INCREASING THE UTILITY OF INFORMATION SYSTEMS IN SCHOOLS: LESSONS FROM THE LITERATURE

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Introduction

Schools and the teachers and administrators within them are bombarded with vast amounts of information that is potentially useful in instructional planning and school improvement. Students' test scores, attendance, grades, behavior, results of other measures, information about curriculum goals and standards, special programs, student and community interests, and parent surveys are just a sample of the data that is regularly collected and/or transmitted to schools. Teachers, at least implicitly, are expected to incorporate their knowledge of this wide array of information into coherent and effective instructional plans. Expectations for school level planning similarly abound as schools attempt to meet increasing legislative demands for accountability, responding to repeated waves of district, state, and national findings in combination with state and local mandates and local school priorities to direct their school improvement agendas.

Despite implicit expectations, however, the availability of information in schools has outstretched its utility. At best, such information represents an important resource base for decision-making and action; at worst it represents a disorganized and overwhelming set of unknown messages. Can the potential power of information be marshalled? Other sectors have been quick to apply the computer's capacity to store, organize, and analyze information to create multifaceted management information systems to support their decision-making. The availability of low-cost, high-power computer technology coupled with user friendly software systems, make such information systems a reasonable possibility in schools as well.

The Multilevel Evaluation Systems project is exploring the requirements for information systems that could help teachers and administrators sort through, analyze, and apply comprehensive information about their students, community, instructional processes, and outcomes to improve their schools. Toward this end, a multi-disciplinary literature review was conducted to glean guiding principles for system design and implementation. The direction of the literature review conducted was shaped by Lucas' (1975) observation that the major reason information systems fail is that designers concentrate on technical aspects while they overlook users' organizational behavior and needs. Hence, rather than focusing on the technical details of developing an educational information system, this paper concentrates on the organizational behavior and needs of teachers and principals and how evaluative information can be best developed and presented to match those behaviors and needs.

The major research literatures covered in this paper include Teacher Planning, Evaluation Utilization, Information Representation and Decision-Making, and Computers and User Friendliness. The research literatures on Management Information Systems (MIS) and Cognitive Psychology were also investigated. Since the findings from these investigations reiterated and lent further support for the findings reported in the other four categories, the decision was made to incorporate the MIS and Cognitive Psychology research into these other four sections.

Our rationale for choosing these four major topics is described here to help the reader see the relationship between the topics and improving an instructional information system's sensitivity to users' organizational behaviors and needs.

The purpose for the section on teacher planning is to better understand teachers' routine planning and decision-making processes so that an information system can be optimally designed to naturally fit into and accommodate those routines. Gringas and McLean (1981) findings reinforce the importance of this issue. They found that many designers who claim to have a user orientation still develop programs that do not meet user expectations. Not surprisingly, they also found that the designers' images of actual users were significantly different from the users' self-images. Useful information systems clearly need to be grounded in users' actual needs rather than in designers' assumptions about those needs. To avoid faulty images, this section of the paper suggests some of the issues that will be of special concern to teachers. However, to insure that users' needs are truly being incorporated into the design of an information system, potential users will have to be continually consulted and their recommendations heeded during all phases of the system's design and implementation.

The section of the paper on evaluation utilization concentrates on the factors which have been found to influence the utility and influence of evaluation data in educational decision-making. Following Lucas' (1975) observation that many intended users do not actually use information provided because of inadequacies in the system's design or implementation, the section on evaluation utilization addresses what aspects of design and implementation are necessary for encouraging information use.

How information can be represented in a manner that is both easily comprehended and directly applied is the focus of the third section of the paper. Lucas (1975) points out that many information systems fail because users do not understand the systems' output or are overwhelmed with the amount of information with which they are presented. Research on information representation can help avoid such failures by suggesting principles of effective displays.

The section of the paper on computers and user friendliness offers several concrete suggestions for creating systems that are both easily learned and easily operated. The central admonition of this section is similar to that of the section on evaluation utilization; that is, to increase utility, be sensitive to the user. However, because of the number and specificity of detailed suggestions made in the literature, a separate section on user friendliness seemed warranted.

The conclusion of the paper summarizes the major principles and implications suggested by the research. The summary is conceived as a checklist of planning and review questions that can be used to insure the design and implementation of a maximally useful information systems.

Teacher Planning

Introduction

Planning is an important aspect of a teacher's work. Teachers report that they spend between 10-20 hours each week in planning, and much of that is during non-school hours (Clark & Yinger, 1979). Planning decisions influence the content, materials, social climate, grouping, and activities experienced in the classroom (Shavelson, 1982). According to Yinger (1980) there are five basic levels of teacher planning. They are yearly planning (selection of general materials, placement of pupils, and sequencing and organizing of instruction for the entire school year), term planning (determining weekly schedules and unit activities within the time framework of the term), unit planning (laying out activities that are to be part of instructional units in specific areas of subject matter), weekly planning (focusing on specific activities and the schedule for those activities), and daily planning (making last minute changes or preparations for the day's activities). The proposed MLES information system is intended to aid teachers and principals with yearly, term, and unit planning that is focused on larger chunks of curricular content or student behavior. To better understand how an information system can help teachers and principals with these types of planning, this section of the paper summarizes recent theory and research concerned with teacher planning and suggests their implications for the design of effective information systems.

Research on Teacher Planning

Research and theory in cognitive science indicate the importance of understanding how teachers think, their existing schema, and their modes of information processing. However, research on teachers' thought processes has focused almost exclusively on particular learning episodes and has neglected broader types of planning activities (Clark & Peterson, 1986). In other words, research about the types of planning the MLES intends to affect is practically non-existent. Nonetheless, findings from related areas of teacher planning research can offer insights on teachers' orientations and general planning dispositions. The related areas surveyed by this review are how and what teachers consider when planning, the impact of time of year on planning, the influence of teacher expectations on planning, and the possible negative effects of planning.

How and What Teachers Consider When Planning

Yinger's cyclical teacher planning model (Yinger, 1978) offers one potentially useful model for understanding how teachers plan. This model uses a cognitive approach to describe how teachers interpret and elaborate on information during the planning process and how teachers' past experience and knowledge will affect that process. According to this model, there are three stages during teacher planning: Problem-Finding; Problem Formulation/Solution; and Implementation, Evaluation, and Routinization.

In the Problem-Finding stage, the general planning task is translated into a specific planning problem called the problem-conception. This is accomplished by teachers considering in a cyclical fashion their own knowledge and experience, their teaching goal conceptions (their expectations and theories about effective teaching), available materials, and other external factors such as the teaching environment and school organization (physical characteristics of classroom and the school, the number of students in the class, the length of the school day, and the teacher's relationship with the principal and other teachers), curriculum and resources (guidelines inherent or explicit in school or district objectives and programs, personnel, and materials supplied to the school for teaching certain subjects), and pupil characteristics (students' background and teacher's judgment of students' ability , maturity, attention span, and ability to work in a group). During this stage of teacher planning, an information system can be potentially useful by increasing teachers' base of knowledge. This might be done by generating reports about school and district requirements, available instructional and other resources, and pupils' and their parents' characteristics, and by suggesting measures teachers can use to gather more information about any of these areas.

An information system may be particularly useful during the Problem-Finding stage if it is able to generate reports that are sensitive to an individual's or a school's teaching goals. Such goals incorporate teachers' expectations for cognitive and affective outcomes, as well as the teachers' implicit and explicit theories about the nature of effective teaching. Munby (1983) also found that teachers' implicit theories (principles) and beliefs about teaching are tied to their teaching goals and significantly influence the effectiveness of any curricular, organizational, or instructional change. He found that most teachers' principles and beliefs could be categorized according to the following constructs: student learning and developmental goals (curriculum goals; extra-curricular, academic, and personal goals; and subject matter principles), teacher autonomy and authority (efficacy, degree of control over curriculum, evaluation, etc.), teachers' needs (e.g., teachers' needs for order, for interpersonal and collegial relations, and for increasing professional knowledge), students' needs and limitations (students' personal and academic needs, student differences, and student limitations), and conceptions of factors which facilitate learning (motivation, self-esteem, questioning, instructional variety, application and transfer, classroom climate, and order). One possible way of making an information system sensitive to teachers' teaching goals might be to have teachers input their more important teaching goals into the system and have the system recommend measures or bring up information that is responsive to teachers' priorities.

Relevant to the kinds of information teachers might find useful during the Problem-Finding stage, Shavelson and Stern (1981) found that teachers usually seek the following information about their students: ability or achievement, class participation, self-concept, social competence, independence, classroom behaviors, and work habits. These factors, used in making pedagogical decisions about students and related to the aforementioned teaching goals, signal elements that might be included among an information system's pupil characteristics measures.

Research by Floden, Porter, Schmidt, Freeman, and Schwille (cited in Potter, 1983) suggests the importance of specific information on district test results and district instructional objectives. They found that these factors had significant impact on teachers' planning and their willingness to change the content of their teaching.

The next stage of the planning process, Problem Formulation and Solution, also proceeds in a cyclical fashion, whereby the teacher alternates between representing the problem, formulating partial solutions, and mentally trying out solutions until a workable plan results. This cycle can better be conceived as a coil in which an initial problem conception begins at the top and moves downward in a circular motion through repeating cycles of developing and fine tuning the problem conception and a tentative solution, checking the solution's workability, and matching the tentative solution to the expectations of the problem conception. When the tentative solution does match the goals of the problem conception, this stage is complete, and the tentative solution is ready for the stage of implementation, evaluation, and routinization. Although an information system may not be able to offer any direct assistance to teachers during the stage of problem formulation and solution, the finding that teachers focus on the elaboration and refinement of a single alternative at a time does have potential implications for the sequence of information reports and suggested planning procedures accompanying a system. The sequence of reports might start with general level reports to help users locate specific problems or educational variables that are of interest to them. Then more specific and detailed inquiries and reports can be generated to aid the users in clarifying the nature of the specific problem identified. Further, to be consistent with teachers' current routines, and thereby potentially facilitate use, accompanying procedures might focus on the development and refinement of one alternative solution at a time.

The final stage, Implementation, Evaluation, and Routinization, is when the solution is tried out and evaluated in practice. The results of this stage add to the repertoire and experience of the teacher, which in turn become an important part of subsequent planning. At this stage, the information system can be useful by recommending, analyzing, and reporting the results of measures for evaluating the effectiveness of the activities, programs, and environmental or curricular changes the teachers have implemented.

Yinger's model of teacher planning was supported by research (Clark & Yinger, 1979) that found teachers differentiated in their own minds between the problem finding and problem formulation/solution stages. This research also supported the notion of the planning process being a progressive elaboration of one idea rather than the development of several alternative ideas and then the selection of an optimal alternative from among these. These findings further support the notion that an information system and the process surrounding it should be structured to enable teachers to analyze in depth one issue at a time.

It is interesting to note the parallels between Yinger's model and models supported in the management information literature. The latter, as presented by

Brookes (1986), similarly recommends that information systems should be targeted to specific phases of the decision making process (e.g., problem recognition, diagnosis, generation of alternative solutions, evaluation of outcomes of alternatives, and judgments between alternatives). Brookes also recommends that the information needed for recognizing situations that require a response should be separated from information that is needed to solve problems. He found that removal of all information of a problem-solving character from reports can reduce their size by 50% and lead to faster problem recognition (Brookes, 1986). Finally, Brookes notes that the problem-solving information needs to still be available to the user upon their request.

Impact of time of school year on planning. Clark and Elmore (1979) found that teachers during the first five weeks of school are primarily concerned with setting up the physical environment of the classroom, assessing student abilities, and establishing the social system of the classroom. By the end of the fourth week, the teacher has established a system of schedules, routines, and groupings for instruction, and these structural features serve as a framework throughout the school year within which teachers plan particular activities and units. Joyce (1978-79) also found that teacher planning decisions made early in the academic year had a profound influence on teachers' planning for the remainder of the year. Finally, Clark and Peterson (1986) report that several researchers have concluded that the planning that takes place in the first few weeks of the school year has a powerful impact on the behaviors and thoughts of the student and the teacher throughout that school year. This body of research suggests that to maximize the impact of an information system, current information needs to be available either before or at least within the first few weeks of the school year. Such currency might be accomplished by a constant updating of data or an updating of data every spring.

Influence of teacher expectations on planning. It has been found that teachers' expectations of their students' abilities influence their interactions with those students (Brophy & Good, 1970). Furthermore, it has been found that a teacher's initial expectation may serve as an anchor for his or her subsequent estimates of the student's ability (Shavelson, 1982). Dusek (1975) found that even when teachers know their expectations for students are based on false information, the teachers are still influenced by these expectations when interacting with students. This finding was supported by Shavelson and his associates who reported that initial estimators of student characteristics are difficult to overcome, even in the face of conflicting evidence (Shavelson, Caldwell, & Izu, 1977).

The power teachers' expectations exert over their planning and behavior must be cautiously handled by the information system. It is important that a system not lead teachers to false expectations (too high or too low) for their classes, making validity and reliability of the information provided essential. A variety of indicators on each variable reported by the system can help to strengthen the validity base. Having the system remind users of the fallibility of results might be another safeguard. Further, to aid teachers in overcoming false expectations they may already hold, conflicting evidence should be presented in a highly salient manner.

Possible negative effects of planning. Based on ethnographic research, McCutheon (1980) found that some teachers view long-range planning to be a waste of time because of unpredictable changes in schedules and interruptions. Zahorik (1970) found that planning may become counter-productive if teachers become single-minded and do not adapt their lessons to students' needs. Peterson, Marx, and Clark (1978) found, in a lab setting, that students of tutors who planned extensively achieved lower and had poorer attitude scores than students of tutors who did not plan so extensively. It appears that planning can be counter-productive if it causes teachers to be inflexible and unresponsive to student input and their teaching environments. In order to avoid potential detrimental effects of planning, the planning context surrounding the system use should emphasize general strategies and target goals and objectives rather than specific, detailed plans of action. Also, during training and orientation, teachers should be made aware of the negative effects of strict adherence to plans and the importance of modifying plans to be sensitive and responsive to student needs.

General Implications from Teacher Planning Research

The following is a list of the general implications derived from the research discussed in this section:

1. The system could generate reports about important elements in the teacher's problem conception. For most teachers these elements are organized in the following areas: school and district environment and organization, school and district resources, district requirements and tests, curriculum requirements, and pupil characteristics.

2. The system should be sensitive to and accommodate users' unique teaching goals and orientations which are based in the elements contained in the first implication. The teaching goals should include both the teacher's expectations for students' cognitive and affective outcomes, and take into account the teacher's theories and beliefs about effective teaching.

3. Rather than helping teachers generate a list of alternative planning solutions, the system should help teachers clarify their conceptions of their planning problem and to investigate one tentative solution at a time, by using their own knowledge, experience, and teaching goals in combination with information about available materials, environmental and organizational factors, requirements, and pupil characteristics.

4. The system should help teachers evaluate the effectiveness of activities, programs, and curricular or environmental changes.

5. Pupil characteristics that might be included in the system's data base are achievement, class participation, self-concept, social competence, independence, classroom behaviors, work habits, and background characteristics.

6. The system should be available for use by teachers before the school year begins or within its first four weeks to maximize the system's effects on teacher planning.

7. The current data should be entered into the system no later than a month before the beginning of the school year in order to match most teachers' critical period for planning (a few weeks before school starts through the first four weeks of instruction).

8. The system should be sensitive to initial expectations which may lead users to misinterpret or ignore important data. To promote sound expectations, the data should be reliable and valid, important findings should be supported by multiple indicators, and the limitations of the findings should accompany their reporting. The power of prior expectations might also be handled by having the users state their expectations for the data prior to finding out the results. The system could then clearly indicate whether or not those expectations are supported by the available data.

9. The system should demonstrate with examples its value and flexibility in teacher long-range planning. Orientation and training should recognize that some teachers feel that long-range planning is a waste of time due to unpredictable changes in schedules and interruptions. To maximize utility and minimize problems of inflexibility, planning activities could focus on

understanding of the problem and general strategies for their solution that can be adapted to a variety of specific situations.

10. Orientation and training should make teachers aware of the potential negative effects of strict adherence to plans. Over-adherence, in fact, may detract from their sensitivity and responsiveness to students' needs.

Evaluation Utilization

Introduction

Research on evaluation utilization usually focuses on one of the following definitions: (a) use of results to support discrete decisions and (b) use in the general education of decision makers (Cousins & Leithwood, 1986). The MLES project is primarily concerned with the first definition—direct uses of information to help teachers and principals with their decision-making. To better understand how to increase the probability of such utilization, this section of the paper draws upon the recommendations of evaluation experts and on implications derived from the research literature. But before discussing how to increase the system's utilization, suggestions for possible uses of the system are described.

Possible Uses for MLES

Among the many topics discussed in their book, *Toward Reform of Program Evaluation*, Cronbach and his associates (1980) discuss the possible uses of instructional information systems. The book offers the possibilities of a system designed to both assess individual students' needs and diagnose resources that match those needs, make comparisons and other inquiries on a class and school level, and examine school patterns, the demographics of the communities in which they are based, and how funding affects students through different programs. Examples of uses suggested by this book that relate to the MLES information system are checking out the homogeneity or heterogeneity of class assignments, comparing the progress of this year's students with last year's students, examining the school's profile of achievement in reading as compared with math or within the reading area, and finding out how students are doing on decoding skills as compared with comprehension skills.

Besides possibilities for an educational information system, there are also limits. As argued by Lindbolm and Cohen (1979), most decisions and actions are based upon "ordinary knowledge"—that knowledge derived from practical experience which is widely shared, sensitive to context, and comprehensive. By contrast, knowledge that comes from social science evaluations is context independent and selective rather comprehensive. Therefore, the knowledge obtained through evaluations can only serve to supplement ordinary knowledge and cannot be expected to replace or dominate such knowledge.

Suggestions and Implications for Evaluation Utilization

The suggestions of experts and implications from research in the field of evaluation utilization commonly relate to the following general characteristics of evaluations and their context: evaluation quality and credibility, relevance to information needs, communication quality and ease of use, timeliness, commitment and receptiveness towards the evaluation, political climate, and personal characteristics. These factors have all been found to be correlated and to influence in combination, how and to what extent evaluations are used (Cousins & Levinson, 1986).

Evaluation quality and credibility. An evaluation's quality is defined by the sophistication of its methods, the intensity of evaluation activities, and the type of technical approach to the evaluation, while its credibility is defined by the user's perceptions of its objectivity, believability, and appropriateness of the evaluation criteria (Cousins & Leithwood, 1986). Weiss and Bucuvalas (1980) do not distinguish between evaluation quality and credibility, but rather consider credibility to be a part of evaluation quality which is defined as the technical quality, statistical sophistication, objectivity of the researcher, and internal consistency reflected by the evaluation (Weiss & Bucuvalas, 1980). Although evaluation credibility is equivalent to the user's perception of evaluation quality, credibility and quality can differ. For example, evaluations that methodologists might consider of high technical quality may be considered trivial or unbelievable by users and an evaluation perceived as credible to its users might not be of high technical quality to technical experts. Several researchers have reported that improved methodological sophistication was positively related to both direct and indirect use by decision makers (Cousins & Leithwood, 1986). They also reported that when evaluations were perceived by decision makers as having high face validity use and the potential for use appeared to be greater (Cousins & Leithwood, 1986). Finally, Weiss and Bucuvalas (1980) found that perceived research quality was the single most significant factor in determining whether or not a decision-maker chose to use an evaluation.

Concerned with evaluation quality within the context of an information system, Cooley and Bickel (1986) recommend that an educational information system's data should be current and accurate. To do this they advise that the system be merged with school and district's central data files that are used to keep track of daily functions such as attendance, student enrollment, and standardized testing. To increase the incentive for entering current data, they propose offering same day scoring for achievement tests. Finally, they suggest accuracy can be improved by building in checks for out-of-range data within the program and by avoiding corruption of data by shifting the focus of the evaluation from accountability of teachers and schools to local school improvement.

One factor that affects the credibility of an evaluation is whether evaluation findings are consistent or inconsistent with the evaluation audience's expectations. The majority of studies concerned with user expectations found that when evaluation findings were consistent with decision-maker expectations, acceptance and utilization increased; incongruent findings tended to be ignored and other information used instead (Cousins & Leithwood, 1986).

Based on such findings, Alkin, Dalliak, and White (1979) recommend that evaluations be user oriented—that the reports and areas of inquiry be sensitive to user expectations.

Interestingly, Weiss and Bucuvalas (1980) found that results which challenge the status quo and those that are critical of agency practice are associated with increased direct use and increased likelihood of being taken into account. Although this appears to conflict with the findings concerned with user expectations, it does not. Because user expectations and user beliefs in the status quo's effectiveness are not correlated, these authors suggest that many users already question the effectiveness of status quo practices. Furthermore, Weiss and Bucuvalas found that when it is not politically feasible to directly act upon data that challenges the status quo, this type of data still serves the important function of directing the user's attention to possible changes that could be implemented if the opportunity arises.

Another factor that can detract from evaluation credibility is competing information—that information obtained from sources beyond the evaluation (e.g., personal observations) that conflicts with the evaluation data and has bearing on the decision being made (Cousins & Leithwood, 1986). Research has found that knowledge from personal experiences, beliefs, values, interests, and goals are powerful competitors with evaluation data (Cousins & Leithwood, 1986).

Relevance to information needs. Relevance of the evaluation is defined as the extent to which the evaluation is geared to the audience's information needs (Cousins & Leithwood, 1986) or the extent to which the findings are germane to the issues with which the user is concerned (Weiss & Bucuvalas, 1980). Most studies concerned with relevance and utilization have found that evaluations which reflected knowledge of the context in which the evaluations were to be used, sought consensus about the evaluation problem, or demonstrated insight into the necessary decision-making were associated with higher levels of use; evaluations that ignored these issues were associated with relatively low levels of use (Cousins & Leithwood, 1986).

Cooley and Bickel (1986) recommend that to increase the relevance of evaluations carried out by an information system, a system should anticipate and respond to information needs of potential users. In the case of teachers and principals, they felt these information needs included the ability to examine a wide variety of student data in a correlational manner; the capacity to spot new developments or patterns by the use of longitudinal data; the choice of examining data at student, classroom, and school levels (this system is being designed to handle the last two levels as well as district wide comparisons); the ability to conduct inquiries designed by the user; and the provision of information to teachers about instructional materials that would be particularly helpful for students.

Patton (1987), a strong supporter of designing evaluations relevant to the user, recommends the involvement of potential users from the beginning of the evaluation process in order to incorporate the user's interests and informational needs. Further, he suggests using an identifiable, real, specific, and caring group of potential users on which to base evaluation designs, rather than a general or abstract audience. Since the aim of the MLES project is to introduce the system to various school communities, development might use research on teacher information needs as a general framework for user information needs, but then customize that framework to the specific needs of the individuals who make up various user sites.

Communication quality and ease of use. Communication quality is determined by how clearly and orderly the evaluation results are reported and the breadth of dissemination of the results. Research indicates that evaluation presentations or reports that are broadly framed, offer comprehensive recommendations, and use nontechnical language contributed to higher decision impact scores, improved readability, and greater awareness and appreciation of results (Cousins & Leithwood, 1986). Studies also found that dissemination breadth (e.g., reports geared to the public vs. scholarly journals) resulted in higher utilization scores (Cousins & Leithwood, 1986).

One finding that reflects the importance of both communication clarity and ease of use is that utilization increases when reported results require little to no transformation in order to be practically implemented (Weiss & Bucuvalas, 1980). One way of accomplishing this might be to link evaluation results with possible forms of action.

How easily a user can communicate which inquiries he or she would like to conduct is another important aspect of ease of use. Cooley and Bickel (1986) make the following recommendations for improving the ease of use of an information system: the system should be menu-driven, it should be able to produce screen displays as well as printouts, and it should use an easily learned set of commands. They also suggest that the system should have the capability to transfer files between school sites and a central district computer and that a scanner which provides test scoring services and automatically updates students' files with new scores should be available at every school site where the system is to be used.

Timeliness. Timeliness is a matter of decision makers receiving the evaluation results when the information can be used to influence the decision being made. The majority of the research concerned with this factor has found that timely provision of evaluation results was positively related to utilization (Cousins & Leithwood, 1986). Evaluation results were also reported to be of most use at early stages in the decision-making process.

User commitment and receptiveness. Commitment and receptiveness towards evaluations are determined by the attitudes of the decision makers towards evaluation, their organizational resistance, and their receptivity towards changes. It was found that user involvement in the evaluation process contributed to high levels of use of the evaluation results in decision-making. Lucas (1975) suggests that user involvement in the design and implementation of a system is the key for making a system succeed. He reports that user involvement results in favorable user attitudes and perceptions of information systems, which in turn lead to high levels of use. Lucas' recommendation to involve the user appears repeatedly throughout the Management Information System (MIS) literature as a solution to the problems associated with use and nonuse.

Strategies for involving users that also come from the MIS literature include the following (Robey & Markus, 1984):

1. "Steering Committees" involve top management in system design by having them review proposed systems.

2. "Information Requirements Analysis" uses a problem solving approach to determining what information is needed in making decisions, as opposed to merely asking users what they want.

3. "Prototype" allows users to try out an experimental system and suggest changes.

Specifically related to teachers' use of information systems, King (1987) reports that there are three attitudes teachers hold that interfere with their receptiveness towards such a system: pessimism towards making far reaching changes of any kind in classroom practices, skepticism towards computer innovations, and disbelief that instructional information systems as they are currently conceived will provide useful information for teachers. King (1987) also recommends ways in which an information system could be better received by teachers: involve all teachers in the development and implementation process, create a professional support system for teacher-users, and leave teachers' clinical responsibilities alone.

Finally, several researchers found that advocacy by the evaluator of his or her results and forcefulness of communication is associated with greater use (Cousins & Leithwood, 1986). Akin to taking responsibility for fostering commitment among users, Bank and Williams' (1981) findings about idea champions have similar implications. When evaluators emphasized that the evaluations were important activities and had important implications for the user, use increased (Cousins & Leithwood, 1986).

Political climate. Dimensions of political climate include the dependence of the decision makers on external sponsors, the user's and evaluator's political orientations, and inter- and intra-organizational rivalries, budget fights, and power struggles (Cousins & Leithwood, 1986). Not surprisingly, evaluation use increases when its findings can be politically beneficial for the user and decreases when the information can be politically harmful.

Cronbach and his associates (1980) warn against using evaluations as a form of accountability for teachers. They argue that when evaluations are used to look back at what was done with the intent to apportion responsibility among teachers or program managers, the number of suggestions for improvements is reduced. Furthermore, the combination of accountability and standardized tests leads to a narrowing of curricula and promotion of drill and practice.

Weiss (1972) points to the possibilities of building a positive political climate. She recommends that administrators and program managers (as well as teachers) be involved in the evaluation process. She believed this would help change the image of evaluation from "critical spying" to collaborative effort to understand and improve.

Another recommendation comes from Cooley and Bickel (1986) who suggest that in order to create a healthier political climate a system should secure student and teacher privacy with the use of passwords.

Personal characteristics. Personal characteristics are defined in terms of the decision-maker's organization roles, information processing style, organizational experience, and social characteristics. While years of experience does not make a difference with teachers' use of evaluation for instructional judgments; higher levels of leadership, caring, and interest; more skills and initiative; and internal versus external locus of control are associated with increased use (Cousins & Leithwood, 1986).

Increasing the user's knowledge about evaluation is another way to affect utilization. Patton (1987) found that increasing decision makers' knowledge about evaluation in general can contribute to greater use of evaluation data and a greater likelihood that users will continue to seek out evaluation data in the future.

General Implications

The following is a listing of general implications from the research and recommendations of experts, discussed in this section of the paper, for increasing the likelihood of MLES use by educators for making classroom, school, and district-wide decisions. These implications are organized into two categories: those related to the technical design of information systems, and those related to the process surrounding their design and use.

Implications for technical design:

1. The system should offer the user a menu of possible inquiries based upon suggestions from the literature and the specific needs of target users.

2. Data must be accurate and current. To this end, the system can be merged with school and district central data files that are used to keep track of daily functions such as attendance, student enrollment, and standardized testing. Furthermore, the incentive for entering data can be increased by offering same day scoring for achievement tests. Finally, accuracy can be improved by building in checks within the program for out-of-range data.

3. The system should be sensitive to and accommodate users' expectations, and should clearly report whether those expectations are or are not supported by the available data.

4. Analyses should include the ability to examine a wide variety of student data in a correlational manner; the capacity to spot new developments or patterns by the use of longitudinal data; the choice of examining data at a classroom, school, or district wide level; the ability to conduct inquiries designed by the user; and the provision of information to teachers about the instructional materials that would be particularly helpful given a particular finding.

5. To improve clarity of communication, the system should use simple, nontechnical language to report evaluation results and should require little transformation to be applied to educational decision-making.

6. The system must be easy to use. Methods to accomplish this include the following: reducing the amount of memory required by the learner to operate the system (e.g., menu driven and easily learned commands), allowing for the transfer of files between school sites and a central district computer, and making available at every school site where the system is to be used a scanner that provides test scoring services and automatically updates students' files with new scores.

7. The system must secure necessary privacy of information by using passwords to keep out unauthorized users.

Implications for development, training, and support:

1. To increase user commitment and receptiveness towards the system, users should be involved in development and implementation, encouraged to design their own inquiries and test their own expectations, and offered improvement implications that can be derived from the data. Further, training should attempt to improve users' attitudes towards evaluations and should organize a procedure for users to receive post-training assistance on how to use the system and its results.

2. Users must feel that the evaluation reports generated by the system are accurate, based on reasonable criteria and the result of objective study.

3. Someone within the local setting needs to actively advocate the usefulness of the information system's capabilities and the importance of its results to users.

4. The system must be capable of answering the queries that users deem relevant. The development process might start with user information needs based on research on teacher and administration information needs, but also must customize each system to the specific needs of specific target users. This customization might be conducted on the basis of information gathered by questioning a range of potential users on their specific information needs.

5. Data must be timely, current and available, for teachers and principals at the early stages of their decision-making.

6. The system should recognize and balance the power associated with information. The data should not be used for holding teachers and programs accountable. Such uses may lead to reductions in suggestions for improvements, a narrowing of curricula when standardized tests are involved, and corruption of the data by those who are being held accountable. Furthermore, the information this system generates should not be held in the hands of only central officials, but should be available to all individuals the information affects.

7. Training should encourage teachers and principals to believe that better decisions are within their control with the use of the information system.

8. Training should also cover information about the evaluation process in general as well as specific uses of the system's data.

9. To affect future utilization, training might encourage teachers and principals to consider findings which challenge the status quo and to imagine their implications for the future, even if they are not immediately feasible.

Information Representation and Decision-Making

Introduction

The way numerical data are presented affects a user's comprehension and use of that data (MacDonald-Ross, 1977). Washburne (1927) found that both the visual and logical arrangement of data have an important effect upon recall and comprehension of the information. In order to choose formats that facilitate user comprehension and use of data, it is necessary to understand the cognitive limitations and preferences of users as they relate to display formats. This section of the paper begins with a discussion of how information representation affects user information processing. This section also addresses the questions of what format to choose given a specific task, and how to render a particular format competently. Although the findings that come from empirical research on display formats may be helpful for display designs, these findings can never replace the expert designer's experience, intuition, critical skill, and trial of alternative solutions (MacDonald-Ross, 1977). Therefore, it may be beneficial for the development of the system to have an expert review the formats designed and to try out various alternatives with users.

Cognitive Limitations and Preferences of the User

To facilitate teachers' and principals' use of data, MLES must accommodate their cognitive limitations and preferences. The following are brief descriptions of two limitations and two preferences related to the comprehension and use of data, and their implications for the MLES.

Amount of information. Miller (1956) found that humans are only capable of retaining about seven (plus or minus two) chunks of information in short-term memory. Therefore, a good format should allow the user to organize and conceptualize the information in terms of a small number of chunks or categories.

User misunderstanding of statistical properties of data. Remus and Kottemann (1986) found the following four errors to be the most common mistakes made when individuals are asked to interpret statistical findings:

1. Users assume upward or downward trends are occurring when in fact the variations they perceive are random and not persistent.

2. Users may give too much weight to characteristics of small samples and assume them to be representative of the population from which they are drawn.

3. Users sometimes erroneously make inferences about future events based on the occurrence of past events that were independent of each other (Gambler's fallacy).

4. When a decision-maker is faced with several sources of uncertainty simultaneously, he or she may simplify the problem by ignoring or discounting some of the uncertainty. Statistically naive users need to be protected against such misinterpretations. Among the possibilities for safeguards are having a system suppress analyses or reports which are inappropriate (e.g., those based on too small an n), having a system warn users against misinterpretations in those cases where such errors are likely to occur, and/or having a system directly interpret the data as it is reported.

User strategies for processing information. Bettman and Kakkar (1977), and Ghani (1981) found that subjects' strategies for using information are based on the information that is most easily processed. Slovic and Lichtenstein (1968b) also found that people resist making even simple transformations of information. Slovic (cited in

Ghani, 1981) further found that people tend to discount or ignore information that requires inference from the explicit display. Instead, people tend to use only the information that is explicitly displayed and will use it only in the form in which it is displayed. Therefore, a good display should present the information in the most straightforward and applicable form possible.

Format consistency. Users tend to resist changes in information representation styles (Ghani, 1981). Therefore, throughout the system the types of graphs and tables displayed should remain constant.

Choosing a Format

No matter what format is chosen, it is important to remember a point made by Weintraub (1967)—the skills of interpreting any types of graphs must be learned. Furthermore, consideration should be given to whether the information should be represented in a quantitative format or would be better communicated through text or verbal charts. Below are findings that relate to the questions of whether or not to use numeric data and if so, in what format.

Numeric versus adjectival information. Numeric data are numbers reported as numerals or words (10 or ten). Nonnumeric data are adjectival and qualitative descriptions (e.g., extremely large or substantial decline) (Bell, 1984). Scammon (1978) found that subjects receiving adjectival information had more accurate aided recall and comprehended the overall meaning of adjectival information better (e.g., fair, good, and poor) than information presented as percentages. His explanation for this finding is that adjectival descriptions are often inherently evaluative in nature, making evaluation tasks easier since some of the information processing is already done. Scammon also found that subjects were more satisfied and less in need of more information with percentage scores as compared to adjectival information. This finding raises questions about the willingness of subjects to accept adjectival information even if it leads to better comprehension.

Cherry (1966) also reports that users perceive numeric messages to be based on measurement and to be more precise than nonnumeric messages (adjectives) even when this is not the case. Again, the power of numeric information to portray itself as precise can be very misleading when the information is not of a precise nature. Another strength numerical data has over adjectival data is that it allows for easier comparisons across values in a display (Russo & Dosher as cited by Ghani, 1981). The conflict of providing users with information in a form that will be more accurately understood (adjectival) or in a form that will be more readily accepted and more easily compared (numerical) will have to be resolved by development.

When both numerical data and text are involved, Washburne's research (1927) suggests that numerical data should not be presented embedded within text if more than two items are to be presented. Instead, separate tables or displays should be used.

Formats and their functions. When considering which format to choose, one should be aware that no one graphic format proves universally superior and that each format has its own domain of application (MacDonald-Ross, 1977). Washburne compared the effects of using prose, tables, pictographs, and bar charts and reached the following conclusion—there is no graphic format more effective in all respects than all other formats, but rather, different formats of data foster the learning of different types of information.

Vernon (1950) and Washburne (1927) found that particular types of graphs are most effective at representing particular types of comparisons and trends. They found that (1) bar graphs are best for static comparisons, (2) line graphs are best for dynamic comparisons (trends), and (3) pictographs give users rapid and striking general impressions. Furthermore, Schutz (1961b) found that a single graph with multiple lines was better at representing multiple trends than multiple graphs with single lines. Finally, Croxton and Stein (1932) found that bar charts facilitated easier and more accurate comparisons than pie charts, segmented bar charts, or three dimensional figures (cubes).

When presenting exact numbers, tables are one of the most important formats because of their compact nature. However, they have a serious weakness—they are abstract and therefore require more processing by the user (MacDonald-Ross, 1977). Thus, the choice of using a table involves a trade-off between exactness, compactness, and ease of use.

Designing Effective Formats

The following are general and specific recommendations about how to design effective formats.

Headings. Headings provide an explicit structure which assists the reader (user) in integrating the information as he or she reads. To be helpful, headings need to be informative and unambiguous (Wright, 1977). Headings are more easily located when not in all capitals (Poulton, 1967). Headings for graphs may be one way of directing users' attention towards important data and clarifying what the graphs are representing.

Choice of sentences. A sentence with negative wording may be much stronger than its alternative affirmative wording (Wright, 1977). For example, saying "Never use a subject sample size smaller than five" is more emphatic than saying "Choose a sample size of five or larger." Furthermore, Wason (1965) found that negative sentences are more effective at correcting a reader's expectations than positive sentences. However, because readers have an easier time with text that is written using simple, active, and affirmative statements, negative wording should be used sparingly when emphasis is required (e.g., findings or directions which conflict with user expectations).

Adjunct questions. Questions at the beginning of text help the reader to recall and comprehend specific information while questions after the text facilitate recall and comprehension of a broader nature (Rothkopf, 1965). Washburne (1927) recommended using questions after a table or chart to emphasize its chief features.

Color coding. Schutz (1961b) found that, in general, color coding improved performance over the black-and-white code, especially for multiple line graphs. Shontz and his associates reported that color coding works most effectively when (1) many categories of information are to be coded and (2) highly discriminable colors are used. Although color coding may add to the effectiveness of multiple line graphs, the fact that most school sites do not have color monitors may restrict its use.

Bar charts. To make bar charts easier to read, Culbertson and his associates (1959) recommend that the elements of bar charts should be labeled directly rather than indirectly by key or grid. In other words, labels for the bars should be located immediately next to the bars or within them. They also noted that horizontal bar charts may be preferable because they have more room for direct labels.

Line graphs. The four most typical mistakes made when constructing graphs are the following: (1) something on the graph is not explained; (2) items on the graph cannot easily be distinguished due to the design or size of the graph; (3) mistakes exist such as incorrect spacing of tick marks, mislabeling, items omitted, or wrong scales; and (4) some aspect of the graph is missing or partially missing due to poor reproduction (Cleveland, 1985).

To avoid these errors, Cleveland (1985) recommends the following:

1. Make the data stand out.

2. Do not clutter the data region.

3. Do not overdo the number of tick marks.

4. Use a reference line when there is an important value that must be seen across the entire graph, but do not let the line interfere with the data.

5. Do not let labels in the data region interfere with data display.

6. Put keys just outside the data region and notes in the legend or text.

7. Make superimposed data and plotting symbols visually distinguishable.

8. Preserve visual clarity when reducing or reproducing.

9. Choose the range of the tick marks to include or nearly include the range of data (e.g. if scores range from 200 to 800, so should the tick marks).

10. Choose the scales so that the data fill up as much of the data region as possible.

11. Do not always include zero in a scale showing magnitude and use a logarithmic scale when it is important to understand percent or multiplicative factors.

12. Try to avoid scale breaks.

13. If a scale break is absolutely necessary, do not connect numerical values on two sides of a break.

Pictographs. Research found the following characteristics to be essential to effective pictographs: (a) pictorial symbols should be self-explanatory and easily differentiated from one another, and (b) quantity is better represented by number of symbols than size of symbols (Neurath, 1944).

Tables. Ehrenberg (1975) found that tables can be made easier to read by following these simple principles:

1. Round numbers to two significant digits. (This facilitates mental arithmetic.)

2. Provide row and column averages.

3. Use columns for the most important comparisons. (Figures are easier to compare across columns.)

4. Order rows and columns by size of numbers rather than by alphabetical order.

5. Set columns and rows compactly. (Do not space them out to fit the page.)

General Implications

The following recommendations for the design and implementation of MLES are derived from research on how data representation affects users' comprehension and use of data:

1. Use presentation formats that require as little transformation as possible. In other words, present the information in the most straightforward and applicable form possible.

2. Be consistent with representation styles. This means stick to one or a few types of graphs or tables throughout the system's displays.

3. Represent the information in a format that allows the user to organize and conceptualize the information in terms of a small number of chunks or categories (no more than five).

4. Typical user errors in comprehension of statistical data might be avoided by including text with such findings that explicitly states their meanings and limitations.

5. Use adjectival information rather than percentage information when accuracy of comprehension is essential. For example, for greater comprehension on the part of the user, use words such as "performs well in comparison to one's peers" rather than "performs in the 70th percentile."

6. Use numerical rather than qualitative values when comparisons between pieces of information are necessary. Although numerical values are not as easily understood as nonnumerical ones, they are easier for people to compare. For instance, a person can more easily compare the numbers "four" and "five" than the words "fine" and "good." It should be noted that numbers may lead people to believe that there are more distinctive differences between individuals or groups than really exist.

7. No one format has been found superior to all other formats, but it has been found that (1) a tabular representation is best where the task requires the simple retrieval of data, (2) bar charts are best for representing static comparisons, (3)line graphs are best for representing dynamic comparisons (trends), and (4) pictographs are best for creating rapid and general impressions.

8. Graphs and tables should use headings which are informative and unambiguous.

9. Sentences should use negative rather than positive wording to provide special emphasis (e.g., when stating findings or directions that conflict with user expectations). For example, if a user expects that low math achievement scores will be accompanied by low math motivation scores and this is not supported by the data, the system might state "Reject: math motivation and achievement are not related" rather than "math motivation and math achievement have an insignificant relationship."

10. Questions that follow a graph or table may help users to better comprehend the data, derive implications for educational decision-making from the data, and decide whether further evaluation is necessary.

11. If used, color coding should be used for making lines on multiple line graphs more discriminable. Further, the colors used must be easily differentiated from each other.

12. Bar charts should be labeled directly rather than by key or grid.

13. Line graphs should (1) be accompanied by supporting explanatory text, (2) use continuous scales which capture the range of actual rather than possible data, and (3) clearly display data and plotting symbols.

14. Pictographs should be drawn with self-explanatory pictorial symbols that are easily differentiated. In addition, the amount rather than the size of symbols should be used to represent quantity.

15. Tables should (1) contain numbers rounded to two significant digits, (2) provide row and column averages, (3) place most important comparisons next to each other across columns, (4) order rows and columns by size of numbers, and (5) compactly set columns and rows.

Computers and User Friendliness

Introduction

User friendliness is a term which refers to computer programs that are easy to use, tolerant of operator errors, and easy to learn. Research suggests that such programs are preferred by most users, are more time efficient, increase the likelihood of users accomplishing their goals, reduce the number of errors made by users, and reduce the amount of training time that is necessary for learning how to use the program (Simpson, 1985). Recommendations for how to develop a user-friendly computer program come from the literature on software development concerned with computer-human interface. This section of the paper summarizes the major findings and recommendations that relate to developing a user-friendly program.

Recommendations for Developing a User-Friendly Program

The recommendations found in the user-friendliness literature reviewed tended to fall into these six categories: defining the user, minimizing the user's work, feedback, error detection and correction, legibility, user control, and principles of design.

Defining the user. Identifying and defining a program's users is a critical first requirement to assure user-friendliness. Audiences can consist of persons of varied skill levels (e.g., computer expert and computer naive). Below are some recommendations based on knowing one's audience.

1. Match the program to the user's skill level. If the users range in skill levels, two approaches developers might choose among are write for the lowest common denominator and provide different features for different users (Simpson, 1985).

2. Use vocabulary that is at the user's level and common to his or her environment (Simpson, 1984).

3. Anticipate the environment in which the user will use the system. The main factors to consider are light, noise, and distractions. If the environment is unknown, it is best to assume a bright, loud, and distracting one, which would be best accommodated by a program that has high contrast, is not dependent on meaningful sounds (alerting signals), and has the capability to be stopped temporarily at any point and then later started up where the user left off (Simpson, 1985).

Minimizing unnecessary labor. A user-friendly program attempts to minimize both the unnecessary mental and physical work required by the user in order to allow the user to concentrate his or her efforts on the purpose of the program. Mental work is the work involved in recalling commands or data, performing mental calculations, deciding what action to take next, and inferring meaning from the data reported. Physical work is the work involved in flipping switches, pushing keys, and changing disks. The following recommendations have been made in order to reduce memory and typing demands:

1. Be consistent with input and output routines (data entry and screen displays). Consistency makes a program easier to learn and results in fewer errors after one has learned it (Simpson, 1985; Gaines & Facey, 1975).

2. Provide prompting. Tell the user explicitly what to do next (Friend & Milojkovic, 1984; Simpson, 1985).

3. Use a menu driven program (Simpson, 1984).

4. Keep computer messages as concise as possible (Friend & Milojkovic, 1984; Simpson, 1984; Simpson, 1985).

5. Design documentation manuals so users can locate information speedily. For instance, include content lists, indexes, page headings, and section headings. Also, communicate how to carry out procedures by a list of steps rather than by prose (e.g., sentences and paragraphs) (Wright, 1983).

Feedback. Feedback is information that the computer provides to a user indicating that something he or she has done has had an effect on the computer. Feedback can confirm that the user has typed the appropriate characters or used the correct command. Feedback can also inform the user that he or she has made an error. Furthermore, feedback can let the user know when the computer is performing a function that must finish before the user can continue. The following are recommendations for how to produce feedback that will keep users on track:

1. Display typed characters on screen (echoing) in order to inform users what input the computer is receiving (Friend & Milojkovic, 1984).

2. Validate data on entry (Gaines & Facey, 1975). Use response classifications such as correct, incorrect, or unrecognizable (Friend & Milojkovic, 1984).

3. Give users feedback when their inputs will alter data or cause the program to branch (Friend & Milojkovic, 1984).

4. If the program requires a delay of five or more seconds, a message should appear on the screen telling the user what is going on (Simpson, 1985).

Error detection and correction. Error tolerance is a central characteristic of user-friendly programs. Programs are error tolerant when they guard against a variety of input errors and allow users to easily correct mistakes that they have made. The following are recommendations for insuring error tolerance:

1. Anticipate possible errors, check for them, and protect against them (Simpson, 1984).

2. When an error is detected, alert the user and tell him or her how to recover. Alerting signals must differ from the customary background (e.g., flashing messages or beeps) (Simpson, 1984).

3. Allow for erasures and response editing (Friend & Milojkovic, 1984; Gaines & Facey, 1975; Simpson 1984, 1985).

4. Have users signal the end of their inputs by typing a "terminator" such as the enter key or the return key; this will allow them to confirm or edit their responses (Friend & Milojkovic, 1984).

5. Enable users to make corrections by re-entering data or backtracking with the cursor (Gaines & Facey, 1975).

Screen display design and legibility. Although screen layout is partly art and partly science, development can profit from observing the following recommendations:

1. Do not crowd the screen displays (Simpson, 1984).

2. Move from one screen display to another (paging) rather than scrolling (Simpson, 1984).

3. For greatest readability text should be in upper and lower case letters with double spacing between lines (Tinker, 1965).

4. Most displays require a title centered at the top of the screen telling the user at what he or she is looking (Simpson, 1984).

5. Identify the different types of information that will need to be displayed on the screen (e.g., title block, numerical information, error-message line, and prompt line) and allocate a consistent screen area for each information category. Further, assure that the information on the screens do not stray from their assigned areas. Finally, if possible, separate each area of the screen from the next by at least three rows or columns of blank spaces (Simpson, 1984).

User control. Palme (1983) reports that computer users who are inexperienced and insecure prefer software which is fairly restrictive and guides them along predetermined paths with carefully worded questions. But as their experience grows, they become frustrated by the restrictiveness of the same software. He found that the more experienced the users became, the more they wanted the freedom to decide what to do and the ability to add new facilities to the software (e.g, macros, complex sequences of commands). Therefore, the ideal software must accommodate users with varied amounts of experience and allow the users to decide how to use the computer. In order to increase the user's control over operating a program, the following recommendations have been made:

1. Sustain operator orientation. In other words, always inform the users where they are in the program and where they can go (Simpson, 1985).

2. Give the user the control for deciding when to move on in the program, what to save, and when to quit (Palme, 1983).

3. Always make help available to users on line as well as with the aid of documentation. Provide both a general help facility (e.g., possible commands) and a specific help facility that explains what the computer expects at that moment (Palme, 1983).

4. Allow users to move from a menu-mode to a command-mode (Palme, 1983).

5. Allow users to save a series of commands (Palme, 1983).

Principles of design. As mentioned earlier in this section, understanding the prospective users of a program is an important first step in developing a user-friendly program. Along with identifying prospective users and their needs, three other design principles have been recommended by Gould and Lewis (1983):

1. A panel of prospective users (e.g., teachers and principals) should work closely with the design team during the early formulation stages.

2. Early in the development process, prospective users should actually use prototypes, and their performance and reactions should be measured.

3. When problems are found in user testing, they should be fixed in an iterative fashion. This means there should be a cycle of design, test and measure, and redesign, until each problem is solved.

Conclusion

This paper has reviewed the research literature relevant to matching an information system's design and capabilities with teachers and schools' organizational behaviors and needs, summarizing the findings of empirical studies and the experience-based recommendations of experts in a variety of disciplines. By going beyond the literature of educational information systems, we hoped to capitalize on (rather than reinvent) research conducted in other fields (e.g, management information systems, graphic design, and decision-making). Our review of these various disciplines revealed considerable consistency in lessons learned and insights gleaned. From this we have derived 10 major principles for creating an effective, efficient, and attractive instructional information system. Each of these principles, presented below, is followed by a check list of questions to aid in its application.

Guiding Principles and Check Lists for a Successful Information System

1. Create a system relevant to user needs and preferences.

_____Have the system's primary users been identified? Who are they (e.g., primary or secondary teachers, principals, and school board members)?

_____Have users clarified the role of the system in their short and long term planning (e.g., to increase efficiency in planning, monitoring and problem spotting, to improve student achievement, and to increase equality of opportunity to learn)? Is the system designed to directly support these roles?

_____Have teachers and the school articulated short and long term educational priorities? Probe for goals in the areas of curriculum, extra curricular activities, student learning and development, teacher control and authority, and motivational aspects of learning (e.g., instructional variety and self-esteem). Is the system sensitive to these priorities?

_____Does the system contain information that users feel will support teacher and school planning? Probe in the following areas:

1. district and school priorities and requirements,

2. pupil characteristics (e.g., demographic information, academic needs, attendance, stability),

3. pupil outcomes (performance on standardized tests, curriculum based tests, attitude measures, career plans),

4. parent/community characteristics, and

5. available resources?

_____Does the design of the system account for the following attributes of prospective users:

1. computer skill level,

2. skill and experience in analyzing and interpreting data,

3. vocabulary, and

4. graphic/reporting preferences?

_____When will the system's data be needed (e.g., before school year begins)? Will the data be entered and be available before users need to use it?

_____Is the system design responsive to the ways users' conceptualize problems and their solution?

_____Have the ways the system will support and facilitate teachers and schools routine functioning been clearly identified?

_____Have users been centrally involved at each stage of planning and implementation and been given adequate opportunity to review and suggest improvements (e.g., through steering committees, repeated prototype trials)?

2. Account for the organizational and political climate.

_____Have special sources of resistance to implementing such a system been identified (e.g., staff resistance to change, competition for financial resources, computer or data phobia, fear of misuse/abuse) and addressed?

_____Have influential actors in decision-making, resource allocation and leadership roles been identified and convinced of the importance of the project?

_____Does the system avoid using the data for teacher or staff evaluation/accountability, and instead focus on facilitating improvement?

_____Is student and teacher privacy protected with the use of passwords?

3. Minimize the memory load of commands and procedures needed to learn and operate the system (make learning easy).

_____Are input and output routines consistent?

_____Are prompts always presented with directions about what users should do next?

_____Are menus of possible inquiries offered to users?

_____Is on line documentation or help available to users?

_____Does the system detect errors and allow for easy correction?

_____Are computer messages concise and clear?

_____Does the system use simple and nontechnical language?

4. Minimize the amount of information that the users need to process at any given moment. Make processing easy and avoid information overload.

_____Can information reported on a single screen or page be organized into a maximum of five to seven chunks?

_____Do display screens have the following characteristics:

1. uncrowded text and graphs,

2. paging rather than scrolling,

3. upper and lower case letters with double spacing between lines, and

4. a centered title at the top of the screen that tells the user what is being viewed?

5. Do reports and displays facilitate users' comprehension and correct interpretation of the data provided?

_____Are the tables and graphs selected to ease comprehension and utility:

1. tables for simple retrieval,

2. bar charts for static comparisons, and

3. single or multiple line graphs for dynamic comparisons (trends)?

_____Are graphs and tables marked with clear headings in upper and lower case text?

_____Are statistical data accompanied with text that explicitly states their meanings and limitations?

_____Are graphs and tables followed with questions to encourage active processing and to direct users attention toward specific applications or further data collection?

6. Insure the accuracy of data.

_____Does the system have built in checks for out of range data?

_____Does the system offer same day scoring with scan machines that enter the data directly into the system?

_____Does the system have safeguards to prevent inappropriate analyses and interpretation (e.g., analyses that are based on too small an n, calculations that are technically incorrect)?

7. Does the system encourage users to confront their expectations?

_____Are users asked to state their expectations regarding possible relationships, trends, or relative standings?

_____Are users informed if their expectations are supported or not supported by the data?

8. Maintain users sense of control when using the system.

_____Are users given the opportunity to edit and confirm inputs by typing a terminator such as the enter key?

_____Are users provided with feedback after every data entry and computer command, and during computer delays?

_____Are users given control to decide when to move on in the program, what to save, and when to quit?

_____Does the system allow users to generate their own unique queries?

9. Insure that user attitudes are positive toward using the system and incorporating its results into their planning.

_____Have users been actively involved in the system's development?

_____Do users feel a sense of ownership of the system?

_____Do users perceive a relationship between the system and their school responsibilities?

_____Do users have confidence in the accuracy and objectivity of the data?

_____Is there sufficient training to assure that users are comfortable with the process and able to operate the system?

_____Do users believe their information system facilitates better planning? To increase such beliefs,

> _____Has training presented concrete examples of how the system has been used to improve planning?
>
> _____Are users encouraged to consider findings which challenge the status quo and to imagine their implications for the future, even if they are not immediately feasible?
>
> _____Are there opportunities to modify the system to help it better meet teacher needs?

10. Provide continued support and advocacy for the system's use with users after they have completed the training.

_____Do users know where they can receive further assistance for using the system and analyzing its data after the training has finished?

_____Are users consulted and informed before changes are made in the system?

_____Is there an influential "idea champion" in every local setting who actively advocates the system's capabilities and the importance of its results to users?

_____Are users given the opportunity to evaluate the system (e.g., electronic suggestion box or written evaluations)?

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