Thus, whilst Keely did open up opportunities for "bottom-up" solutions to the foregrounded issues, the backcloth of whole class teaching was not called up for discussion in this way, in spite of Eesha's presence within the training meeting forum. Instead, Eesha sporadically faced mild comments of derision from some of the other participants for her department's continued use of individualized learning.

Conclusions

Our story of reform described two numeracy coordinators, both of whom instigated changes that were aligned to the policy framework. Working within a more typical interacting activity system frame, we were able to describe these innovations and the ways in which they selectively borrowed policy tools matched to departmental priorities. However, this left aside any reference to the almost diametrically opposed experiences of the two coordinators. The concepts of boundaries, boundary objects and boundary crossing provided mechanisms that allowed us to theorize and explain these contrasts within the process of policy implementation. Additionally, these

concepts necessitated an understanding of the broader discourses of classroom practices in mathematics education as anchors that structured both policy advocated practices and the practices that dominated within the participating schools' mathematics departments. In this expanded activity theoretical framework with boundary objects playing a critical role, the partial nature of policy implementation in both departments, the contrasting experiences of the two coordinators and the constraining/affording nature of broader discourses could all be theorized and connected.

In conclusion, our sense is that activity theory works well to describe, explain (and celebrate) the minutiae of the inception and incorporation of change. When considered together with the concepts related to boundaries – that link the perceptual with the structural, stories of innovation can integrate questions of status and impact of change on the one hand, and connect these to diverse experiences of change on the other hand. A more complete, and more rigorous story, can therefore be told.

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Notes

1. "Practice" and "activity" are widely and varyingly used in educational research literature. It is thus necessary to note our use of these terms. We use the term "practice" to refer to patterns of work organization within our focal activity systems which are not directly oriented towards the system's specific object of reform, but which remain important in order to explain differences between the two departments in relation to their integration of the policy. The word "activity" is used to talk about collective actions that are focused on the object of reform within the system. Activity systems in our theorization are therefore stretched somewhat to encompass both object-oriented activities and historical patterns of practice which may not be directly aligned to the focal object.

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