LEARNING COMMUNITIES IN MATHEMATICS: DEVELOPING AND STUDYING INQUIRY COMMUNITIES IN MATHEMATICS LEARNING, MATHEMATICS TEACHING AND MATHEMATICS TEACHING DEVELOPMENT

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Learning Communities in Mathematics (KUL/LCM[1]) is a project which aims to design and study mathematics teaching development for the improved learning of mathematics through inquiry communities between teachers and didacticians[2]. This paper introduces the LCM Project briefly with aims and a theoretical account, and an outline of implementation including methodology, data collection and analysis.

THEORETICAL PERSPECTIVES: INQUIRY AND COMMUNITY

Chambers' dictionary suggests that *to inquire* means to ask a question, to make an investigation, to acquire information, or to search for knowledge. In the LCM project, we conceptualise inquiry at three levels:

1 Inquiry in mathematics:

    a Teachers and didacticians exploring mathematics together in problems and tasks in workshops;

    b Pupils in schools learning mathematics through exploration in tasks and problems in classrooms.

2 Inquiry in teaching mathematics:

    Teachers using inquiry in the design and implementation of tasks, problems and mathematical activity in classrooms.

3 Inquiry in developing the teaching of mathematics:

    Teachers and didacticians researching the processes of using inquiry in mathematics and in the teaching of mathematics.

We see learners developing understandings through inquiry, resulting in developments in cognitive structures and processing both for individuals and community. Here we might draw on constructivist perspectives in which inquiry is

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[1] KUL stands for Kunskap, Utdanning og Laering which is Norwegian for Knowledge, Education and Development. It is the name of a research programme of the NFR, Norges Forskningsraad, the Norwegian Research Council. The LCM Project at Agder University College is funded within this programme. Project number 157949/S20

[2] The term didacticians means those professionals with responsibility for theorising teaching. Didacticians may also be teachers or teacher-educators. We avoid the term 'educator' since it is ambiguous – teachers are also educators.

seen as a tool through which intersubjectivity in mathematics, or mathematics teaching, etc. can be seen to develop. Reflection on the processes of inquiry develops metacognitive activity in which learners becomes more knowledgeable about their own learning (Cobb, 1996, Glasersfeld, 1995: Jaworski, 1994; Mason, 2001;Wells, 1999). We draw overtly on processes and strategies in learning mathematics through problem-solving and exploration and related heuristics (Polya, 1945; Mason et al. 1982; Schoenfeld, 1985)..

Also central to the project are interaction and communication in *learning communities* in fostering common understandings and supporting individual growth. We recognise the situated and distributed nature of knowledge in *communities of practice* (Lave & Wenger, 1991; Wenger 1998) and the importance of nurturing *inquiry communities* (Wells, 1999) to question existing practices and develop more effective practices.

Key elements of the LCM Project involving development and research are

- *Creating Partnerships*: Didacticians and teachers work together for mutual benefit and support – teachers should be involved in design and implementation at conceptual levels for the success of innovation.

- *Designing Activity*: Design of tasks for workshops and classrooms; design of approaches to learning and teaching; design of research/inquiry to learn about developmental processes and learning outcomes.

- *Research* into Designing Activity and Creating Partnerships

Design in this project can be seen to relate to the *design research paradigm* which has been expressed as follows:

> An emerging research dialect …contrasting with dialects of *confirmation* or *description* … attempts to support arguments constructed around the results of active innovation and intervention in classrooms. The operative grammar, which draws upon models from design and engineering, is generative and transformative. It is directed primarily at understanding learning and teaching processes when the researcher is active as an educator. (Kelly, 2003)

We see the term *educator* here to include both teachers and didacticians. The role of teachers in design research needs some clarification. Wittmann suggests that "teachers need to be trained and regarded as partners in research and development and not as mere recipients of results" (1998, p. 95). Moreover, he says that design "cannot be left to teachers" (p. 96). "The teacher can be compared more to a conductor than to a composer, or perhaps better to a director … than to a writer of a play" (p.96). While we would agree that teachers should be regarded as partners, the nature of such partnership is a major focus of study. We see teachers and didacticans as co-learners as in

> In a co-learning agreement, researchers and practitioners are both participants in processes of education and systems of schooling. Both are engaged in action and

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reflection. By working together, each might learn something about the world of the other. Of equal importance, however, each may learn something more about his or her own world and its connections to institutions and schooling. (Wagner, 1997, p 16)

Together we shall study the processes and practices of engaging in *inquiry* of various sorts, in various ways. We see research itself as a process of inquiry which has significant implications for development of teaching (Chaiklin, 1993) and draw on a framework for analyzing development in co-learning research partnerships, involving reflexivity between

Knowledge and Learning,	Inquiry and Reflection,
Individual and Community,	Insider and Outsider researchers;

and reconciliation with prevailing societal and systemic norms (Jaworski, 2003).

Thus, the project will study the processes involved in creating communication and collaboration between teachers and didacticians in which theoretical ideas and visions can be interpreted in practice; produce insights into key issues in developing inquiry communities to enhance mathematics teaching and learning, and provide indications for sustainable practices in mathematics teaching development and learning improvement.

PROJECT IMPLEMENTATION

Main elements of design

We see this as a combined research and development project. It involves design and innovation in three modes in which activities will be researched.

1 **Workshops at the College:** Teachers and didacticians working together on mathematical problems and tasks (using ICT). Creating a community of inquirers – we are all learning at a variety of levels.

2 **Teacher teams working in Schools**: Teachers building on experiences in (1), working together within a school to design mathematical tasks (including ICT) for the classroom. Drawing on support from didacticians according to needs.

3 **Innovative Teaching in Classrooms:** Teachers teaching classes using inquiry tasks and ICT according to experiences from (1) and design at (2) to engage students in inquiry and learning in mathematics.

Modes (1) and (2) will take place simultaneously, with workshops developing starting points for thinking and activity in teacher teams. Mode (3) will follow cycles of (1) and (2): didacticians will observe a selection of lessons and talk with teachers and pupils.

Looking at Learning Longitudinally

We know that mathematical learning in classrooms in Norway is problematic: students' achievement does not meet expectations and curriculum goals are not satisfactorily achieved (Brekke et al, 1995; Alseth et al 2003). To explore

development in teaching we need also to look at learning, and ask, is learning improved? Thus we are designing instruments for a longitudinal study in which we look at current practices in mathematics learning, teaching and use of ICT at the beginning of the project and twice during the life of the project in project schools. We will seek further funding to apply these instruments to a random sample of schools nationally for comparative purposes.

Choice of schools

We have recruited 7 schools chosen for diversity of age range and sociosystemic factors. Agreements are based on requirements that the school (Principal or Headteacher) must be committed to the project: willing to support teachers, contribute to time and other resources and disseminate findings in and beyond the school; also, a minimum of three mathematics teachers must be participants in the project, attending workshops and engaging in task design and classroom innovation.

Design and nature of workshops

Our aims for workshops are to produce problems or tasks to get us working with teachers on mathematics; develop community with understanding, respect and confidence; lead to dialogue on tasks for classrooms, ways of working in classrooms, ways of achieving L97[3] objectives. Planning has suggested the following style of events: introduction to the workshop; small group work on questions, tasks or problems – teachers and didacticians together; small group feedback; discussion of what we have learned; discussion of needs.

We are planning three workshops initially in which we hope to see a progression from engaging together in mathematics to considering how inquiry in mathematics leads to mathematical learning, and further to thinking about ways in which inquiry might take place in classrooms to address the curriculum at any level. We hope to address the question of, what are our needs in designing activity for the classroom? This might involve, for example, more understanding of inquiry approaches; reading material related to developing teaching; help with mathematics; help with ICT and so on.

The use of "we" here begs the question of *who* is in focus at different times. Teachers and didacticians bring different knowledge and skills. Initially workshops will be planned and coordinated by didacticians with a major aim to draw teachers into professional dialogue and develop a common discourse. Developing *community* requires us all to trust and have confidence in partnership. Teachers have fundamental knowledge of activity in schools, school ethos, and systemic organization. Didacticians have an initial role to promote *inquiry* as indicated above. The professional discourse should develop awarenesses of what inquiry can mean and what practices might be involved in the school environment. Teachers will have specific needs in developing inquiry approaches and these should be revealed and

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[3] L97 is the Norwegian National Curriculum

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addressed. Didacticians will need to learn about issues that have to be addressed in promoting inquiry in schools. Two further workshops will be planned to addrfess questions and issues arising in school work. Research will explore development in all of these areas from initial planning.

Teacher planning – lesson design

The teacher team in each school starts to work on design of classroom activity with an aim to plan a set of lessons involving inquiry approaches which teachers will teach and together we will explore the outcomes. Didacticians will visit schools periodically, join teachers in their discussion and provide support as jointly conceived. We are aware of other projects in which models for this kind of activity can be found, such as Japanese Lesson Study (e.g., Stigler & Hiebert, 1999); Learning Study (Marton et al., 2003); The Formative Assessment Project (Black, et al., 2002), and will draw on learning from these projects. Again, activity here and issues arising from it will be a focus of research.

Classroom Innovation

Teachers will teach the planned lessons, with audio or video recording wherever possible, taking some opportunity to observe each other, meeting at agreed intervals to reflect on the lessons and recognise issues, re-plan where necessary, and keep a record of thinking and outcomes. Didacticians will provide support as needed and possible, collect data in classrooms and conduct individual and focus group interviews.

Data and Analysis

Data will include: notes (handwritten) from various activities; audio recordings (from workshop design meetings; workshops; teacher group planning meetings; lessons); video recordings (from workshops; lessons); other data (from workshop tasks, problems, schedules; materials for use in classrooms). This data will be subject to data reduction techniques to point out significant episodes to which we will then apply in depth qualitative analysis, triangulating between alternative forms of data and methods of analysis. In addition we will have data from our longitudinal study which will be subject to suitable quantitative or qualitative techniques.

Project timescale

Workshops and school activity will begin in the autumn of 2004 and continue to spring 2005. Teaching and observation of lessons will take place in Spring 2005. Summer 2005 will be devoted to analysis of the extensive data that will be available by this time. This will constitute Phase 1 of the project. In autumn 2005, we shall hold workshops to review activity and to conceptualise Phase 2 of the project. Early in 2006 we plan a major conference to present findings from Phase 1 and explore possibilities for continuation and extension of the activity of the project. Sustainability and dissemination will be key issues for this conference.

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