The Pursuit of Useable Knowledge in Instructional Technology

☐ Rita C Richey

The object of inquiry in instructional technology is not simply knowledge, but useable knowledge. This paper explores the dimensions of relevance with respect to research and suggests ways the research community can accommodate the needs and interests of practicing professionals in the field. Research relevance is examined as a reflection of: (a) practitioner and disciplinary values; (b) perceived credibility, viewed in terms of authenticity, methods employed, and replicability; and (c) perceptions of utility based upon the concrete nature of the findings. Specific recommendations relate to expanding the range of topics addressed in our research, expanding the range of research methods employed, orienting our research communication to specific practitioner communities, conducting research under natural conditions, replicating research, and establishing links between abstract and concrete findings. Finally, the role of the practitioner as an educated consumer of research is discussed.

☐ Educators have historically fretted over the difficulties inherent in establishing links between research and practice. Such worries encompassed the extraordinary time required to translate research findings into accepted commonplace routines, as well as the frequent inability to effect change at all in spite of seemingly overwhelming research support. Over the years, the field of instructional technology has also had these same preoccupations from time to time (Clark, 1989; Finn, 1953; Heinich, 1984), and many questions continue to surface as to the extent to which the field's research and practitioner communities are effectively communicating. This is particularly critical to a field in which the object of its inquiry is not simply knowledge, but *useable* knowledge. In other words, research should be responsive to the current or emerging needs of practitioners and ultimately to the solution of professional and social problems. Acceptance of such a premise implies that researchers not only must recognize and anticipate professional needs, but their research agendas must be attuned to those needs.

Useability is, in one sense, a matter of individual judgment. As such, it is highly dependent on one's values and beliefs. It is also a function of individual imagination and ingenuity. However, useability is a social construction as well, a function of the prevailing state of knowledge and technology in a field. At any point in time, there is substantial agreement among professionals in the field on the most pressing issues and problems, and research not directed in some manner toward these issues is not perceived as being useable. Knowledge may also be considered unuseable if its applications are viewed as infeasible, obsolete, or not socially beneficial. Other knowledge may simply be so abstracted from everyday concerns that few can conceive of a practical use.

There are diverse forms of useable knowledge stemming from highly diverse types of research. Useable knowledge can be the product of basic, as well as applied research. It can be the product of experimental, as well as nonexperimental methods. However, it must be reliable and authoritative. It can be in a form ready for immediate use, or it can still need translating into a form more conducive to application in instructional or work settings.

The research-practice issue is complex and multidimensional. There are aspects of the problem that pertain to methodology, others that relate to diffusion of innovation, and others that concentrate on relevance. This latter dimension of the research-practice interface is a matter of the extent to which the professional communities view the topic and findings of a study as significant and useful. Relevance is the perception that the findings are in fact useable knowledge.

Explorations of research relevance are typically examinations of shared perceptions, the extent to which researchers' notions of relevance are congruent with the perceptions and needs of practitioners. The metaphor of academics living in an ivory tower implies a rarified and distant research environment, a culture different from that of the "real world." However, this seems to be an overly simplistic explanation of differing perceptions of the relevance of research. It is an interpretation that implies a need for shared vision rather than sharpened vision.

The word *relevance* elicits thoughts of Keller's use of relevance in his ARCS (attention, relevance, confidence, satisfaction) theory of motivation design. Here, Keller (1983) equates relevance with the situation in which "important personal needs are being met by the learning situation" (p. 406). His views of relevance relate to needs, familiarity, and values (Keller, 1983, 1987). In the context of research, relevance has similar connotations. The key dimensions discussed here are values, credibility, and utility. Values influence one's perceptions of the relevance of research in many of the same ways as a learner's values influence his or her motivation towards instruction and learning. Credibility is influenced by familiarity, but is a broader concept. It also includes methodological considerations and perceptions of authenticity. Finally, the notion of utility encompasses Keller's emphasis on whether needs are being met—in this case the needs of the practitioner. With respect to research, these three factors seem to serve as a type of internal screening process that consumers of research use to determine the relevance of a given study for their work. First, does the topic seem to conform to one's views of what's important, of what's interesting? If so, is the research credible? Is it valid? Finally, is it useable? I will explore each of these aspects of relevance and suggest ways the research community might better accommodate the needs and interests of practicing professionals in instructional technology, as well as explore ways in which practitioner communities may become better informed consumers of research.

ACCOMMODATING PRACTITIONER VALUES

Values and the Recognition of Relevance

Values are integrally tied to research and have a dominant influence on perceptions of its worth. Strike (1979) argues that "the most persuasive argument concerning facts and values holds that factual claims are never sufficient to entail value claims" (p. 13). There are at least two interpretations of the concept of values that are pertinent to this discussion. The first relates to personal interests, and the second speaks to beliefs and ideals. Both share a role in influencing whether individuals are attracted to a given study and to whether they will give it the amount of concentrated attention required for eventual application in a work environment.

One of the most common responses to the question "What makes research relevant to me?" is "If it concerns an area that I'm interested in." If one probes further, such interest reflects current practical needs ("I need to build a case [at work] to support a recommendation or practice") and curiosity ("I like to look at trends. I like research that brings out something new in the field"). Interests vary from one point in time to another or from a given community of practitioners to another, reflecting varying cultures and constraints. Teacher interests and needs differ from corporate training designers. Teachers are typically learner-centered and demand flexi-

bility and autonomy, while many trainers are more interested in consistency, replicability and impacting profit. Interests can also vary among industries. Even though interest is highly variable, there are topics that normally command considerable professional attention. These reflect the common needs of most practitioner communities, such as the creation of effective, efficient, and cost-effective instruction.

While personal interests influence whether individuals are attracted to a given piece of research, it is beliefs and ideals that shape the extent to which such interest is sustained. Strike (1979) suggests that:

> . . . situations do not become problems unless we approach them with values which specify what properties these situations *ought* to have . . . . It is our ideologies which turn events into problems. Not that human needs are irrelevant, but our ideologies tell us what human needs are . . . and legitimize or fail to legitimize needs expressed by various groups as having a claim on public attention (p. 10).

Values influence whether the research commands attention and how the research problem is defined. One example of this was the bulk of research speaking to the minimal impact of class size on learner achievement. This clearly was incompatible with prevailing teacher opinion, and by and large, the research was ignored. Clifford (1973) noted this phenomenon 25 years ago when she concluded that "application of, or deference to, research depends less upon its quality or completeness than upon such social and ideological factors. . . upon the *zeitgeist* of education and society" (p. 37). Today, society's fascination with the computer is directing our research and problem-solving efforts to a great extent. Learner control is explored in terms of hypermedia. Electronic performance support systems are seen as key solutions to the design cycle time problem. Of course, one advantage of multiple sets of social and professional values is that there is a possibility of support for a very broad base of research.

Synchronizing Research and Values

Researchers can assume a number of positions with respect to the question of values. They can remain silent on such issues, or they can identify the values of others (the workplace, for example) and orient the research around those values, or simply select values of their choice and formulate problems and proceed on the basis of that viewpoint (Lindblom & Cohen, 1979). Strike (1979) proposes another position when he suggests that the object of practical research and practical theories is to get the world to correspond to the values of the researcher.

Regardless of the strategy selected, if research is to have an impact on the workplace, it must be synchronized with the dominant values and interests of a particular practitioner community. Ultimately, this synchronization is a matter of coordinating research goals to the goals of practice. Some instructional technologists argue their goal is the creation of resources and environments for *learning*. Others argue their work is directed toward *performance improvement*. Others suggest the goal is *organizational improvement*. With diverse practitioner goals, researchers must select those communities most likely to be interested in their work and create links. These connections can be made in a number of ways, but two of the most obvious are through the topics being studied and the channels of communication.

Research Topics. Research topics determine practitioner interest and perceptions of useability to a great extent. While some research topics are dictated by formal policy decisions, such as those of a funding agency, more often they are determined by the idiosyncratic interests of individual researchers who operate under few constraints. What topics are currently being addressed in our journals? I randomly selected one recent volume, # 41 (1993), of *Educational Technology Research and Development (ETR&D)* to see if topical patterns could be identified in the empirical research reported in both the research and development sections of those four issues. Two striking conclusions emerged. A third of the studies pertained to message design topics and almost another third emphasized teaching/learning strategies. However, the underlying topic in 10 of the 13 research reports was some aspect of computer applications, and half of the nonempirical articles in these issues were also technology related—4 dealing with com-

puters and 2 with television or video. This literature primarily addressed product development issues. There was no research directly pertaining to instructional systems design problems, models, or techniques. No projects addressed resource utilization, management or evaluation topics. Learner characteristic variables did have secondary roles in some research.

Our research must address a broader range of topics if it is going to command the interest of a similarly broad range of the discipline. I would like to see research that validates design models and processes, such as approaches to rapid prototyping and cognitive task analysis. There is also a need for systematic evaluation of the popular electronic performance support systems. I think there is also a need for more research on professional issues, such as studies of technology-related policy formation or studies addressing the certification issue. I would like to see research on facilities design and management. I would like to see research on the reduction of design cycle time and designer decision-making processes.

Adamski's (1998) research is an example of the exploration of new topics and the synchronization of the interests of multiple practitioner communities. This study involved the development and validation of models for constructing job performance aids (JPA) for use in high-risk environments, specifically the aviation industry. This project had four distinct phases: (a) a comprehensive review and synthesis of the instructional technology, message design, and human factors literature that addressed JPA design, and interviews of subject matter experts in each area; (b) the construction of two JPA design models, one conceptual and one procedural, and evaluation of these models by the expert panel; (c) the application of the models in the development of a JPA for use by aviation cabin crewmembers to assist their decision-making performance in aircraft emergency situations; and (d) an evaluation of the effectiveness of the JPA and the design models through the observation of cabin crew-member performance in an aircraft cabin simulator. This developmental study has produced and validated two design models, a product available for immediate use, and findings pertaining to design and training for the use of JPAs. There are specific recommendations for practitioners in the study.

How does a field as a whole expand its range of research topics? Would journal or professional organization guidelines be heeded sufficiently to alter the course of inquiry, given the traditional independence of researchers? Would public dialogues between researchers and practitioners highlight pressing needs? Would collaborative research agendas focus on practical issues and problems? Would research synthesis and theory construction efforts provide validated direction for practice, capitalizing on the knowledge base that already exists? These questions have no answers, but perhaps each suggests one way of centering attention on the issue and thereby encouraging changes in our collective body of research.

Channels of Communication. Research is directed to specific communities via the journals in which the studies are published. The degree of congruence between researcher and practitioner values is a function, in part, of the extent to which journals are specialized. However, since this field cannot support a plethora of research journals, most are generic rather than specialized in nature. This means that if a study does have a particular practitioner focus, the researcher must flag it. This is currently accomplished by some authors through their titles, problem statements, and through the discussion of findings and implications. There are other standard mechanisms that facilitate practitioner access to pertinent research findings, including introductory comments by editors and the use of key words for accessing retrieval systems. Of particular value, however, would be the publication of an annual volume of comprehensive reviews of research on topics of current interest, similar to the *Review of Research in Education,* but directed only to instructional technology research. Not only would such a publication aid scholars, but also it would provide practitioners with syntheses of large bodies of research. They could utilize research findings without devoting inordinate time to the examination of individual studies. The reviews would be timely, and research as a whole could be more readily linked to varying practitioner interests without the necessity of creating new journals. The issue is not only one

of meeting special interests, but also one of the accessibility of research findings.

One last comment on the subject of research and values: If everyone agreed on an issue, if everyone shared the same beliefs, there would be no reason to do research. Research is about exploration of unclear topics and often research is about disrupting beliefs and creating controversy. While research should respond to disciplinary interests and values, it should never be expected merely to confirm conventional wisdom.

ESTABLISHING THE CREDIBILITY OF RESEARCH

To be useable, knowledge must not only be responsive to societal and individual values, but it also must be credible. The issue is essentially one of ascertaining how the profession determines that a given study is accurate and, consequently, credible. I will explore three factors—(a) perceptions of authenticity, (b) confidence in the research methods, and (c) replicability.

Establishing Authenticity

Research credibility is dependent to a great extent on how authentic it is deemed to be. At times, authenticity is confused with authority. The research community is often influenced by one's opinion of the institution a researcher is associated with, the person's academic preparation, or other unrelated factors, such as age, or academic rank. A common practitioner viewpoint is that researchers without recent "practical" work experience lack the authority necessary to command respect for them and their findings. At other times, a particular research finding is judged to be "authentic" if it concurs with one's own experiences. Lindblom and Cohen (1979) describe this situation as one in which scientific knowledge conforms to ordinary knowledge, or "knowledge that does not owe its origin, testing, degree of verification, truth status, or currency to distinctive . . . inquiry techniques but rather to common sense, casual empiricism, or thoughtful speculation and analysis" (p. 12).

The difficulties occur when research findings run counter to ordinary knowledge, when they do not "ring true" to past experiences. Conflicting research data are typically ignored. Chinn and Brewer (1993) have shown the ways we reject research findings that are inconsistent with our prior beliefs, our ordinary knowledge. When findings do not support conventional wisdom, they are largely ignored. Research cannot be wholly credible without directly confronting the discrepancies between its findings and prevailing opinion. On the other hand, when findings are consistent with ordinary knowledge and common experience, a high level of credibility is established. The dilemma can be one of building bridges between one's research and this ordinary knowledge without resorting to the study of trivial topics and issues.

Often perceptions of authority and concurrence with the real world depend on the extent to which the study's design and setting conform to the real world and its real problems. In other words, the research is seen as authentic. Authenticity is suggested if the research is situated in natural work settings and if the subjects are realistic. Realistic and useable stimulus materials suggest authenticity as well.

It should be emphasized that such authentic characteristics are not only peculiar to applied research, in spite of the fact that natural settings are more inherent to such studies. Research that tends to be more basic in nature can also have authentic traits even while controls are established to isolate the effects of key variables. Subjects in basic research can be representative of those learners in natural settings. Likewise, the instructional content and materials used in basic research designs can have realistic elements.

Nonetheless, much research lacks an authentic atmosphere. Ross and Morrison's (1996) examination of experimental research methods in the field showed that between 1983 and 1992, only 44% of the research in the research section of *ETR&D* took place in a classroom setting, while between 1953 and 1962, 67% of the research took place in such settings. Between 1983 and 1992 only 18% of the stimulus materials were actual teaching/learning materials, while in the earlier time period one third of the studies used actual materials. This suggests that research is typically not fully anchored in the real world, and the trend is toward using less—not more—authentic research environments.

This does not appear to be a trend, however, toward conducting basic rather than applied research. Rather it seems to be applied research using convenience samples and settings.

In my analysis of the research described in *ETR&D* in 1993, only two studies took place in a natural environment, with two thirds of them occurring in laboratory or simulated settings. Twenty percent of the 1993 studies used actual stimulus materials, and another 42% used materials typically categorized as "realistic." In other words, they were similar to actual teaching/learning materials in many respects, but not actually used for instruction; often they had been altered for experimental purposes. The analysis of subjects showed a preponderance of college student subjects—53%. In most cases these students served as an experimentally accessible sample rather than true representatives of a target population. Nearly a quarter of the studies used a K–12 student sample. There were no studies involving adults in a training environment. One survey included instructional designers.

When the dominant portion of the research in an applied field has simulated attributes, there can be concerns as to its perceived credibility. While this may not damage the integrity of an individual study, it is more serious when it characterizes a *collective* body of research. Even more serious concerns pertain to the nature of the subjects. No research in this group speaks to the interests and needs of designers and trainers outside of the school setting, a very large and growing segment of instructional technology practitioners. This leaves the field open to the charge of substantially neglecting a key element of the practitioner community.

Jones's (1998) study is a good example of authentic research that is likely to produce useable knowledge. She examined the manner in which a particular rapid prototyping design process was collaboratively used by the design teams and the customers in actual projects. Particular attention was given to its impact on design and development cycle time, perceptions of product quality, and customer and designer satisfaction. The ultimate goal of the research was to validate and refine the rapid prototyping model so that it more accurately reflects reality and its applications to a broad cross section of design environments. This study is a form of developmental research (Richey, 1997; Richey & Nelson, 1996) that uses qualitative techniques. It was dependent on data from designer and developer work logs and interviews, client interviews, and review of other extant reports and records. The three projects studied varied in duration, complexity, and instructional delivery system, encompassing both paper-based training and computer-based training. A Detroit area design firm opened its files to the researcher. Rather than seeing the research as intrusive, the firm obtained useful data regarding the effectiveness of its design procedures. Management needs such data, but is typically unable to devote time to projects of this sort, even if they do possess the requisite research skills. The topic of this research is one that is currently discussed a great deal in the literature, but typically in a somewhat abstract fashion since there is little empirical research available even under simulated conditions. Research on this topic, and other topics as well, can be especially authentic, and consequently especially useable, when it is situated in "real life" settings using subjects in their natural roles with all of their concomitant constraints and irregularities.

Enhancing Confidence in Research Methods

Methodological Rigor. Another aspect of research credibility is the extent to which it is sound methodologically. Ultimately, the methodology of a given study impacts the extent to which one is persuaded to believe in the accuracy and subsequently heed the study's findings. Frequently, methods concerns are more critical to the research community than to practitioners, or practitioners may be willing to assume methodological expertise if the authority of the researcher has been established. Unfortunately, there have been concerns with the technical quality of some of instructional technology research over the years (Clark, 1989; Clark & Snow, 1975; Heinich, 1984; Lumsdaine, 1963). In 1989, Clark still lamented that "Too many studies present simplistic conceptualization and design coupled with suspiciously elab-

orate statistical analysis of data" (p. 57). These are questions of the rigor with which our research is being conducted, and of its ultimate defensibility. This may not have been a dominant opinion during the 1980s and presumably the field has progressed over the past decade, but even so the field must be vigilant in maintaining high methodological standards. In addition, there are other questions of a more philosophic nature that should be entertained as well.

Alternative Methods. In the scientific community, there have been debates among positivists and interpretivists that have implications for methodological credibility and the corresponding strategies that researchers use. The positivist orientation is that "the nature of science is essentially abstraction and generalization . . . . It is only by virtue of our willingness to abstract that we can ever find a pattern, and patterns are the bedrock of science" (Goldenberg, 1992, p. 354). Positivist research tends to focus on testing hypotheses. Interpretivist research seeks patterns of interrelationships among many facets of a problem, and ". . . uses a lens that permits a much less precise vision of a much broader strip" (McCracken, 1988, p. 16). In keeping with these and other divergent philosophies, researchers tend to be oriented toward alternative methods. They tend to produce either quantitative descriptions and analyses of behavior with the goal of prediction or qualitative verbal descriptions of situations with the goal of interpretation.

The basic differences among the various methodological positions relate to the notion of causality. House (1991) highlights the critical problem when he questions "How is it possible for research to be relevant to practice if the researcher cannot guarantee that Event A will be followed by Result B . . . ?" (p. 8). While causal relationships have traditionally been the domain of experimentation, other methods are also informative in this respect. For example, those that identify patterns of behavior, or validated models and products also imply *If—Then* relationships that are a rich source of practical knowledge. Perhaps the way to establish the highest level of confidence in a group of findings is for the various methods to converge on a common solution. This necessitates a body of research with methodological diversity and balance.

There may be a relationship between some perceptions of the "impracticality" of our research, and the fact that the bulk of our published findings from the past were derived primarily from experimental designs. Such concerns may not be well founded since experiments are a reliable vehicle for causal inference. The difficulties may lie not so much with reliance on experimental methods, but rather on the typical use of experimental designs in contrived settings.

Clearly, relevant research can utilize an experimental design. One example is the research of Kuhn (1997), an experiment based upon the actual training of medical residents using problem-based learning and facilitated discussion techniques. This is a matter of some controversy within medical education. The object of the study was to determine if this teaching method is a more effective way of facilitating the acquisition of expertise by novice physicians than is the traditional lecture approach. There were two experimental groups cast in different hospital settings. Both of these groups had received instruction on the diagnosis and treatment of asthma patients using problem-based training techniques. There were also four control groups, two at each hospital setting. Each site included one group of attending physicians and one group of third-year residents who had been taught asthma treatment with lecture techniques. The sample then consisted of novice physicians (the experimental groups), intermediate physicians (the third-year residents), and expert physicians (the attendings). Charts of asthmatic patients of all residents and attending staff from the two hospitals were collected and a random selection was evaluated to measure diagnostic expertise and transfer of training. This study found that novice physicians could be trained to perform in the same manner as experts (and better than the intermediate physicians) given the proper instructional strategies; however, the study concluded that the use of problem-based learning was more appropriate for those who already had a basic knowledge of the subject matter. This was a traditional experi-

mental study in many respects, but the fact that it occurred in a natural teaching/learning environment enhanced its relevancy.

It is not unusual for a variety of methods to be employed in a given study. For example, Hill and Hannafin (1997) describe a study of the strategies used by adult learners using the World Wide Web, an open-ended hypermedia information system. This research is basically qualitative in nature, but also incorporates traditional survey and quantitative techniques. While the research involves procedural manipulations (such as researcher prompting during the learner's search activities on the Web) and selective targeting of key variables, the task and the setting were representative of those occurring naturally in many learning environments.

Arguments for methodological diversity also stem from fears that by limiting one's methodology options, one is limiting the selection of research topics themselves. Nearly 20 years ago Mishler (1979) warned that research methods tend to determine the problem investigated instead of the reverse. The admonition is still being made with respect to research in instructional technology (Driscoll, 1995). If we, as a discipline, continue to expand our range of methodologies, it is likely that we would expand the topics that we study as well.

Establishing Credibility through Replication

The Role of Replication. Chinn and Brewer (1993) note that the credibility of data is dependent in part on their replicability. King (1995) describes the traditional process and role of replication: "The replication standard holds that sufficient information exists with which to understand, evaluate, and build upon a prior work if a third party could replicate the results without any additional information from the author" (p. 444). The issue of replicability is one in which the instructional technology field as a whole seems vulnerable. In Schwen's 1977 examination of the criteria by which we should judge disciplinary research, his first standard was "Inquiry in educational technology should be publicly verifiable" (p. 11). In other words, research designs should be clearly documented and replicable. A particular problem is that treatment materials are often unavailable. It is seldom possible to replicate studies using the same instructional materials or programs, but there may be a more basic difficulty. The problem may not be a reluctance to replicate because the primary research lacks sufficient detail, but rather that replication is not seen as a priority, or even interesting and challenging.

The replicability issue, however, is more complicated than simply being a case of unobserved standards. Kaplan (1964) noted that "Many important scientific observations take place on special occasions whose recurrence is incidental to their scientific significance . . . . when such events happen again . . . the recurrences can be expected to differ in ways relevant to the purposes of the observation . . ." (p. 127–128). This is not atypical of many of the problems we study. Although there are many situational similarities, few education and training events are exactly replicable in their entirety. Kaplan (1964) suggests that the real issue is not whether the research is replicable, but whether the observation is distorted by subjectivity. In quantitative research, this can be avoided by determining the reliability of instrumentation or by using multiple observers. In qualitative research, distortions are avoided by establishing "trustworthiness" (Lincoln & Guba, 1985), and there are techniques for establishing both external reliability of the data and internal reliability of the data's analysis.

Still, it seems that some type of research replicability is critical if a field is to have faith in the authenticity of its knowledge base. Herrnson (1995) has identified various notions and levels of replication, including:

- repetition of a study in its entirety, using the same procedures and the same stimulus materials;
- repetition of the analysis of the original data set;
- extending the analysis of a given data set.

The first case is true replication. It supports the authenticity of the findings using an independently collected data set and also can increase confidence in the original findings. The second case is reanalysis, and this constitutes a verifica-

tion of the original study or "determines the robustness of the analysis by using a different statistical technique" (Herrnson, 1995, p. 453). The third case involves a secondary analysis of the data, typically using the previously collected data as a basis for further study of different problems or more in-depth exploration of selected variables. This approach has been particularly useful with large data sets, or those that are longitudinal in nature.

In instructional technology, true replication is sometimes constrained if one is conducting the research in natural rather than contrived settings. However, even in these situations it is possible to duplicate research using the same, or similar, stimulus materials and the same procedures to verify findings. Reanalysis and secondary analysis are rare in our field due to the data sets being typically unavailable to the larger scholarly community. However, if data sets were accessible, the instructional technology knowledge base could be greatly enriched in a cost-effective manner.

There is a fourth variation on the replication process, one in which a study's procedures are repeated, but selected elements are varied. This would help us determine whether the unique characteristics of each situation take precedence, or whether there are generalized findings that are likely to be applicable to a variety of settings. This is key to the creation of useable knowledge in the field since practitioners are typically concerned with a type of external validity, the extent to which findings can be generalized to their own situations (House, Mathison, & McTaggart, 1989). *Systematic* replication could help identify the impact of alternative settings, the impact of alternative types of learners, and the impact of alternative types of content. Replication of this type is not dependent on the use of any particular methodology. The argument for its use transcends the various philosophical positions relating to methodology. Replication of all types would facilitate the credibility of research in instructional technology.

An example of research that is rooted in replicated results is that of Richey (1992). This was an investigation of those factors that impinge on training interventions and influence knowledge retention and changes in attitude and on-the-job behavior. The research spanned a four-year period studying corporate-wide training efforts to improve plant safety in a large automobile company. The study was conducted and replicated twice using path analysis techniques, and resulted in findings pertinent to systemic training design. The findings showed that the various training outcomes were related, but that knowledge retention had no direct relationship to on-the-job behavior. Instead, knowledge predicted attitude change, and attitudes in turn predicted behavior. This speaks to the complexities of transfer of training. The research further suggests that training outcomes were shaped to a great extent by factors external to the instruction itself. Organizational climate factors and the role of the adult trainee's pretraining knowledge, attitudes, and work habits were particularly important in predicting transfer of training. It was a study of many factors pertinent to training design, and its credibility comes not only from the fact that it was conducted in natural training environments, but that the findings were consistently replicated.

Facilitating Replicability. While most researchers would not disagree with encouraging replication, the dilemma is a practical one—how can it be done? There are two parts to this task: (a) setting journal standards, and (b) establishing public data sets. First, "Information for Author" announcements should include directions for authors to indicate on their manuscripts if their data set is available for replication. Manuscript reviews should then address the issue directly. This can be accomplished by rating a manuscript in terms of the extent to which the described study is replicable. Are the procedures described in sufficient detail to allow replication? Are stimulus materials required for replication available? Are directions included describing how this is possible? Is the data set public? How can it be obtained? These latter points could be included in a short footnote at the end of the paper. Another approach is for the journals to favor studies in which the researchers have replicated their own work in an effort to confirm their findings.

The second problem is that of storing and archiving the pertinent materials so that they will be readily available for other researchers.

Relying totally on the organization and diligence of individual researchers seems risky at best. There are existing vehicles that might be used to facilitate replication. After researchers used their rights to first publication, one's data sets could be made available for downloading through the Web. At the same time, stimulus materials, and/or data collection instruments, as well as the Web site address, could be deposited in the ERIC Clearinghouse on Information & Technology (ERIC). This would trigger a cataloging and distribution system. This process would make it possible to wholly replicate research, or to replicate research with systematic alternation of key variables, or to engage in reanalysis or secondary analysis of the data.

I am not oblivious to issues such as concerns of ownership, of protecting one's data for future work, or of protecting the anonymity of sources. Public data sets can expose one's professional persona to criticism as well as praise. There is also the potential obstacle of funding agencies or data sources, especially those in the private sector, claiming proprietary rights to the data. Obviously, much deliberation would be required in the development of replication policies and procedures, but guidelines are available from other disciplines. Even though there are risks, they should be outweighed by the benefits replication would afford.

BUILDING PERCEPTIONS OF RESEARCH UTILITY

The most common interpretation of research relevance relates to the perceived utility of the research findings. It is the essence of useable knowledge. In the vernacular, assessments of utility range from the old maxim, "There's nothing as practical as a good theory," to appeals for researchers to simply "Get real!" These two perspectives are often shaped by impressions of the research finding's level of abstraction as much as they are by the substance of the finding.

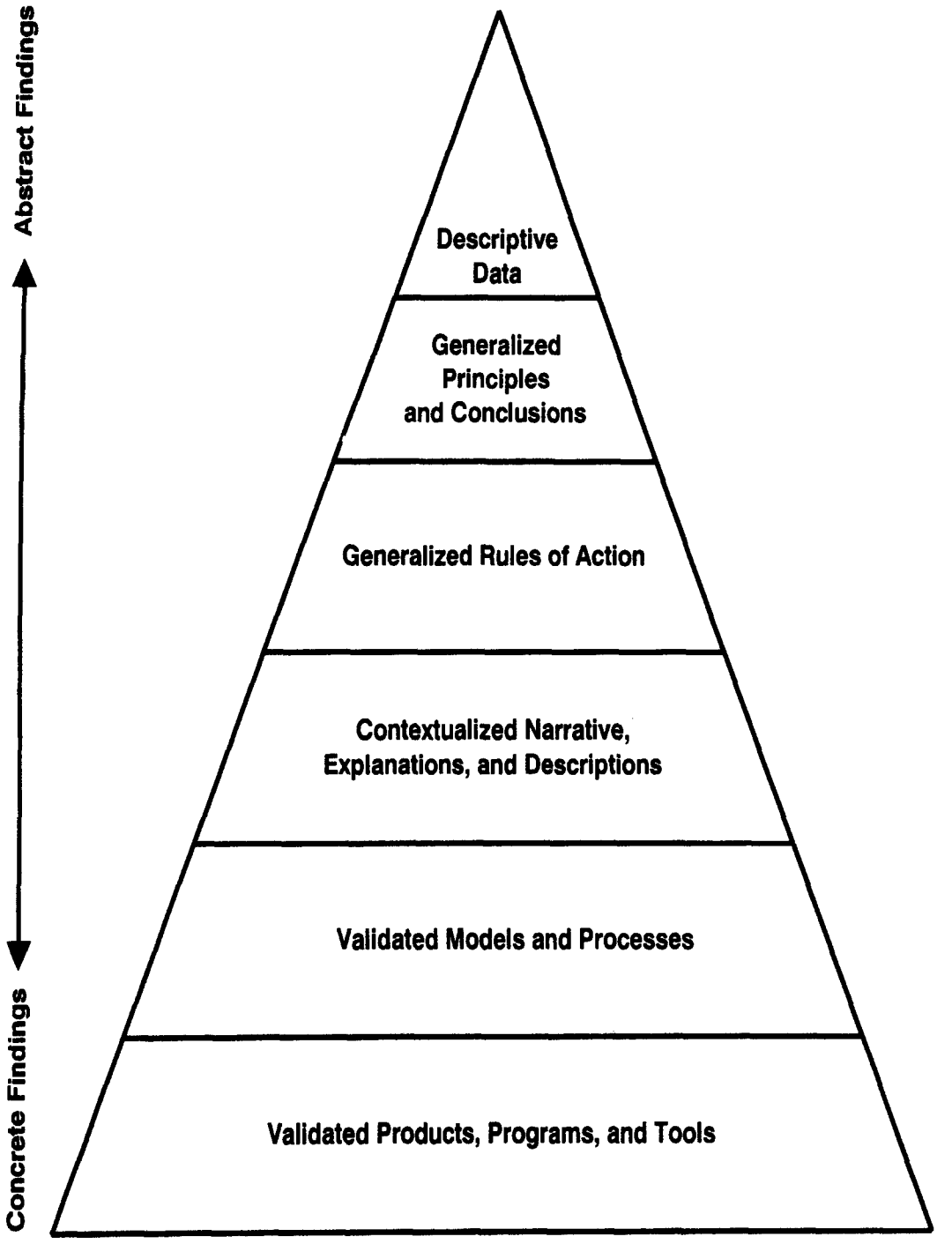
The Concrete Nature of Utility

Most research is useful in some respect to someone. The difficulties lie with making the practical connections. How can the utility become apparent to others? One scheme for analyzing research products in terms of their utility borrows on Edgar Dale's Cone of Experience (Dale, 1946). Dale's original cone graphic was "a visual aid to explain the interrelationships of the various types of audio-visual materials, as well as their individual positions in the learning process" (p. 47). The cone emphasized the contrasts between "direct experience and pure abstraction" (p. 47). It provided direction for the selection of instructional experiences and audio-visual aids. The point of Dale's cone is that one should use the various media to *anchor* reality to abstract thinking at different points during the learning process. It was not an effort to promulgate the use of realistic, concrete visual aids, but rather to promote the value of the *integration* of concrete experiences and abstract learning (Seels, 1997).

The message of the Cone of Experience may well be applicable to an analysis of the products of various research efforts. Research findings, like audio-visual aids, can be categorized in terms of their placement on an abstract-to-concrete continuum. Some research, like survey research, results in a set of descriptive data. Other studies produce generalized conclusions suggesting cause-effect relationships. For example, a study might produce generalized statements describing the relationships between preinstructional attitudes and outcomes of teaching/learning experiences. These findings are abstract and require "translation" into more concrete sets of instructional specifications in order to apply these findings to actual classroom situations. On the other hand, it is possible for a research project to produce findings, such as a validated multimedia instructional product, that are concrete and immediately useable. The degree of abstraction is likely to exert considerable influence on one's perceptions of the utility of particular research findings. What might be called a "Cone of Utility" can be used to identify the various categories of instructional technology research findings and their placement upon an abstract-concrete continuum. (See Figure 1.)

For instructional aids, placement on the abstract-concrete continuum is a function of the

Figure 1 ☐ The Cone of Utility



Note: Based upon the "Cone of Experience," (Dale, 1946).

amount of direct experience afforded learners. Does the message consist of just verbal symbols, or does it have aspects that are visual, observational, or actual "hands-on" experiences? For research findings, placement on this continuum is a function of the extent to which the findings:

- are generalized;
- provide specific directions for practice;
- are contextualized; or
- are elaborated with detail.

Abstraction can be a function of the degree of *generalizability* of the finding across teaching-learning situations. Generalized principles tend to pertain to single or interacting variables as with most experimental and quasi-experimental research, but they may stem from simple descriptions of a given trait in representative samples. Because they are abstract and are based upon carefully selected samples, such findings have the potential of being applicable to the widest range of circumstances.

Research outcomes can also be considered abstract because of the lack of *specific practical directions*. For example, at a mid-point in Gagné's career he conducted an experimental study of varying instructional sequencing conditions and their impact on achievement and positive transfer (Gagné, Mayor, Garstens & Paradise, 1962). This study supported what he subsequently called cumulative learning theory. However, Gagné, Briggs, and Wager (1992) made these findings concrete by detailing general rules of action related to building learning hierarchies and curriculum maps, and rules for teaching subordinate skills prior to teaching more complex but related skills. These guidelines provide the research findings some practical significance.

Abstraction can also be a function of a lack of *contextualization*. Detailed narrative explanations of a phenomenon are seen as more concrete than generalized findings not only because they provide a fuller description, but because we typically rely on context to help us understand human behavior.

Finally, abstraction can be a function of *detail*. Detail eliminates the need for further application, adaptation, or enhancement prior to use in a work setting. The most detailed research products are typically validated instructional products or programs, or tools that can be used by designers and developers; they are immediately marketable. However, even somewhat more general models of processes typically contain sufficient detail and direction to readily lend them to use.

Facilitating an Appreciation of Research Utility

The proposition underlying the Cone of Utility is that the more one is able to *integrate* abstract and concrete research findings, the more likely others are to see the research itself as useful. The message here is more complex than merely suggesting that applied research is more useful than basic research, or (to suggest a more contemporary argument) that qualitative and contextualized research is more useful than quantitative and experimental research. Rather, it suggests that the relationship between instructional technology research and practice can be strengthened by:

- producing research that covers the entire range of outcomes on the abstract-to-concrete continuum;
- linking the more concrete research outcomes to their theoretical foundations; and alternatively
- linking the more abstract outcomes to concrete problems and conditions.

Expanding the Range of Research Findings. Our current state of affairs is that published research in instructional technology tends to produce more abstract than concrete findings. To a great extent this is a function of the proliferation of experimental research in the past, in spite of the emphasis on qualitative designs in the discussion literature. While there is currently a trend toward publishing more qualitative research, findings are still frequently abstract in nature. These abstractions are exacerbated if the research has been conducted under contrived conditions, simulated settings using subjects atypical of the workplace in which the results are to be used. Interestingly, the predominance of published experimental research contrasted sharply with Higgins and Sullivan's 1989 find-

ings that the Association for Educational Communications & Technology (AECT) membership preferences were for case studies and applied research studies. These are types of research that tend to result in findings more contextualized in nature—narrative explanations, validated models, processes and products.

Clearly we need more research in instructional technology that produces concrete findings. We need qualitative research that produces context-specific explanations of phenomena. The current state-of-affairs in the field is that even though there is a great deal of innovative development work, there is little research on either the design and development processes being used, or on the many products created via these processes.

Linking Concrete and Abstract Findings. Perceptions of relevance are enhanced not only when findings are immediately useable, but also when the findings' theoretical foundation is clearly explicated. Such descriptions are one way of anchoring the concrete outcomes to more abstract ideas and generalizations. This anchoring process is similar to what Hannafin, Hannafin, Land, and Oliver (1997) call "grounded design." Grounded designs are based on a defensible theoretical framework, empirically verified through previous research, generalizable to multiple situations, and validated through successful implementation. These criteria speak as much to the perceived utility of a product as to its theoretical foundation. Utility is dependent on a history of successful use in similar settings, and expert designers tend to use their research knowledge as a tool to persuade clients of the efficacy of the various design techniques (Atchison, 1996).

This linking process is a two-way operation. Researchers can make the utility of their work more obvious by establishing links between abstract findings and their corresponding concrete applications. There are at least three ways this can be done:

1. by conducting basic research that deals directly with instructional technology concerns, rather than relying exclusively on the research and theoretical foundations from other disciplines;
2. by selecting research topics that have the potential of contributing to the solution of pressing, practical problems; and
3. by conducting field experiments.

Instructional technology has traditionally relied on a theoretical foundation "borrowed" from other disciplines—psychology, communications, engineering, business, computer science, and education in general. This is not atypical of applied fields. As our field matures, a theoretical foundation is emerging that directly addresses our own issues—such as conditions-based design theory and message design—and is being produced by our own scholars. To the extent that this trend continues, even our most generalized forms of inquiry will become increasingly anchored in the concrete activities of instructional technologists. Thus, even the most basic research will become more directly relevant to the field.

As the field begins to rely more on its own research, there will likely be a natural emphasis on current problems of instructional technology practitioners. As such, our research will not simply enhance *perceptions* of utility, but will be more useful at its core. This does not suggest a narrowing of our intellectual scope. Broad-minded conceptualization and being open to new ideas certainly aids disciplinary problem solving, but the most useful research is that which directly addresses our own problems. Ross and Morrison (1989) maintain that research that relates to real-life applications achieves a degree of external validity not inherent in other studies. For example, a study of the effectiveness of design teams, for instance, is more useful than studies of teaming in other circumstances, even though we should make efforts to learn lessons from the experiences from other fields of study.

Finally, research of all types can be anchored in the concrete if it is conducted in natural environments. This not only provides authenticity as previously discussed, but the additional variables present in such settings provide the possibility of a far richer data set than can be derived from laboratory-like research settings, even though there are dangers of confounding results. Reigeluth (1997) makes this point when he concludes that a theory is more useful if it "incorporates a wide range of conditionality to

account for the probabilistic nature of instruction" (p. 43).

PRACTITIONERS AS EDUCATED CONSUMERS OF RESEARCH

This discussion of the interface between research and practice has suggested changes in the research enterprise to facilitate the development of useable knowledge. Research application, however, stems from a partnership of researchers and practitioners with shared responsibilities. Researcher efforts to attune their agendas to practitioner needs will be futile if corresponding changes are not made to raise the typical level of practitioner sophistication with respect to research.

While practitioner access to research must be facilitated, such efforts will be wasted if practitioners are not informed readers. Few of the practitioner-oriented journals and magazines emphasize research, and it is common—even for those in graduate programs—to confuse publication with expertise. Readers must be able to distinguish research reports from opinion-based discussions of issues, and likewise distinguish such discussions from literature reviews and research syntheses. Readers of those journals who do publish research should have basic skills in interpreting research reports. They should understand the role of basic research and the techniques for making use of such findings. They should appreciate the value of replication. They should be aware of the fundamental principles of inquiry.

This task of being an informed consumer of research is further complicated today because of the mass of information of widely varying quality available through the Internet. Consequently, there is a greater need for individuals to be discriminating readers, to differentiate between propaganda and marketing ploys and legitimate recommendations based upon data.

The task of developing this informed consumer of research may ultimately belong to universities, to professional organizations, and perhaps to the researchers themselves. However, it is the practitioner's responsibility to engage in the task. Responsible professionals maintain a program of competency development and knowledge base expansion.

TECHNIQUES FOR CREATING USEABLE KNOWLEDGE: A SUMMARY

Throughout this paper I have suggested a series of techniques for enhancing the useability of instructional technology research. These are certainly not all-inclusive, but rather are intended to stimulate further thought and practice in this regard. These suggestions are:

- Expand the range of research topics to address the interests and values of a broad spectrum of the field; such expansion would move beyond the study of technology and instructional strategies by including subjects such as: validation of design models and processes (e.g. rapid prototyping, cognitive task analysis, designer decision-making processes), professional issues and challenges (e.g. technology-related policy formation, certification, design cycle time reduction), systematic evaluation of commonly used tools (e.g. various electronic performance support systems).
- Focus research on real world problems directly pertinent to instructional technology issues and practice.
- Conduct both experimental and nonexperimental research in natural work and learning environments using realistic subjects and stimulus materials.
- Employ a variety of methodologies in the conduct of both basic and applied research.
- Establish research credibility by replicating findings and making data sets available for reanalysis or secondary analysis by others.
- Overtly link abstract research findings to concrete problems, and concrete findings to their theoretical foundations.
- Publish annual research reviews to disseminate current findings on timely issues of interest to specific practitioner and scholarly communities.
- Cultivate an educated population of research consumers.

CONCLUSIONS

The production of useable knowledge is not a simple issue. It involves technical expertise, as well as the ability to anticipate and address critical problems. It involves being a good scientist, as well as being able to communicate and work with those who use science. It involves knowing what's relevant and how to make the relevance of knowledge apparent to others.

The discussion of research-practice interface begs the question as to whether researchers should be primarily concerned with current problems in the workplace or with the demands of theory construction. Both are legitimate positions, and they may not be fundamentally incompatible. In 1953, Finn suggested that . . .

> Without a theory that produces hypotheses for research, there can be no expanding of knowledge and technique. And without a constant attempt to assess practice so that the theoretical implications may be teased out, there can be no assurance that we will ever have a theory or that our practice will make sense. (p. 14)

It is hoped that the recommendations presented here may help bridge those gaps that sometimes divide researchers and practitioners, as well as divide researchers themselves. At the same time, these recommendations may contribute to making the research in instructional technology even better. □

Rita C. Richey is Professor and Program Coordinator of Instructional Technology at Wayne State University in Detroit. Her e-mail address is rrichey@coe.wayne.edu.

REFERENCES

Adamski, A. (1998). *The development of a systems design model for job performance aids: A qualitative developmental study.* Unpublished doctoral dissertation. Detroit, MI: Wayne State University.

Atchison, B.J. (1996). *Roles and competencies of instructional design as identified by expert instructional designers.* Unpublished doctoral dissertation, Detroit, MI: Wayne State University.

Chinn, C.A., & Brewer, W.F. (1993). The role of anomalous data in knowledge acquisition: A theoretical framework and implications for science instruction. *Review of Educational Research, 63*(1), 1–49.

Clark, R.E. (1989). Current progress and future directions for research in instructional technology. *Educational Technology Research & Development, 37*(1), 57–66.

Clark, R.E., & Snow, R.E. (1975). Alternative designs for instructional technology research, *AV Communication Review, 23*(X), 373–394.

Clifford, G.J. (1973). A history of the impact of research on teaching. In R.M.W. Travers (Ed.) *Second handbook of research on teaching* (pp. 1–46). Chicago: Rand McNally.

Dale, E. (1946) *Audio-visual methods in teaching.* New York: The Dryden Press.

Driscoll, M.P. (1995). Paradigms for research in instructional systems. In G.J. Anglin (Ed.), *Instructional technology: Past, present, and future* (2nd Ed.) (pp. 322–329). Englewood, CO: Libraries Unlimited, Inc.

Finn, J.D. (1953). Professionalizing the audio-visual field. *Audio-Visual Communication Review 1*(1), 6–18. (Reprinted in D.P. Ely & T. Plomp (1996). *Classic writings on instructional technology* (pp. 231–241). Englewood, CO: Libraries Unlimited, Inc.)

Gagné, R.M., Briggs, L.J., & Wager, W.W. (1992). *Principles of instructional design* (4th ed.). Fort Worth, TX: Harcourt Brace Jovanovich.

Gagné, R.M., Mayor, J.R., Garstens, H.L., & Paradise, N.E. (1962). Factors in acquiring knowledge of a mathematical task. *Psychological Monographs, 76* (7, Whole No.526).

Goldenberg, S. (1992). *Thinking methodologically.* New York: Harper Collins Publishers.

Hannafin, M.J., Hannafin, K.M., Land, S.M., & Oliver, K. (1997). Grounded practice and the design of constructivist learning environments. *Educational Technology Research and Development, 45*(3), 101–117.

Heinich, R. (1984). The proper study of instructional technology. *Educational Communications and Technology Journal, 32*(2), 67–87.

Herrnson, P.S. (1995). Replication, verification, secondary analysis, and data collection in political science. *Political Science & Politics, 27*(3), 452–455.

Higgins, N., & Sullivan, H. (1989). Perspectives on educational technology research and development. *Educational Technology Research & Development, 37*(1), 7–17.

Hill, J.R., & Hannafin, M.J. (1997). Cognitive strategies and learning from the world wide web. *Educational Technology Research & Development, 45*(4), 37–64.

House, E.R. (1991). Realism in research. *Educational Researcher, 20*(6), 2–9, 25.

House, E.R., Mathison, S., & McTaggart, R. (1989). Validity and teacher inference. *Educational Researcher, 18*(7), 11–15, 26.

Jones, T.S. (1998). *Validating the process of designing and developing instructional materials using the rapid prototyping methodology.* Unpublished doctoral dissertation. Detroit, MI: Wayne State University.

Kaplan, A. (1964). *The conduct of inquiry: Methodology for behavioral science.* San Francisco: Chandler Publishing Company.

Keller, J.M. (1983). Motivational design of instruction. In C.M. Reigeluth (Ed.) *Instructional-design theories and models: An overview of their current status* (pp. 383–434). Hillsdale, NJ: Lawrence Erlbaum Associates, Publishers.

Keller, J.M. (1987). The systematic process of motivational design. *Performance and Instruction, 26*(10), 1–8.

King, G. (1995). Replication, replication. *Political Science & Politics, 27*(3), 444–452.

Kuhn, G. (1997). *Using problem-based learning techniques to develop the expertise of emergency medicine residents.* Unpublished doctoral dissertation, Detroit, MI: Wayne State University.

Lincoln, Y.S., & Guba, E.G. (1985). *Naturalistic inquiry.* Beverly Hills, CA: Sage Publications.

Lindblom, C.E., & Cohen, D.K. (1979). *Usable knowledge: Social science and social problem solving.* New Haven, CT and London, England: Yale University Press.

Lumsdaine, A.A. (1963). Instruments and media of instruction. In N. Gage (Ed.), *Handbook of research on teaching* (pp. 583–682). Chicago: Rand McNally.

McCracken, G. (1988). *The long interview.* Newbury Park, CA: Sage Publications.

Mishler, E.G. (1979). Meaning in context: Is there any other kind? *Harvard Educational Review, 49*(1), 1–19.

Reigeluth, C.M. (1997). Instructional theory, practitioner needs, and new directions: Some reflections. *Educational Technology, 37*(1), 42–47.

Richey, R.C. (1992). *Designing instruction for the adult learner: Systemic training theory and practice.* London/Bristol, PA: Kogan Page/Taylor and Francis.

Richey, R.C. (1997) Research on instructional development. *Educational Technology Research and Development, 45*(3), 91–100.

Richey, R.C., & Nelson, W. (1996). Developmental research. In D. Jonassen (Ed.), *Handbook of Research for Educational Communications and Technology* (pp. 1213–1245). New York: Simon & Schuster.

Ross, S.M., & Morrison, G.R. (1989). In search of a happy medium in instructional technology research: Issues concerning external validity, media replications, and learner control. *Educational Technology Research and Development, 37*(1), 19–33.

Ross, S.M., & Morrison, G.R. (1996). Experimental research methods. In D. Jonassen (Ed.), *Handbook of research for educational communications and technology* (pp. 1148–1170). New York: Macmillan Simon & Schuster.

Schwen, T.M. (1977). Professional scholarship in educational technology: Criteria for judging inquiry. *AV Communication Review, 25*(1), 5–24.

Seels, B. (1997). The relationship of media and ISD theory: The unrealized promise of Dale's cone of experience. In M.R. Simonson, O. Abel, N. Maushak, and K. Wright (Eds.). *19th Annual Proceedings: Selected Research and Development Papers Presented at the 1997 Annual Convention of the Association for Educational Communications and Technology* (pp. 357–361). Ames, Iowa: Iowa State University and Association for Educational Communications and Technology.

Strike, K.A. (1979). An epistemology of practical research. *Educational Researcher, 9*(1), 10–16.