

Note: The following seminal article was first published in the *Journal of Technology and Teacher Education* in 1993.

Defining a Field: Content, Theory, and Research Issues

Jerry Willis

University of Houston

The emerging field of information technology and teacher education (ITTE) can be defined in many different ways. This paper proposes that ITTE be defined through a subject matter focus on the use of information technology, in all its forms, in teacher education. Although all of us prefer certain theories and methods of scholarship, there are many reasons to avoid defining, and thus limiting, the field by defining it in terms of a particular theory or research methodology. We should be thoughtfully eclectic when it comes to theoretical frameworks as well as the way in which theory is developed, used, and modified. We should be thoughtfully eclectic when it comes to methodology. There are many sources of information.

During my graduate school days, a new scholarly field, applied behavior analysis (ABA), emerged from a basic research field, the experimental analysis of behavior (EAB). EAB is more commonly known as Skinnerian behavioral psychology. As a field ABA has as its prime purpose the use of Skinnerian principles of learning to solve significant human problems. As that field emerged, shaped by people like Donald Baer, Montrose Wolf, Todd Risley, and Vance Hall at the University of Kansas, a general perspective on what should be studied and how it should be studied emerged. And, just as the EABs had done in 1957 when they created the *Journal for the Experimental Analysis of Behavior*, the ABAs established their own journal in 1968. And 25 years later, that publication, the *Journal of Applied Behavior Analysis* (JABA), is still a focal point of scholarly activity for those who practice applied behavior analysis. Over the past quarter of a century it has represented the interests, advances, and issues that occupy the applied behavior analysts.

The first issue of *JABA*, including an article by [Baer, Wolf, and Risley \(1968\)](#), set the tone of the journal. Three important dimensions of applied behavior analysis were addressed: the underlying *theories* of learning that should guide research and practice, the types of *data* that should be gathered in applied research, and the research *designs* to analyze behavior. The authors took strong stands on all three issues—appropriate theories, appropriate data, and appropriate designs. In the 25 years since 1968 thousands of articles, books, and monographs have been published in the ABA tradition and much of that work is still guided by the foundation laid down by Baer, Wolf, Risley, and other pioneers.

In many ways the *Journal of Technology and Teacher Education* represents a step in the establishment of a new field in the same way that *JABA* did. And in some ways this paper represents an effort to set the tone for scholarship in the field of information technology and teacher education just as the Baer, Wolf, and Risley paper did, to some extent, for applied behavior analysis. There are, however, some significant lessons to be learned from the *JABA* experience. For example, ABA is, in many ways, a narrow system. In the 1970s, ABAs, myself

included, believed we had found The Truth, and we enjoyed being around others who shared that strong belief. We believed the principles of applied behavior analysis could transform virtually all the human and helping professions. Programmed instruction and behavior modification were widely used in education; token economies seemed to transform back wards of mental hospitals, and several large corporations reported significant improvement in worker performance when behavioral management programs were put in place.

There were, of course, some scholars sympathetic to the ABAs who gently suggested that ABA was much too narrow to serve as a foundation for a fundamental change in society. One such person was Frances Horowitz, a noted developmental psychologist who served as Chair of the department where the major ABAs taught (the Department of Human Development at the University of Kansas). A paper titled "Living Among the ABAs" compared the ABA culture to the early psychoanalysts and the Gestalt psychologists (Horowitz, 1973). The similarity was not that these groups held similar views on theory or research methodology. All three were close-knit groups using alternative research models and alternative theories of learning. Horowitz acknowledged the progress ABA had made in many areas but expressed several concerns about the future. Most of her concerns dealt in one way or another with the narrowness of the field and the isolation reflected in the reluctance of ABAs to integrate research from other fields into their own work. That narrowness and isolation might, Horowitz noted, prevent ABAs from becoming aware of and profiting from the work of cognitive developmental theorists like Piaget. Twenty years later, Horowitz's question about whether ABAs would, like the psychoanalysts and Gestaltists, "cull the land riding high upon its produce, only to deplete the tillable soil" (p. 4) has a partial answer. Like psychoanalysis and Gestalt psychology, ABA did not deplete the "tillable soil" and then simply fade away. It did, however, fade. In the 1970s it expanded from fields like special education where it had made significant contributions and began widespread cultivation. However, by the end of the 1980s, it had retreated back into its strongholds. An ERIC search for that decade using the term "applied behavior analysis" produced ten hits. Exactly half of them dealt with mental retardation, learning disabilities, or delinquency, all traditional strongholds of behavioral approaches. That is not an impressive range of topics for a movement that would change society.

In the late 1980s the cognitive model largely replaced ABA and related behavioral approaches as the "up and coming" paradigm for research and practice. In education behavioral theories still play an important role in specific areas such as classroom management. However, cognitive/constructivist theories (CCTs) have come to the forefront in areas as diverse as the design of the curriculum and teacher education. Today CCTs appear just as robust and generalizable as ABA did to many in the 1970s. However, if we could look into the future we might find that by 2005 CCTs have receded into their traditional strongholds such as child development, language development, and problem solving while a new version of some blast from the past (psychoanalysis?) has come to the forefront.

The ebb and flow of theories is a natural phenomenon in many fields of scholarship, but for an applied field like information technology and teacher education, the adoption of one theoretical model, or one family of research designs, is probably counterproductive. As it did with ABA, psychoanalysis, and Gestalt psychology (and probably will with the current cognitive/constructivist theories) the decision to attend to scholarship within only one theoretical or methodological tradition may facilitate progress for a while but will ultimately limit progress as the scholarly veins of gold play out and the motherlode eludes us. It isolates a field from useful knowledge and narrows the focus of scholars to topics that seem amenable to their chosen theory or research model.

The argument can certainly be made, however, that if you eliminate the focus on a particular theory of learning or the reliance on a special research methodology, fields like ABA and psychoanalysis would disappear. Their very core is expressed in their position on these issues. The field of information technology and teacher education need not, however, burden itself with the narrowness and isolation a core of foundational beliefs requires. There are other ways to build this field that will create a core that holds it together while at the same time it encourages and nourishes fresh insights, new approaches, and paradigm shifts. If Kuhn (1970) is correct in his analysis of how fields of scholarship advance, there are two very different ways in which a field can progress. One type, "normal science," involves filling in the next piece in the jigsaw puzzle using the field's accepted paradigms and research models. The other type, "revolutionary science," provides that breakthrough or paradigm shift that moves the field beyond an impasse that has halted progress. Revolutionary science does not limit itself to the accepted paradigms and research models.

The core of information technology and teacher education should encourage "normal science" while at the same time supporting alternative models and perspectives that may be the foundation for a paradigm shift that moves us to a higher level.

Why Should the Field Exist? A Subject Matter Focus

Information technology (IT) and teacher education (TE) exists as a field because there is a developing need for the dissemination of knowledge about the roles and functions of IT in teacher education. In North America, the International Society for Technology and Teacher Education (ISTTE) serves as the scholarly home for this emerging field, and the *Journal of Technology and Teacher Education* (JTATE) is a primary outlet for scholarship. In the United Kingdom, the Association for Information Technology and Teacher Education (AITTE) and the *Journal of Information Technology for Teacher Education* (JITTE) serve similar purposes. These groups emerged in the late 1980s. There would have been little reason for organizations like ISTTE or journals like JTATE in 1950, 1960, or even 1970. Computer technology was expensive, the concepts of instructional technology were not well developed, and their use in both education and teacher education was minimal. In 1970 established fields like instructional technology met the needs of teacher educators. In 1980 general organizations with an emphasis on K-12 education (e.g., the predecessor to the International Society for Technology in Education and the Computer Using Educator Special Interest Group in the Association for Computing Machinery) met many of the needs of teacher educators interested in the use of computing technology.

However, in the 1980s the sophistication and complexity of the technologies used in education began to overwhelm generic organizations and publications. Some of the interests, needs, and problems of computer-using educators who taught languages, for example, are different from those of educators teaching science or social studies. In addition, the software, hardware, and instructional strategies used by educators at different levels and in different areas began to diverge. In the 1970s, when most of the software was drill and practice or tutorial, there was a larger common core at the center of educational computing. Today, the software and hardware used in a high school chemistry class may differ significantly from that used in a first grade classroom. The loss of a large common core of knowledge, and the corresponding increase in specialized knowledge and procedures, led to the creation of a number of new organizations such as the Association for Computers and the Humanities, the Association of Small Computer Users in Education, the Association for Computers in the Social Sciences, and the Society for

Computer Simulation. All these organizations came into being because technology-using practitioners and scholars in those disciplines needed channels of communication and collaboration.

Focused organizations, and focused publications, have emerged in the past decade to support domain-specific work on information technology. They do not replace the more generic organizations but serve the specialized needs of members interested in specific, targeted areas of scholarship and practice. For example, at focused conferences participants feel a camaraderie that is difficult to achieve at larger, more general meetings.

The same thing applies to general educational computing journals versus focused publications. Established general publications such as *Computers and Education*, *Computers in the Schools*, *Educational Technology*, and the *Journal of Educational Computing Research* are important and needed. However, they do not meet all the needs of practitioners and researchers. That is why focused journals have been established. Publications like *Collegiate Microcomputer*, *Computers and Composition*, *Computers in Human Behavior*, *Journal of Computers in Mathematics and Science Teaching*, *Journal of Computers in Childhood Education*, *Journal of Artificial Intelligence in Education*, *Journal of Educational Multimedia and Hypermedia*, *Journal of Special Education Technology*, and *Social Science Computer Review* are of limited interest to most of the large and diverse group of educators interested in educational computing and instructional technology. However, each of them is the major journal for a segment of that group. With this first issue, the *Journal of Technology and Teacher Education* joins the growing group of focused journals in educational computing and instructional technology.

JTATE exists to publish scholarship on the topic of information technology and teacher education. Information technology is broadly defined. It includes everything from video in all its forms to computer-based information and instructional delivery systems as well as telecommunications and satellite technology. The term *information technology* also includes the theories, models, and strategies of instructional delivery. It is not limited to hardware and software. Teacher education includes preservice, inservice, and graduate preparation in all areas related to education. *JTATE* will publish papers that deal with IT in TE as both a topic of instruction and as a tool for enhancing instruction on other topics.

Though broad, this definition of the coverage of *JTATE* does exclude most of the content published in other journals. For example, papers on the use of a promising new computersupported approach to teaching problem solving in a third grade classroom would not be appropriate for this journal. On the other hand, a paper on procedures for preparing third grade teachers to use such an approach would be appropriate for the journal.

With the subject matter appropriate to this journal established, let us now turn to other issues that often determine whether a particular paper is appropriate to a particular journal. In the following sections I will discuss units of analysis, theoretical frameworks, and research methodology.

What Units of Analysis Should Be Considered?

In papers on technology and teacher education the units of analysis run the gamut from macro- to microlevel. The unit of analysis in [Robinson's \(1992\)](#) paper on the English National Curriculum was government policy at a national level. Papers by [Ryan \(1992\)](#) and [Strudler \(1992\)](#) dealt with one college of education while [Woodrow \(1992\)](#) dealt with one methods course. At an even more molecular level [Strang, Hoffman, and Abide \(1992\)](#) looked at the

decisions teacher education students made while playing a classroom management simulation and Williams, Copley, Huang, and Bright (1992) analyzed the classroom behaviors of mathematics teachers using videotaped sessions and a classroom observation scale. Although the papers cited here vary considerably in the type and size of unit analyzed, all make important contributions to the field. *JTATE* will consider papers without regard to the size or type of unit analyzed. The *Journal* thus accepts many types of data as sources of knowledge.

What Theoretical Frameworks Are Acceptable?

Although there is certainly a place for journals that serve the needs of adherents to one theory, the great majority of journals are eclectic, at least to some degree, when it comes to theory. In their current form theories in social science and education are relatively crude. While they can be somewhat helpful to practitioners and researchers in the area of information technology and teacher education, no single theory has achieved a level of confirmation and sophistication that would justify focusing solely on scholarship within that theoretical tradition. *JTATE* thus follows the tradition of many other journals that focus on a topic of study, or area of practice, that accept papers from many theoretical perspectives. Journals of that type include *Computers Reading and Language Arts*, *Distance Education*, *History Microcomputer Review*, *Information Technology and Libraries*, *Journal of Special Education Technology*, and *Social Science Computer Review*. These journals all deal with some aspect of information technology in education or teacher education, and they all meet the needs of a specific group of educators.

Most people would, I think, agree with the decision to keep *JTATE* theoretically eclectic, but there is another way to look at the question of theory. Many teacher educators, particularly those who have been active in traditional scholarship, argue that while potential contributors should not be required to adhere to one particular theory, they should be required to cast their work within the framework of some established theory that has emerged from basic research. This issue is based on our assumptions about how scholarship, or knowledge, is best advanced (Willis, in press-a, in press-b). You could argue, for example, that we are most likely to advance understanding in a field if the scholarship is orderly, planned, and systematic. This general idea can be translated into very specific procedures that require researchers to develop hypotheses based on their understanding of one or more theories and then to systematically test those theories. The result is confirmation, or lack of confirmation, for a particular theory. There are strong traditions in education that support this model as the only acceptable foundation for research and scholarship. There is considerable pressure, in fact, to stay within the lines of established scholarship. A few years after finishing my doctorate I remember feeling guilty when I published a paper that did not meet the methodological and theoretical standards set by my research design and statistics professors in graduate school. It was a practical piece that directly addressed a practical issue without attempting to frame the question in a particular theory. (The question was whether group intelligence test scores predicted individual intelligence test scores as well for "emotionally disturbed" students as they did for "normal" students. They did not.) I also remember being very surprised when the nontraditional articles I wrote were cited more frequently and reprinted more often than my traditional articles.

Traditional research methods that adhere to all the tenets of the standard scientific method (as applied to the social sciences and education) are appropriate for some, but by no means all, of the questions that face us today. In the early phases of my own research career I was greatly influenced by an article in the *American Psychologist* by Perry London (1973). In the article, London argued that the assumption "good theory drives out bad practice" may be incorrect. This assumption was a guide to much of the research in education and the social sciences during the

first 70 years of this century. If you believe this assumption then conducting research that advances theory is the highest calling. All other research is second rate or worse.

London proposed the opposite. Suppose the careful analysis of good practice drives out bad theory. If this assumption is true, activities such as developing good practice, and analyzing what good practitioners do, becomes a high calling. Although London's argument fell primarily on deaf ears in the 1970s, some scholars in the 1980s have proposed similar ideas. For example, [David Battersby \(1987\)](#) argued against the idea that practitioners are dependent on "elitist" theory developers to guide their work. He proposed that theories that guide the work of practitioners must be grounded in concrete experience. Battersby used the term "craft theory" to indicate theories that emerge from practice. He proposed that craft theories, which is theorizing by practitioners, may be more profitable than "theorizing-from-above" by academic experts who work within a particular philosophical perspective such as positivism, subjectivism pragmatic-materialism, or critical theory. (For an analysis of Battersby's perspective see [Clark 1988](#)). London's ideas were also echoed in the 1980s by [Donald Schön \(1987\)](#):

We should start not by asking how to make better use of research-based knowledge but by asking what we can learn from a careful examination of artistry, that is, the competency by which practitioners actually handle indeterminate zones of practice...(p. 13).

Although London's perspective is echoed in the work of scholars such as Schön, it is not accepted by a majority of researchers in education today ([Gagnè, 1990](#)). Many issues, including the question of whether theory should evolve from successful practice or successful practice derive from established theory is a very debatable issue ([Kagan, 1990](#); [Borgen, 1989](#)). On this point and many others, scholarly work based on epistemologies congruent with positivism, for example, is quite different from work based on a constructive epistemology. In *JTATE*, papers based on either approach will be considered.

Theoretically grounded, empirically-based research has much to offer the field. The same can be said, however, for strong professional practice articles that report thoughtful reflection on experience. Both are promising approaches, but both types of scholarship have weaknesses that should be avoided. [Donald Schön \(1987\)](#), in his book *Educating the Reflective Practitioner*, eloquently makes the case against one type of research and for another:

In the varied topography of professional practice, there is a high, hard ground overlooking a swamp. On the high ground, manageable problems lend themselves to solution through the application of research-based theory and technique. In the swampy lowland, messy, confusing problems defy technical solution. The irony of this situation is that the problems of the high ground tend to be relatively unimportant to individuals or society at large, while in the swamp lie the problems of greatest human concern (p. 3).

From Schön's perspective much of the standard research is based on the "prevailing idea of rigorous professional knowledge, based on technical rationality" which is "an epistemology of practice derived from positivist philosophy, built into the very foundations of the modern research university" (p. 3). This approach assumes the problems of practice are well formed and can be solved by the systematic application of "scientific knowledge" which comes from traditional, theory-based research. Schön does not accept this model. He feels the professions, in accepting this model of scholarship because of the prestige associated with it, sacrifice relevance for rigor. To him the "swampy zones of practice" are beyond the reach of traditional research methods. In the swamp, problems are not well formed, and they do not lend themselves to solutions developed in experimental cubicles on college campuses.

In many ways, the "rigor versus relevance" problem is more serious for professions than sciences. When asked a question for which there is not yet a solid answer, a scientist can simply say it is up to future research to provide an answer. If a problem is not amenable to rigorous research the scientist can study something that is. If that limits the problems that can be addressed by the scientist, it is a price many disciplines are willing to pay. And society gives the sciences the freedom to make that decision.

Such is not the case with professions. Physicians are not allowed to refuse treatment to a patient because there is no definitive answer, from traditional scientific research, to the question of which treatment will be effective. Teachers are not allowed to exclude students from school because there is no definitive answer, based on traditional research, to the question of how best to educate them. In this context the decision to study only those "high ground" problems that are amenable to traditional research has serious and detrimental consequences if the most important questions are in the swamp where the dominant research approaches are not applicable.

Although the potential weaknesses of high ground research are serious, many topics are amenable to such research. Theory-based, quantitative research papers submitted to *JTATE* must deal with relevant, important issues that relate directly to the mission of the *Journal*.

At the other end of the continuum is another type of scholarship. Papers on "professional practice knowledge" rarely deal with irrelevant topics. Most deal with the crucial but "swampy" issues that are hard to research within traditional paradigms. A professional practice article is a paper written by one or more thoughtful practitioners. It is based on the analyzed experience of those practitioners, and it reflects their "best thoughts" on the issues addressed. Like a traditional research paper, it should reflect the author's awareness and understanding of existing knowledge on the topic and it should go beyond what we already know and understand.

If the danger of traditional research is that it rigorously deals with unimportant topics, the most common failing of professional practice scholarship is that it deals with a serious issue without adding anything to our understanding. For example, an article that simply describes a particular project, without drawing thoughtful generalizations and conclusions that other practitioners should consider is not very useful. Neither is a paper that describes problems that are well documented, and solved, in the existing literature. Professional practice papers, like research papers, must meet standards of acceptability. This issue will be discussed in more detail in the next section.

Schön's framing of the problem of research as one of relevance versus rigor is appealing, but it is not accepted by all those who advocate alternative approaches to theory and research. In their discussion of the multisource nature of learning [Iran-Nejad, McKeachie, and Berliner \(1990\)](#) argued that Schön's assertion that practitioners must choose between rigor and relevance may not be accurate. They argue that rigor can be achieved while studying those "swampy" problems of Schön's because investigators can create or adapt methods and instruments that bring rigor to the swamp. For them the problem is not a choice between rigor or relevance, it is a choice between the assumption of *simplification by isolation* and *simplification by integration*. Traditional research methods in psychology and education attempt to simplify the focus of study by isolating it from all other factors. Often the result is research conducted in artificial environments on artificially constructed variables such as nonsense syllables. Research based on the assumption of simplification by integration frequently involves the use of alternative methodologies that facilitate research in the natural environment. Research methodologies are the topic of the next

section.

Issues such as theory-based versus problems-based research, rigor versus relevance, theory-guided practice versus practice-guided theory, and simplification by isolation versus simplification by integration all deal with questions a scholar in this field must consider when planning a program of research. The journal will not insist that authors adopt a particular answer to these questions, but all of us should understand the implications of those questions and the various answers to them.

What Research Methodologies Should Be Accepted?

As noted already the question of which research methodologies are acceptable is complex. A preference for a particular research methodology is generally a reflection of preferences for a particular type of learning theory that is based on a certain theory of knowledge or epistemology, which may in turn be based on one or more established schools of philosophy. In an effort to avoid an infinite regress that takes us back to the differences between the philosophies and theories of knowledge of Plato and Aristotle, perhaps it would be best to simply say that *JTATE* will not focus on one "source" or "type" of knowledge and thus will not restrict potential contributors to one or another research methodology. There are many methodologies within the qualitative and quantitative traditions of the social sciences that are appropriate for the study of topics relevant to *JTATE* readers (Howe, 1988; Hoshmand, 1989). Ethnographic studies, control-experimental group studies, action research, and case studies will all be considered. In addition, some relevant topics may be amenable to scholarly traditions from apparently distant fields of scholarship such as philosophy or economics. Reports on the development of instructional packages for teacher education might, for example, follow the instructional development model that emphasizes the importance of recursive formative evaluations over summative evaluation (Willis, in press-a). In the field of computer science software developers are familiar with the alpha and beta testing phases in creating commercial programs. That model may be a good fit for some research and development projects in teacher education as well. *JTATE* also welcomes papers that follow the expert appraisal model used in publications such as *PC Week* and *InfoWorld* to evaluate new software packages.

When it comes to methodology the issue is thus not whether a certain method of study was used but whether a particular methodology was appropriately and effectively used.

Experimental-control group research, case studies, ethnographic research, and action research, are different, but for each there are established, defined standards that help reviewers evaluate the quality of the work. The question of quality should be carefully considered by investigators, especially when using methodologies that are new to the research team. Some traditionally trained researchers, for example, have been taught that qualitative methodologies are little better than "armchair philosophizing." When they decide to use qualitative methods themselves, they are often unaware that designing and carrying out good qualitative research is as at least as complex as conducting good quantitative studies. The results is often a poor quality study that simply does not meet minimum standards for that type of qualitative research.

JTATE manuscript reviewers will not use an absolute quality standard, however, regardless of the type of scholarship. If the paper deals with an important, relatively unexplored topic, somewhat crude methodologies may be acceptable because even rough hewn studies on a new and difficult topic contribute to our knowledge. In an established area of study, where others have already developed good research methodologies, the expectations will be higher.

In Summary

The *Journal of Technology and Teacher Education* is a focused, topic-specific outlet for scholarly work that addresses the use of information technology in teacher education. It deals with information technology as a topic of study and as a medium for delivering instruction on other topics in teacher education. It accepts papers that deal with large and small units of analysis. Papers that look at national or international policy issues, for example, are welcome as well as papers that present microlevel analyses of student and teacher behaviors.

The *Journal* is not atheoretical, but it recognizes that no one theory and no one perspective on the appropriate relationship of theory to practice is so well established that it should be adopted as a standard. With that in mind, authors should make informed decisions about theory and practice issues. And in the same vein, the *Journal* does not prefer one research methodology over another, but methodology is important. The methodology used should be appropriate to the goals of the research and in terms of quality it should reflect, or improve upon, the current standards in the area studied.

A decade from now, in the year 2003, I hope all of us will look back on the *Journal of Technology and Teacher Education* as a publication that, in its first decade, helped define the field of information technology and teacher education. Whether it achieves that goal will, to a great extent, depend on the editorial board, contributors, and readers. As you read this first issue, I hope you will begin to think about ways you can advance this field. And when your work bears fruit I hope all of us will read it in an issue of the *Journal of Technology and Teacher Education*.

References

- Baer, D., Wolf, M., & Risley, T. (1968). Some current dimensions of applied behavior analysis. *Journal of Applied Behavior Analysis, 1*(1), 91-97.
- Battersby, D. (1987). Is there a place for "craft theory" in educational administration? *Educational Management and Administration, 15*(1), 63-66.
- Borgen, F. (January, 1989). Evolution of eclectic epistemology. *Counseling Psychologist, 17*(1), 90-97.
- Clark, J. (1988). Is there a place for "craft theory" in education administration? Yes, but not in the way Battersby suggests. *Educational Management and Administration, 16*(1) 65-68.
- Gagné, N. (1989). The paradigm wars and their aftermath: A "Historical" sketch of research on teaching since 1989. *Teachers College Record, 91*(2), 135-150.
- Horowitz, F. (1973). Living among the ABAs-Retrospect and prospect. In E. Ramp & G. Semb (Eds.), *Behavior analysis: Areas of research & application* (pp. 3-15). Englewood Cliffs, NJ: Prentice Hall.
- Hoshmand, L. (1989). Alternative research paradigms: A review and teaching proposal. *Counseling Psychologist, 17*(1), 3-79.
- Howe, K. (1988). Against the quantitative-qualitative incompatibility thesis or dogmas die hard. *Educational Researcher, 17*(8), 10-16.

- Iran-Nejad, A., McKeachie, W., & Berliner, D. (1990). The multisource nature of learning: An introduction. *Review of Educational Research*, 60(4), 509-515.
- Kagan, D. (Spring, 1990). Research as Art: Reclaiming educational research for teachers and other speakers of standard English. *Action in Teacher Education*, 12(1), 7-11.
- Kuhn, T. (1970). *The structure of scientific revolutions*. Chicago: University of Chicago Press.
- Robinson, B. (1992). The English national curriculum and the information technology curriculum for teacher education. In D. Carey, R. Carey, D. Willis, & J. Willis (Eds.), *Technology and Teacher Education Annual-1992* (pp. 12-17). Charlottesville, VA: Association for the Advancement of Computing in Education.
- Ryan, T. (1992). Using technology: A college of education's experience. In D. Carey, R. Carey, D. Willis, & J. Willis (Eds.), *Technology and Teacher Education Annual-1992* (pp. 1-11). Charlottesville, VA: Association for the Advancement of Computing in Education.
- Schön, D. (1987). *Educating the reflective practitioner*. San Francisco: Jossey-Bass Publishers.
- Strang, H., Hoffman, M., & Abide, M. (1992). Cooperative participation in a Computer-based teaching simulation. In D. Carey, R. Carey, D. Willis, & J. Willis (Eds.), *Technology and Teacher Education Annual-1992* (pp. 629-633). Charlottesville, VA: Association for the Advancement of Computing in Education.
- Strudler, N. (1992). Schools, restructuring, and technology: Implications for teacher education. In D. Carey, R. Carey, D. Willis, & J. Willis (Eds.), *Technology and Teacher Education Annual-1992* (pp. 140-143). Charlottesville, VA: Association for the Advancement of Computing in Education.
- Williams, S., Copley, J., Huang, S., & Bright, G. (1992). Effect of teacher involvement in curriculum development on the implementation of calculators. In D. Carey, R. Carey, D. Willis, & J. Willis (Eds.), *Technology and Teacher Education Annual-1992* (pp. 435-438). Charlottesville, VA: Association for the Advancement of Computing in Education.
- Willis, J., & Giles, D. (1976). *Great experiments in behavior modification*. New York: Harper and Row.
- Willis, J. (in press-a). Technology and teacher education: A research and development agenda. In H. Waxman & G. Bright (Eds.), *Research Models for Technology and Teacher Education, Society for Technology and Teacher Education Monograph Series, No. 1*. Charlottesville, VA: Association for the Advancement of Computing in Education.
- Willis, J. (in press-b). Sources of knowledge: One way versus many ways. *Computers in the Schools*.
- Woodrow, J. (1992). A computer-based curriculum and instruction course. In D. Carey, R. Carey, D. Willis, & J. Willis (Eds.), *Technology and Teacher Education Annual-1992* (pp. 94-98). Charlottesville, VA: Association for the Advancement of Computing in Education.

Acknowledgement

I would like to acknowledge the comments and suggestions made by Dr. Richard Felder,

Professor of Chemical Engineering, at North Carolina State University. His comments were invaluable in revising this paper.

Contact Information:

Jerry Willis

Center for Information Technology in Education

College of Education

University of Houston, TX 77204, USA

Contemporary Issues in Technology and Teacher Education is an online journal. All text, tables, and figures in the print version of this article are exact representations of the original. However, the original article may also include video and audio files, which can be accessed on the World Wide Web at <http://www.citejournal.org>