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ABSTRACT

This paper suggests the importance of considering factors outside of the classroom in accounting for the presence of inquiry, and identifies some of these factors. The conclusions are based upon a study of staff developers and teachers who took part in the Bank Street College Mathematics, Science and Technology Teacher Education project. Participants completed questionnaires designed to both evaluate the training experience and identify direct evidence of changes in teaching method. In addition, on-site evaluations, observations, and interviews were undertaken. It was found that teachers recognized and appreciated the value of the inquiry strategies during training, but that these strategies were not taken up immediately. However, observations showed that the multimedia program, "The Voyage of the Mimi," which was used by the teachers, did provide opportunities to open up lessons in a positive fashion. In addition, local constraints served to inhibit transitions to new approaches planned by teachers after their training. Finally, it was found that successful implementation was more often the result of cooperative and collective growth and development than the work of one person. It was concluded that the instructional models and measures must be designed to take into account these system-wide features. (10 references) (EW)

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System-Wide Factors in Sustaining Technology-Based Inquiry Environments

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Paper presented at the meeting of the American Educational Research Association, New Orleans, April, 1988.

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System-Wide Factors in Sustaining
Technology-Based Inquiry Environments

Laura M.W. Martin

Examining the ability of teachers to organize inquiry for students and for students to engage in "explosive" learning (Engestrom, 1987), confronts us with a problem in dialectics discussed by members of the Frankfort School, among others (see Adorno, 1967, 1968): the need to address issues of individual psychology and group psychology simultaneously. Group processes are not always additive individual ones. For instance, although we are aware of the intrinsic value of a skilled teacher, individual aptitudes or skills do not predict the difficulty schools have today in organizing effective instruction. In fact, a wonderful teacher may be thwarted to various degrees in her efforts to structure meaningful science experiences for children because of her isolation from colleagues and resources. Likewise, students whose original productions are routinely suppressed during a school day can show great creativity under different circumstances, when a guest instructor is brought into the class, for instance, or when they are given the chance to develop expertise in a new cultural domain of school, like technology (Cole & Griffin, 1987).

This paper proposes that it is essential to consider factors outside the players in the classroom in accounting for the presence of inquiry, and it identifies some of these factors.

Individual children's interactions with what instructional situations have to offer are a part of a complex social system that needs to be held in the analysis, inconvenient though it may be. I argue that extra-class factors are part of the root system of learning. In a domain such as inquiry which tends to make us focus sharply on the individual construction of concepts, particular care must be taken to identify situational factors that may be at work.

This conclusion was forced home to us after we studied staff developers and teachers around the country who had participated in a training program at Bank Street College: the Mathematics, Science and Technology Teacher Education Project. Between 1985 and 1987, eighty-two individuals from thirteen communities (thirty-seven schools in all) were trained in the use of The Voyage of the Mimi materials, a multi-media package designed to promote science and math in fourth through eighth grades. Besides learning to use the Mimi and to understand the key concepts covered in its modules, participants became acquainted with principles of inquiry-based instruction, equipment management, and resource planning. Planning included strategies for introducing the program to key district personnel, for designing related in-service, and for locating and organizing human and non-human program support.

Training participants varied somewhat with respect to their backgrounds in science and their experience teaching science. Participants had been teaching an average of 14 years. The first group of teachers and staff developers, from the New York

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metropolitan area, tended to be less familiar with science instruction methods and concepts. Later groups, from national sites, included more and select junior high school teachers and staff developers and so were more experienced with science instruction. The schools and districts represented urban, suburban, and rural districts and consortia; private and parochial schools as well as public districts.

Despite the experience of some of the teachers, the principles of inquiry covered during training were new to many. In particular, teachers learned about the Investigative Colloquium method (Lansdown, Blackwood, & Brandwein, 1971), new questioning and wait-time strategies (M.B.Rowe, 1978); Curriculum Webbing (Hayes, 1982), and other methods for carrying out hands-on explorations in ways that stimulate students' observing, hypothesizing, inferring and so forth. Technology was introduced as a facilitator for an inquiry approach. Teachers learned how to operate the equipment and were given suggestions for using the video and software. The training week consisted of a combination of workshops, demonstrations, discussions, and lectures designed to help teachers experience what their students would go through and at the same time help them develop an analytic frame to the activities.

After the one week of intensive training sessions, teachers and staff developers returned to their districts with at least some idea about how to proceed in using the materials and in developing a broader base for innovation in their science and

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math programs. Bank Street field trainers were available for consultation and training in person or by phone or electronic network, according to the districts' needs.

The research arm of the project, which had collected pre-training information about the participants' backgrounds, approaches, and opinions, asked the teachers to judge the merits of their training experience at the same time that it sought direct evidence of changes in teaching method. Questionnaire, interview and observational data were collected at several points in time for each group of trainees. The initial group, trained in 1985, was followed through their third year of program implementation. Throughout our association with the sites, the researchers and trainers also kept informed about the local conditions which were nurturing the innovative ideas about inquiry.

Our observations and interviews and the reports from the participants revealed certain patterns that we feel comfortable about generalizing from, in part because they confirm what others have found about the adoption of innovation (see Hall, Wallace & Dossett, 1973). What we saw was:

First, that with a few exceptions, teachers are learners in their classrooms. There are two parts to that sentence that need to be emphasized. One is that teachers are learners, the other is that this learning happens at their workplace. The value of inquiry strategies were certainly recognized and appreciated during training, but they was not immediately taken up everywhere. We saw, however, that the materials teachers had to

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work with--in particular, the very wonderful _Mimi_--could create windows of opportunity in which disruptions in instructional routines occurred and could be utilized to open a lesson up in positive ways. For instance, the highly captivating video drama that is the core of the _Mimi_ created more questions and excitement among students than any textbook-based experiences teachers had ever arranged. The wealth of thinking that ensued encouraged some teachers to allow students to pursue individual or small collective investigations and report back, and to make their own guesses about how to undertake their investigations.

So, many teachers reported becoming comfortable with not knowing all the answers, with breaking up whole group formats, and with using new media in the classroom. This could not have happened in an in-service seminar. Still, although many tried, not all participants were able to sustain the opportunity created by the materials. The microcomputer-based laboratory instrument that was part of the _Mimi_ package, for example, presented difficulties to teachers everywhere. This was in part because of the hardware, in part because of the difficulty of the concepts it covered, and in part because of its novelty as an instructional tool. It seems, as one staff developer put it, teachers teach the same way that they learned, and if they were not used to a hands-on approach, although perhaps finding it amusing and exhilerating to experience, they tended to lapse into their familiar routines.

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We did encounter solitary movers and shakers but not often enough to be able to depend upon such a phenomenon to diffuse the program or to make sense of our results. In order to support the very difficult job of organizing inquiry-based experiences, then, the nature of the teachers' work milieu needed to be considered.

Individually, teachers developed inquiry-based activities to a greater extent when they were familiar with the conceptual content. But tendencies to conduct teacher-centered lessons, create patterns of fact delivery, and to limit questions and access to technology because of ignorance (all obstacles to inquiry that we noted), as well as the need to build up the planning and executing side of complex lesson structures were pervasive, regardless of how informed individual teachers were. And the teachers, by the way, saw this.

Teachers and staff developers left the training with plans for making transitions to new approaches. Immediately, though, the plans most often became useless because local constraints caused changes that reverberated in the classroom. Some have argued that school districts are loosely coupled systems (Parish & Aquila, 1983), not directly responsive to movement in far corners of that system. That might be true in some respects, but I am nonetheless reminded of the butterfly effect discussed by Gleick (1987) for example and how in fact, minor perturbation can produce unpredictable developments elsewhere. Some of these atmospheric disturbances for inquiry were: changes in staffing, changes in scheduling, and misunderstandings between players in the system.

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The good news is that we were able to identify features of systems as well that, in effect, produced buffers for the kinds of undermining yet characteristic forces that are typical of the school workplace. Specifically, we found that more extensive technology-based inquiry development was catalyzed by the materials in sites which have:

- district-level goals for organizing training and for introducing new science approaches to teachers; in addition, official approval for teacher experimentation with the program is vital;

- staff developers who had contact with teachers in their classrooms and with district decision-makers in their offices;

- informed administrations and parent bodies;

- teams of teachers trained and working together in buildings. Staff developers also were more effective when they worked together.

Furthermore, success was not related to the amount of technical equipment available, although there were certain preferred configurations.

Many successful models for supporting the inquiry activities evolved, but all shared these characteristics. Success was not limited to one type of school system or type of community.

An interesting observation we made was that in none of these successful cases did the implementation plan represent any one person's brilliant idea. Collective growth and development, rather, was the rule. In the case of defining clear program

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goals, these did not come out of the blue, but were "in the air." The districts were expectant of change, and subsequently supportive of technology that promoted an inquiry approach.

An obvious question finally, is whether introducing technology for inquiry is different from introducing any other innovation. Our data suggest that meaningful support for such inquiry-based instruction shares many features with support systems for any difficult new approach. We see too, however, that the specific procedures involved in changing over a science classroom cannot be captured by general organizational principles. By virtue of their districts' organizations, certain staff developers were able to apply understanding and awareness of teachers' needs for hands-on activity ideas, for help with troubleshooting, for learning concepts of light, sound, temperature, and navigation to expand the program.

In a sense, how to talk about all this is an ecological validity issue. The problem in talking about school systems in relation to inquiry is that inquiry seems to depend on the teacher's notions, the children's misconceptions, and the structure of particular activities.

Should we then persist in injecting the setting into our analyses? Yes, because we can then better account for individual differences, we can gain some more chances to make program adjustments, and the fruits of our research are more likely to be applicable.

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We must also think about ways to design measures and models that take into account the system-wide features. If we are designing teacher tutors or if we are modelling instruction in other ways, we need conceptualizations of intellectual functioning that capture the consequence of individual experience and include the broader operating constraints. These may appear as weighted coefficients, or maybe, if the chaos analogy is apt, as simple warnings to the users that perturbations must be expected. These, we know, can be stabilized in the long run, without recourse to outdated description and explanation.

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