Alternative Paradigms for Research In Instructional Systems

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Introduction

According to Kuhn (1970), no paradigm for research ever solves all the problems it defines, nor do two competing paradigms leave the same problems unsolved. When planning research and deciding among paradigms, the question is: Which problems most urgently require solutions? It is important to answer this question because adherence to particular research paradigms may affect which problems we are ultimately able to solve.

The paradigms that guide our research necessarily delimit our problems, theoretical assumptions and methodologies. In a mature science, one paradigm typically dominates. Progress occurs when this dominant paradigm, unable to account for a growing number of anomalies discovered in the course of normal scientific inquiry, is replaced or "overthrown" by a competing paradigm (Kuhn, 1970). In a developing science, by contrast, numerous paradigms may vie for acceptability and dominance.

Instructional systems is such a developing science. Its practitioners draw from the research and theory of several fields, including psychology and information systems, to establish a basis for their own theory development and research. As they do so, they will also reflect shifts in theoretical or research paradigms within the field. Heinrich (1970), for example, documents the shift from behavioral to cognitive that has occurred in psychology and research in instructional technology. New research paradigms are also finding their way into educational research (e.g., natural-

Table 1

Examples of Alternative Research Paradigms Employed in Instructional Systems Research

Research Paradigm	Study Utilizing the Paradigm
Quasi-experimentation	1. Hannafin (1983)—a study of the performance effectiveness of an empirically verified instructional system vs. traditional instruction over an 8-month time span.
Meta analysis	2. Kulik, Kulik, & Cohen (1979)—a metaanalysis of outcome of studies of Keller's Personalized System of Instruction.
	3. Kulik, Kulik, & Cohen (1980)—a meta-analysis of findings concerning the effectiveness of computer-based college teaching.
	4. Bangert, Kulik, & Kulik (1983)—a meta-analysis of masterybased approaches to high-school instruction.
	5. Klauer (1984)—a meta-analysis of the effects of pre-instructional acts, such as behavior objectives, questions, and learning directions, on intentional and incidental learning.
Case Study/Ethnography	6. Baird & White (1982a)—a case study in which the process of acquisition and the nature of retention of intellectual skills were studied on three adults.

istic inquiry in evaluation, Guba, 1978; developmental research, Sanders, 1981; practical research, Schubert, 1980), and many of these hold promise for research in instructional systems. Because of the developing nature of instructional systems, instructional systems researchers should embrace a wide variety of research paradigms and not yet yield to the dominance of any one.

While the traditional experimental paradigm plays an important role in our search for functional laws and cause-effect relationships, the focus of this paper will be on alternative paradigms to experimental inquiry that may be useful to instructional systems researchers. Cook and Campbell (1979) note the difficulty in the theoretical systems of the social sciences of maintaining experimental control over all outside variables that may impinge on a dependent variable under investigation. They offer a variety of quasi-experimental designs to permit valid causal inference even in the absence of rigid experimental control. In instructional systems, we also face interesting and important questions that are noncausal in nature and thus not amenable to solution through experimental or quasi-experimental designs. A variety of alternatives to experimental inquiry will be presented in this paper. Each will be discussed in relation to the types of instructional systems research problems they will enable us to investigate. Finally, specific examples will be described of some of the alternative paradigms as they have been implemented in instructional systems research.

	7. Baird & White (1982b)—a case study in which the process of learning genetics with understanding was investigated.
	8. Center for New Schools (1974)—an ethnographic study of teacher-student relations in a public alternative high school.
Systems-based evaluation	9. Hanson & Schutz (1978)—a research and development effort to install, evaluate, and improve a new, research-based instructional program.
Cost-effectiveness	10. Klein & Doughty (1980)—a study of cost-effectiveness evaluation applied to an innovation program in higher education.
	11. Golas (1982)—a study of the effectiveness and cost of alternate models of formative evaluation for printed instructional materials.
Model Development	12. Reiser and Gagne (1983)—the development of a model for selecting media on the basis of practical factors and learning effectiveness.
Technique Development	13. Driscoll & Tessmer (In press)— the development and testing of a rational set generator for teaching and testing defined concepts.

Alternative Paradigms for Research in Instructional Systems

A variety of alternative paradigms for research and specific examples of research studies in instructional systems that have employed these paradigms are summarized in Table 1. Each is discussed below, both in terms of how it might generally apply in the field and how at least one researcher has employed it.

Quasi-experimentation. Quasi-experimental designs for research represent a step between strictly experimental and nonexperimental paradigms. They deserve attention because they solve some of the problems raised with respect to experimental control in instructional research. For example, it is not always possible or desirable in instructional research to randomly assign individual students to treatment conditions or to assign some students to receive a particular treatment which others will not receive. For example, a study investigating achievement differences between students receiving instruction via computer versus those receiving a traditional format. Teachers (or parents or administrators) might insist that all students should receive the computerized instruction.

Other problems stem from the myriad of uncontrolled factors present in classroom settings that can nullify the application of laboratory findings to these settings. Effects found in short term experimental studies may also fail to hold up in the long term because of these mitigating classroom influences. Studies conducted directly in these settings will face problems with experimental control. Cook and Campbell (1979) present numerous designs for field settings in which all the controls of the laboratory cannot be maintained. They discuss statistical as well as design strategies for use in these settings that

will permit valid causal inference despite the lack of controls.

A specific example of a quasi-experimental study in instructional systems is Hannafin (1983), who investigated achievement differences in mathematics between Anglo and Hispanic students assigned to either traditional instruction or to an empirically verified instructional system. The study took place over a period of 8 months, and is one of the few studies to examine performance effectiveness of instructional systems over an extended time period (see also Ebmeier and Good, 1979, and Grabe and Latta, 1981).

Meta-analysis. Meta-analysis is a nonexperimental technique that uses previously reported research findings as its "subjects," meta-analysis (Glass, 1977) can serve an increasingly important function in instructional systems research. It provides a statistical means for synthesizing research findings, a task that typically precedes the planning of a "next step" in any line of research. It can help us come to global conclusions as to whether a previously researched instructional technology has an effect on learning and how large the effect is. This is particularly important when controversies exist in the literature over the effectiveness of a particular technology.

Kulik and his associates have been responsible for a number of recent meta-analyses of research on the personalized system of instruction (Kulik, Kulik, and Cohen, 1979), computer-based college teaching (Kulik, Kulik, and Cohen, 1980), and mastery-based approaches to high school instruction (Bangert, Kulik, and Kulik, 1983). In addition, Klauer (1984) synthesized effects of such pre-instructional acts as behavioral objectives, questions, and learning directions on intentional and incidental learning.

Case Study and Ethnography. While quasi-experimental designs help us to account for contextual influences on learning variable, these influences become an integral part of the investigation in case studies (cf. Glaser and Strauss, 1967) and ethnography (Rist, 1977). Both assume that phenomena cannot be validly studied in isolation, that context in part determines and defines any phenomenon in question. Researchers employing these paradigms argue, for example, that different contextual influences will be operating in different settings, mitigating the effects of any particular learning variable or technology. Explanation of effects must therefore directly consider what contextual factors were operating and how they affected results in a given situation.

Baird and White (1982a,b) use case study to more directly investigate the individual's involvement in learning than is permitted by experimental designs. They assume that general learning principles will be so masked by context and individual differences that they should not be specified a priori but rather allowed to emerge as an investigation proceeds. In two studies examining how several adults learn and retain genetics concepts and skills, Baird and White identified and described two different learning styles and specific recurring learning deficiencies that led to inadequate learning.

One type of case study, ethnography, draws from the assumptions and methodologies of anthropology. Those applying ethnography to education seek to study the "culture" of a teaching-learning environment, and employ such techniques as naturalistic observation and unobtrusive measurement. The Center for New Schools (1974) study of student-teacher relations in an alternative high school is one of several examples reviewed by Wilson (1977).

Systems-based Evaluation. Factors stemming from the context in which a new technology or instructional system is implemented can also greatly affect its success or effectiveness in the setting. Social, political, or economic problems can impair technology effectiveness to as great or greater degree than some inherent problem with the technology itself. To monitor these types of influences, then, systems-based (Cooley and Lohnes, 1976; Borich and Jemelka, 1982) or naturalistic (Guba, 1978) approaches to evaluation offer more than experimental, comparative designs. Systems-based designs will enable us to define what makes technologies effective in some settings and not others, so that we will be less likely to discount a technology simply because it was not the solution to our educational ills.

Hanson and Schutz (1978) followed a systems-based, developmental approach to install, evaluate, and then improve a new, empirically based instructional program. The point of their project was not to compare the new program to some competing one, but to use data on a continual basis to make adjustments in the new program so that it would be effective for a particular setting.

Cost Effectiveness. Cost effectiveness/cost benefit questions are also among those that do not lend themselves to experimental investigation. Only cost analyses will reveal one technique or set of procedures to be more or less expensive than a competing technique. As for questions of effectiveness, criteria by which a technique or program is judged beneficial despite its cost should be defined, taking into consideration situational variables.

In a series of articles on cost-effectiveness analysis and its use to evaluate educational programs, Doughty (1979), Lent (1979), Beilby (1980), and Klein and Doughty (1980) discussed conceptual and practical criteria for judging cost-effectiveness, presented models for applying cost analysis to decisions about educational technology applications, and provided a case study of these analysis techniques applied to an innovative program in higher education. Klein and Doughty (1980) also reflected on their experience of conducting a cost-effectiveness study and presented both benefits and problems that resulted from it.

Golas (1982) also utilized Beilby's method of cost analysis in a study looking at a specific instructional design technique rather than an entire program. She determined that providing designers with guidelines for making revisions in print materials, based on empirically derived features of effective instruction, was equally effective but less costly than having the designers gather student data on which to base their revisions. Such a finding certainly has implications in tight economy where ways of cutting costs while maintaining effectiveness are welcomed. Other cost effectiveness/cost benefit findings might also help to broaden the application of instructional

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systems technology.

Technique and Model Development. Briggs (1982a) suggests that future research in instructional systems include both model and technique development. As learning environments grow more diverse and learners participate more in determining what they will learn, new models of instructional design or substantial revisions to old ones may be warranted. Similarly, as content-to-be-learned grows more problematic, new techniques for analyzing and presenting it may be required.

Technique and model development were the object of inquiries conducted by Driscoll and Tessmer (in press) and Reiser and Gagne (1983), respectively. Driscoll and Tessmer developed a new method for systematically creating examples for teaching concepts and testing student acquisition of them. The method produces examples that cover a full range of concept discrimination and generalization. Reiser and Gagne developed a model for selecting media for instruction on the basis of both practical factors and learning effectiveness.

Summary. The examples described above are by no means exhaustive of what new approaches are being applied in instructional systems research. See Briggs (1982b) for a discussion of some other research paradigms and dissertations that have employed them. These examples are indicative of new directions in which we can and should be heading. It is also worth noting that research paradigms need not be applied singly to answer questions of interest. It may be to our advantage to combine them, as for example, a hypothetical quasi-experimental study investigating differential effects of two instructional strategies that also includes measures of development time and cost. In addition, time and cost data might be routinely collected in development projects to serve as a comparison base in later research.

Conclusion

We will miss asking and investigating important questions concerning our instructional design models, their implementations and applications, if we hold to a narrow view regarding research. Traditional experimental research designs do answer some of our questions, particularly with reference to single and interacting learning variables, but they leave much of the story untold. It is time we embraced a range of inquiry paradigms for research in instructional systems.

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