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ABSTRACT

Successful introduction of school computer literacy programs, necessary in today's worldwide computer revolution, must take into account the nature both of this innovation and of school culture. Computer literacy will be a radical rather than ameliorative innovation and will challenge school culture. Hence an innovator must ensure that educators, parents, and community groups understand the program's effects on the three institutional dimensions of school culture--teacher and student work, knowledge distribution, and teacher professionalism and expertise. Social science models of planned educational change have proven inadequate for implementing innovations, but they have identified factors an innovator should consider, such as activity coordination, school social structure, and users' needs. Innovation implementation must involve actual change, not merely nominal change. Actual school change, however, should be "constructive," where both new routines and the principles behind them are adopted, rather than "mechanical" or "illusory," where only labels and routines are incorporated. Based on these concepts, an innovator should (1) use proven methods of introducing new school programs; (2) identify the school cultural traditions challenged by the innovation; and (3) base monitoring techniques on a causal model that specifies what should be observed. (RW)

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To be a professional educator is in part to be motivated, expected, or even pressured to continually change one's ideas, attitudes, and behavior about the schooling processes. It is only natural that a teacher talks with others, read journals, goes to workshops, attends professional meetings, and so on, with the expectation of gleaning an idea or a tactic to improve instruction. Administrators and educational scholars organize committees and task forces, write essays, develop materials, and carry out research with the objective of improving the practice of schooling. Parents, pressure groups, and other social forces are always expecting the schools to change to meet their demands. A prime example of a social force demanding the schools' attention is the topic of this conference, the "chip" and the blossoming world-wide technological revolution which is not yet reflected in school programs. Today, because of this revolution in computing technology and the consequent use of mathematical methods in many areas previously untouched by quantitative techniques, the question of what should be taught must be raised again. The computing revolution is generating an ever-broadening need for both computer literacy and mathematical literacy. These needs create pressure for innovation in schools. Also, advances in computing are making possible instructional innovations such as rapid tailoring of drills (Atkinson, 1972), complex diagnostic procedures (Brown & Van Lehn, in press), and two-dimensional simulations (Campbell, 1980).

Instructional technologies like these provide another type of pressure for innovation in schools. Thus, both new curricula and new instructional procedures need to be--and will be--developed and implemented.

We agree that this need for new programs is critical. A serious gap exists between the mathematical and scientific knowledge being acquired by a few students and the ignorance of a large majority. The majority of our young people graduating from high school and college have only rudimentary notions of science, mathematics, and technology (Hufstedler & Langenberg, 1980). This portends trouble in the decades ahead, for the role of science and technology is growing throughout our society, in business, government, the military, and in other occupations where it never before intruded. Today, people in a wide range of nonscientific and nonengineering occupations and professions must have a greater understanding of technology than at any time in our history. Yet our schools do not now provide such understanding. The decline in emphasis on science and mathematics in our school system is in marked contrast with other industrialized countries such as Japan, Germany, or even the Soviet Union, which provide rigorous training in science and mathematics for all their citizens.

Clearly, the computer provides a technology which can be used to handle, rapidly and easily, many complex computational problems. In fact, in some respects, much of the drudgery of mathematics in past curriculum programs can be eliminated, like interpolation of logarithmic functions in trigonometry. Most important, however, is the need for an increasing emphasis on problem solving. The computer should not be seen only as a tool to do traditional tasks. Increasingly, fields never before touched by quantitative techniques are building mathematical models to solve their problems. This trend is clearly reflected in the National Council of Teachers of Mathematics' strong recommendation for problem solving to be the focus of school mathematics in the 1980s (NCTM, 1980a).

In summary, attempts to change schooling practices must be viewed as natural phenomena whose impetus comes from personal, professional, community, and other social sources. Programs that respond to the revolution in computer technology need to be developed and implemented. However, the successful implementation of such programs will not just happen. Our purpose in this paper is to examine the problems involved in planned educational change with particular reference to introducing a new program in schools.

First, we will characterize innovation in terms of its effect on school life. Second, we want to draw attention to the need to consider the culture of schools. In our experience, an adopted program is not necessarily a used program; if a program <u>is</u> used, it is rarely assimilated into the school in the manner intended by the developer. Third, we will discuss sources of information on the diffusion of innovation, and present various theoretical models of the change process. Next, we will identify some of the problem of implementing change, including those factors that make educational innovation so difficult. Finally, we will apply a set of recommendations baaed on this knowledge of planned educational change to the implementation of a new program.

Innovations as Cultural Change

The difficulty of implementing a particular innovation depends on many factors, ranging from the characteristics of the innovation itself to the structure of the culture affected by the change. McClelland (1968) discusses how effective implementation may involve different levels of cultural restructuring. The simplest level is the substitution of one isolated component of a system for another, such as a change in textbook. If this simplest of changes causes further systemic alterations, such as the purchase of manipulative materials for the classroom, that is a higher level of change. The most complex of all changes deals with values, such as asking teachers to value an active classroom over a quiet one.

This way of characterizing innovations focuses on the degree of restructuring they involve. We have labeled the poles of this dimension ameliorative innovation and radical innovation. Ameliorative innovations are designed (or perceived as designed) to make some ongoing schooling practice better or more efficient, but do not challenge the traditions associated with the school culture. For example, the non-programmable calculator as a replacement for the slide rule in engineering classes does not challenge how knowledge of engineering is defined in that culture, or how teachers are to work. Thus, it is an ameliorative innovation.

At the other extreme, radical innovations are designed and perceived as challenging the cultural traditions of schools. For instance, "modern mathematics" texts asked schools to define mathematics content differently; "team teaching" asked schools to develop new staff relationships. Obviously, we think new programs based on the computer and its associated technology should be designed with radical change in mind. The computer must not be put in the back of a classroom as a toy for students to play with occasionally while the instructor proceeds to teach paper-and-pencil procedures for interpolating logarithms. One of us personally observed that situation in the past year.

Culture in Schools

Our basic premise is that the implementation of innovations should be deliberately planned with the culture of the school in mind. The reason for establishing systematic procedures for assimilating innovations into the culture of schools comes from the growing literature on school stability. Recently, education in the U.S. has been characterized by massive efforts, sponsored by foundations or the federal government, to engineer and implement changes such as team teaching, programmed learning, individualized curriculum programs, modern mathematics, modern science, or open multi-graded schools. But, as Goodlad (1976), Bellack (1978), and the Conference Board of the Mathematical Sciences (CBMS) (1975) have argued, it is usually very difficult to find evidence that what teachers and pupils do in those schools has significantly changed. For example, CBMS (1975) in a review of the modern mathematics movement was forced to conclude that modern mathematics was not a major component of contemporary education in the United States, and that there was no evidence it had ever been given a fair trial. Goodlad (1976) in his review of several attempts to change teaching practices, concluded that schools are very stable institutions inherently resistant to such changes.

To discuss the culture of schools, we will follow the sociological notions used by Popkewitz, Tabachnick, and Wehlage (in press) in their examination of exemplary Individually Guided Education (IGE) schools--a part of the IGE Evaluation Project (Romberg, 1976). "First, school is a place of work where students and teachers act to alter and improve their world, produce social relations, and realize human purpose. Second, schools are places where conceptions of knowledge are distributed and maintained. . . . Third, schools contain an occupational group whose conduct gives legitimacy to the forms of work and knowledge that enter into schooling. Often that group uses the slogan 'professional' to establish its status, privileges, and control" (Popkewitz, Tabachnick, & Wehlage, in press, p. 37).

These three institutional dimensions--work, knowledge, and professionalism--were used because they direct attention to the social assumptions and values that underlie school practices and constrain the implementation of innovations. By our definition, radical innovations challenge basic assumptions about work, knowledge, and professionalism.

Work. First, school should be seen as a place of work. Children in schools are doing work when they do assignments, manipulate objects such as microscopes, build things in industrial arts class, and answer questions on a test. Teachers in schools are doing work when they take attendance, plan lessons, lead discussions, read stories, and evaluate children's performance.

The nature of school work becomes apparent when we look at the initial school experiences of children. Apple and King (1978) showed that kindergarten children are taught particular distinctions between work and play. Work was what the teacher gave directions for children to do. Children perceived work as coloring, drawing, waiting in line, cleaning up, and singing. The definition of work did not concern specific accomplishments but instead concerned the motivation of the activity. Play activities were those permitted only if time allowed, only after children had finished assigned work. Classroom work was related to certain classroom social relations. All work activities were compulsory, done simultaneously by children, and directed toward identical products. The purpose of classroom work was always defined by the teachers. Diligence, perseverence, participation, and obedience were paramount as evaluative criteria.

In a similar vein, Jackson (1968) characterized the work of the teacher as being a supply sergeant, a dispenser of special privileges, an official timekeeper, and a traffic manager. The need to control great numbers of individuals in schools produces a form of spectatorship in which students spend much of their time waiting for the teacher's directions. Although these aspects of schooling may not viewed fondly by teachers, they are nonetheless embedded in teacher training, school architecture, and definitions of professional competence. Many computer-based innovations challenge traditional conceptions of school work. Altered conceptions of students' work are involved when students turn their attention to a computer terminal, whether they do so as consumers of a program or as programmers. The work of teachers is also changed to include diverse new responsibilities like scheduling computer use, interpreting computer output, learning certain uses of a computer and its peripherals, helping students to use computers, and tolerating the absorption many students exhibit when using terminals.

Thus, an innovation can sustain, modify, or otherwise interact with conventional patterns of work. Consequently, we must consider the relationships between an innovation and elements of institutional work in order to make apparent the significance of intervention.

Knowledge. The second institutional dimension of school culture concerns the conception of knowledge. Young (1971) and others pursuing the sociology of knowledge have characterized schools as institutions that distribute and maintain certain types of knowledge. Young argues that the relationship between teachers and students is essentially a reality-sharing, worldview-building enterprise. As teachers and students interact, they develop a shared vocabulary and shared ways of reasoning which give sense to one another's actions and provide a framework applicable to future experiences. This shared understanding is based upon an implicit value structure that defines "being educated."

The most important change we expect from computer technology concerns a change in the knowledge distributed by schools. Computer use involves many forms of knowledge that are new to schools, as acknowledged in a recent position statement of the National Council of Teachers of Mathematics (1980b). Knowledge about computers and computer use is obviously new (e.g., programming, employment of extant routines in problem solving, data retrieval, machine idiosyncracies, etc.). Also new is the fact that computers can make certain kinds of instruction easier, giving more children access to knowledge associated with that instruction.

It is evident today that computer use offers greater tutorial support than was possible before--thanks to computer applications in drill, tailored testing, record keeping, complex diagnosis, finely tuned individual prescription of tasks, instant unthreatening feedback, etc. This may have effects on the way teachers allocate their efforts (that is, the way teachers work); it may also undermine conventional notions of what it means to be educated. With the new technology, some accomplishments that were once difficult are made easy; some once unimportant are made important.

Profession. The professional position of teachers is our third dimension of school culture. Professional educators are vested with the authority and power to define pedagogical practice. The label "professional" is used by occupational groups to express the belief that they are highly trained, competent, specialized, dedicated, and effectively serve the public trust. But the label is more than a declaration of public trust. It is also a social category that implies status and privilege. The label "professional teacher" signifies not only technical knowledge and service, but also the power of teachers to bestow a social identify upon their clients (students), a social identity that can affect students' subsequent status as adults.

Like other professional groups, teachers use their power to preserve and expand control, and to resist disadvantageous changes in power relationships. For example, Becker's (1952) study of parent involvement in Chicago schools reported that teachers reacted to parent involvement in ways that preserved their own control and status in the institution.

Much of the bureaucratization of schooling in recent years has been to the benefit of teacher professionalism at the expense of lay involvement. Technical language, increased specialization, and greater hierarchical differentiation of school personnel make the work of teaching seem esoteric and immune to outside influence. For example, in a study of a Teacher Corps project (Popkewitz, 1975), technical jargon set apart the initiated (teachers, university professors, school administrators) from the outsiders (lay people from an Indian community). Shibboleths like "competencies," "modules," "cycles," and "learning styles" forced the Indians to look to experts for interpretations of school experiences. The technical language introduced a perception of efficiency and prevented critical scrutiny of educators' priorities and beliefs.

The technical language of computers will replace one set of symbols with another. The potential loss of perceived expertise is a real threat to many educators.

In summary, our argument is that schools are complex social institutions which are not easily altered. The faltering implementation of an innovation into school culture can be examined in terms of its effects on the work of teachers and children, the knowledge dispensed, and the professional position of teachers.

Institutional resistance to innovation can also be understood by considering the perspectives held by the persons involved. Their perspectives are important because they govern the way innovations are ultimately used. Innovations are introduced into social situations in which people have beliefs, hopes, desires, and interests, and into institutional contexts that structure actions. The net effect of an innovation can easily be a surface change congenial to existing values and assumptions. Innovations tend to be assimilated into existing patterns of behavior and belief, frequently coming to function as little more than slogan systems that legitimize the values and assumptions underlying the status quo.

If developers want the essence of their innovation to be implemented, they must assure that its effects on the work of teachers and children, on the nature of knowledge dispensed, and on the professional position of teachers are understood by all persons involved. Innovations not understood in this way have generally failed to endure in a form that would please developers. At best, they have been assimilated into the existing school culture without affecting that culture. If administrators, teachers, the immediate community of the school, or the general public misconstrue the innovation, it likely will be implemented in a distorted form, if at all. This was the fate of many reform programs of the past twenty years.

Our colleagues in the IGE Evaluation Project (Popkewitz, Tabachnick, & Wehlage, in press) have documented in rich detail how this fate befell IGE, even in some schools that were reputed exemplars of IGE. One of us (Romberg) was made sadder but wiser to see a similar fate befall Developing Mathematical Processes (Romberg, 1977). Other examples abound. The matrix algebra materials of the School Mathematics Study Group (SMSG, 1965) and The Man Made World (Engineering Concepts Curriculum Project,

1968) are other examples as well-conceived federally funded projects that were never widely implemented. Despite their virtues, these innovations contradicted certain aspects of school culture. High school mathematics teachers' beliefs concerning which parts of high school mathematics are indispensible left no room for the intrusion of matrix algebra, a content previously not taught in high school. The Man Made World, an excellent introduction to engineering for high school students, was seldom used, largely because no high school teachers regarded themselves as teachers of engineering.

The rejection of Man: A Course of Study (MACOS) (ESI, 1965) by religious groups in local communities is an instance where persons other than professional educators have helped make the culture of schools refractory to change. Innovations can even run afoul because they contradict children's beliefs about the nature of work or teacher-child relations. Au and Jordan's (in press) study of culture-bound participation structures is a case in point. Questioning strategies used successfully by teachers with white, middle-class children fail with children of Hawaiian background, reportedly because the children attach different meaning to adults' behavior and expect something different of them. Heath's (in press) study of a black community in the Piedmont Carolinas similarly illustrates how children assimilate school events to the culture of their community.[1]

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[1]Findings such as these affirm the importance of making school practice sensitive to cultural dimensions of student diversity, a central concern of the Wisconsin Research and Development Center.

School administrators', teachers', parents', community groups', and even children's understandings of an innovation and its challenges to the existing culture of schools must be considered when developing an implementation plan.

Planned Change

One who seeks to disseminate an innovation for use in schools is engaging in planned change. The extensive research literature on planned change includes such classic references as Bennis, Benne, and Chin (1969), Havelock (1969), Lippit, Watson, and Westley (1958), Maccoby, Newcomb, and Hartley (1958), Miles (1964), and Rogers (1962).

In that literature are many attempts to develop guidelines for planning educational change (e.g., Baldridge, 1970; Havelock, Huber, & Zimmerman, 1969; McClelland, 1968). As noted by Havelock (1969) in his review, such models of planned change can be grouped into three main classes: the research-development-diffusion perspective, the social interaction perspective, and the user-as-problem-solver perspective.

The research-development-diffusion perspective--associated particularly with Guba (1968)--is characterized by a sequence of planned, coordinated activities, a division of labor, and a rather passive target population. This model is often criticized for giving little heed to users' own perceptions of their needs. Also, it fails to recognize the importance of schools in generating worthwhile problems for research and development, as Klausmeier (1968), Phillips (1980), and Romberg (1970) have noted.

During the past decade, many innovations based upon this model were advertised and adopted, then dismissed by teachers as badly matched to the student population of their school system. Hamilton (1978) has argued that lack of significant change is in part due to the inadequacies of this "center→out" development-implementation process. New programs are developed by a few central individuals, who prepare implementation procedures. However, in practice school staffs unaware of the problems, assumptions, and alternatives considered in development gradually modify the new program back to fit old habits. For example, primary school staffs assigned to new open plan schools inevitably introduce partitions and other permanent fixtures so that within a couple of years, the school operates as if walls were there.

The social interaction perspective is basically sociological in nature, and considers the path taken by an existing innovation as it moves through a social system. This model has guided a great deal of empirical research in agriculture (Roger, 1962), education (Carlson, 1965), and medicine (Menzel & Katz, 1958), and emphasizes characteristics of innovators (Rogers, 1965) and theories of rejection (Eicholz, 1963) as well as adoption. Also stressed are important aspects of the social structure such as group membership and opinion leadership.

This model's weaknesses include lack of concern with how the innovation is developed and with the adaptations the user may make. While education is a social enterprise, there has been a failure by many to consider the organizational structure of the school (Perrow, 1969).

Different curricula make different assumptions about learners, about the system of delivering knowledge to students, and about the technology of the instructional system. Failure to appreciate these assumptions may make adaptation of the new program very difficult.

The user-as-a-problem-solver perspective stresses (1) starting with the user's need and its diagnosis, (2) providing nondirective help from outside, and (3) encouraging the user to develop his or her own internal resources and capacity for change. The main drawbacks of this perspective, according to Havelock (1969), are that it puts great strain on the user, it minimizes the importance of outside resources, and it is not suited for large-scale implementation. The possibility of generally applicable guidelines for planned change has been called into question by Broudy (1965), Cronbach (1975), Phillips (1981), and others.

In essence, the point is that the social sciences at best produce short-lived generalizations, and at worst, can never generalize beyond the situation studied. While none of the perspectives is perfect, each identifies factors that should be considered when planning educational change.

The Occurrence of Change in Schools

From our shared experience in the evaluation of Individually Guided Education (IGE) and from Tom Romberg's experiences in the evaluations of the School Mathematics Study Group and Developing Mathematical Processes (Romberg, 1977), we find it useful to consider the different sorts of school responses to radical innovation that get viewed and labeled as "change." Responses to radical innovations can be loosely divided into nominal change and actual change.

Nominal change. Nominal change is the most prevalent type of response to innovations. It involves adopting nothing but labels. Educators are good at this. If team-teaching is in this year, we label groups of teachers as "Team Red," "Team Blue," etc. Next year, when individualism is in vogue, the new term gets prominence in the school reports. But the routines are not changed. In many cases, we do not fault school staffs for this strategy. As institutions, schools are under considerable political and social pressure to do things they were never designed to do; nor do they have personnel trained to do them. To maintain political viability or keep pressure groups at bay, nomimal change is often reasonable.

Nominal change is recognized and admitted by practitioners. For example, many principals of IGE schools admitted that they really did not have regular Unit meetings, did not have an operative Instructional Improvement Committee, and did not group and regroup students on a regular basis. Reasons or excuses why such practices were not operative were freely offered. Such statements were usually accompanied by a promise or a wish that in the future things would be changed.

Actual change. Actual change occurs where the school staff understands that a radical innovation is expected and attempts to implement it as such. But even when the staff perceives themselves as having actually changed, we must distinguish between different kinds of actual change. We present here a three-part taxonomy that emerged in the IGE Evaluation as a useful way to describe different kinds of IGE implementation (Popkewitz et al., in press). The kinds of actual change are labeled mechanical change, constructive change, and illusory change.

Mechanical change describes a situation in which practitioners have adopted not just the labels, but also the rituals and routines of a new program. However, this implementation is done without fully grasping or taking to heart the values and principles that guide the program's development. Mechanical change is analogous to following the letter of a law, but not understanding its intent.

Mechanical change is unquestionably actual change at the procedural level, and that is not inconsequential. Most educational programs specify procedures to be followed. For example, in most modern math texts, a chapter on sets was added, and often one on other number bases, etc. Mechanical adopters dutifully cover those chapters. However, their coverage is mechanical, done without understanding the purpose of the chapter. Drilling on "base 7" addition facts is not what the authors had in mind. Likewise, in the IGE program, we found schools in which the staff dutifully specified instructional objectives, grouped students according to need, assessed progress, kept records, etc. What was missing was reflection, common sense, and an understanding of the purposes of the routines.

Given what Hamilton (1978) has characterized as a center-out approach to planned change, this shallow form of implementation is understandable. In a center's efforts to convince practitioners to adopt a new program, the "how" of implementation is usually emphasized. The assumptions, practical compromises, and inevitable arguments that were involved in developing the program are not mentioned. Hence, the staff of an adopting school has little sense of the reason for change.

In schools exhibiting mechanical change, there is a strong sense of efficacy. That is, teachers are convinced that children are benefiting from the innovation in demonstrable ways. Their defense of the program may not cite the developer's broader educational purposes, but will make reference to outcomes other than the teachers' own successful acquisition of vocabulary, rituals, and routines.

Constructive change refers to those instances that most please the developer of an innovation. The staff of a school adopting the innovation understands its underlying values and principles, and appreciates its larger educational purpose. The language, rituals, and procedures of the innovation are used in light of that purpose. The staff's grasp of the purpose of the innovation enables schools like this to rise beyond orthodoxy and to construct local adjustments for the purpose of better serving the ends of the program. In schools that have responded to a radical innovation with constructive change, deviations from letter of the law are sometimes made for the purpose of better serving the law's intent. It is this kind of change that Goodlad (1979) and others are seeking. In the IGE Evaluation, a few instances of constructive change were found (see Popkewitz, et al., in press).

In illusory change the trappings of a radical innovation, its language and rituals, are adopted, but teachers show no conviction that the effects of the innovation will be demonstrable in their own right. In other words, only ipso facto justifications are given for the innovative program. In such a context, doing a good job becomes equated with trying hard and with employing state-of-the-art techniques, regardless of the net effect on children. Teachers find solace as participants in the innovation. If children are not shown to benefit, then their failure to respond is rationalized as inevitable. In this regard, the developer and the school staff may have discrepant beliefs about the capabilities of children and the kind of knowledge the school offer them. The developer's innovation gets assimilated into the teachers' world view.

This situation invites slippage of procedures, despite staff sincerity about implementing the innovation. The surface trappings can lead a casual observer to believe that the innovation has been fully implemented, which makes this type of change insidious. Careful and repeated observation in the IGE Evaluation (Popkewitz, et al., in press) revealed that some reputed exemplars of IGE fit this description. As prescribed by IGE rituals, teams of teachers were formed, a team leader chosen, and team meetings were held at scheduled times. Unfortunately, the team meetings were not devoted to the kinds of activities recommended in IGE procedural guidelines, activities like sharing ideas about instruction, making decisions about how to group and regroup children, etc. The causal observer is not the only one affected by the illusion. Surprisingly, the teachers themselves in these schools believed that bonafide implementation of IGE had occurred.

Distorted conceptions of education can arise in illusory change. Some teachers in the IGE Evaluation equated the learning of rituals with being educated (e.g., how well children read was not important, so long as they acted like children who could read). Similarly, many schools in the past considered that they were teaching a "modern mathematics" course by adding a chapter on sets. We are particularly afraid that in many schools, computer literacy will be approached as nothing more than an additional topic in some math class. Unless computer technology permeates school culture beyond that level, the schools will be deluding themselves about fostering computer literacy. Frankly, we are haunted by the unfortunate prospect of computer equipment being wheeled into a classroom with the announcement, "It's your week to cover computers."

We support the utilization of computers in schools. We also recognize the need for systematic implementation procedures. We have presented some alternative perspectives on planned change and descriptions of actual change because we believe these matters need to be considered by developers of educational innovations.

Recommendations

Based on our experience and upon this review, we would like to make three general recommendations. They follow a "center → out" orientation, but the notions embedded in each would be true for any implementation strategy.

Recommendation 1. Our first recommendation is not to abandon proven ways of recruiting and introducing schools to a new program. By all means prepare a dissemination plan and develop materials to support dissemination.

The dissemination plan should include an initial <u>awareness stage</u>, which introduces the new program and provides school staff with the information they need to decide whether to adopt or reject the program. Teachers and school leaders will certainly be included in plans to generate awareness of a program. Less obvious but equally important targets are the clients of schools--children, parents, and community groups.

The plan will include, of course, an <u>installation stage</u> in which the new program is begun. Group discussions have demonstrated their value in helping participants identify particular changes they hope to achieve through the program (Havelock, 1970). Extensive inservice training of teachers is usually needed, and most materials will be developed for teachers. It is also important to direct attention to the needs of administrators, particularly school principals. Few innovations survive without the ongoing support of the school principal (Chesler, Schmuck, & Lippitt, 1963).

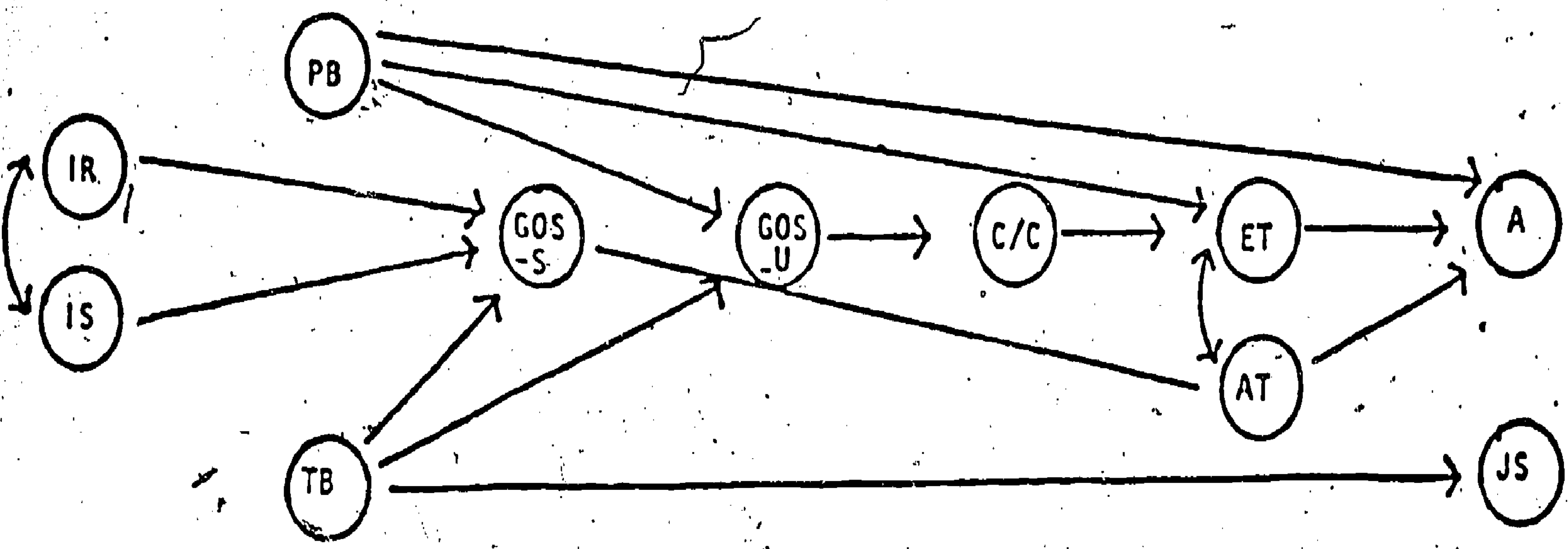
<u>Recommendation 2</u>. Our second recommendation is that innovators identify the cultural traditions that will be challenged by the innovation. To do this, they should examine the traditions surrounding work, knowledge, and professional relations in schools. Unexamined cultural traditions can block perfectly reasonable innovations. Fortunately, as Popper (1949) argued, cultural traditions--once they are identified--can be criticized and changed.

Curricular traditions (e.g., teaching a year of geometry to fifteen-year-olds) provide rational predictability and a comfortable social order to schools. For reasons that have little to do with educational aims, cultural traditions of schools are hard to change. But, as satirically narrated by Peddiwell (1939) in his classic The Saber-Tooth Curriculum, traditions may need to be changed--such as a course on "saber-tooth-scaring-with-fire" taught long after there were no more saber-tooth tigers left to scare. Today, slide rule courses can still be found, even though calculators have made the slide rule obsolete. Elementary statistics are often taught using nonintuitive computational shortcuts developed in a precomputer era. If radical change is warranted (and we are convinced it is) then we must understand the sources of current traditions and challenge those traditions directly.

Recommendation 3. A systematic monitoring procedure should be planned and implemented for any innovation. To monitor something means to gather information about it at several points in time. Campbell and Stanley (1963) make a strong case for an interrupted time-series design to study the effects of planned change on single populations. Two measures (pre- and posttesting) on a single population simply do not given enough information to demonstrate effects due to implementation. At least four observations (two before implementation and two after) are necessary to distinguish between change due to implementation and change due to natural growth. At least six are needed to discern drift, decay, cycles, etc. Obviously, the larger the number of observations, the more we can detect.

As a part of such a plan, we suggest causal modeling to specify the variables to be observed, to identify expected relationships, and to assist in communicating the expected changes. This approach can be used to study the natural ongoing nature of schooling events, and permits us to focus on the effects of a change on various characteristics. The first three of five steps in the causal modeling process are pertinent here: Step 1, identifying the key elements (variables) of the model; Step 2, hypothesizing the relationship between variables; and Step 3, scaling the variables. To evaluate planned changes, we have found it useful to organize our thinking about schooling in the following sequence. First, consider outcomes. Then consider means of instruction; this should include the actions of pupils and teachers as well as the planning for instruction. Next, consider background characteristics of both pupils and teachers. Finally, all the elements of a support system need to be considered. For example, for the IGE Evaluation project, we specified ten variables, developed scales for each and hypothesized the linear relationships between them as shwon in the causal diagram in Figure 1 (Price et al., 1978). In this diagram, the directed arrows (-->) imply hypothesized "causal" relationships, the double headed arrows (↕) imply correlated relationships and the lack of an arrow (such as between PB and AT) implies no relationship.

If key elements are identified from a causal model, a reasonable monitoring scheme following an interrupted time-series framework can be developed. Our motive is not to advocate statistical esoterica. The kernel of our recommendation is the suggestion that developers attempt to be explicit about the chain of events they would expect, pursuant to implementation of their innovation. Through doing that, they will acquire a better grasp of what phenomena to monitor.



A = Achievement
JS = Job Satisfaction
ET = Engaged Time
AT = Allocated Time
C/C = Classroom/Curriculum Decisions

GOS-U = General Operating Style with Units
GOS-S = General Operating Style with School
PB = Pupil Background
TB = Teacher Background
IR = Interorganizational Relations
IS = Intraorganizational Structure

Figure 1. "Causal" diagram for the IBE/Evaluation Project Phase I (Price et al., 1978).

Furthermore, communication with potential users of the innovation may be improved. If a developer provides explicit speculation about diverse effects of an innovation, schools adopting it will be better informed and more likely to show constructive change.

Conclusion

In conclusion, we want to emphasize two things. First, we want to discourage the belief of many computing savants that software refinements and plummeting hardware costs lead inexorably to worthwhile computer uses in schools. Implementation is not inevitable. It is naive to believe that, "To be available is to be implemented." We hope that developers will be dissuaded from that rosy outlook by instances we have cited of good, available innovations that failed to make inroads in schools.

Second, we want to mention once again the propensity for people to water down innovations until they are comfortable. The odds are in favor of computers following the fate of televisions in schools; they may be used, but in important ways that leave school traditions of work, knowledge, and professional relations unchanged. To forestall that fate, innovators must meet those traditions head on.

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