Networks That Alter Teaching: conceptualizations, exchanges and experiments

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ABSTRACT *'Professional development' has become a password to a variety of activities ranging from self-directed experimentation in the classroom to full-blown research projects with peers and, occasionally, with external sources of expertise. From its initial, more restrictive and individual sense of in-service training, it has taken on institutional, even systemic dimensions, and has been identified as a pre-condition for thorough-going school reform. Even in its present form, however, the concept is problematic. The claim is made here that (a) it does not take into account the more 'artisan' or 'craft-centered' nature of work in the classroom, (b) that it is overly school-centered, and (c) that it under-estimates the real gradient of instructional change. A research-based, cross-school alternative for reflection and change is proposed, with a focus on bridging the gap between peer exchanges, the interventions of external resource people, and the greater likelihood of actual change at the classroom level.*

Introduction

The literature on professional development has become voluminous (Lieberman, 1988; Lieberman & Miller, 1990; Little, 1990a; Hargreaves & Fullan, 1992; Darling-Hammond, 1994; Guskey & Huberman, 1995). Its conceptual predecessor, 'staff development' was a less ambitious, less institutional call for many of the same components: ongoing collaboration between teachers, upgrading of pedagogical repertoires, higher levels of content-matter mastery, tighter connections between school districts and external sources of knowledge and technical support (in particular, the university), compensation for inadequate pre-service education and connections between the improvement of teachers' capacities and school restructuring. All that has shifted to a broader, more systemic mandate in which 'professional development' plays a prominent role (Little, 1993; Talbert & McLaughlin, 1994).

The reasons for this shift in terminology are only partly visible largely because the 'school restructuring' movement is in full flux, and its demands on and by practitioners are still volatile. Let us, however, go over this ground more deliber-

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ately before presenting the modal forms which professional development has taken.

First, there has been widespread dissatisfaction with the *organizational aspects* of conventional 'staff development' (Fenstermacher & Berliner, 1983; Wade, 1985; Huberman, 1985). In particular, most offerings have been one-shot seminars or workshops, with little follow-up and, thereby, few remaining traces when researchers verify enduring effects (e.g., Henderson, 1978; Daresh, 1987). Even in the case of longer sessions, there is no dramatic increase in *content-matter mastery* (Borko & Putnam, 1995), especially in mathematics and science, unless a continuing or more intensive model is designed. Next, staff development has been an almost wholly *individual process*, placed under the responsibility of the teacher concerned, with little concern for the potential of collaborative work before, during and after the event. The development process, in fact, is seen more as making up for intrinsic deficits than for realizing one's professional potential (Lieberman & Miller, 1990). Nor has 'staff development' been explicitly *connected to the broader reorganization of the school curriculum or infrastructure*, such that within-school articulation between grades or connections between schools and outlying constituencies have been adequately taken into account (cf. Fuhrman & Elmore, 1990; Tafei & Bertani, 1992; Prestine & Bowen, 1993).

What has changed, fundamentally, can be resumed in two general points. First, in the US context at least, the more 'systemic' analysis of school reform calls for greater professional integration, instructional and content-matter upgrading, local autonomy—but also responsiveness to higher standards—and mastery of a less prescriptive curriculum while aiming for higher-order cognitive operations. In parallel, almost in counterpoint, the teacher professional as an 'empowerment' community, represented foremost by the teacher researcher movement (e.g. Cochran-Smith & Lytle, 1992), has asserted that the capstone to reform are initiatives managed largely by teachers themselves, and involving dedicated school time and resources for cooperative experimentation, access to external expertise, the conduct of teacher-initiated research, and participation in local decision-making when questions of goals and resources are on the table. Lieberman & Miller (*op. cit.*) have provided a catalogue of professional development activities that emphasizes this tendency:

- teacher study groups—in an informal setting
- curriculum writing—teacher-led and teacher initiated
- teacher research projects, with the focus on initiation to the collection and analysis of data
- peer observation: in pairs, usually with activities and students specified in advance
- case conferences—a group of teachers meeting to discuss individual students
- program evaluation and documentation
- 'trying out' new practices
- teacher resource centers
- participation in outside events and organizations

A Critical Look at Some Underlying Assumptions

Although the Lieberman and Miller repertoire is wider, most designs have two defining characteristics I would like to examine. First, they are mainly *school-based;* they situate 'systemic change' locally, not least at the level of a minimally 'collegial' teaching staff (Nias *et al.*, 1989; McLaughlin *et al.*, 1990; Johnson, 1990). My argument here is that the vision of a schoolhouse as a bonded community of adults and children is an unlikely one, with a few hundred children in the same place by virtue of living in the same neighborhood, tutored by adults brought together more by the vagaries of their career paths and the central office than by affiliation or purpose. Others, too, have evoked the within-school constraints of 'cliques' (Bruckerhoff, 1991),'contrived collegiality' (Hargreaves & Dawe, 1990), and 'the persistence of privacy' (Little, 1990b) in trying to enact collaborative reforms. On the other hand, there have been counter-arguments (e.g. Nias *et al.*, 1989; Rosenholtz, 1989) and a trend toward 'disaggregating' effective collaboration to the department or grade-levels (Lichtenstein *et al.*, 1991). Similarly, the more affective, supportive role of peers has been put into evidence from several sources (see the review by Little, 1990a).

A second aspect of these trends is more inferential. My analysis is that these are essentially structural or organizational changes that do not directly affect instructional life in the classroom. For one thing, they may eat up the time that teachers need to master the new maths modules or reading enrichment activities to be introduced in order to meet the newly formulated set of school-wide goals (e.g. Hyde & Sandall, 1984). For another thing, to get from a peer discussion on cooperative learning to its enactment in one's classroom is a phenomenal leap, and there is scant evidence that it is taken. In fact, the changes implied in instructional repertoire, classroom organization, pacing, use of materials, rehabituation of students' habits and expectations, emergence of unknowns and uncertainties, initial—and sometimes enduring—impressions of ineptitude compared to one's 'usual' practice, etc., are collectively dissuasive. Empirical studies of the enactment of major and minor innovations (e.g. Huberman & Miles, 1984; Miles & Louis, 1990; Anderson, 1995) have documented this pilgrimage. We thus have a 'discussion culture' among teachers and in the many forums of organizational reforms, interspersed with timid attempts at the level of actual implementation. As collaborations intensify, linkages take shape, and teachers' self-defined professionalism bears its fruits, we may well note changes to what is now a modal pattern. Even more devious is the phenomenon brought to light by Cohen (1990) in his now-notorious study of Mrs Oublier: the impression on the part of many teachers that they *have,* in fact, modified their instructional practices, whereas external observers see few changes, even on a long-term basis. Finally, Anyon (1994) has shown trenchantly how little a difference professional development in particular *and* educational reform more generally can make in an inner city marked by poverty and social marginalization. This calls for greater humility in our pretensions on both counts.

Toward an Alternative Model

This raises the obvious question of alternatives. A few years ago, I wrote a contentious chapter about 'teacher bricolage' in the classroom (Huberman, 1993), by which I referred to an 'artisan model' of teaching. By this I meant principally that the links between instruction and outcome remained obscure, no matter how robust our conceptual base. There are not enough strong generalizations to override apparently minor variations in pupils, teachers or instructional situations (cf. Snow, 1974). Thus, professional development cannot repose forcefully on a stable, replicable or highly codified knowledge base—cannot be transferred linearly. Much of our actual knowledge as we learn and perfect our profession, is 'embodied', the result of swings between experimentation and the search for constants (cf. Pratte & Roury, 1991). The classroom teacher remains essentially a 'tinkerer' or 'instructional handyman', who can put together a host of materials lying around at various stages of a construction or repair job. These materials meet the particular need that emerges at a specific point and are fashioned to fit that particular purpose (cf. Harper, 1987, for a wonderful example in another domain).

Gradually, our teacher builds up an increasingly differentiated and integrated set of procedures, representations, and algorithms for 'reading' the next task and for knowing which materials will be required at the outset. Adapted from Lévi-Strauss, this image of the 'bricoleur' (Hatton, 1987; Yinger, 1987) entails a continuous dialogue with the instructional situation as it evolves; it is inherently personal and pragmatic, and makes both technical communication between teachers and changes in instructional procedures, a difficult exercise. As one of our teachers put it in an ongoing study of micro-level innovations, (Huberman *et al.*, 1995), 'I didn't know what to do with my body'.

The 'artisan' model has other characteristics worth mentioning briefly. First, it often works by ongoing improvisation, in what Yinger (*op. cit.*) calls 'a conversation on practice'. There is a general plan, as in the Comedia dell'arte or in jazz groups, but within it are nested a series of not-yet defined 'moves', should the course of events prove unworkable or less interesting than the challenges one fashions for oneself (for details, see Huberman, 1993). This is a virtually idiosyncratic practice, yet it is loosely harmonized with others, and it sets up the following paradox: as we tighten articulations between classrooms in order to ensure children's progression through the curriculum, we need to coordinate that institutional-level planning with large zones of instructional latitude in the classroom for individual teachers.

Given that profile, how do artisans construe professional development? When do they seek out peers in relation to their craft? Typically, they are more interested in fellow artisans who are slightly farther along than they or who have fashioned a new procedure (e.g. a fellow 9th grade physics teacher with promising materials in plane geometry; a fellow 2nd grade teacher experimenting with activity corners). Unless one teaches in a very large school, these people will be in other buildings, or they will be in centralized services (universities, resource centers).

In particular, cross-school groups may afford more insight and expertise than is

available in one's own institution, but this knowledge may not be known. Then, too, we have 'guilds' of the same subject matters or grade levels, units providing a form of social glue which facilitates communication and common work. These groups can be so organized as to allow for—in fact, push towards—both exchange and experimentation, with less static or potential humiliation than a longer co-habitation in the same building may trigger. Finally, they allow for the circulation of more conceptual information from outside, but at the times and in the directions dictated by the group.

Outline of an Experimenting Teacher Network

It is well-known that, most of the time, we learn alone. We confront a problem, reach for the solutions at hand, and try to resolve the problem. There is strong evidence that the procedure in the classroom is no different, even for more consequential dilemmas we may confront with children or instructional sequences (Dreeben, 1973; Lortie, 1975; Little, 1990a; Huberman, 1985). In a Swiss study of some 160 secondary-level teachers (Huberman, 1989), the most frequent scenario was the 'lone wolf' scenario. It resembles, in many ways, the procedures initially described by Schön (1983, 1987). (Segments of the models that follow are adapted from Guskey & Huberman, 1995.)

The scenario is not without its pleasures, as Schön so well describes, along with others (cf. Harper, *op. cit.*), who have described solitary problem-solving through iterative chains of reasoning and direct action. In fact, in the Swiss study mentioned earlier (cf. Lowther *et al.*, 1982), we were able to predict 89% of the cases of 'disenchanted' or 'dissatisfied' older teachers and 97% of the cases of 'satisfied' teachers. Put briefly: *teachers who invested consistently but mostly alone in classroom-level experiments—what they called 'productive tinkering' with new materials, different pupil grouping, small changes in grading systems—were more likely to be 'satisfied' later on in their career than most others, especially those involved in large-scale reforms.*

In reviewing this constellation of 'predictors' of professional satisfaction in teaching, we approximate the 'mainstream' literature on the quality of work life. Ashton & Webb (1986) put it simply and well, noting that 'work is likely to be satisfying when we value what we do, when it challenges and extends us, when we do it well, and when we have ample evidence confirming our success' (p. 162). The secondary-school teachers in this sample presumably thrive when they are able to tinker productively inside their classrooms or with two to three peers in order to obtain the instructional and relational effects they are after (cf. Lowther *et al.*, 1982). McLaughlin & Yee (1988) have delineated more precisely some of these requisite conditions, under the rubrics 'level of opportunity' and 'level of capacity'.

Let me now move from the 'lone wolf' paradigm described above to a more continuously 'innovating' model. First, some assumptions. I assume that, structurally, the 'lone wolf' model of solitary experimentation and reflection will remain entrenched, much in the 'artisan mode', and that whatever skill-enhancing mechanism we devise will have to be grafted, at least partially, on that model. In the

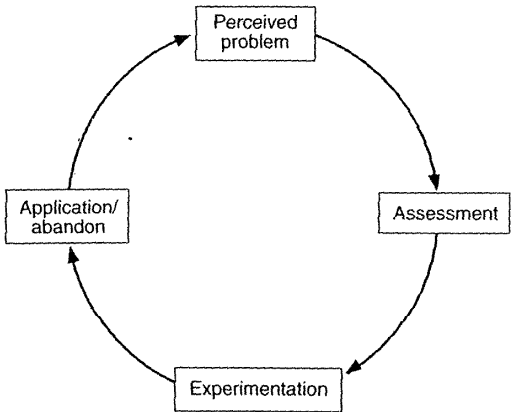

FIG. 1. 'Closed' individual cycle.

current organization of schooling, teachers will remain, for some time at least, 'professional artisans', working primarily alone, with a variety of new and scrounged-together materials, in a self-tailored work environment. Like good craftspeople, they are active tinkerers, intent on developing an instructional repertoire that responds to—even anticipates—most contingencies in the classroom.

The Closed Individual Cycle

Let us now thread our way from the 'lone wolf' to the 'innovating' paradigms. Figure 1, the 'closed individual cycle', depicts the way many teachers contend with the instructional challenges they face. Let us take, for example, an official biology unit that has shown itself to be too difficult for much of the class. The problem is felt, diagnosed, and experimented with (photocopies of 'easier' texts, work in mixed-ability groups, increase in exercises and 'debriefing' sessions). If this suffices, the same strategy will be used again. If not, another strategy will be pursued. Literally dozens of instructional matters are resolved—or not—this way in classrooms and they correspond closely to the more 'provincial' artisan mode of instructional management.

The Open Individual Cycle

To gain time, let us assume the same situation—an inadequate biology text. The cycle depicted below is similar, except that, at the moment of looking for solutions, the teacher reaches outside the classroom, as it were, and turns to fellow biology teachers, people at the local teacher education facility or to a wider span of biology materials. This is a primitive, but often successful, form of outreach, given the knowledge acquired, the new resources made available and the consul-

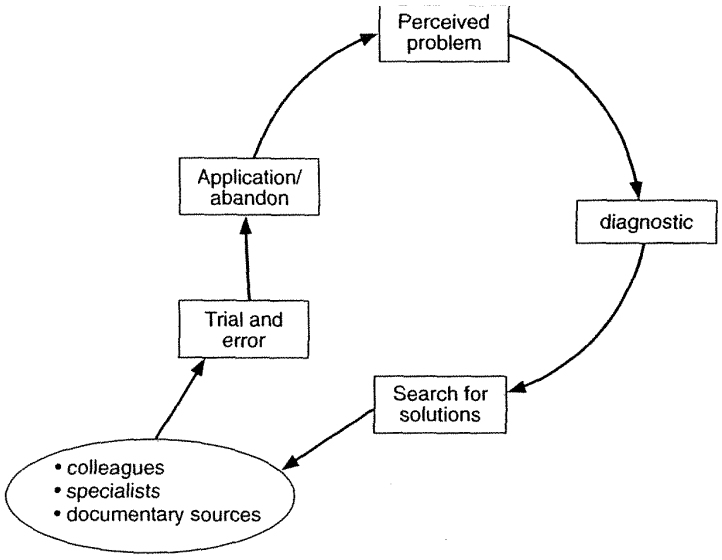

FIG. 2. 'Open' individual cycle.

tations furnished. Still, the success of the enterprise depends almost entirely on the social network of our biology teachers and their willingness to make something of the information and expertise provided. We are still in a 'lone wolf' paradigm and the key questions are still outstanding: how high is the quality of this easily-accessible knowledge, and how do they manage to turn it into durably modified classroom practice, when the available data suggests a high rate of discontinuity?

Closed Collective Cycle

The next cycle (see Fig. 3) brings us closer to a collective enterprise, but one without resources from outside the group. Note that we are not in a school here (although we could be), but among teachers from several schools who share the same discipline, interests, preoccupations, level, or type of pupil. An important premise here, at least beyond the elementary-school level, is that a biology teacher has more to learn and to give, professionally speaking, in a group of fellow biology teachers from several schools than with the one to two peers who teach biology in that person's own building. In any event, these are 'professional craftspeople', and they are traversing a cycle that goes from exchange to experimentation.

Let us stay with the 'biology' example, although we could easily focus on evaluation, lab work, differences in pupils' ability and motivation, and so forth. In the 'experience-sharing' phase, there is an exchange of 'case' material ('In my class...'). There is also, however, a strong dose of more explanatory or diagnostic

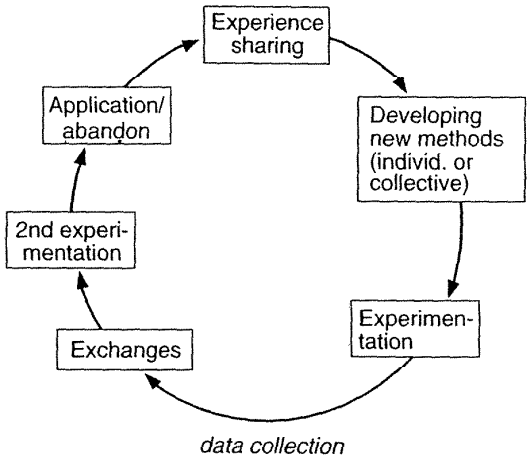

FIG. 3. 'Closed' collective cycle.

discussion: reflection on one's work and discussion of seminal issues about learning and teaching science in different contexts. In other words, this is one version of the 'communities' for teacher research that are fast springing up in the literature (e.g. Cochran-Smith & Lytle, 1992), and that are built into our later models. This version sensitizes teachers to the fact (a) that their theories have been largely derived from their practices, (b) that their experiential base is only one of several possible and equally legitimate ways of construing the same events or the same learning patterns, and (c) that the language of exchange is an imperfect and frustrating vehicle until there has been protracted interaction, mutual experience and the gradual capacity to imagine other perspectives than one's own from the inside out. This is a key component. It entails both 'de-centering' and a growing psychological commitment to members of the group and their individual enterprises.

This combination of experience-sharing and reflection is a core component of this and the next cycle. As we know, school scheduling provides very little slack time for exchanges that are not purely functional. Most conversation has to do with what Yinger (1987) calls a 'language of practical action,' as opposed to a forum for representing practice 'in larger, more visible patterns' that are accessible to all, and that combine meaningful units of thought and action. It is from the 'teacher empowerment' movement that more collective 'reflection' is now in demand, incorporated into the school year rather than conducted on a voluntary basis.

'Experience-sharing' leads to the conclusion that new texts and new experiments are called for. Some of the experiments can be done individually; others will call for collaborative work in class. Our biologists work up a series of both, and agree to try them out. They come together to discuss these experiments and to make revisions.

The group then decides, let us say, to collect some pupil work samples ('data collection' on Fig. 3) in order to see how well the new procedures worked. This is a qualitatively different, decisive part of the cycle. First, it involves some ongoing monitoring. Next, it renders more *public* and *visible* what has gone on in each class relative to this experiment. We are no longer in a verbal exchange mode, a 'discussion culture', with nothing on the line. These professional exchanges, carried on around what are presumably real data collected in the class of each member, set up a situation of clarification and comparison, and they only work when the group, in its earlier phases, has come to a level of mutual comfort and complicity in one another's company.

Practically speaking, the idea here is to set up exchanges around specific products or performances so that the next round of experimentation can be more successful, notably that risk-taking can be a more tolerable exercise... Ideally, some of these experiments are carried on together—as exchanges in action and not exchanges on action Schön, 1983). Still, at worst we are looking at real life data, coming from attempts to change the learning environment. How did the experiments go? Which constellation of groups worked best? Which of the children's representations arose most often? In what form? At the same time, some group cohesiveness has taken hold. The evidence is fairly clear that minimal cohesiveness increases performance, and vice versa. As Mullen & Copper (1994) conclude from a set of integrated studies, what distinguishes groups that perform well is not necessarily that their members interact with smooth coordination, nor that they like each other that much, nor that they are proud of their group, but that 'they are committed to successful task performance and regulate their behavior toward that end' (p. 225). Both dimensions, however, the affective and the technical, are probably important in educational settings.

Finally, the remainder of the model shows that a group of this nature can remain together, either to refine the biology module or to work on other issues. We are in the realm of more prolonged 'teacher action research' or 'collaborative inquiry' (Lambert, 1989; Baird, 1992), both informed, however, by collective development and experimentation. And we are there, it should be noted, with virtually no recourse to external expertise or direction from external specialists. We are relying, as it were, on the collective wisdom—or lack thereof—of individual participants.

Open Collective Cycle

Before going on, let us have a look at Fig. 4. There are a few core premises to bear in mind:

- In this illustration, the group comes from several schools, but shares a subject-matter, discipline, grade-level, problem, or activity to be worked on.
- The 'cycle' is managed by the group, not by a consultant or specialist. In some instances a 'process facilitator" might be useful. However, external specialists are called in at various moments, in accordance with the kind of issue with

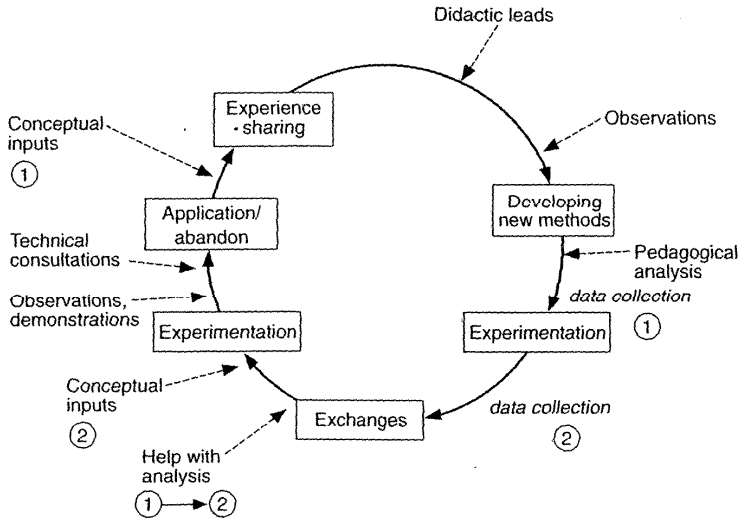

FIG. 4. 'Open' collective cycle.

which the group is contending at that moment. These consultants are people of different kinds, including more experienced peers, something which is foreign to most in-service work. Also, their intervention can be brief, varying from a couple of weeks to 2–3 months, and depending on the evolving goals or pace of the group. They are there at specific moments for specific purposes, to discuss cases or to provide conceptual foci. They are resource people, not group leaders.

Now for the successive stages of the cycle. Let us try a new example, say, experimental science in the 5th and 6th grades. These teachers have come together because the materials at hand are purely workbook oriented, and the basic text calls more for memorization than for active problem-solving.

Conceptual inputs. The cycle can begin virtually anywhere. In the example below, we have started with some conceptual inputs (11 o'clock on the model), although a strong case could be made for beginning with what we have called 'experience-sharing'. These are the two most likely points of entry. The conceptual inputs might come from a university psychologist who has worked on social constructivist perspectives in math and science. She provides a frame or sensitization for conducting and monitoring experimentation in class in small groups, for the kinds of cognitive confrontations and eventual shifts one might observe, for the relationship between the conduct of small experiments and what actual scientists do, and for the possible links between science and math curricula at the upper elementary level.

If we go rather from exchanges back to the conceptual inputs the group has just received. What do they signify? How well do they illuminate the cognitions and

performances one has observed over the past years? What exactly is a social constructivist perspective of teaching in real-time, in garden-variety classrooms? Presumably, some reading may be done and discussed at this phase of the cycle. It will be in the ongoing shifts from practical experience to more formalized knowledge that we can hope for the descriptions, discussions and debates that constitute for teacher researchers the 'joint construction of knowledge through conversation' (Cochran-Smith & Lytle, 1992, p. 309).

There is some question here about the relative *timing* of conceptual inputs. It is a topic which authors from the social constructivist school have studied closely. A strong argument is made by Ross & Regan (1993), for whom sharing and conceptual inputs should be mixed, to demonstrate how 'sharing with dissonance' (the confrontation of points of view, with continual interruptions to relate the theory to one's practice, trade versions, make explicit one's point of view, stay open to another perspective), are particularly beneficial.

Experience sharing. This step has two functions The first is to make acquaintance, via one's own experience with science teaching in the upper elementary grades. This is the reason for the group, and the sharing of experiences has primarily a technical, initiating function (the more social, convivial moments will come in the interstices). At one level, there is the matter of what each person has experienced with the official science curriculum. At another, all members of the group have a professional biography in science teaching that explains why they are dissatisfied and which alternatives would be both appealing and, given one's own pedagogy, acceptable. It is here that the wealth of experience accumulated through the career cycle can be shared. Shared, but, as we just saw, not necessarily aligned. The idea is not to come to agreement on a set of pedagogical beliefs, but to get as much understanding of one another to continue working together, including dissonant viewpoints and exotic perspectives.

Didactic leads. These too, are provided in part by outsiders to the group, most likely by science educators from a neighboring resource center or university. Their function is to build on the conceptual inputs and sharing of experiences by providing alternative scenario, in class. For example, many hands-on science programs have groups of pupils acting as scientists: making hypotheses, collecting and weighing evidence, drawing conclusions. Common projects have to do with measuring acidity levels in the water, building rain collectors, understanding the conditions under which pH levels can be lowered, etc. Talking through didactic leads puts flesh and bones on the conceptual inputs and suggests small, manageable experiments one has imagined or done oneself in class. Bringing along materials—or skipping directly to the discovery and observation components—could also be beneficial.

Observations. These are observations of places in which some of this novel didactic activity is ongoing. These classrooms are identified, typically, by the didactic specialist, and they have the merit of allowing visiting teachers to see 'in

the flesh' how their peers enact new practices under everyday conditions. In terms of learning scenarios, of combining conceptual with didactic elements, this is one of the most powerful vehicles for moving from a conventional practice to a novel one. In effect, few modes of learning have shown themselves to be as consequential as observational learning, when the observations are focused and related to one's own experience. In actual fact, it is seldom practiced, perhaps because it is (wrongly) associated with mimicry. Also, again typically, there will be a thousand questions to be asked afterward, and, through the more informal contacts, a possible widening of the network of science teachers in the region. Once again, the observations can come elsewhere in the cycle—even the beginning—if participants are eager to see them as initial sensitizers.

Developing new methods. It is here that the group begins to construct some modest alternatives to the science text and workbooks. These are tentative procedures and materials that have been cobbled together, but they are a start. Some members of the group will want to work on different modules, some on the same.

Pedagogical analysis. The figure also shows that an external analysis might be useful. By this is meant the entry of a specialist—who may well be a more experienced peer—who can take a sympathetic but rigorous look at the procedures and materials that have been put together. Alternatively, one can invite back the person(s) providing the conceptual and didactic leads, asking for a more fine-grained look. Or one might skip this component altogether.

Experimentation. By this point, we could assume that a shared technical culture and some interpersonal complicity have developed within the group—at least for those that are still active. Our premise is that the preceding steps will have consolidated the group, as is the case in most task-centered group dynamics efforts of this type. What happens now is that each member tries out the materials and sequences that have been elaborated. Conceptually, this is an important moment. Group dynamics theory suggests that if a public commitment to change is made—as in this instance—there will be follow through. Otherwise, the magnitude of effort is likely to be highly variable and, in the mean, trivial. The same lines of research also suggest that groups of this type are more likely to take risks than would the same individuals left alone in their classrooms (Wallach *et al.*, 1962). Also, in keeping with social identity theory, individuals come gradually to comply with the demands and expectations of other group members, owing to the subtle powers which reward or punish individual members. Identifying with the group thus increases accountability to the group (members move to action) and reduces social loafing (Steiner, 1966). Groups with these characteristics are more often what Little (1990a) calls 'subject subcultures' (p. 197): teachers of the same discipline, or at roughly similar grade levels, or sharing a similar pedagogical perspective.

Another facet of group dynamics is the facility, in groups drawn from different schools, of giving and asking for help and advice. This turns out to run counter

to the still-prevalent norms *within* schools (Glidewell *et al.*, 1983; Huberman, 1993). There, one does not readily solicit help (in order to preserve one's sense of competence and status equality), nor does one typically offer advice (for fear of appearing arrogant). One can, however, swap experiences in which help is latent, tell a story in return which contains advice ('I once had the same kind of "droop" just after Easter...So what I tried...'). There is evidence that these norms are changing, but not rapidly. Note that in the cycle we are discussing here, help and advice are literally built into the discussions. Also, since what is being tried out is new to all, temporary difficulties, even failures, are socially legitimate. Everyone is stumbling, and feels free to talk about it.

Exchanges. The figure also shows another constraint on the group. Each member will collect pre-test data and, after the experimentation, will collect post-test data. The figure also shows that external help can be provided for the analysis of pre-test (1) and post-test (2) data. These data are less there as evaluative instruments than as *an obligation to actually conduct the experimentation* and to debrief with other members in the group in ways that are not purely anecdotal. Ideally, these exchanges will also include work samples, test results, final products, and, in so doing, will make for a more concrete, technical exchange of information. But they can be more informal. The core function of the exchanges is the clear evidence of embarking on an adventure together, one in which each member has actually taken some risks, instructionally speaking, but with the expectation that there will be uncertainties and dead ends.

Conceptual Inputs (2) and Experimentation

Following on the first experimentation, the analysis of its results in terms of pupils' engagement, productivity or performance, and ongoing exchanges about the mass of small mysteries, epiphanies and tragedies, the cycle calls for another visit from a conceptual specialist. It is clear that the discussion at this point will be different from the initial one (conceptual inputs (1)). There will have been a conceptual articulation of individual frames, didactic and pedagogical leads, the creation and execution of an experiment and the analysis of its results. For example, one will be talking less about social constructivism in science than about what happened, and especially why, when teachers' expectations were foiled in the first part of the different experiments tried out. We would expect, in fact, that the effects of this second conceptual component, built as it was on a experiment with common features and thoroughly discussed, would be a strong one—would knit theory a bit more to the varieties of learning. As the figure shows, these inputs lead to a revision of the same kind of experimentation or to the design of new ones.

The moments of conceptualization are decisive. First, they stave off the rush to action—the eagerness to get the next experiment 'right'. Next, as the constructivists like to say, they give the time needed for one's confusion. Gradually, members will be still better able to consider their own views and practices from

the perspective of other group members. At the same time, common knowledge is gradually broadened (seeing more various ways of acting in one setting) and deepened (conceiving more aspects of the situation).

Demonstrations and consultations. This is a delicate point. We might well imagine that the next experimentation cycle resembles the first one. There is, however, a more 'intrusive' scenario, as shown in Fig. 4. The figure suggests, in effect, that group members will scan more actively for teachers more experienced than they are, or for teacher educators familiar with the kind of project they are working on. Why this emphasis on 'technical assistance'?

Joyce & Showers (1982, 1988) have shown convincingly, I believe, that we think magically about the mastery of complex instructional procedures—about what learning psychologists call 'enactive mastery'. It is not simply by trial-and-error, observation and verbal exchanges with colleagues that complex skill learning occurs, in the classroom or elsewhere. In effect, in other areas of expertise—law, medicine, social work, athletics—there are periods of focused observation, demonstration and at-the-elbow consultation while the novice runs through the successive components of the new practice. They are guided apprenticeships. In education, by contrast, we seem to have come to believe that no rigorous technical support is needed,or durable pedagogical change by falsely extrapolating from the principle that each teacher has a unique instructional and interpersonal style. Because, in so many cases, teachers effectively teach themselves to teach, they may assume that they can teach themselves to teach otherwise. This turns out, in many ways, to be harder. Nor is practice in isolation an adequate solution, not only because it 'grooves' errorful activity, but also because it affords so little opportunity for conceptual clarification allowing teachers to make sense of their cumulative experience.

In fact, most evidence points in the opposite direction; demonstration by experts, systematic observation of teachers undertaking new practices, interventions on the spot in the form of 'coaching' and two-tiered apprenticeship (Schön, 1987) seem to be required for any major shift in the learning environment created by the teacher—required and, in most instances, appreciated. The same trends appear in the 'implementation' literature (Fullan, 1991). Teachers tend to remain 'stuck' at lower levels of mastery for lack of explicit counsel from external experts or from experienced peers—but from peers who know how to respect and integrate the 'artisanry' of the teacher they are advising. In his meta-analysis of inservice training, Wade (1985) concluded clearly that models which incorporate observation, feedback, and practice are more effective than programs that do not use those methods. Note that this does *not* assume imitation of expert models, but rather a more through-going, self-conscious application of individual styles and modes of 'bricolage'.

In effect, the kind of problem-solving built into this cycle *assumes* that the process of learning, experimentation and change will be moderately complex novel, ambiguous, contradictory and conflicting. *These are, in effect, the idea conditions for significant learning, be it for adults or for children* (see Salomon &

Globerson, 1987). Oftentimes, too, they can trigger self-doubts in more than one sector at once: in one's sense of content mastery, in one's implicit theory of learning, in one's comfort with instructional management. But just as the group literally sets off these unsettling feelings in its members, it also provides a safe haven to experiment with them (Abrams *et al.*, 1990). This is achieved through the interpersonal bonds that build up gradually among members and which outlive the group itself, creating thereby a more durable network for later contacts.

All this is pertinent to our science teachers. What is unusual, perhaps, in this model is that we have *both* a self-directing group and a set of external interventions. In many respects, it is alike other 'rational' models that have demonstrated their efficiency, like that of Stallings (1989): try, evaluate, modify, try again. At the same time, it respects some of the key 'collaborative' canons laid out by Lieberman & Miller (1991): (1) a culture of support for teacher inquiry; norms of colleagueship, openness and trust; (2) opportunities and time for disciplined inquiry; (3) teacher learning of content in context; (4) reconstruction of leadership roles; (5) networks, collaborations and coalitions.

Application/Abandon

We have come to the end of the cycle shown on Fig. 4. The group, singly or collectively, will adopt some of the new science approaches they have constructed together. Others will be discarded. More important, perhaps, an enlarged network will have been created: a network of upper-elementary science teachers, itself connected to specialists in neighboring universities and resource centers on a longer-scale basis. One knows now where to call, where to visit, how to mitigate an enduring uncertainty or obstacle. We have, then, a plausible scenario for the professional development of teachers.

Conclusion

This scenario has more general rewards. As noted earlier by Ashton and Webb, it combines community of effort with a greater certainty of practice and a more solid sense of teaching efficiency, often in the sense of having learned to listen and minister to pupils in more differentiated, challenging ways. It respects a more particularistic vision of the teaching career, what we have earlier called the 'artisan model'. It is also clear how much this kind of enterprise can bring to professional educators at day-to-day grips with the enactment of instructional change in their classrooms.

The question remains: how likely are such networks to spread? Are they already in operation? The answer to both questions is clearly 'yes' (e.g. Rogers, 1979; Gray & Caldwell, 1980; Cusick, 1982; Popkewitz & Myrdal, 1991; Lieberman & McLaughlin, 1994). Most, however, correspond to our Fig. 3, the 'Open collective circle', of have introduced only fragments of Fig. 4. There remains a somewhat magical assumption that discussion and sharing will translate into masterful classroom practice without the necessary consultations, observations, demonstra-

tions and staged conceptual inputs or didactic leads. Nor do we have anything like rigorous empirical studies of follow-through in existing networks. They are seen largely as low-key, easy access to trusted forms of expertise and support.

Finally, this model does not preclude interactive work at the level of the school building. In some respects, in fact this model could be converted to an action research project within an establishment. The differences are threefold. First we have centered on teachers of similar grade levels or subject-matters, not on institutional problems. The network design lends itself, to both, but is more powerful in instances where I may be the only science or math teacher around, and I can go only as far as my best student pushes me.

Next, we have assumed that there is ongoing work at the school level, and that this is a complementary, not competitive, mechanism. It may have to vie with school-level projects for resources, or tie school-level agendas to network priorities, which is a realistic—and probably enriching—objective. Also, a small but critical mass of teachers from one school that joins such a network, for example a group of secondary-level science teachers, can provide follow-up support and resources for one another locally far better than is possible through a more episodic mechanism.

Finally, we have centered our analysis on one key segment of school life: the instructional process. Ultimately, this is where cognitive activity is situated, where skill mastery, academic attitudes and conceptual growth are engaged—or not. Structural changes alone do not translate directly to this level (Elmore, 1992). Had we both exemplars, cross-school experimenting groups and within-school restructuring groups, we might better advance the agenda of professional development and, thereby, affect the environments of learning more rapidly and with greater understanding for the conditions which teachers are actually confronting in modifying their instructional practices.

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