USING CONTRADICTIONS IN A TEACHING AND LEARNING DEVELOPMENT PROJECT

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Yrjö Engeström (2001) asserts that contradictions in an activity system create potential for change and development. In this report a large research project aimed at developing mathematics teaching and learning is described and it is shown how Activity Theory can be applied to support understanding and progress. The project is producing evidence of contradictions that it is hoped will have a role in achieving its goals. We use accounts from the early stages of field work to outline some of the contradictions that are being encountered.

INTRODUCTION

Our[1] purpose here is to report on the early phase of a long term research and development project that aims at exploring the development of communities of inquiry comprising university didacticians[2] and school teachers. The developmental purpose of the project is for teachers and didacticians to work alongside each other in developing the quality of students' experience and learning of mathematics. In the first part of the paper we offer a brief description of the project using the framework proposed in Jaworski (2003) and then offer an analysis of the project in terms of Activity Theory (AT). In particular we will draw attention to the elements of artifacts, rules, community and division of labour that are identified within AT as mediating tools and context for the development of knowledge within an activity system (e.g., Engeström, 1999). In the second part of the paper we discuss the existence of contradictions or tensions (Engeström, 2001) within an activity system and their role in the development process. We then offer some evidence of contradictions and tensions within our own project.

THE LCM PROJECT

The project, Learning Communities in Mathematics (LCM)[3] was conceived by the Mathematics Education Research Group at Agder University College (hereafter referred to as the 'College' and is planned to run, initially, for four years. It began in January 2004, although preparation extended for fourteen months prior to this. The essence of the project is to develop communities of teachers and didacticians, in which we learn together through inquiry. 'The communities both support the inquiry and grow through the inquiry' (Jaworski, 2004a, p. 26). The concept of *community of inquiry* has been used and explained by Gordon Wells (1999), Ed Elbers and Leen Streefland (2000) and Elbers (2003); who, in turn have related it to other eminent scholars. We believe that we are giving the concept a particular interpretation: for example in the positioning of didacticians and teachers as 'co-learners' and in the use

of inquiry as a tool to achieve 'inquiry as a way of being' (Jaworski, 2004a), we hope we will bring new insights and understanding to teaching and learning development.

Groups of teachers from eight schools (at least three teachers from each school) have agreed to join the project; a necessary condition is that the school principal supports the activities and goals of the project within the school. The schools include elementary, middle and upper secondary schools, thus involving students from 6 to 19 years of age. Initially the project entails regular workshops held at the College, meetings between teachers (occasionally including didacticians) within schools, and school visits by didacticians. A principle aim is to design and study classroom activity that is inquiry-based. Inquiry is seen as a design, implementation and reflection process in which teachers should be central (Jaworski, 2004b). As the project develops it is intended to produce video recordings of classroom activity to study the outcomes of design, and as a developmental tool. The data collected will also enable the exploration of the process of developing 'communities of inquiry' (e.g. Wells, 1999), within and between schools and the College, and provide evidence of changing classroom practices. The project was first introduced to PME in Jaworski (2004a); here we provide a very brief analysis of the project using the framework proposed in Jaworski (2003).

Knowledge and learning

The project is concerned with teachers' and didacticians' learning more about processes of teaching and learning, about teacher and teaching development and the development of communities of inquiry. It is hoped that the knowledge generated will be of value to the international community concerned with mathematics teaching development. LCM also aims to provide a supportive context within which teachers can reflect upon and develop their own knowledge of teaching and learning and classroom practices, and improve their mathematical learning environment for pupils.

Inquiry and reflection

It is intended that all participants within LCM will engage reflectively in inquiry into their own practices. All participants within the project are researchers, inquirers and generators of new knowledge within the context of their own practices and activity.

Insider and outsider

Although LCM was conceived by researchers within the College it is a fundamental aim of the project to engage teachers as co-learners. The didacticians are simultaneously *outsider* researchers (Carr & Kemmis, 1986), as we seek to explore developments in school, and *insider* researchers as we monitor, explore and evaluate our own activities and progress in developing inquiry communities. It is intended that teachers will also become researchers/inquirers into their own practice, and thus they too will become insider researchers; also that teachers and didacticians will work closely together as co-learners in their respective practices. The development of

teachers as researchers/inquirers is a principle aim of the project (Jaworski, 2004a, 2004b).

Individual and community

As the title of the project suggests, at its heart lies the notion of 'community' where all participants can share individual experience and knowledge resources. It is intended that the diversity of knowledge (Wenger, 1998) available will be recognised and valued by all members of the community and that community knowledge will develop through joint activity. As individuals, teachers and didacticians each contribute to the knowledge shared by the community and grow within the community. Each can or will draw upon community knowledge as they operate individually within their own classrooms and spheres of activity.

LEARNING COMMUNITIES IN MATHEMATICS - AN ACTIVITY THEORY MODEL

Activity Theory is widely used as both principle of explanation and object of study (Engeström, 1999) in the context of teaching and learning development projects (e.g. Engeström, Y. Engeström R., & Suntio, 2002, Karaağaç & Threlfall, 2004). Engeström (1999) develops Vygotsky's picture of a 'complex mediated acted act' to present a 'structure of an emerging activity system' that 'explicate[s] the societal and collaborative nature' of the activity (p. 30). It is this model (fig. 1.) of an activity system that we use here to analyse the LCM project.
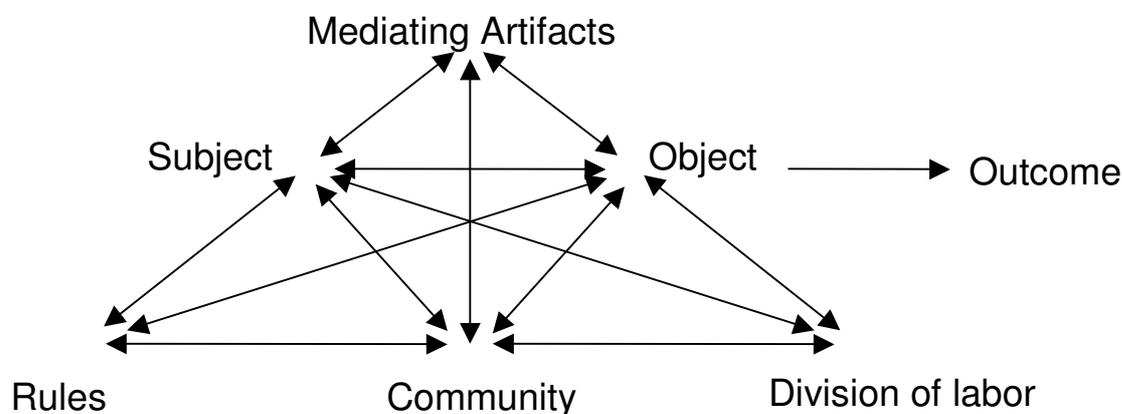

Fig. 1. The structure of a human activity system (based on Engeström, 1999, p. 31)

The LCM project exists at a number of levels at which the above model could be used as an analytic tool. It could be applied at the level of the individual participant (teacher or didactician) within the project, or at classroom and school levels, or applied to the project as a whole. At each level the 'subject', that is the 'acting person or persons' would be defined differently as would the object, or goals, of their activity. At the present phase of the project it is possible to identify communities at an institutional level, which is the focus in this report. We can consider the subject as the individual teacher working on, as object, her/his own classroom practices to

stimulate inquiry as a means of teaching and learning (the outcome), or it may be a group of teachers within a school working collaboratively on producing new teaching materials to use with their classes, or it could be the team of didacticians planning the agenda for a workshop. The range of possibilities that can be analysed with the activity theory model is, indeed, very broad. What should be noted is that in the model 'subject' does not mean 'research subject', in LCM we are co-learners and in this respect we are each of us participants of joint inquiry.

It is possible to identify the community as comprising the group of collaborating individuals, didacticians or teachers within each school, or the college, or indeed the wider professional or 'interested' communities (parents, employers, curriculum authorities, etc.) within which the teachers or didacticians are placed. Each community will have different characteristics and identity which will be, in part, evident in the rules (leadership, accountability, conventions for decision making, behaviour and speaking, etc.) and the division of labour (planning, preparation, reviewing events, etc.) but also in its values, goals and shared history. Community, rules and division of labour provide the socio-historical context for the activity.

'Mediating Artifacts' elsewhere referred to as 'Tools and Signs' (Engeström, 2001), are those objects and events that are used by the acting subject to achieve the desired goal. Thus, within the project community as a whole we are using workshops, school meetings, video recordings and relevant literature to facilitate the communication of ideas and support the development of approaches to teaching and learning. At an individual level, teachers may take ideas introduced in the workshops and produce materials suitable for use with their classes, these ideas and materials would be part of the collection of mediating artifacts that teachers use in their work, and tools that will enable them to review and revise their approach to their work. Language and discourse also play a crucial role in mediating activity and these also provide an important means of gaining insight into the nature of activity in individual classrooms, school meetings and meetings of didacticians.

CONTRADICTIONS AS SOURCES OF CHANGE

Engeström writes of 'the central role of contradictions within an activity system as sources of change and development' (2001, p. 137). He is careful to note that these contradictions (and/or tensions) within the activity system are not the same as problems or conflicts. The contradictions may be perceived by the acting 'subject' (as in the case reported by Karaağaç and Threlfall, 2004) or 'latent', that is evident to the outsider but not to the acting 'subject' as in Engeström et al. (2002). Given the potential of contradictions and tensions as agents of change, one focus of our research in this phase of the project has been the identification of contradictions within participants' activity in the LCM project.

For example, here, briefly, is a crucial tension that we experience in our own practice. At this stage of the project our evidence comes mainly from accounts recorded by didacticians, and as we record observations of events in school inevitably these

emerge as *outsider* accounts. This is in stark contradiction of the project goal, which is to position didacticians and teachers as co-learners. Here the tension lies within the 'division of labor' where we experience a demarcation between insider and outsider yet seek to establish co-learning partnership. We return to this point later. The concern of didacticians to engage teachers as co-learners and the intent of didacticians as insider researchers within their own practice are both described in detail in Cestari, Daland, Eriksen and Jaworski (2005).

Our discussion here focuses on our interpretation of observations made in meetings and classroom visits and subsequent discussions. An issue that is of concern to us, as to all researchers, is to ensure that our evidence base is the outcome of *systematic* inquiry. Our data is accumulating through a combination of structured, organised research events, such as the completion of questionnaires and tests, and unstructured but, none the less systematically documented meetings at the College and schools, and classroom visits that have a variety of purposes, such as discussing expectations and purposes, familiarisation of the context or simply courtesy calls. The accumulating collection of data is already large and varied. We make claims for our inquiry being 'systematic' through the approach taken in the examination and analysis of data in the light of current theory and the thorough testing of ideas against the rich variety of data available. At this early stage, some of our evidence has the *appearance* of being anecdotal – taking the form of stories. Such story-accounts are rooted in our field notes and in audio and video recordings of meetings and workshops; and as such they transcend the substance of anecdotes. They are recorded systematically, and the notes and interpretations produced are tested by other members of the team who have participated in the events recorded. The episodes that we record illuminate theory and can be used to guide the development of our research activity. We offer one such story.

School A is an upper secondary school (for students aged 16 to 19). To teach at this level the teachers require at least a Masters degree. The team of teachers in LCM is well qualified and highly experienced. Shortly after the series of workshops commenced, a team of didacticians visited the school to meet with the teachers in LCM and the school Principal. The purpose of this meeting was to explore the teachers' goals, constraints and opportunities within the project. The teachers articulated their goals for joining in the research as, first, 'to be part of a project led by the College' (didactician's field notes 041013), thus strengthening ties between the two institutions. Second, they expressed a desire 'to improve their approaches to teaching mathematics' (ibid.). These goals are located within the whole project 'community' and teachers individual 'mediating artifacts' respectively. The latter goal was later in the meeting contradicted, implicitly, by other statements made by the team of teachers. As the discussion moved on to consider approaches to a specific topic in mathematics the teachers talked with some satisfaction about their current approaches to teaching the topic (recorded in didactician's notes and reflections). In a later meeting, comprising the LCM team of teachers and a different team of

didacticians (one didactician in common to both visits), consideration was given to the results of tests conducted in the school as part of a longitudinal study that contributes to the project. The results included some surprisingly weak responses in basic arithmetic (e.g., adding fractions, identifying the correct operation for a word problem, etc.). The reaction from the teachers (as recorded in didactician's field notes) was: – (1) *Are the teachers in the lower schools being told these results*? Which could possibly be interpreted as, it's a problem that the teachers in School A face but it is the task of teachers in other schools to resolve. (2) *Will these test results be the focus for a workshop*? Which could possibly be interpreted as, it is up to the didacticians to provide a context for the discussion of the problem. (3) *The curriculum planners need to be made aware of these results*. This could possibly be interpreted as seeing a resolution in a redesign of the curriculum. With each statement the teachers appeared to distance themselves from a responsibility to support their own students in the development of basic arithmetic skills, and possibly to reform their own teaching approaches. That is, we can perceive contradictions between the stated desire to be part of the project community yet an apparent distancing of themselves from sharing the responsibilities of the community as a whole. We accept that the interpretations suggested are also indicative of a set of beliefs held by didacticians. An aim of the project is to develop sufficient trust between didacticians and teachers so that these interpretations can be shared without any implication of criticism being intended or perceived (as highlighted in Cestari et al. 2005).

An additional point is worth noting from the account of the discussion of the longitudinal test results. Within school A, students are separated into classes of higher and lower achieving students and despite the fact that the outcome from the test was disappointing overall, it was the teachers of the lower achieving students who showed an interest in what they might do themselves to address the issues. A possible interpretation here is that syllabus and assessment requirements create contradictions and tensions within rules, community and mediating artifacts. Assessments can be used, especially with the higher attaining classes, as instruments to motivate students' engagement, they can also be seen as conferring status within the school community. Success in examinations is also a 'passport' to further education and employment opportunities. In this account, we believe it is possible to find evidence of both perceived and latent contradictions. The teachers of the higher attaining classes (especially) feel a pressure from a demanding syllabus and a high stakes assessment regime. Although the teachers have met to discuss how some of the ideas that have been shared in the workshops (relating to the use of inquiry processes) can be implemented in their classes, their overriding concern is with the syllabus which they must address and the preparation of their students for their examinations. Furthermore, moving away from the practice that has proved acceptable for years entails a high risk, both with the students' performance and routine demonstration of teachers' competence. Here we see tensions between the project goal in terms of the development of inquiry approaches and the constraints of the curriculum, and between teachers current tried, tested and trusted practices and the uncertain state of

'inquiry as a way of being'. There is also, we believe, a latent tension between the teachers expressed desire to develop their teaching and other expressions that indicate that they believe they are performing well and that developments in practice need to occur elsewhere.

As noted above, we are conscious of contradictions within our own (didacticians') activity and we want to draw attention to these because we are also 'insider researchers' exploring our own activity. Our (team of didacticians) concern is to develop inquiry as a way of being for ourselves and the teachers and to begin this we have, so far, organised three workshops with teachers. A central feature of each workshop has been working together in small groups on mathematical tasks that we believe will open up possibilities to think together in inquiry ways, and to use inquiry as a tool to promote inquiry as a way of being. In the process, we expect these tasks to inspire and challenge teachers at a variety of levels. Teachers can also re-package tasks for use with their own classes if they wish to do so. The feedback received following the workshops is that teachers have enjoyed them and found them of value. However, the 'contradiction' here lies in the mediating artifacts, the tasks, in that many teachers are seeing the tasks as the purpose of the project rather than the inquiry processes which the tasks help to illuminate. In other words some teachers are seeing the project as about 'inquiries' or 'inquiry tasks' (in some contexts these might be described as 'investigations') rather than the processes they model as a way of being. Didacticians thus face new challenges in design of activity to promote inquiry.

Another contradiction that we (team of didacticians) experience arises because of the position that we have been required to take to ensure the project becomes established. This has inevitably initiated the development of a community in which the team of didacticians are *perceived* as taking a leadership, and possibly authority role. Our (didacticians') intention is to work in partnership as co-learners with the teachers and although there will be a necessary 'division of labour' we do not want there to be an imbalance of power. It is the expression of what "we want" that captures the dilemma here.

CONCLUSION

The application of an Activity Theory model and the identification of tensions within and between the nodes of the model are providing a means for understanding our own practices as researchers and interpreting the engagement of teachers and didacticians as co-learners. Casting contradictions and tensions in the role of sources for development provides access to areas of the project to which developmental effort needs to be made. The project will progress as we (didacticians and teachers) develop trust within and between our communities, reflect on the contradictions, and find the means to bring those which are latent to the surface, and resolution to those which are perceived.

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1   Unless otherwise indicated the personal pronouns 'our', 'we' refer to the authors of this paper.
2   Didacticians are people who have responsibility to theorise learning and teaching and consider relationships between theory and practice. In the project we refer to the university educators as 'didacticians' in order to recognise that both teachers and didacticians are educators and both can engage in research.
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