Emerging Communities of Practice: Collaboration and Communication in Action Research*

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Abstract

This article chronicles the experiences of Dialogues in Methods of Education (DIME), a group of school and university faculty. Over the past 22 years, DIME members have studied together how to improve their own teaching practices through research, the sharing of ideas, and mutual support. They have also engaged in critical analysis of the disciplinary and institutional forces shaping their work. The history of DIME shows the importance of accommodating difference as well as mutual support for long-term collaborations.

Educational action research is often characterized in relation to community. We speak of the neighbourhood as a community; cultural communities; communities of practice; interpretive communities; scholarly communities that extend through time; and entities as diverse as the classroom community and the global community. Among these are the communities of inquiry supporting the action research itself (Grunau, Pedretti, Wolfe, & Galbraith, 1998; Watt & Watt, 1991). These communities are crucial to the path of the action research.

Communities vary enormously in their size and their duration. Despite these variations they all define some sense of belonging to a group. This accounts for the warm feeling that we associate with the notion of community. But while communities include some people, they inevitably serve to exclude others. Even the charter members of a community may feel that some aspects of themselves are denied, just as other aspects are affirmed. A community can thus raise as many problems as it solves. How can the community create a sense of focus, of belonging to something, without denying individual differences in experiences, values, and perceptions?

This article describes a community called Dialogues in Methods of Education (DIME) in which dialogue around shared values and beliefs, as well as around differences has led to a meaningful experience for its members, and has endured for over 22 years. This

community is not presented as a model, but rather for the insights it provides about how communities can support action research. It highlights questions such as: In what sense is this activity a community? How important is it to be a community? How does being a community affect learning? Can we and should we make the community more effective? and What does learning in this community tell us about education in general?

Practices of Science and Science Education

A familiar image in science fiction is that of the mad scientist working alone. But this image is far from the everyday reality of most scientists and may be the most fictionalized aspect of some science fiction stories. In reality one of the most striking facts about successful science is that it exists by virtue of communities of practice (Lynch & Woolgar, 1990; Nelson, Megill, & McCloskey, 1987; Pickering, 1992). These communities are maintained by communication through professional societies, journals, research institutes, the linking of research with academic courses, graduate student development, team research, interdisciplinary research, electronic networks and data bases, and other organisational and technological mechanisms. Science does more than just employ these communication tools; it may fairly be said that science as a human activity is the progressive unfolding and enlargement of a community of inquiry manifested through various forms of communication and organisations. As Peirce (1867 [1958]) noted long ago, our scientific knowledge of the world is constructed by these communities of inquiry.

Educational research may also be characterised in terms of communities of inquirers. But it often lacks many of the linkages that appear essential to inquiry in other disciplines, such as those of the physical and biological sciences. Specialised terminology often serves to divide researchers from one another and from practitioners, rather than to unite them. For example, the relations among terms such as "whole language", "constructivism", "constructionism", "inquiry-based teaching", "process learning", and "progressive education", are difficult to articulate and sometimes serve to hinder, rather than enhance dialogue. Institutional constraints often hamper the collaboration needed to construct useful theories. In most schools, teachers are given scant time for extended inquiry and little recognition for what they may accomplish. University researchers are rarely rewarded for the extra time and effort needed to conduct extended work in school or community learning settings. As a result, the deep connection between research and practice that Piaget (1970) called for in his "science of education" has not developed as it might.

The situation in education may contrast with that of other applied disciplines as well. In engineering, medicine, and agriculture, the processes of inquiry, the research values, and the representational devices (mathematical formulas, graphs, diagrams, terminology, etc.) are closely allied with those of the corresponding disciplines within the basic sciences. For example, medical practice draws directly from biomedical research. While there is miscommunication, competition for resources, and contradictions, these enterprises are more tightly linked than are teaching and educational research.

There are also well-known institutional constraints. Teachers attempting action research often do so without the support of a collaborative research community. The communities that do exist are separated by discourse and by what problems are deemed worthy of attention. Practitioners, who have the least formal training, the least financial resources, and the least time, also have the least social support for their investigations.

The lack of social support for investigations of teaching and learning -- the absence of a vibrant community of inquiry -- leads to specific practical difficulties. For example, many physics teachers view their task as one of communicating standard conceptions of energy and matter. To encourage questioning of these conceptions would contradict their view of their role as teacher. In contrast, many educational researchers would argue for the value of tentatively accepting and exploring both the alternative conceptions that students might

hold and the standard ones. Practising physicists might have their own strongly held and different conceptions of both learning and energy-matter. Resolving these differences is not the issue, but rather it is the lack of opportunity to engage in dialogue about the significance of different views and for all involved to grow in their understanding within a challenging, yet supportive, community (see Feldman, 1996). Thus, the high valuation of research and dialogue within the scientific communities does not always carry over to research in mathematics and science education.

Action Research Communities in Literacy Research

Despite the barriers alluded to above, there are abundant examples of cross-institutional and cross-disciplinary communities in which researchers and educators are working together to effect change through action research, especially in the last decade (see Angwin, 1998; Atweh, Kemmis, & Weeks, 1998; Carr & Kemmis, 1986; Cochran-Smith, & Lytle, 1993; Davis, Resta, Miller, & Fortman, 1999; Newman, 1998; Noffke, 1995). Many of these communities are in the language arts or social studies areas, but there are also examples of collaborative communities in mathematics, science, and technology education (Feldman, 1994; Fulton, 1996; Watt & Watt, 1991). In all these projects we see how different perspectives and experiences become assets rather than liabilities, and how mutual support leads to productive collaborations that bring about changes in practice.

We highlight here just two examples of successful collaborative communities for action research in language arts. These developed about the time that DIME did and provide useful points of comparison. The first of these involves work on elementary school writing and reading in New Hampshire. This research began when Donald Graves, then a professor at the University of New Hampshire, began studies of the development of children's writing (Graves, 1978). Believing that it was necessary to look beyond the laboratory, Graves went to classrooms to observe what children actually did when they wrote -- how they held a pencil, how they used the space on a page, or how much time the teacher allowed them to write. He also began to examine the larger social and institutional contexts for writing, such as the fact that schools spent many times more dollars for textbooks than for materials to support writing, or that purchases for lined paper, which was used for writing, were outpaced by purchases of the blank paper used for ditto worksheets.

Soon many others joined and extended this research community. Lucy Calkins at the University of New Hampshire conducted a two-year classroom study in Atkinson, New Hampshire (Calkins, 1983). This work was a collaboration between Calkins and the teachers, Carolyn Currier, Pat Howard, and Mary Ellen Giacobbe, and the principal, Jean Robbins. But it also involved university researchers, such as Graves, Susan Sowers, and Pulitzer Prize winning author Donald Murray, who also taught at the university. As they worked together to develop better ways to support the teaching and learning of writing, they also learned more about writing.

One of the ideas that emerged through work in these classrooms was the writing workshop. Teachers would set aside time each day for students to write on topics of their own choosing. During that time they might read, do research, produce drafts, or talk with their peers. This was a substantial change to the ordinary classroom practice and required major efforts to convince administrators and parents of its value. Teachers had to confront questions such as "What about spelling?" when they altered the emphasis in language arts from skills to writing. This is turn led to new research questions and the need for teacher dialogue.

Those involved shared many things, including the belief that good teaching must be based on listening to children. This point is crucial, and reappears in our examination of a community for action research in mathematics and science. It also plays a central role in how the teachers and university researchers interact with one another. The participants

also believed that writing was important as a means of self-growth, as a way to learn, and as a way to participate in a social world, not just as a set of skills to be demonstrated on a test. Because of this they all felt that they should be writers, as well as people studying or teaching writers. This writing was not only for publication, but also for constructing their understandings of what they observed and of their own writing processes.

At the same time, participants brought different experiences to the new community. Some taught professional writers; others taught children in kindergarten. Some focused on creating publication outlets for children's writing; some were more concerned with connections between reading and writing. Their collaborations became multiple and soon extended far beyond the initial projects in southern New Hampshire. The ideas and publications from this work continued (e.g., Atwell, 1987; Hansen, Newkirk, and Graves, 1985; Newkirk and Atwell, 1988; Roderick, 1991). This research, collaborative and action-oriented, was deeply grounded in real classroom practices and in the understanding of children. It has significantly influenced writing instruction in many schools, especially in the US, Canada, and Australia.

Starting in 1981, a group in Cambridge, Massachusetts began developing *Quill*, a computer program to support the teaching and learning of writing (Bruce & Rubin, 1993). Some of the experiences of the New Hampshire writing research recurred in the *Quill* project. In order to design a program that made sense for children, the researchers needed to start by working in classrooms. The research became a collaboration among software developers, writing researchers, teacher educators, school administrators, classroom teachers, and others, including, most notably, the students who pushed its *Quill's* limitations.

Perhaps the most successful work with *Quill* occurred in Alaska in 1983-85. As in other sites, collaboration meant finding ways in which people in diverse institutional settings could bring their special expertise to bear on common problems. Ron Scollon at the University of Alaska initiated the *Alaska Quill* project in part because of the research he and Suzanne Scollon had done on the education of native Alaskans (Scollon & Scollon, 1981). Their research had shown that differing discourse conventions led to strereotyping and miscommunication in intercultural communication. It had also shown that there was a greater potential for education in village schools than was typically acknowledged at that time (Barnhardt, 1985a). Perhaps the most salient finding was that new technologies, especially those that emphasised communication, could be especially effective for native Alaskan students (Scollon, 1983).

The Scollons were soon joined by Carol Barnhardt, who shared those concerns and was working closely with schoolteachers in Alaskan villages. Almost from the beginning, teachers such as Bonnie Bless-Boenish began to shape the project as well. Teachers in Alaska who worked in small villages were concerned about communication: How does one remain connected with people hundreds of miles away, when there may not even be a connecting road? This shared need was one of the reasons why communication through electronic networks was already established at the time the *Alaska Quill* project began. It was thus natural to explore how networking could be used to support the project. Soon there was an *Alaska Quill* communications network, built on a clumsy patched gateway between two established networks. But the patch was not an issue. What mattered was that teachers and university researchers felt a sense of community, and a shared mission. Thus, they used the network to share discoveries, teaching ideas, tips for equipment use, and often, frustrations with the technology (Barnhardt, 1984, 1985b). As with the writing projects described above, discovery and improved teaching grew inseparably out of the interactions of a diverse, but cooperating community.

As Dewey outlined (Dewey, 1916 [1966]), "community" and "communication" share more than just the same Latin root. Through communication we are able to establish what is

common (another descendant of Latin "communis") among us -- our shared beliefs, values, and goals. These shared things are the basis for our communities, which are in turn established, maintained, and expanded through communication. This may explain why communities for action research around language learning arise more easily. Students, teachers, and researchers used the *Alaska Quill* communications network to carry out research, much of which was to study their own communication.

The writing process work of that time has been criticised for romanticising how writing develops (North, 1987), and for not attending to the multiple forms of literacy that students bring to school (Cazden et al. 1996). Nevertheless, most of its critics acknowledge that teachers engaged in collaborative, action-oriented inquiry about their practice generated valuable insights about teaching and useful ideas for progressive change in schools. The recognition of that potential has stimulated continuing work in recent years through organisations such as the National Writing Projects, the Whole Language Umbrella, and The Literacies Institute.

The Origins of DIME

Sociologists of science have emphasised the importance of community and communication in many areas of scientific research (Latour and Woolgar, 1986; Lynch & Woolgar, 1990; Pickering, 1992; Star, 1988), but that perspective has not been fully incorporated in mathematics and science education research. The success of action research communities for literacy raises the question of whether similar communities might be beneficial for mathematics and science teaching. For example, the National Academy of Sciences and the Smithsonian Institution train leadership teams in elementary science composed of school administrators, teachers, and scientists, and the National Science Foundation urges research groups in the sciences to collaborate with public educators in educational reform projects. Educational researchers, e.g., the National Association for Research in Science Teaching, (Shymansky & Kyle, 1992) have collaborated with scientists to plan science education research in a new mode, including action research. But the extent to which these efforts embody principles of teacher initiative, social action, and critical inquiry remains to be seen. In order to see how such a collaboration might work, we examine here a cross-institutional community called DIME. It demonstrates the need for new kinds of alliances, organisations, or perhaps new kinds of institutions to effect educational change.

The story begins with a paper called "Teaching by Listening" (Easley & Zwoyer, 1975), which showed how children were able to engage more deeply in the process of mathematical thinking when they were encouraged to articulate their own, perhaps unconventional, ideas and not just listen to the teacher. Through this telling, the children often revealed aspects of their thinking that could provide invaluable guidance to the teacher. For the teacher, this approach called for a new way of thinking about the teaching of mathematics, one in which the teacher's role was not to transmit mathematics to children who knew little, but to listen to children as a first step in nurturing their construction of mathematics theories.

Studies of teaching by listening continued with the support of a research grant designed to learn more about the ways primary-school children (ages five to eight) discover and talk about their concepts of number and numeral. Easley led a team of clinical interviewers who worked directly with children. A mathematician (Peter Braunfeld) examined the number system in relation to what the clinical interviewers were learning from children. A mathematics teacher educator (Harold Lerch) studied the use of hands-on mathematics materials by teachers. The successful collaboration among educational researchers, teachers, mathematicians, and children meant that the collaborators learned from each other and that the results of the research had a richness and grounding not possible through more separated research. One finding was that there was a large gap between

mathematics educators and children's ways of thinking in mathematics.

In 1977, Easley and Bernadine Stake then began work with primary teachers in places as diverse as Chicago, Kankakee, and Urbana (Stake, 1999). Early in this research they learned that when experts demonstrated their best methods in the teachers' own classes, they relied on backgrounds of mathematical ideas and a confidence with mathematical dialogue that the teachers did not share. Thus, teachers were often unable to emulate these innovative teaching methods. Moreover, the teachers were not learning how to learn as teachers. Demonstration and imitation was not an effective way to foster learning to teach. The research revealed great differences in mathematical ideas among children, teachers, administrators, educational researchers, and mathematicians. These differences are accentuated through lack of communication among the groups. Each group is isolated from effective communication with the others about how to improve teaching and learning.

Easley and Stake decided to address these learning and communication problems directly. In 1978 they and Linda Brandau called a meeting of volunteers from the adult groups mentioned above. Enjoying the prospect of breaking out of their institutional isolation, members volunteered to meet for two days (Friday-Saturday) every fall and spring and have been doing so ever since. A new institution, called DIME (originally Dialogues in Mathematics Education), came into being from an effort to break down communication barriers between groups who played different roles in existing institutions. Communication opened up with two other groups: mathematicians, administrators, and, in one classroom after another, also with children. Elizabeth Easley played a crucial role in helping members stay connected with the group.

Visitors at DIME meetings were frequent. Eventually, DIME teachers broadened their concerns to other areas of the curriculum, first to science teaching and learning, and then to literacy and the arts. To reflect this expansion of interests, the name of DIME was changed to Dialogues in Methods of Education. Collaboration in classroom action research was central to DIME from its inception. Because of the previous research showing children's ability to grow through responding to challenging problems, and the work showing the importance of dialogue in learning, an initial focus was the use of challenging story problems in small groups. This approach has remained an important theme in DIME meetings, and has been adopted and adapted by many DIME members. Although it has spread as a method, it remains as an hypothesis to be explored, rather than a practice to be adopted without critique. This is true of all the methods presented in DIME meetings.

While teachers shared story problems at DIME meetings, that sharing did not give them enough problems to sustain their own reform efforts. They were on their own to find more. Many were able to invent sources of more such problems. Cross-age interaction of mathematics students in problem solving (developed by Rhonda Priest in Carlinville, Illinois) provided a ready source of good problems. It meant tutoring help for the younger children in her class, and had substantial learning benefits for the older students and their teacher. Approaches such as these were shared at DIME meetings, adding to the ongoing dialogue about teaching and learning.

Over time, DIME members adopted a number of general principles. One was the listening to children notion that had informed the earlier research of Easley and Zwoyer. They saw the value of clinical interviews, which respect and help us understand the ideas of children, no matter how bizarre they may seem from a standard adult view. They also saw came to understand that differences in mathematical ideas exist among cultures, and among children. Perhaps most importantly, they saw that dialogues between people of different views are valuable as a basis for understanding and improving our own views on any subject, from mathematics to the role of a teacher.

An example of a current issue in DIME discussions is the explicit or implicit choice of

themes in mathematics instruction. Textbooks typically present a fixed sequence of operations, skills, and facts, so arranged that what one studies today is seen as absolutely essential to what is studied a month later. Teachers often stress other themes including discipline components with a moral tone such as neatness, promptness, following directions carefully, or doing one's own work. An alternative theme is measurement. Within DIME, all of these are treated as possibilities to be explored, critiqued, and shared, not as new methods to be imposed.

Over the two decades of DIME's history, several offshoot projects emerged:

- Several local DIME groups were formed and met for varying periods of time.
- Teachers collaborated with educational researchers in various action research projects (Easley and Taylor, 1990; Easley, Taylor, and Taylor, 1990).
- Groups of teachers collaborated on research proposals. One of these investigated problem-solving dialogues in groups of children. Another is developing materials conforming to NCTM standards across a district.
- Three writing conferences were held; seven teachers published articles and presented conference papers about their teaching innovations in educational journals.
- A newsletter has been published for 12 years, giving news about meetings and publishing articles on classroom practices and research.

A recent DIME meeting had fourteen elementary teachers, one elementary principal, three mathematics education specialists, one speech therapist, five university educators, two mathematicians, one physicist, one education undergraduate student, two education graduate students, one museum educator, one art student, and two educational consultants. Other meetings have included secondary teachers, scientists, and members of other professional groups. More than eight school districts in three mid-western clusters have been involved. Regular DIME meetings, originally held in Urbana, soon began in southeastern Michigan and Carlinville, IL. The enthusiasm and attendance has remained high, despite the increasing difficulty for teachers to get professional leave to attend on Fridays. Today, there is a newsletter, an email group, and a web site <http://inquiry.uiuc.edu/dime.php3 to accompany the face-to-face meetings.

Ideas Developed Within DIME

Members of DIME have learned many things. What follows are some widely shared ideas that have percolated within and beyond DIME. This learning guides DIME now in continuing collaborative efforts to develop a broader, and more effective educational reform. Some of these emerging ideas within DIME pertain directly to teaching and learning:

- Adults often underestimate children's capabilities for strong mathematical and scientific thinking.
- If children are not challenged by difficult problems they sometimes conform to low expectations.
- Teachers can facilitate dialogue among children in large or small groups. But that dialogue facilitation role may be more difficult to assume in mathematics or science lessons.
- Lack of mathematical knowledge is not what blocks adults from listening to and supporting pupils' mathematical thinking. It is more the assumption that the teacher must be the classroom authority and judge on all matters of instructional content.

Other ideas within DIME relate to the process of change in teaching:

- Teachers do not invent or adopt new methods *de novo* but modify known methods to improve them.
- Teachers need good examples, if they are to try something quite different from familiar

methods.
- Examples alone are never sufficient.
- After trying a new method, there must be time to criticise it and modify it to make it work better.

There are also several ideas in the DIME community regarding the challenge of building communities of inquiry around issues of teaching and learning:

- Teachers don't always share ways of doing things with colleagues.
- It is difficult to work in ways that obviously differ from those our colleagues seem to trust.
- Established institutions impose constraints of time, schedule, or custom that hinder collaboration, communication, and reflection.
- Most teachers share in family and household care as well as earn a living. If schools cannot provide the time teachers need for conferencing, then teachers may be on their own to find it.

These ideas reflect the experience of DIME members who are both responsible for facilitating learning in their classrooms and learners themselves. They reveal the kind of multi-layered discussion that typifies DIME meetings, with topics including specific example of children's learning, teacher change, family life, and political realities.

Rules for DIME Meetings

DIME members have valued informality in the meetings and have not been inclined to institute bylaws, offices, committees, or other organisational trappings. Nevertheless, a shared culture has emerged in which implicit rules govern key aspects of social interactions. We have identified five such rules that facilitate communication among the members.

One rule is that everyone has something to contribute. A moderator ensures that every attendee gets a chance to take the floor, at least once during the two-day meeting. This may be to share student work, to show a videotape of classroom interactions, to report on a conference, to share a new teaching method or curriculum materials, or to present a professional problem and seek advice, such as how to work better with teachers in the school who operate from a different pedagogical philosophy. Although interactive dialogue is the norm, others wait their turn to make their presentations. This rule can be viewed as the logical extension to adults of the teaching by listening principle that emerged independently in the research on both language arts and mathematics learning.

A related rule is that divergent views should be respected. DIME members generally espouse teaching by listening, hands-on learning, cooperative groups, the use of manipulatives in mathematics, problem-solving, whole language, and other progressive educational practices. But they do not view any of these practices as perfected or final, nor as dogma. Moreover, they extend their philosophy of learning to adults. Thus, both new and old members are given ample opportunity to articulate their ideas and to explore the consequences.

A third rule is that no standpoint, e.g., formal educational research, is privileged above all others, and no standpoint, e.g., the beginning teacher, is devalued. The goal is not to find a single truth and no one method is assumed to be adequate for determining the best approach to teaching. Instead, members work to discover what each perspective offers, viewing their own accounts of teaching and learning as provisional and subject to revision in the light of continued dialogue.

A fourth, rather specific rule, is that no one can make a second point until the group has a chance to discuss the first point. This was instituted in response to some early meetings in

which some members had a tendency to make speeches. People talk naturally, and even heatedly at times, about each others' concerns, often late into the evenings.

A fifth rule is that good learning activities can foster dialogue. Participants at DIME meetings often visit schools in session, and new kinds of communication are experienced between adults and children. At a recent DIME meeting, participants visited the Wiley elementary school in Urbana, where teachers had been working in teams with university students to develop kits to support interdisciplinary science learning (Fortschneider, 1992). DIME members observed students using the materials the Wiley teachers had developed. Freed for the moment from the need to manage their own classroom, the visitors were able to observe the use of the kits, talk with students about their projects, and listen to their developing conceptions of scientific phenomena. Although worthy as curriculum materials, the kits served the more significant function of enhancing dialogue among teachers and between teachers and students.

There are thus five rules for DIME interactions: (1) everyone has something to contribute, (2) divergent views should be respected, (3) no standpoint is privileged, (4) no one can make a second point until the group has a chance to discuss the first point, and (5) good learning activities can foster dialogue. Most DIME members would assent to all of them, but they stand as an ideal in relation to a much more complex practice. Participation is far from equal; some views are accepted more easily than others; some participants are accorded more privilege than others; some make many points in a row; and long periods go by without learning activities. Still, the valuing of dialogue over prescription, the willingness to question, and the recognition of all participants as learners shape the group process significantly.

Models for Teacher Growth and Change

Discussions within DIME and reflection on the DIME experience have highlighted two contrasting models for teacher change. The first of these was tried in the early days of DIME, but is now seen as having limited usefulness. In this model, innovative activities are developed, perfected, and then disseminated. The forms of the dissemination may vary greatly. For example, student textbooks implicitly define a type of teaching and are thus one way to spread desired forms of teaching. Teacher's guides provide even more direct guidance for teachers to follow. More recently, videotapes and videodisks provide models of teaching excellence. Scope and sequence charts can be used to define the content and order of teaching, and thus serve as another route for dissemination. Observing expert teachers and imitating their practice is another route.

Figure 1 represents this approach schematically as the Demonstrations Model. In this model, innovative activities or teaching approaches are developed, and then, through an essentially imitative process, teachers incorporate these activities into their own practice. The pervasive problem is that, even when the model is excellent, the copy is less than ideal. Part of the explanation for this is that assimilating the practices of another into one's own system is difficult. But a more fundamental issue is that the so-called innovative activities are typically but the surface manifestations of deeper processes. A teacher may have been able to develop activities that work for her and her students because she learned how to listen to what they were saying. But the hours of listening and struggling to understand are not immediately evident in the 20-minute demonstration that grew out of that listening.

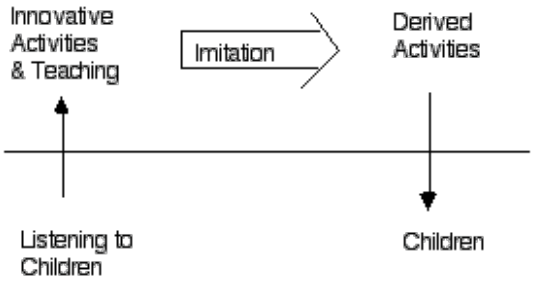

Fig. 1. Demonstrations model for teacher change

A contrasting model for teacher change has emerged through the DIME experience (Figure 2). Here, change is viewed as an ongoing process within a community of inquirers. There are no sharp distinctions between experts and novices, but rather a recognition that each person has experiences worth sharing. Educators in various roles have contributions to make, but ultimately any insights about teaching and learning must be related to what is learned by listening to children.

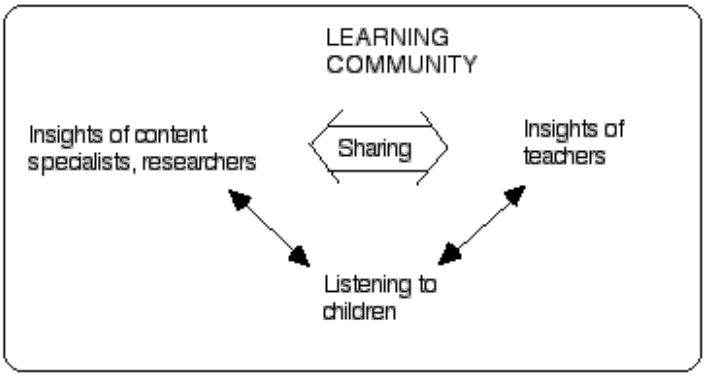

Fig. 2. Learning community model for teacher change

In a learning community model, such as we see in DIME, there is no point at which one can say that the method has been perfected and is ready to disseminate. Instead, teachers continually share their insights, their questions, and their frustrations to help each other develop a richer and more fruitful understanding of teaching and learning.

Conclusion

The examples in this chapter show diverse ways in which people have collaborated in action research communities. We could go on to look at many other examples (e.g., the North Dakota Study group, the Whole Language Umbrella), and many successful efforts without formal names and citations. Although these efforts exhibit a variety of histories and forms of collaboration, a common theme is that their structures have emerged from consideration of the needs of the individuals taking part in them. Thus, successful structures follow from the goals, interests, and concerns of those engaged in the action research. A corollary is that dialogue within the collaborative is essential, not just to exchange information, but to define the participation of the members. It is noteworthy that supportive dialogue thus serves as a teaching approach, as a research tool, and as an essential element for successful collaboration.

Various writers have argued that we should not focus on sameness within a community, but on pluralism and difference. Gregory Clark (1993), for example, considers the issue of

how a democratic community can accommodate difference: Does a focus on difference serve to compartmentalise differences or lead to tacit valuing of one set of values and ideas? Does the commonality of a community entail the exclusion of certain people or ideas? Building on the work of Edith Wyschogrod and Nel Noddings' ethics of caring, Clark argues (p. 74) that we should

> ... direct the discourse of community to the maintenance of equitable relations first, and then to individual and collective work.
>
> [This] renders the progress of expertise in a community secondary to a relational and epistemological practice of confronting differences so that its participants can come to understand how the beliefs and purposes of others can call their own into question. With this as its primary practice, the project of maintaining community can accommodate both equality and difference.

Differences among participants in educational action research communities can have diverse consequences, depending on how they are accommodated. The richness of action that grows out of the groups described here derives in part from the fact that differences were not subsumed into a larger order, but instead respected and seen as indicative of valuable contributions. At the same time, each group developed some sense of common purpose that ultimately delimits what differences are accepted. It is a challenge for a community to maintain a focus without denying individual experiences, perceptions, and values. Successful action research communities need to invest effort to accommodate difference and change. Listening to others, a simplistic mantra, may be a key to this process.

We might additionally ask whether we should enlarge our conception of mathematics and science education to encompass the kinds of communication that occurs in the literacy communities. After all, the sociology of science is replete with analyses showing how communication about both commonalities and differences, through talk, conferences, reading, writing, diagrams, charts, and tables, and so on, is at the heart of scientific practice (Latour & Woolgar, 1986; Lynch & Woolgar, 1990).

Teaching mathematics (or, for that matter, teaching anything) is not a skill learned through imitation. That this is so, may be more evident by consideration of learning in less patently intellectual areas. For example, physical education experts now call for individualised programs in which the learner is urged to "listen to your body" as a necessary condition for deciding what kinds and amounts of exercise are most helpful. Imitation is not enough; the learner needs to build a knowledge base and continue to ask questions about what, when, where, why, and how. If this is true for callisthenics, it must be even more the case for the complex and dynamic intellectual task of teaching mathematics and sciences. Rather than relying on demonstration and imitation, teacher growth and curriculum development call for collaborative communities of inquiring professionals.

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