
THE LEARNING NETWORKS OF ISOLATED TEACHERS: THE USE OF AUDIOGRAPHICS COMMUNICATION TECHNOLOGY TO BUILD A VIRTUAL MATHEMATICS DEPARTMENT

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Four teachers of secondary school mathematics in small rural schools, an adviser and a participant researcher are using Farsite audiographic equipment to develop a learning network. A description of the patterns of interaction within the project leads to a discussion of issues for future planning within this project and more general principles for developing later networks. We identify some skills for networking in the cyber-age, and discuss some advantages of audio-graphic networks over face-to-face contact.

Teachers who work in schools where there is only one teacher of senior mathematics are isolated from discussions about the teaching and learning of mathematics. This project is designed to offer these teachers the opportunity to share ideas with other, similar teachers on a regular basis through after school meetings using communication technologies that already exist in their schools.

The schools involved all have audiographic equipment that allows a teacher in one school to teach groups of students in other locations. This equipment has previously not been used after school hours for teachers' meetings, nor do teachers of mathematics normally use the equipment for teaching between schools. We are investigating the potential of this equipment as a tool for teacher communications and professional development related to teaching secondary school mathematics.

Liz Burge uses the metaphor of a weaving loom (in preference to an information highway which has connotations of isolated bits, metallic vehicles, streaming along concrete pathways) in her discussion of the use of conferencing technologies for learning (Burge, 1995). This more gentle, less hurried image suits the story we are about to tell. We are weaving together a network of teachers, we are weaving theory and practice, and we are tying together our ideas with those of our colleagues. For these reasons we are weaving the metaphor through this paper. Firstly we summarise briefly those things that were set in place before the weaving began: the loom is taken to be the institutional structures in which we are working, the warp threads refer to our methodology and pedagogy, and the tools link us to a discussion of the parameters under which we are working¹. Secondly, we describe the sessions, the weaving that is occurring and the patterns that are emerging. Finally, we consider some trends and issues for the design of future patterns.

THE LOOM: BACKGROUND CONSIDERATIONS

The institutions This project links five institutions, four schools and a college of education, each of which is affected by massive changes in education. Teachers are aware that their work is substantially different from that of their city counterparts and are interested in the work of their colleagues in other isolated schools. At the College, advisers and lecturers are aware of pressures to offer courses in ways that do not disadvantage isolated learners. Teachers and policy makers in all our institutions are watching this project with interest. Each institution is supporting the development. We are all keen that it should work. Does this feature mean that it is doomed to succeed?

The people The four teachers involved in the project all responded to an invitation from Kevin, the Mathematics Adviser, to become part of a network. This network was not designed with a specific content planned for the curriculum, and there is no qualification to be gained by being part of this network. Instead it is designed to enable teachers to

discuss those issues that interest them, in the company of an adviser who could be expected to provide some leadership and support. Teachers indicated their areas of interest before the first session began. We aim to achieve good principles of adult and distance education such as those described by Boyd (1993):

"Good distance education is ... particularly concerned with linking the teaching-learning experiences of people with complementary educative interests and capabilities who are geographically separated. ...

"... the heart of the matter ... is that responsible creative free-willed selves are struggling to reach one another, in order to help, despite constraints ..." (P237)

All the participants knew Kevin and Elaine prior to enrolling and two of them were part of an earlier project that was run when Elaine was a mathematics adviser (Mayo, 1996). The teachers knew in advance that we were aiming to develop a democratic, non-hierarchical network. The teachers have a vested interest in making the project work, but they indicated that they would continue to be involved only if they felt it was helpful to their teaching and to their use the technology.

The research In the current study Elaine takes the role of participant researcher using an emancipatory methodology²: she is not trying to be an objective observer. Above all this is a study about making changes that are people friendly. It supports the use of what Liz Burge describes as synomorphic communication technologies (devices that "give to" rather than "take from" the humanity of the communication) (Burge, 1995, p.154). Our work is informed by the Senge's concept of a learning organisation (Senge, 1992) and by the invitations such as that of Tony Bates (Bates, 1995) to work toward a vision for how things might be in open and distance learning.

The technologies Farsite audiographic software allows us all to link using an audio conference call, and at the same time to share a communal computer screen. We can all hear each other and we are all able to see and write on a virtual, shared whiteboard. We are unable to see each other. We are not yet using the Internet, except to refer to for resources. Between the sessions we use a variety of other technologies. Telephone, fax and post have been used to share information and materials. An e-mail link was established after the third session. In addition Kevin or Elaine visited each teacher in the first two months of the project, and Kevin has met all the teachers at other regionally organised events. A conference call without the shared whiteboard was used at the end of 1998 to evaluate progress. Despite these other connections the audiographic link remains the dominant tool of the network.

The meetings Prior to the sessions Kevin and Elaine tried to overcome potential technical problems by learning about Farsite and the bridging technology. In planning the sessions we considered protocols for communication. Essentially Kevin was to coordinate the sessions with Elaine offering contributions when they seemed necessary or appropriate. All participants are aware of the high costs of networking, both in terms of money and time. We planned to meet initially for three sessions, each of 45 minutes, spread out over seven weeks, two further sessions were later added to the 1998 package. In 1999 sessions are longer: 90 minutes each and we aim for two per term.

The network The project was promoted as being network for professional development using communications technologies. We also made it clear to teachers that we were all learners together and did not have a great deal of experience in the use of the medium. Teachers have agreed to be part of a research study. We are not a network of equals because our interests and responsibilities are different. In what ways, we wonder, are we like a virtual mathematics department?

THE WEAVING

The fabric grows as the weavers weave their threads. Our threads are the experiences and activities we each bring to each session; our tools are the audiographic system and the other communications technologies we use; the cloth that emerges is our network.

The Weaving - Kevin's Story of the Three Sessions

Getting started "During 1997 I spoke with several teachers who were enthusiastic about the possibility of running audiographic sessions for the purpose of professional development in mathematics. Elaine set up a network during 1996 and was supportive of another attempt at it.. I met with Elaine on several occasions, and spent hours familiarising myself with the software. I also sat in on a couple of sessions observing a group of year 11 students being taught agriculture using the equipment."

The format for sessions "Schools were invited to become part of a network. No experience with the equipment was expected. A suggested format for the sessions was proposed:

- short introductory activity while establishing link with participants
- main activity on previously agreed theme
- open forum for issues of the day
- something to use in tomorrow's teaching
- closure and preview of the next meeting.

Four teachers responded positively and topics were set for the three sessions. All that remained was to organise the bookings. We ended up with three 45 minute sessions during August and September. These worked out well enough for us to book a further two sessions in October and November."

Session One - Introductions. "Three of the four schools participated in the first session. For much of the session only an audio-link was operating. During this time we discussed the format of the next session and clarified the meaning of "novel approaches to class work". Once the graphic link was established there was a feeling of relief (at least on my part!) and the interactive nature of the activity on the screen appealed to the participating teachers. Somewhat ambitiously we set a task for each teacher to make a slide of a simple type-able puzzle to share in the next session."

Session Two - Novel Approaches to Class Work "All four schools participated in the audio link and three of them were also able to participate in the graphic link. The introduction was the same activity as had been used briefly in the previous session. Having something interactive on the screen while everyone joined the conference worked well. A framework for the main discussion had been faxed to members before the session: this acted as a good catalyst. We set ourselves the task of talking through any approaches we have used or seen that: make the teaching more student centred; gave the students more control and responsibility for their own learning; assisted in maintenance and retention in an interesting way; and addressed the issue of motivating students. One teacher revealed as system of portfolios he was using. This aroused interest and it was agreed to make it the focus of the next session. Teachers also wanted to share the slides they had prepared, but time had run out: the agenda of the next session was determined by the progress of this one."

Session Three - Slides and Portfolios "Everybody got linked up - for the first time! Additionally, Elaine was on an audio link from another province. The planned agenda was for everyone to: present their slide; share some information about themselves and their school; discuss portfolios; begin a problem solving activity. We didn't get beyond the sharing of slides. Two of the four teachers succeeded in sharing workbooks thereby

managing a part of the session themselves. They were ecstatic, all four of them, even those who had not succeeded themselves. It was agreed that we would continue the project through the fourth term. Things had just started to happen."

Session Four - Absences "I didn't make it to this session so my knowledge is second hand. The intention was that I would out at one of the remote sites in South Westland while Elaine would be in North Canterbury with another participant. Unfortunately I got stranded by floods and didn't make it to the session. I talked to the teacher from South Westland the next day and was told that all had gone very well without me. The agenda was a continuation of the previous session and managed to get to the point of this teachers sharing a portfolio of work on measurement. Elaine had a copy of the screens with her in North Canterbury, and I understand she simply "did a Kevin" in facilitating the session."

Sessions Five - A Number Portfolio "The focus for this session was the sharing of resources suitable for a portfolio on number. Prior to the session participants had used a variety of technologies to send material to the rest of the group. They used conventional mail, faxes and e-mails with attachments. They then talked about the activities during the session, relying on the fact that everyone had a hard copy. None of the teachers chose to display their tasks on screen during the session. I provided a series of slides on screen to encourage discussion of issue such as: what is a portfolio, why use a portfolio, contents of a portfolio, and using portfolios to encourage mathematical understanding. By the end of the session, which was the last for the year, there was general consensus that there was more than enough material for teachers to use as a unit of work at the start of the following year. We finished with an expectation that the sessions would continue next year."

Pluses and Minuses "I wasn't particularly looking forward to the second session. Given the technical glitches that had happened in the first session it was worse than going to the dentist. I was at the mercy of the technical equipment. If things fell over, I didn't know when or where it would happen, and I wasn't sure if I could react in such a way as to make the conference be seen as a worth while experience. It was a little like teaching for the first time all over again. Strategies had not developed to redeem the irredeemable. A lot of this was in the head rather than apparent. Teaching is like that too.

"The technical hitches that have occurred in the sessions have provided a good learning opportunity for the whole group and have to an extent worked to our advantage. It has become clear to all the teachers that there is no single technical expert in the group and all can help. This was emphasised by my absence in the fourth session. That message is filtering in a subtle way into the exchanges on mathematics teaching. An atmosphere has been developed in attempting to master the technology that has a spin off for the culture of the group that is forming. This is becoming a group of teachers helping themselves, not just technically but mathematically as well. I may be the hub of the wheel but I am not the source of all knowledge.

"A shift of control occurs as the sessions move on. Initially I set a structure and proposed an agenda, and this is always the backstop position for the sessions, but the rate and direction of development is increasingly determined by the participants. By the third session control of the medium had significantly shifted to the teachers as they took us through their slides as they gained confidence and competence with the technology so they woke up to the possibilities of the technology. More and more they are creating their own unique micro-world of professional development."

The Weaving - Elaine's Comments about the Network

Background "As a participant researcher I am clear that "supporting" includes helping in any way, including running for help in times of technological crisis, and discussing ideas

from literature and experience,. At the same time I am trying to record the process and document the progress of the network. Rarely do I talk to Kevin or any of the group without a tape recorder running. Our discussions form part of my data."

Planning sessions "The planning sessions with Kevin are valuable for teasing out ideas about how to use this project for the benefit of all participants, with the concerns of the teachers as the key issue, the development of a successful network as second, and my research as third in priority.

"We plan the audiographic sessions and the other necessary detail of the project, but the meetings also provide a venue to discuss common issues: discussions about teaching strategies and mathematical activities for the classroom are commonly raised by Kevin; I commonly introduce issues related to networking and maintaining the cohesion of the group. We philosophise too."

The audiographic sessions "There are four dominant strands of conversation running through the sessions. Initially most of the talk time was related to technology and team building, with less on mathematics and teaching. We have spent a lot of time supporting each other in using the technology and trying to help each other solve the individual problems we are having about getting it to work. The strategy has been to maintain a cheerful, philosophical approach to problems where several of us offer suggestions. Because of the supportive tone of these conversations they contribute to second strand: teambuilding. The third session included more spontaneous laughter than earlier sessions, and that laughter was linked to our glee at successes in solving technical problems. We all managed to get hooked on to the system at one time! The third strand of conversation relates to the mathematical activities that the teachers have developed to share. Except for the problems suitable for classroom that Kevin has used, mainly as discussion starters in each session, there has been little focus on mathematics content. Any mathematical discussion quickly moves on to talk about teaching strategies, ways of dealing with the very mixed classes that arise in small schools, ways of organising students to work independently, and issues related to assessment and the recording of assessment judgements."

Discussions "The discussions on assessment are leading toward a different form of dialogue. As the teachers clarify what they are trying to do and why there are differences arising. Some teachers are seeking to record very detailed information about student progress, others tend to be much more holistic and to focus on processes rather than content. Questions arise about our assumptions, and the dialogue becomes more reflective. We are all sharing resources that relate to our current discussions, commonly classroom materials are shared by teachers and articles or references to curriculum guides and documentation from Kevin and Elaine. In this way the discussion is informed by both theory and practice."

The Weaving: Elaine and Kevin Report on the Responses of One Teacher

Our assumptions about the value of the project have been confirmed by the comments made by teachers. For example one teacher emphasised the value of the networking and hinted at the satisfaction that comes with getting the system to work. She liked "Talking to other teachers with similar sorts of class structure and problems. Getting some new resources. Getting the system to work!" She also commented that "It's a great way of getting in touch with other people. [It d]oesn't feel so lonely - even though I have been to courses in Nelson and I know quite a few of the maths teachers in the area in some ways I feel a bit left out as I have some different sorts of problems than they do." These sentiments were echoed at the end of the year when we evaluated progress in an audio-conference. Teachers had suggestions about the ways of making the learning about the technology easier, and the whole tenor of the conversation was very positive.

OUR NEXT WEAVING: 1999 DEVELOPMENTS

The fabric that is evolving from the process is our network has four patterns emerging: the links within the network, the development of dynamics within the group, the evolving protocols, and the links between theory and experience. We will continue to weave these patterns.

Growth in the Links Within the Network

Despite the fact that group members have not yet met face to face there are strong connections emerging among the members. Two of them spent time together at a Heads of Department meeting late in 1998, the other two are meeting early in 1999 at an Area School's sports meeting. Kevin will also attend that meeting, and other teachers from schools and other curriculum areas plan to look in on the audio-graphic conference that coincides with the meeting. During 1998 we included some sharing of information about ourselves and our schools in the conferences, but this was less than we had hoped.

The teachers are keen to continue the project into a second year. "We are just getting into it" said one teacher. Another said "We couldn't not continue - we're developing all these great skills".

An attempt to use e-mail as an additional tool for networking has generated very little activity. For the two teachers who do not have easy access this is yet another technological and organisational hurdle to overcome. We used it sparingly during 1998 and will continue to monitor the possibilities for easy access by the teachers.

We used a digital camera to photograph teachers in their schools and tried to transmit these pictures during a session. The files proved to be too big to be transmitted efficiently within the audio-graphic system, and the graphic capability of the system did not allow detail to emerge. Experiments like this (experiments that are technically failures) have allowed us to share some information about each other and have strengthened our bonds within the group. A development for 1999 could be to establish a web page where we can post graphic items.

Development of Dynamics Within the Group

Strands that contribute to cohesiveness of the group in the first few sessions include:

- we are all learners together
- we can all contribute our suggestions
- supportiveness of those with a problem - people come first
- recognition that our preparation for new activities is now different from earlier times-no longer do we become expert before we become involved. We learn by making mistakes. This could be a fundamental skill of the cyber-age.
- laughter that results from sharing the glee of a colleague who has beaten a technical problem
- individual contact by Kevin and/or Elaine with the teachers - listening to their interests and opinions and adjusting the sessions accordingly
- reassurances that we are all facing problems
- trust that Kevin will move the discussion along, and that Elaine will watch for the things that may have been missed. Should we, and how can we, move these responsibilities on to the group? How will the dynamics change as the group evolves?

Growth in the Protocols

Kevin talks about the shift of control to the teachers. They are now leading some sections of the sessions. We wonder whether and how this shift of control can evolve. This is a culture that uses visual and auditory cues, but has no body language. There are times when silences seem unnatural, we are learning to use our voices to show we are concentrating. At other times the silences seem natural. Where Kevin uses the audio-graphic screen to note significant observations, or points not to be missed in later conversations there is a silence that goes unnoticed, until Elaine transcribes the tape. Our next step is to see how we can use the screen more interactively within our discussions.

Will the teachers begin to take even more control? Under what conditions? As the project moves forward the more long term protocols will emerge: projects such as this do not normally last beyond a school year.

Links between Theory and Experience.

Theory, reflection, experience, and our developing understanding all interact to allow the group to use this medium more and more effectively. Mayo and Hannah (1998) distinguish between literature that offers suggestions for distance educators and other more systemic literature that provides more theoretical models. During 1999, now that we have a collegial network in place and we are not so concerned about the nature of the technology, we are conscious of the ways in which the discussions allow us to compare and contrast our different views on the teaching learning process.

The metaphor of a building a virtual mathematics department provides us with a tool for discussing our roles and responsibilities. It could allow us to find novel ways to share resources, planning, tasks, and ideas. It implies stability, for mathematics departments normally have similar staffing from year to year. It might allow us to share ideas or theories, both formal (published) and intuitive (experiential) theories about leadership, and what constitutes good professional development, and about what good teaching is.

PATTERNS FOR THE FUTURE

We have come to believe that an element of risk taking is a pre-requisite to taking part. All of us are prepared to be seen to make mistakes, and by acknowledging this we may make it easier for others to gamble. A sense of collegialship reduces the sense of risk taking, and we believe the fact that the teachers each knew our style before they enrolled is not a coincidence. This relationship is designed to operate for more than one year so that we can capitalise on the benefits of our past experiences. We see continuity as having a part to play in enabling teachers to become more deeply involved in discussions of issues surrounding their work. This has implications for the planning of teacher professional development opportunities. While knowledge and technical expertise are important, the human factors are far more important. Without these a network would not be established.

The use of metaphor is helping our process. The weaving, networking metaphor can be used to foster a collaborative community who work together to adapt the technology to support their needs. Adapt the technology to the people, not visa versa. Enjoy the tool, laugh at its frustrations, weave contingency plans into the fabric. The metaphor of network as a virtual mathematics department will inform our ongoing development, it will allow us to explore our future roles and to analyse the responsibilities of group members. Strategic thinking, decisive action and clear leadership at critical points has enabled the group to function effectively. We have questions about how this control can be more equitably shared, and whether it should.

There are some advantages in not having the distractions of having to comply with conventions of body language. Alternate ways of using voice and visual cues can be developed. The interplay audiographics changes the focus of attention. Participants report that it is possible to write and think more easily when not distracted by the need to the speaker by nodding or maintaining eye contact

In future projects we would retain the distance networking (it is relevant to teachers); the multiple communications aspects (each medium has its uses); the audiographics (it is fun and there is potential for things to happen differently); the team approach to development (sharing of ideas is important for professional growth); and above all, an extended time frame so that we can capitalise on our past shared experiences.

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Endnotes

¹ Refer to an earlier version of this paper (Mayo and Hannah, 1998) for a more detailed discussion of the structures under which we were operating.

² Patti Lather (Lather, 1992) distinguishes between research paradigms based on the purposes of the researcher. Research can be used in four ways: to predict (scientific, quantitative methods), to understand (descriptive, qualitative methods), to emanipate (participatory methods), and to deconstruct (post-structural techniques).