Teacher Research, Action Research: the Logo Action Research Collaborative

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ABSTRACT Action research is a form of professional inquiry in which the teacher's role is seen as key to educational improvement. This paper describes methodologies developed by the Logo Action Research Collaborative – a national network linking 100 teachers at nine sites – that facilitate and support collaborative inquiry by teachers into their own teaching practices, in order to understand, improve, develop, and incorporate new forms of student assessment, teaching methods, and curriculum. The project focused on the Logo computer language, a powerful learning environment for problem-solving and mathematical inquiry. The authors provide background information on action research as an evolving discipline. They identify three phases of a year-long action research cycle, and describe key strategies developed by the project to support teachers in taking on a research frame of mind, identifying areas of concern, and undertaking and completing action research projects. The paper includes several illustrative examples of action research investigations undertaken by teachers, and demonstrates the benefits to the students and teachers involved. It closes by making a case for the potential contribution of action research to current educational reform initiatives and school restructuring.

Introduction

Who would believe that teachers would volunteer to meet regularly from three till seven every Friday throughout the school year or to drive 20 miles over icy mountain roads to share one student's portfolio with colleagues on a school snow holiday, or to write up a research plan to share at an all-day Saturday meeting in August? Yet such instances of teacher dedication are typical of the hundred educators participating in the Logo Action Research Collaborative.[1] They are part of a growing number of teachers who are

reclaiming the authority and responsibility for improving their own classroom teaching practices through research. The research they conduct is not the academic research accessed by standard literature searches and traditionally the exclusive province of professional researchers. It is research designed, conducted, and implemented by the teachers themselves for the purpose of improving the teaching and learning in their own classrooms. It is context specific, taking place in real classrooms and involving particular children. The conduct of this research must not undermine the teacher's primary job of teaching and the data collection must not conflict with or impose on classroom instruction. The research methods used are generalizable, but the results may apply only to the work of a particular teacher meeting students' needs in the context of his or her own classroom. The professional inquiry into student learning these teachers are pursuing is called action research.

Action Research: what it is and where it comes from

Action research is a term used to describe an evolving discipline. The working definition of action research used in this paper is a systematic inquiry by collaborative, self-critical communities of teachers, which takes place in schools. It is pursued out of a desire or need to improve educational knowledge and practices. It is accomplished through a recursive cycle of (1) identifying a problem area, (2) studying it by gathering data, and (3) reflecting on the data in order to make teaching decisions grounded in evidence rather than in hunches. Action is an integral part of the research and not an event which may – or may not – follow the study's completion.

Action research was first used in a social action context before it was so named, and is sometimes still called emancipatory research. In 1945, J. Collier, the Commissioner of the US Bureau of Indian Affairs, advocated the action research cycle as a democratic way to improve the living conditions of American Indians (Kemmis & McTaggart, 1988b). Action research for social change was developed and described by Kurt Lewin (1946, 1948) as a systematic method for groups of people directly affected by planned social changes to take responsibility for an ongoing cycle of planning those changes and systematically evaluating their effects. The changes were often mandated from above by top-down policymakers; however, the community members who were responsible for making the changes determined how to do so. In the developing world, oppressed groups have used action research or as Paulo Freire calls it, conscientization, or consciousness raising, as a way to understand their relationship to society and politics. In the USA this approach was an important component of citizenship training by the Highlander Center for Research, where Martin Luther King, Rosa Parks, and other leaders in the civil rights movement were trained in researching issues in order to take action grounded in a study of the situation (Horton & Freire, 1991).

Stephen Kemmis & Robin McTaggart of Deakin University in Australia have thoroughly described the use of action research in education (Kemmis & McTaggart, 1988a, 1988b), where the classroom teacher usually becomes the key change agent. Action research by classroom teachers has been more commonly practiced in Great Britain than in the USA. In 1974, the Briton John Elliott founded the Classroom Action Research Network (CARN) to provide ongoing support to the Ford Teaching Project [2] teachers who were examining their own practices in implementing inquiry learning (Elliott, 1976/77). Through the project, the teachers became a critical community of practitioners researching their own work while attempting to formulate generalizations based on an examination of their teaching practices. Although the Ford Teaching Project was completed some years ago, CARN has continued to flourish, now serving as an international network for action research by teachers.

The value of the CARN approach is that teachers find answers for their own authentic questions about practical issues of teaching and learning. In describing action research, John Nixon (1981) has stated:

> *One of the assumptions . . . is that action research can be*
> *undertaken by any teacher in any classroom. This is not to say,*
> *however, that it can be taken lightly. Action research is an*
> *intellectually demanding mode of enquiry, which prompts serious*
> *and often uncomfortable questions about classroom practice. It*
> *requires a willingness on the part of teachers to learn about their*
> *own classrooms and a desire to develop themselves*
> *professionally.*

This kind of research is respectful to the people involved, considering them to be co-researchers rather than subjects. It has often been used in schools to implement a newer curriculum such as the Mathematics and Teaching Program (Owens et al, 1988) and the Social Literacy curriculum developed in Australia (Kalantzis & Cope, 1989) or to integrate an innovation such as computer technology into existing teaching practices in the way that CARN has supported teachers in doing (Somekh, 1986). The Teachers' Workshop in Madison, Wisconsin, uses the method to work with teachers in creating classrooms that embrace cultural diversity (Caro-Bruce, 1991). It is remarkably well suited for use by members of a community interested in change from the bottom up or who want to become co-reformers in implementing change mandated from the top down.

The methods employed in action research are those of qualitative educational research, drawn from the descriptive sciences, ethnography, anthropology, phenomenology, heuristics, and epistemology. Action research focuses on the particular circumstances of an individual teacher or classroom and is designed to resolve real teaching and learning issues. It differs from traditional educational research in its emphasis on action. Traditional educational research – whether qualitative or quantitative – assumes the researcher is objective, remaining outside the situation under study. However, an action researcher is usually also the teacher. Integral to

action research is that the researcher takes actions grounded in understandings gained from the study, rather than simply documenting the situation. Therefore, in contrast to many research studies, the results of an action research study are immediately applied, and this application becomes the focus for the next cycle of the research.

While the results of most action research studies are specific to a particular situation and are not usually generalized to other communities and cultures, there are techniques for aggregating the results of small studies or linking knowledge gained in several studies which can be used to produce a larger picture and more generalizable conclusions. This is an area that needs more development. Moreover, the methodologies for conducting the research are themselves generalizable as tools for studying any aspect of classroom culture.

Action research democratizes research, extending it beyond the domain of academics and other highly trained specialists. It can be – and often is – employed by such experts, but it can also be used by a classroom teacher and classroom volunteers to create a better education for children in today's complex world.

Teacher research as beneficial to the teacher involved, the children learning, the curriculum, and the broader school community no longer needs defense. The argument has been made and documented many times over (e.g. Goswami & Stillman, 1987; Kemmis & McTaggart, 1988b; Oja & Smulyan, 1989; Watt & Watt, 1991); the gap in knowledge about teacher as researcher is not why but how to support teachers in volunteering to take on a disciplined study without the benefit of special degrees, extensive training in research methods, or expensive group facilitators, and within the context of already over-committed professional lives.

This paper reports on the mysterious how. It describes the framework and methods developed, revised, or borrowed by the directors of the Logo Action Research Collaborative [3] in collaboration with participant researchers in a number of pilot sites. The central challenge in supporting action research by teachers is to create the context for shared honest inquiry and real learning among participants. We have found that formal processes with specific rules – gently facilitated – can provide the discipline necessary to interrupt the usual teacher-room talk, which is the norm among colleagues in most school settings. These processes support teachers in taking a more curious and intentional look at their practices, adopting an attitude we have come to call 'a research frame of mind'. Making this shift in thinking is essential to being able to do classroom research.

The support structures designed by the project are not content specific. However, the participating teachers were all using the Logo computer language in their teaching; their research questions involved the teaching and learning of Logo. The methodologies developed enabled teachers to study some aspect of their teaching with Logo, to experience a sense of mutual support by sharing real concerns, and to be able to use tools of research for reflection, interpretation, revision, and improvement of

their work. Before we describe these methodologies, we explain why we found Logo teaching and learning to be rich with opportunities for action research.

The Logo Component

In the 1970s, MIT Professor Seymour Papert and his colleagues in the MIT Logo Group set out to create a computer-based learning environment that would simultaneously foster the learning of important concepts of mathematics and computer science and the learning of generalizable problem-solving strategies. Papert believed that this environment could transform the learning of mathematics from the formal procedures for memorizing algorithms he observed in most schools to a constructivist [4] approach now widely espoused (Papert, 1971, 1980). From the beginning of the introduction of Logo in schools in early 1980s, serious questions existed about whether Papert's vision could ever be achieved in actual classroom settings. Many of the earliest classroom implementations seemed to trivialize the potential of Logo by limiting students' activities to simple computer graphics and omitting much of the power inherent in Logo as a problem-solving environment. (See Appendix B: Logo Research.)

Considered as a whole, and including all its variants, Logo is an expressive medium which allows for many different kinds of learning. As in other areas of education, learning outcomes vary significantly with teachers' knowledge, experience, approaches, and objectives and with students' interests. Since Logo's introduction, the learning possibilities available through Logo environments have continued to expand through the development of more sophisticated software programs and interface devices. Logo learning environments now include computer animation, word processing, robotics, and cybernetics, as well as turtle geometry, which was the basis of Logo's first implementations. However, although he learning possibilities with Logo have multiplied, many teachers still feel a sense of disequilibrium in trying to achieve the potential benefits of the original Logo software.

The major incentive for establishing the Logo Action Research Collaborative came directly from teachers who were directly involved in implementing Logo in the schools. Many classroom teachers liked Logo and felt it was important. Yet they felt administrative pressure to justify their enthusiasm, and to defend the inclusion of Logo in the curriculum. They frequently asked questions such as, "Where can I find research to prove that Logo is good for my students?" Yet when the question was returned to them, "What are your students learning with Logo?", most were not sure, offering vague responses such as, "It just seems to be worthwhile learning", "My students smile a lot and talk a lot about how to solve programming problems", "They seem generally involved". And at the same time, these teachers also recognized that their statements about Logo's benefits did not apply to all of their students.

Many Logo teachers have had major problems implementing this computer-based learning approach which requires a shift away from teaching as telling towards teaching as facilitating. To move towards a vision of Logo as an open-ended environment in which learners have greater responsibility for their own learning requires teachers who understand important aspects of Logo learning. The teachers need to possess a collection of strategies to challenge students' curiosity, support students' project development, and probe students' understanding (M. Watt, 1982; Watt & Watt, 1986). The kind of professional teacher needed for effective Logo teaching – and possibly any teaching – begins to approximate what Donald Schon (1983, 1987) has called a reflective practitioner.

The problem is compounded by the fact that most Logo teachers have insufficient knowledge about using Logo. Many are teaching with Logo on the basis of several after-school workshops or a single computer literacy course. Even Logo teachers who have taken as many as nine credits of Logo course work, experience some of the same difficulties as less knowledgeable teachers. Regardless of their technical expertise, most Logo teachers have not participated in a culture of people working collaboratively to discover how the language can be really useful to children. This represents a very different level of professional inquiry than taking a course or a series of workshops.

When we began our project, therefore, we were convinced that Logo teachers were well suited to become action researchers: they exhibited some degree of questioning, wondering, or confusion about their work with Logo. They believed in the value of Logo for student learning and wanted – or needed to know more specifically about the learning of their own students. They wanted to do a better teaching job, but were unsure just what that would look like. They volunteered to take on a new role of teacher researcher in order to answer their own perceived need for more knowledge, understanding, and skill as Logo teachers.

The History of the Logo Action Research Collaborative

The Logo Action Research Collaborative (LARC) was initiated in 1986 as an exploratory effort to support teachers using Logo in building professional cultures for studying and assessing Logo learning in order to deepen their understandings and improve their practice. Its purpose is to support experienced teachers to

- critically examine their practices;
- engage in collegial reflection and dialogue;
- increase their content knowledge of Logo;
- develop methods for assessing student learning;
- carry out an action research project;
- revise, improve, or develop their teaching practices;
- develop more authoritative professional voices;
- provide peer support to research by colleagues; and

- contribute new professional knowledge to the larger educational community.

LARC supported a series of collaborative research meetings conducted over a school year. The first pilot cycle included nine teachers in 1986-87. The second pilot cycle included eight teachers in 1989-90. During the first two pilot cycles, we developed a set of materials and activities with a focus on Logo learning. During 1990-91, we disseminated these materials to 90 teachers at nine sites around the USA, where school district personnel led collaborative action research groups with teachers in their own districts.

The first step in LARC's development was a National Science Foundation (NSF)-supported classroom research project, *Exploratory Research on Critical Aspects of Logo Learning: a collaborative project with teachers as observers*. We defined "critical aspects of Logo learning" as knowledge skills and understandings in problem-solving, mathematics, and computer science which are essential for effective learning of Logo and are typically not discovered by students in isolation. Learning them often requires timely intervention by teachers and supportive classroom environments. One of the outcomes of the critical aspects research was a method for supporting action research (Watt & Watt, 1988). Another was a description of critical aspects of Logo learning, fleshed out with examples of student work gathered by participating teachers (Watt & Watt, 1992.

LARC development continued with a second NSF-funded project, beginning in 1989. During the 1989-90 school year we worked with a group of teacher researchers (representing grades four through eight) from Boston, Brookline, and Concord, Massachusetts. During 1990-91 the project expanded to involve nine different school districts representing all grade levels – preschool through high school. Groups of teacher researchers in Boston, Brookline and Concord, Massachusetts were led by past project participants. Six additional groups were led by experienced Logo teachers and teacher educators in Bellevue, Washington; Brattleboro, Vermont; Chapel Hill, North Carolina; Chicago, Illinois; Ladue, Missouri; and Madison, Wisconsin. All leaders attended a Leadership Institute held at Education Development Center and were supported throughout their leadership primarily through collaborative electronic discussions over telecommunications.

Assumptions of the Logo Action Research Collaborative

The work of developing LARC was informed by our basic belief that the teacher is key to improving the quality of learning for students. Generic ground rules and assumptions for the collaborative work include the following:

- Teachers are invited to participate, not mandated to take on this work, but accepting the invitation involves making a commitment to participate in the group for the entire year.

- Each teacher is respected as a capable professional who through a disciplined study, can understand and resolve subtle issues about the learning cultures in his or her own classroom.
- Teachers identify their own questions for inquiry.
- Each student of a teacher researcher is respected as a unique individual with a name, personal dignity, worth, and specific interests. A student must not be regarded as an object of study even when some aspects of his or her learning is presented to the group.
- Specific instances of a teacher's or a student's work are used as a focus for inquiry about questions of teaching and learning.
- The methodologies used encourage reflection, documentation, and description rather than arguments and discussion. Some of these processes have rules and formats which create the conditions for collaborative reflection and conversation.
- Participants are invited to take on a 'research frame of mind' in relation to puzzles and dissonances in their practices.
- Findings are shared and may be used to inform and change any group member's practice; larger dissemination is not required, but may be facilitated.
- Some writing is required as a way to share thinking and knowledge, including a final summary report concluding the year-long action research cycle.
- Collaboration persists over the course of one year and may extend for many years. This is not speedy work; it is challenging and often painstakingly slow work.
- Teachers develop collegial relationships with each other, rather than taking on roles as students or subordinates. This is true even when the group is facilitated by a traditional authority figure, for example, a university researcher or school administrator.
- Research is demystified; qualitative studies are designed and carried out by the participants in response to their own formulations of problems.
- Teachers engaging in their own professional inquiry are better able to facilitate their students in inquiry learning. The practices of the group facilitator should represent the best available pedagogy as well as appropriate research methods, and teachers may want to incorporate this pedagogy into their own teaching practices.
- Calls for national reform of education, including *The NCTM Curriculum and Evaluation Standards for School Mathematics* (National Council of Teachers of Mathematics, 1989), *The NCTM Professional Standards for Teaching Mathematics* (National Council of Teachers of Mathematics, 1991), *Science for All Americans* (American Association for the Advancement of Science, 1989) and *The NSTA Scope and Sequence Initiatives*, ask teachers to pay greater attention to the learning styles and knowledge of individual students. Reflective teaching and research

practices are one way for teachers to develop this more professionally demanding approach to teaching.

The LARC network was established for the benefit of teachers conducting their own research projects. In addition the participating teachers served as co-researchers with the project directors to develop materials, approaches, and methodologies for dissemination to other sites for use by local leaders of action research collaboratives. While some of the materials and methods have a Logo focus, many are generic, and we anticipate that all are easily adaptable to other domains of learning.

Three Phases for Facilitating a Year-long Teacher Research Cycle

The methods developed in the course of the LARC project for supporting action research established a one-year cycle of 14 after-school meetings with three overlapping phases. The first phase, Observation and Research Practice (roughly four sessions) is devoted to developing and practicing common ways of seeing and speaking. During the second phase, Question Formulation and Data Gathering (about six sessions), teachers formulate their problems and design their research plans. The third phase, Data Analysis, Reporting, and Presenting (approximately four sessions), focuses on synthesis through data analysis, report writing, and the sharing of findings.

Each phase has its own methods, processes, and structures to support the work. The facilitating leader of each research collaborative determines which are used and how they are adapted to the particular group's work. Some examples of these facilitating structures follow.

Support Structures for the Observation and Research Practice Phase

We learned that a fruitful way to get started is to ask each teacher to choose two students to follow with regular documentation and data collection. This documentation may include portfolios of Logo programming projects, augmented by students' notes, sketches, and journal entries, as well as teacher's notes and observations of working sessions. Teachers are asked to choose one student because of their own particular interest in or curiosity about that student. The second student is chosen to represent contrasting qualities or characteristics. For example, if the first student is female, the second should be male. If the first is a reluctant student, the second might be chosen for eagerness. If the first loves Logo programming, the second might be chosen for resistance. The choice and reasons are the teacher's.

There are a number of reasons for having participants engage in this activity. Such observation allows participants to begin doing research in a small, non-threatening way. As the observations proceed, teachers begin to raise research issues such as confidentiality, participant observations, who

owns the data, and how the data are organized. Teachers learn to base their observations on specific data, rather than on generalizations. The data become a focus for group deliberation and development of a common language, before the design of formal research projects. Discrepancies between teaching and student learning confront teachers early and may provide a focus for their problem formulation and research design. The process allows trust to develop among group members as they confront real issues and dissonances.

Another structure used during the first phase is a collaborative learning challenge: a difficult Logo programming problem which thrusts participants into the role of learners. Teachers are asked to create a collaborative 'Logo quilt' made up of several squares, each of which has its own design. We intentionally interrupt the programming after an hour's work so that participants can share what they have accomplished up to that point and reflect on their own learning. This discussion begins an ongoing process of identifying some of the key components of the knowledge and process involved in Logo programming. Participants brainstorm lists of the actual knowledge used in constructing their programs. Knowledge is listed under headings such as problem-solving strategies, mathematics, computer science, aesthetics and cooperative learning stratgeies. Next steps include looking at the knowledge that was not used, but which might have been useful. By participating in such discussions, teachers review their knowledge of Logo; learn new mathematical content, programming skills, and problem-solving strategies from each other; and start developing a common language for describing Logo learning. At the end of the session, we introduce the list of critical aspects of Logo, which was developed in our first pilot (Watt & Watt, 1992). Participants are invited to use the list and modify it throughout the rest of the project.

Other structures for supporting collaborative inquiry during the Observation and Research phase include:

- group reflections on key words such as 'research', 'action', and 'Logo';
- pairs of participants programming a symbol representing Logo's meaning;
- peer sharing and editing of written descriptions of teaching contexts; and
- participation in a process called 'What Knowledge is Kathy Using?' for assessing examples of student work (see description below).

Support Structures for the Question Formulating and Data Gathering Phase

During the Question Formulating and Data Gathering phase, teachers find, define, and refine their own research questions and identify ways to gather data that will work with their teaching approaches. They then begin to gather data and attempt to make sense of them through preliminary data analyses. Support for this work requires skillful listening and facilitation by group leaders. During this phase there are many tentative starts, some of

which may turn into more focused studies; others may change entirely before a research focus is fixed upon. Such shifts in focus are appropriate for this phase of the process. We recommend that teacher researchers search for an issue or concern that is compelling enough to them personally to justify the many hours they will spend studying it.

The agendas for meetings during phase two are responsive to the specific work of the participants. The structures used during this phase support teachers is group inquiry and analysis of the specific data they are gathering, yet are open-ended enough to allow new questions to arise. The group leaders facilitate the efforts of all the participants to plan their research and carry out the plans. Some leaders visit teachers in their classrooms during this time. The conversations that follow a classroom visit seem to be especially fruitful in helping teachers converge on a specific research question.

A process called 'What Knowledge is Kathy Using?', introduced during phase one using samples of student work provided by the leader, is continued during phase two using data provided by participants. This formal reflective process, in which the leader or a group member serves as chair, begins with the distribution of a copy of the student's work to each group member. The chair identifies the concern of the teacher who brought the example to the group, presenting the background information in a descriptive rather than evaluative manner. One general criterion for the presentation is that the student whose work is presented and his or her parents should be able to be in the room and feel comfortable with the description.

Participants study the samples of the student's work and then offer their responses to the question, 'What knowledge did this student use?' Each contribution is written without evaluation or discussion on large sheets of newsprint posted on the walls. The process is done methodically, with time taken to clarify the wording of each description. Often headings may emerge, but an undifferentiated list permits a later sorting and may be preferable.

In the second step of this process, participants respond to the question, 'What potentially relevant or useful knowledge is this student not using at this point in his or her work?' They are encouraged to consider the way the student is working and what he or she might be trying to do. After a lengthy list is generated, a third set of questions is posed: 'If you were the teacher, what one intervention might you make? How? why?' Once again, each participant's suggestions are heard and recorded – but not evaluated.

No discussion is permitted in the course of this process (though participants may ask clarifying questions) to ensure that teachers do not shift from a descriptive research frame of mind to a defensive posture about decisions made in their practice. Prohibiting discussion also serves to ensure that the presenting teacher can provide enough information to allow the group to consider the particular issue fully, given meeting time constraints. The presenting teacher is asked to listen to the ideas offered by colleagues, but not to evaluate them or indicate whether he or she has tried

them previously. The chair or a volunteer compiles a list of all ideas offered and makes copies for all participants. It is the presenting teacher's responsibility to take the list home and make a professional decision which, if any, of the ideas will be integrated into practice. At subsequent meetings teachers often report about what has happened and bring in new examples of the student's work.

This process provides participants with a simple, straightforward way to share strategies for teaching and for assessing student learning that they have found useful. Many teachers report that this is a powerful experience for them. Supporting another teacher's effort at problem-solving forces participants to move outside their own contexts and beyond their own methods to seek solutions. They hear the teaching ideas of others, together with explanations of why and how to implement those ideas, and they are entirely responsible for deciding whether or not to adapt the ideas to their own classrooms. If some of the mathematics or Logo programming ideas are new or not understood by a participant, the group takes time to explain them after the formal process is complete.

Another process used during the Question Formulating and Data Gathering phase begins with brainstorming around the question, 'What are Data?' Participants think of as many potential data sources as possible and the leader lists them on blackboards or sheets of newsprint. Then the leader supports participants in considering the validity of each source suggested. We define data as physical evidence. For example, a conversation does not comprise data unless notes are taken, or it is recorded or transcribed. Notes on this process, which are distributed to all participants, help them to identify the data sources for their own research.

Other support structures for the Question Formulation and Data Gathering phase include a Focusing Question Process and an Action Research Planner:

The Focusing Question Process is used throughout the project to help the group work with an individual to clarify an issue, define a research question, or generate suggestions about a particular problem. The format and ground rules are similar to those used for 'What Knowledge Is Kathy Using?'

The Action Research Planner is a printed form, first used when a participant is beginning to define a research question. It lists the phases of an action research project so that participants can make their preliminary research plans and discuss them with each other and with group leaders.

Support Structures for the Data Analysis, Reporting, and Presenting Phase

The third phase of the research cycle is devoted to a thorough analysis of the data each teacher has gathered over the course of the year. During this phase, participants examine each others' data, describing what they see; look for patterns in the data; help to clarify each other's research focus; and deal with issues generated by the process of the research itself. Part of the

meeting time is spent supporting participants in identifying findings in their data and in writing reports about what they have learned.

A key support process used repeatedly during this phase is group data analysis. Once a participant has gathered a substantial amount of data, the group has a strong role to play in providing insight into the data. The data may consist of printouts of one student's programming projects gathered over a period of time; copies of many students' programs; transcripts of interviews with students; a set of teacher's notes; student's self-evaluations; videotapes; or a batch of test papers or surveys. A complete set of the data is distributed to each group member for review. Sometimes, the researcher has a clear idea of what she is looking for and is asking for confirmation: 'I think this collection of procedures shows that students are collaborating with each other. Can you help me trace some of the ideas that students might have borrowed from or taught to each other?'

At other times, a researcher may find the data confusing and ask for help finding a focus:

> *I've had my students draw up contracts for how they will resolve*
> *problems that occur when they are working together at the*
> *computer. After one round of programming projects was complete,*
> *I had the students review their contracts, answer questions about*
> *how well the contracts had worked in resolving any disputes that*
> *occurred, and make new contracts for their next round of projects.*
> *But I can't tell if their second set of contracts is any different than*
> *the first. Can you help me see whether or not the students have*
> *become more sophisticated in how they think about working*
> *together?*

In all cases, insights from the group have substantially added to a researcher's understanding of his or her own data – although, as in other processes used during the year, the final analysis of the data is the researcher's own. He or she is responsible for using or ignoring any of the insights that emerge from the group.

The writing process is the least developed aspect of our action research work. This may be partly because writing requires each participant to expose their process, findings, and writing abilities, first to other group members and then, possibly, to readers beyond the group. Perhaps turning research into teaching action is a sufficient utilization of the knowledge learned by a teacher. Or perhaps we have not yet understood the process well enough to develop appropriate scaffolding for this part of the research cycle. One intervention used by several group leaders during the 1990-91 year was to start writing and editing as part of the project start-up rather than waiting until the research is all but complete.

Two structures are used to support writing during the Data Analysis, Reporting, and Presenting phase. One structure addresses writing in progress. Participants share copies of their preliminary drafts. A set of common guidelines provided for peer editors encourages group members to

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be as supportive as possible of each other. Peer editors provide the first audience for the piece and begin by identifying the strong points in the writing, as well as any points that need clarification, documentation, or reorganization. The goal is to help participants communicate as effectively as possible about the purposes for their research, the methods that they used, and their findings. Peer editing takes place in one-on-one conferences, small group feedback sessions, or whole group author's circles. Another structure used for writing is an Action Research Report Planner which serves as a preliminary outline and guides planning for the final research reports.

Outcomes for Teachers in the Pilot Cycles

Through direct involvement in research – formulating questions, observing, documenting, gathering a variety of data, and making sense of it – teachers gained insights about the teaching and learning in their own classrooms. At the same time, they came to recognize and respect their own and their colleagues' ideas, experience, and expertise. Furthermore, from ideas shared by colleagues and/or modelled by the leaders, they acquired a greater variety of pedagogical strategies.

As teachers gained knowledge about individual students, they developed wider repertoires of ways to support the learning of particular students. They became more aware of different learning styles and cultural diversity. In the process, they discovered that Logo learning was not necessarily linear; it was frequently messier than they had expected. Thus, they developed a greater appreciation for the types of strategies need to support open-ended problem-solving and project development.

We observed that teachers who participated in the process of researching their own practice became more flexible, more effective teachers. They also became more authoritative, articulate spokespersons about what their students were learning and were more able to justify the choices they made as Logo teachers. Some experienced teachers entered the project thinking they knew everything they needed to know to teach Logo effectively – one had even taken three graduate-level Logo courses. After a year as classroom researchers, the same teachers realized that they had a lot more to learn about teaching and learning with Logo. They also had a number of strategies to continue learning and collegial support to help them do so.

Examples of Changes in Classroom Teaching
Practices due to Action Research

(1) During his first year as a Logo researcher, Donald [5] a fourth-grade teacher, followed students whose Logo work puzzled him. The research meetings gave Donald a way to reflect on his work, and the suggestions made by his colleagues helped him to find new strategies for supporting his students. The two students he followed were Kathy, a tentative learner who

did not seem to be making progress or to benefit from his instruction, and Jerry, an extremely quick learner, but resistant to receiving help from a teacher; Jerry preferred to use only his own ideas, even when he was stuck. Donald felt that both students were missing important learning opportunities. He brought examples of both students' work to the research group and asked for feedback about the issues that were puzzling him. After a session in which the group looked at one of Kathy's programs in great detail, identifying the Logo knowledge she was and was not using, Donald was able to tailor some interventions that helped Kathy make what seemed to be remarkable progress during the next few months. After a similar session focusing on Jerry's work, Donald learned to provide some input to Jerry indirectly by giving ideas to a classmate within earshot, or leaving a resource book open to a particular page – since Jerry usually resisted direct interventions but was receptive to information he overheard or found.

(2) Barbara was a computer specialist in an elementary school who taught large numbers of students in a computer lab each day. Her teaching approach stressed whole-class lessons followed by individualized problem-solving at the computer. Her students were required to remain in their seats and were not allowed to bring pencils, notebooks, or other objects into the computer lab, or to speak to other students during their working time. As part of her research, Barbara focused on a problem she had communicating with students whose first language was not English and who could not understand her instructions. One approach she used was to pair one of these students with a partner who spoke his language, but who understood more English. Because the pairing was so successful she later decided to pair all the students in one particular 'experimental class'. She also allowed students to get out of their seats during class and walk around to see what other students were doing. As a result of her research, Barbara gave herself and her students permission to work in a way that allowed students to learn from each other, rather than just from the teacher, and documented the advantages of this approach for student learning.

(3) Phyllis was also a computer specialist in an inner-city middle school who taught large numbers of students each day. She was concerned about students in a large sixth-grade class who did not seem to be learning effectively, who seemed to need her attention constantly, and who engaged in disruptive or non-productive behaviour an unacceptably large proportion of the time. Initially, rather than looking for changes she could make, Phyllis explained away the situation by referring to the students' socioeconomic and family problems, to the timing of the class just after lunch hour, and to the large number of students. Phyllis decided that her research would focus on creating a supportive classroom atmosphere. In an attempt to change the culture of the class she posted technical information at several places in the classroom so that students would not have to rely on her so much. More significantly, she began to identify certain students as potential Logo helpers, and to make helping each other and learning

from each other a specific goal for her students. She explicitly legitimized the sharing of ideas among students. Her research data included interviews she conducted with students about getting and giving help, and sharing ideas with other students. The process of surveying her students' attitudes about sharing became a focus for her class. she also kept copies of students' programming projects so that she could trace the sharing of ideas from student to student. By the end of the year, Phyllis found a great deal of sharing among groups of students, as documented by their work, and she was also able to trace students' attitudes towards cooperation as revealed by their interviews. She reported that the classroom atmosphere had changed significantly with disruption and impatience for the teacher's attention replaced by a calmer atmosphere and more productive effort.

(4) Darlene wanted her fourth- and fifth-grade students to learn to use variables and recursion, but she was unsure whether they could understand the concepts involved. She kept detailed anecdotal notes about her own teaching of one fourth-grade class, recording her teaching interventions, what she said, her students' comments and questions, and the Logo examples they produced over a period of a few months. During the course of her research, Darlene came to understand that a recursive procedure call – in which a procedure calls a copy of itself as a subprocedure – is a fundamentally different concept than the simple looping she had envisioned. Therefore she needed a different metaphor to make this distinction clear to herself and her students. She read articles on the subject and adapted the ideas presented for use in her classroom. Finally, she used her detailed notes to develop a curriculum to teach all her fourth- and fifth-grade students to use variables and recursion. Subsequently, she wrote and submitted for publication an article based on her experiences.

(5) Bill team-taught science and mathematics as well as Logo to two classes of sixth graders. His investigation focused on the processes by which sixth-grade students learn to use variables. His original intention was to introduce the use of variables to his most mathematically able students. In the course of his research he developed a number of open-ended challenges to support this learning and to his surprise, found that with good challenges and appropriate support, all of his sixth graders were capable of doing the work. He subsequently integrated these new challenges into his ongoing curriculum.

(6) Gabrielle was concerned about grading and evaluation of her sixth-grade Logo students. Her action research focused on developing explicit expectations and grading criteria in consultation with her students. For each project, she developed an outline of the particular Logo skills and strategies to be used, and the value to be associated with each one. In this way she was able to develop a system of grading that made her learning expectations explicit, that allowed her to add new skills and expectations to the evaluation criteria for each new project, and that was perceived as fair by her students because they had helped her create it.

(7) Paul recognized that one of the powerful problem-solving tools built into Logo is the use of subprocedures to break a difficult problem into separate, clearly defined, and more manageable parts. He was concerned that his sixth-grade students were not using subprocedures effectively, and instead were writing long, undifferentiated programs which were difficult to read and debug. Furthermore, once they had completed a project to their own satisfaction, they were reluctant to edit their procedures to make them conceptually clear. As part of his research, Paul tried an alternate approach. Instead of asking his students to create their own designs from scratch, he gave them copies of another student's program, which was incomplete and difficult to understand. He challenged them to edit the procedure to make it more readable and to complete the project. In the context of his challenge, Paul found that his students were able to use subprocedures and focus on some of the ideas that Logo was designed to help students learn.

These examples indicate some of the ways that participants in the LARC used the action research process to identify needs in their own classroom practices, bring those needs to the group for collaborative support, make changes in their teaching, and document the effects of those changes.

Concluding Comments

Many teachers have described the sense of personal renewal they have gained through participation in LARC. For example, Paula Upshaw, a LARC teacher researcher, wrote in her project summary,

> *The LARC project has been beneficial to me in that it has provided*
> *an exiting and invigorating atmosphere for a fresh look at my*
> *teaching skills and interests. I have been forced to look at my own*
> *methods as well as having been made aware of the variation in*
> *learning that occurs among children. I have had to test my*
> *theories in a systematic way. This was clearly the best year I*
> *have had teaching Logo. (1991, p. 15)*

However, the ramifications of the LARC project extended beyond the participants' own classrooms. Six teachers who participated in the initial research group took on leadership roles for the 1990-91 cycle. Several worked on revising their districts' Logo curricula to include more important content and processes. Several designed and led workshops for district teachers. Three teachers published articles in the newsletter of the Boston computer Society's Special Interest Group on Education. Two others submitted work to national professional journals, *The Computing Teacher* and *The Logo Exchange*. Several teachers appeared on 1991 programs at the Lesley College Conference on Computers in Education, the New England Association of Teacher Educators, and the National Educational Computing Conference. These represent professional contributions that extend beyond

what is traditionally considered part of a teacher's role. Many similar examples are available from the nine dissemination sites.

These examples of teacher professional development, though hopeful and worthwhile in their own right, may seem small in the face of the large challenges currently facing education. However, action research by teachers is also one avenue, largely unknown and unexplored, for approaching the broader challenges of school reform and professional empowerment of teachers. We now have ample evidence that action research by teachers creates grounded knowledge and understanding which can provide the impetus for improved teaching and learning in classrooms. It is well suited to schools because of its democratic methodology, respect for individuals, inclusiveness, openness to diversity of perspective, and inexpensiveness to fund. The results of research conducted by the teachers responsible for implementing the changes achieve a real fit between the needs of the learning community and the action taken.

Although action research is beginning to be recognized at the policy level as a tool for change, it cannot be mandated, only facilitated. The teacher researchers must be volunteers and care deeply about the importance of their study to inform their decision-making about their own teaching. Although there have always been a few teachers who have individually undertaken study of their own practices, most teachers remain unaware of this form of professional inquiry. If action research is to involve more teachers and have an impact on broader reform efforts, opportunity, support, and facilitation are necessary in the school and school district. This paper has described enabling conditions and processes that teachers themselves can use in establishing collaborative action research groups and represents a small start at disseminating how to implement this form of professional inquiry.

The potential contexts for action research are many – virtually any aspects of education which can be improved if teachers take the opportunity to deepen their understandings about the teaching and learning in their own classrooms. Many of the currently proposed educational reforms provide fertile ground for action research projects. The issues involved in implementing reform initiatives such as the *Curriculum and Evaluation Standards for School Mathematics* (NCTM, 1989), the *Professional Standards for Teaching Mathematics* (NCTM, 1991), *Project 2061* (AAAS, 1989), the whole language approach to language arts; embracing cultural diversity; integrating technology into the curriculum; and achieving school-based management have much in common with the issues faced by Logo teachers. Action research can be used as part of curriculum development, as a way to develop new forms of ongoing assessment, and to support adoption of new teaching practices. Indeed, the current wave of support for school restructuring requires a key role for teachers as decision-makers. Action research has a central role to play in helping school communities inform their decision-making through practical investigations and formative research undertaken by teachers. The methods

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for incorporating action research into such efforts will require development and articulation.

Whatever its potential for achieving broader impact, the professional energy and insights gained by teachers who undertake action research underline its potential for deep and lasting impact on those who practice it. That effect is attested to by LARC researchers Cathie Field and Judy Bachman (1991):

> *One of the most important outcomes of this study was the impact that it had on the teachers. It made us more aware of how we teach and interact with students, not only with Logo, but in all areas. We have always known that taking the time to observe and reflect is a valid and productive use of teacher time. Yet this really became obvious to us during this study. Because of this process, we find we now approach these same tasks differently. In the past years, teaching Logo was very systematic. We gave out projects, and evaluated the products. Now we know that observing the process more carefully will give us more valuable information about the learners. At one time, we felt that this was 'one more thing to do' and too time consuming. In the future, we will use these methods as part of our classroom record-keeping. (p. 12)*

Acknowledgements

The development of the specific methodologies used in the LARC project were sparked by involvement in a number of teacher research projects over the past 20 years. We wish to acknowledge specifically several that preceded this project and that have deeply informed out work.

Bill and Sara Hull of Cambridge, Massachusetts, developed the Children's Thinking Seminars (Hull, 1979) in the early 1970s, and invited outstanding teachers from the Boston area to attend regular seminar meetings. The seminars' agenda was to ask teachers to describe specific instances of children's thinking. Participants were expected to – and often did – write descriptions that were shared among the group. The group collaborated through conversation, written 'Notes and Commentary', and

later through the Children's Thinking Network Newsletter in moving ever deeper into the description of learning and the discrepancies between what was taught and learned (M. Watt, 1979). Participants experienced the seminars as professionally nourishing and some teachers maintained their participation over several years.

Patricia Carini of the Prospect Center in North Bennington, Vermont, developed methodologies to support teachers in collaborating on phenomenological research. For example, she and her colleagues developed and shared structured ways to reflect on the meaning of the word or an example of a child's work. One research format called *Staff Review of the Child* focused the teacher's inquiry on illuminating the whole person by looking for motifs and themes used in writing, art, or play. Another format supported a group in looking at a whole teaching practice in response to the presenting teacher's description of the context and focusing question. These methodologies provided formal structures which allowed participants to move from evaluation to reflective understanding (Carini, 1975, 1979, 1982).

Ralph Mosher of Boston University led a group of teacher researchers in the Brookline Public Schools in Brookline, Massachusetts, in defining, evolving, and documenting their own democratic classroom practices. Teachers collaborated in developing documentation methodologies which were as natural and as unobtrusive as possible while permitting them to fulfill their primary responsibilities as teachers. They shared all aspects of carrying out research projects over the course of a year and wrote research reports for inclusion in the book *Democratic Classrooms* (Lickona et al, 1979; Lickona, 1993; M. Watt, 1993).

Jeanne Bamberger, Eleanor Duckworth, and Magdalene Lampert, of the Division for Study and Research in Education at MIT, conducted An Experiment in Teacher Development (Bamberger et al, 1981). Their project provided opportunities for teachers to engage in and reflect on challenging learning experiences at their own levels. Participants subsequently documented and reflect on the learning of their students when faced with similar challenges.

During the 1970s Daniel Lynn Watt was a member of the MIT Logo Group, a hothouse environment nourishing some of the seedlings which were to grow into the computer literacy and computer education initiatives of the 1980s. Under the leadership of MIT Professor Seymour Papert, the MIT Logo Group developed a sophisticated, yet accessible, computer learning environment which laid the foundations for widespread use of Logo in classrooms and for its continuing growth. The development of the technology and learning activities went hand in hand with a detailed, ongoing formative evaluation and assessment of student learning. Qualitative analytical methods used by the MIT Logo Group provided starting points for developing the assessment techniques used by LARC teacher researchers to understand what their students were learning.

Molly Lynn Watt's position on the faculty of the Educational Foundations Masters Program for experienced, practicing teachers at

Antioch/New England Graduate School of Education in Keene, New Hampshire, provided another point of reference and comparison to the work of the LARC project. Co-chairpersons Heidi Watts and David Sobel have developed a program which encourages participants to undertake year-long action research master's projects. The expectation is that teachers will examine and improve their teaching practices in the light of current educational theories. They take on the discipline of reflective practice by keeping a journal to document their own process of integrating theory into new practices.

Our deepest collaboration and appreciation goes to our co-researchers, the more than one hundred participants and their leaders in the Logo Action Research Collaborative who labored with us in creating processes and resources while conducting their own studies. They took on many new roles, learned new skills, and participated in formative research at many levels with an integrity, good humor, and commitment to completion that exceeded our expectations. Especially remarkable has been the work by each of the leaders, undertaken according to their own leadership styles with warmth, intelligence, and collaborative support across the miles through phone lines, mail and electronic mail: Sheila Cory, Chris Held, Bob Kondel, Peter Lavelle, Jack McKiernan, Jim MacNeil, Judith Randolph, Marian Rosen, Donna Rosenberg, Phyllis Victorson, and Nan Youngerman.

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Notes

[1] Some of the content of this paper was originally presented at the Annual Meeting of the American Educational Research Association in April 1991 (Watt & Watt, 1991).

[2] The Ford Teaching Project, supported by the Ford Foundation, was initiated in 1973 to address the concerns of curriculum reformers that reform had failed at the level of classroom implementation.

[3] The Logo Action Research Collaborative, funded by the National Science Foundation since 1986, is described in detail below in the section 'The History of the Logo Action Research Collaborative'.

[4] A constructivist view of learning holds that learners actively construct their own knowledge when they engage in experiences which allow them to build on prior knowledge, confront discrepancies between that knowledge and their experiences, and reformulate their understandings to account for new circumstances.

[5] The names of teachers and students have been changed.

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Appendix A: Evaluation Methodologies

Evaluation of the 1989-90 Action Research Cycle

Formative evaluation of the project during the 1989-90 cycle focused primarily on documenting the professional development of the teachers who participated, and assessing the effectiveness of the particular strategies used to support the teaches' action research. An external evaluation carried out by the Regional Laboratory for the Northeast and the Islands included pre–post interviews with teachers and administration of a pre–post Stages of Concern questionnaire. Data gathered by project staff included videotapes or audiotapes of each research meeting; session-by-session evaluation forms completed by participants; leaders' notes; participants' notes, journals, planning documents; data gathered by teachers; and research reports written by teachers.

An interim formative evaluation report on the 1989-90 action research cycle, written by the team of external evaluators from the Regional Laboratory for the Northeast and the Islands, focused on the professional development of LARC participants (Drexler & Loucks-Horsley, 1990). The report focused on four major goals for project participants:

- development of skills and understandings associated with classroom action research and use of that research to inform teaching;
- development of strategies for reflection on teaching practices;
- development of collegial relationships with other participants; and
- contribution to the knowledge of other educators through written reports, presentations, and workshops.

The report concluded that participants had developed skills and understandings associated with classroom action research and, as a result, were looking more closely at how their students learned Logo. All reported that they had changed aspects of their teaching as a result of examining their own practices and sharing ideas with colleagues. Teachers also

reported that they had specific ideas about what they would look for during the next year to document and support their students' work. The report cited collegial sharing as one of the strongest features of the project, from the point of view of participants. As a consequence of participating, all but one participant wrote research reports for eventual publication by the project; several submitted reports of their research and other articles related to their teaching to local professional newsletters and to national professional journals. Finally, six of the eight participants who completed in 1989-90 cycle were planning to continue with the project: four of them served as group leaders or co-leaders for the 1990-91 cycle in their own districts; two continued as teacher researchers. The other two changed positions. One became a school administrator for a school which is a pilot site. The other moved to an independent school and is no longer a Logo teacher, but she has undertaken a small action research project on her own about student use of spell-checkers.

Evaluation of the 1990-91 Action Research Cycles at Nine Sites

Evaluation of the 1990-91 action research groups had a more complex set of objectives and was conducted primarily at a distance:

- We were interested in learning about the professional development of participating teachers.
- We wanted information about the support required for leaders of action research groups.
- We wanted to understand the value of the project for participating teachers, leaders, and school districts.
- We needed information about the usefulness of particular structures and methods, with recommended revisions and additions.
- We hoped to identify what it would take to make this type of activity self-sustaining.

The data we used for the evaluation included videotapes of leadership institute sessions and evaluations by leadership institute participants; background questionnaires completed by teacher participants; copies of meeting agendas, minutes, and support structures used at each site; notes of phone conversations with group leaders; teachers' research questions, plans, and written reports; questions and information shared on the telecommunications network; pre–post telephone interviews with two teachers at each site; the report of a focus group at which leaders reported on the progress, successes, and concerns at each site; and a written evaluation by each group leader.

Questions about Professional Development

In order to find out about the professional development and nourishment of participating teachers our interview questions probed for the following kinds of information:

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(1) What research questions did teachers investigate? Were they able to carry out the whole process: developing research questions, gathering and analyzing data, and writing up and sharing their research with others?

(2) How important is writing for participants, and what expectations, collaborative processes, and support from leaders are effective in facilitating writing by teachers in the project?

(3) What changes do participants make in their teaching practices or the ways in which they conceptualize their work during the course of the project? Have they incorporated any of the specific processes modeled in LARC seminar meetings into their teaching practices?

(4) Although Logo instruction to participants is not part of the project design, do participants learn more about various aspects of Logo during the project?

(5) How important is collegial support to participants? How do they share their work with colleagues in their LARC groups, in their schools and school districts, through publications, or through conference presentations?

(6) How is this form of teacher enhancement different from more conventional forms, such as faculty meetings, graduate courses, or in-service training workshops?

Questions about the Support Needed by Seminar Leaders

In order to find out about the materials and practices used by seminar leaders and the support needed by seminar leaders, our phone conversations and focus group questions dealt with issues such as the following.

(1) How effective was the leadership institute in preparing group leaders? What changes should be made for future leadership institutes?

(2) How did seminar leaders use and modify processes and materials developed by project staff and modelled during the leadership institute? What types of materials were developed or adapted by seminar leaders to supplement project materials?

(3) What support was useful to group leaders themselves? How important is communication among sites and between sites and project staff? In particular, what are the relative values of telephone, mail, and electronic conferencing?

(4) What types of support and acknowledgement do groups and leaders receive from local school administrators, university personnel, and resource people at different times during the year?

Appendix B: Logo Research

When Logo was introduced into schools in the early 1980s as a vehicle for learning with and about computers, its widespread application was followed by controversy and many unanswered questions (Moursund, 1983; Tetenbaum & Mulkeen, 1984). A variety of studies have attempted to measure what students gain from learning Logo, with mixed results

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(Clements, 1985). A Bank Street College of Education study attempted to determine whether students who worked with Logo would demonstrate improvement in problem-solving skills. The general conclusion drawn was that learning experiences with Logo, in and of themselves, did not lead to evidence of transfer to non-Logo activities (see, for example, Pea, 1983; Pea & Kurland, 1984; Pea et al, 1987).

Clements (1985), assessing the results of 40 early Logo studies, asserted that the results, although not conclusive, indicated that "Logo does appear to offer significant educational advantages". A limitation of some of the studies Clements reviewed was that they included very little description of what students actually did in their Logo activities, did not document students' learning based on what they accomplished in the classroom, and ignored or downplayed the importance of the teachers' own Logo knowledge and the content and pedagogy used in teaching. There seemed to be an unspoken assumption among researchers conducting many experimental or quasi-experimental studies that Logo was some kind of 'treatment' for which effects could be measured.

Other Logo research has included more descriptive studies which tend to involve small numbers of students and give more background about the learning context, the specific teaching objectives, and the methods used in particular settings. These studies tend to focus on students' learning in some detail, and while they show that Logo-using students do engage in mathematical problem-solving behaviors, they also reveal specific difficulties students experience in using Logo effectively (Papert et al, 1979; D. Watt, 1979a; Leron 1983, 1985; Hillel, 1984; Hillel & Samurcay, 1985; Hoyles, 1985; Kull, 1985; Noss, 1985; M. Watt, 1986; Weir, 1987). A number of Logo studies have also focused on specific teaching strategies and interventions (Kinzer et al, 1985; Klahr & Carver, 1987).

A number of observers have commented on the importance of the Logo teacher's role (Leron, 1983, 1985; Moursund, 1983; Watt & Watt, 1986). It is disturbing to note, however, that only a handful of research papers have focused directly on teachers' roles in supporting Logo learning (Burnett & Higginson, 1984; Hawkins, 1985; Carmichael et al, 1986; Stavely et al, 1986; Watt et al, 1986).