Research in Technology Education— Some Areas of Need

Theodore Lewis

Research is an important way in which the field of technology education can become further established. At least in the United States, this is not a field that has attracted sustained sponsored research funding over the decades. There has been no equivalent of the federally supported National Center for Research in Vocational Education (NCRVE), an agency that in the past two decades has given substantial character, both in terms of volume and direction, to inquiry in vocational education. For example, the current emphasis on integration of academic and vocational education, a major tenet of the new American vocationalism, draws heavily on NCRVE-generated research. Mainly because of the lack of sustained funding sponsorship, research in technology education has been sparse, outside of the theses of students, and unable to assume a coherent programmatic character. This is not to say that mere sponsorship is the curative the field needs. Sponsorship has its perils, not the least being the politicization of research agendas. But absence of funding reduces the scope and scale of the research efforts of the field.

In her review of research in technology education over the period 1987-1993, Zuga (1994) identified an imbalance of treatment. The studies were skewed in favor of curricular concerns. Among shortcomings were that few studies focussed upon the inherent value of the field. Topic areas that had received little attention included problem solving, cognition, instructional methods and strategies, and technological literacy.

Foster (1992) examined the research topics and methods of graduate students in the general field of industrial education, inclusive of technology education. The results were somewhat different from Zuga's in that program evaluation, and not curriculum, was the most frequent topic area. Foster commented that there was a predominance of surveys, and that about one quarter of the work consisted of status studies. He called for "clear direction from the leaders and veterans in the field" (p.71). Foster (1996) subsequently set forth a research agenda based upon the preferences of selected leaders and researchers. It was consistent with some of the recommendations of Zuga, both viewing technological literacy, and effectiveness of instructional techniques as research priorities.

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In his meta-study of work published in the JTE since its inception, Petrina (1998) suggested that in general, authors have pursued an orthodox line, with very little published in the realm of critical theory. He found that few studies had situated technology education against a backdrop of the politics of education. Reviewing frameworks proposed for the field, Petrina found that none had acknowledged the politics of research. He proposed a comprehensive research framework, guided by a set of "cultural framing questions," paraphrased here as follows:

- How do we come to practice and understand technology?
- Toward what ends and means is the subject practiced?
- What should be the nature of technological knowledge?
- How should the content of the subject be organized?
- How is the subject today influenced by its history?
- How is technology practiced across cultures?
- Who participates in the subject and why or why not?

Petrina strongly suggests that the dearth of studies in the critical paradigm is evidence that the field is conservatively inclined. This makes the research of the journal "political." By way of remedy, he calls for activism on the part of editors and reviewers that could lead to the "shaping" of manuscripts accepted and published in the *JTE*. But this entreaty itself has an unwitting political ring to it, seeming to invest in these editors and reviewers a kind of regulatory power that would take them beyond their expected neutrality, toward artificial contrivance of the discourse of the field. While one can agree that there is need for encouragement and accommodation of a variety of research traditions within technology education, choice of paradigms should probably remain subject to the personal preferences of researchers.

The purpose of this article is to identify and discuss some promising lines along which the research of the field can proceed. The path to be taken here has to some degree been traversed previously, by Foster (1992, 1996), Petrina (1998), Wicklein (1993), and Zuga (1994). Shared with these prior works is the premise that the research of the field needs to proceed on several fronts, and that it should encompass a range of research paradigms. Also shared is the need to provide a means by which researchers can narrow their quest for interesting problems and questions. And indeed, some recurring topics from these prior works are discussed here. But this article also extends beyond the works cited above, in ways that include (a) a willingness to look at research in other subject matter areas of the school curriculum for inspiration for inquiry in technology education, and (b) the willingness to go beyond mere prescription of what ought to be studied, by dwelling and reflecting upon examples of the kind of inquiry being envisaged.

Research agendas are political instruments. They reflect the beliefs and values of those who propose them. But irrespective of political or ideological stance, we must come to terms with the basic question "what are the important questions of the field, and how do we arrive at them?" And the response to that should lead us first to the primary site where the subject is enacted, namely, schools. Thus, the most important questions of the field probably have to do with challenges encountered by students as they try to learn the concepts and processes of the subject, and by teachers as they try to impart this content. If we can agree that schools constitute the primary site of inquiry in technology education, then the ethos of classrooms and laboratories where the subject is taught must be a prime area of research need. And the administrative and policy milieu (comprised of state departments of education, school districts and school boards, principals, and teachers of other subjects) from which the subject must emerge to take its final shape as curriculum would be a target of inquiry.

These initial thoughts provide insight into the value orientation that this author brings to the work. The final outcome here is not intended to be a blueprint from which researchers of the field can proceed. Such a blueprint, to the extent that it is needed, has been adequately set forth by Petrina (1998). Instead, I dwell upon a few selected areas of inquiry that are compelling, because: (a) they relate fundamentally to the basic claims of the field, (b) they remind us that technology education ultimately is about learning and teaching and the primary actors in that enterprise must be brought into sharper focus, and (c) they share and conform to conceptual frameworks (such as situated cognition and constructivism) that unite technology education with other school subjects.

In the remainder of the paper, eight types of questions that can be the basis of inquiry are identified and discussed. These questions pertain to (a) technological literacy, (b) conceptions and misconceptions of technological phenomena, (c) perceptions of technology, (d) technology and creativity, (e) gender in technology classrooms, (f) curriculum change, (g) integration of technology and other school subjects, and (h) the work of technology teachers. Beyond these questions, a brief discussion of the need for adherence to new paradigms for research in technology education is presented, then final reflections are offered.

Areas of Research Potential

Questions pertaining to technological literacy

Though technological literacy is the primary claim of adherents of technology education, the field remains some distance still from being able to operationalize it routinely, thence to standardize it for assessment purposes. The dearth of research here was a common theme in Foster (1992), Petrina (1998), and Zuga, (1994). The clear need is for a multi-dimensioned, sustained program of work. This has been a strong area of conceptualization (e.g. Croft, 1990; Hayden, 1989; Lewis & Gagel, 1992; Pucel, 1995). In *Technology for All Americans*, the International Technology Education Association (1996) asserted that it is vital that the subject be included in the curriculum and made available to all. All high school graduates ought to be technologically literate, meaning that they can "understand the nature of technology, appropriately use technological devices and processes, and participate in society's decisions on technological issues" (p.1). To ensure the inculcation of technological literacy, a need was indentified for educational programs "where learners become engaged in critical thinking as they design and develop products, systems, and environments to solve practical problems" (p.1).

One interesting line of research here can revolve around the quest for meaning. What do we mean by the term “technological literacy”? An example of work in this realm can be seen in Gagel (1995, 1997). Gagel employed phenomenological strategy, primarily hermeneutics (textual analysis), to explore meanings that are ascribed to the notion of technological literacy, and ways in which such meanings diverge depending on the particular disciplinary traditions to which advocates subscribe. Whether there is shared meaning in the field regarding what constitutes technological literacy is debatable. Since advocates of the subject tend to be polarized into process and content camps, it is conceivable that on this count alone there will be divergence of view as to what it means to be technologically literate. There is also the question of the role of performance in technological literacy. Should a technologically literate person be able to display some degree of practical competence? Can technological literacy be measured by paper and pencil examination only?

Another promising line of research here is the manifestation of technological literacy in adult life. Welty (1992) conducted a study of this type, in which adult behaviors, attitudes and knowledge about technological issues were probed. Did these adult subjects engage in political action regarding technological issues? Did they write letters to legislators, sign petitions, or vote on referenda? Such studies could be quite interesting, especially where the importance of taking technology education courses can be shown to influence such manifestations of adult literate behavior.

Whatever we say technological literacy might be, there is a need to avoid the development of an omnibus instrument to measure it. Instead, the concept would have to reflect variation in grade or developmental level. Measuring the technological literacy of a child in the second grade has to be different from measuring that of a child in the ninth grade. Adults would require a different form of the instrument than children.

How to deal with the content of technological literacy instruments is complicated, but the need for instrumentation is clear. Several versions of instruments are conceivable, some assuming a process approach to the subject, and others taking a content approach. In the former, technological literacy might focus on items that test critical thinking or problem solving. In the latter, specific content knowledge would have to be tested, reflecting the main areas of the field, namely, manufacturing, construction, manufacturing, energy and power, and transportation.

Inquiry on technological literacy must allow for consideration of both functional knowledge and school knowledge. Functional knowledge is knowledge and understanding that students derive from everyday life, outside of classrooms (see Tamir, 1991, for an example from science). To make claims about the subject with respect to student achievement, functional aspects of technological literacy would have to be controlled. What do students know about technology, independent of the taught curriculum?

Questions pertaining to conceptions or misconceptions held by students

A fruitful area of inquiry relates to functional knowledge, more particularly to the conceptions that students hold regarding aspects of the subject matter of technology or of technological phenomena. Do the conceptions held by students conform to normative expectations? For example, what conceptions do students have about what happens in an electric circuit when a switch is turned on? Or, do students have conceptions regarding how standard metal bars and rods get their shapes? Do students understand what occurs during the cooling of a casting? Do they understand why an airplane can fly, or what makes elevators go up and down? If asked to represent selected technological phenomena in the form of sketches, what would such representations reveal?

Understanding the conceptions (and misconceptions) that students have about aspects of the subject matter of technology is an important prerequisite for better teaching, and for improved learning. Parallels of this kind of research can be found in science. For example, Trumper (1996) studied conceptions of energy held by Israeli children. Children in the study held anthropocentric views about energy; that is, they associated energy with human beings. Energy was held to be a concrete rather than abstract idea. Fetherstonhaugh (1994) studied the breadth of ideas students held about energy (e.g., can it be stored, is it human-made or natural?). The authors asserted that it is necessary to devise theory that takes into account students' personal constructions of meaning.

Cosgrove (1995) got students to use analogies to help bridge the difference between their own conceptions of electricity, and a standard scientific notion of it. E. L. Lewis (1996) studied conceptual change in eighth grade students regarding elementary thermodynamics. The question of interest was how do students reorganize and reformulate knowledge. Parallels of these types of studies are possible in technology education. Such work would be new, and would open up exciting frontiers for the field.

Questions relating to perceptions about technology

How students view particular aspects of technology content leads to an inductive approach to inquiry. But equally critical is a deductive approach where the larger question regarding how students perceive technology as a whole can be explored. What do students hold the nature of technology to be, and what is the range of their perceptions? Do they view technology as being good or evil? Is technology perceived as something out of control and something we must fear? Is technology viewed to be synonymous with computers? Would everyday implements such as a knife and fork be considered examples of technology? In one recent study, Yasin (1998) examined the perceptions of technology held by high school students in Malaysia. The students were more apt to view modern tools and processes as quintessentially technology than they would traditional tools and processes. They were however concerned that traditional technologies should be preserved as part of cultural heritage. Studies of this type are needed, if we are to gauge whether conceptual change takes place after students pursue technological studies in school. Work in this realm is greatly aided by the development of approaches for such study by Rennie & Jarvis (1995) (see also Jarvis and Rennie, 1996).

Of interest would be the logic that students adopt in discerning what is and what is not an instance of technology. The role of developmental stages in determining the nature of the perceptions of students regarding technology remains an area of promise.

Questions pertaining to technology and creativity

Technology is in essence a manifestation of human creativity. Thus, an important way in which students can come to understand it would be by engaging in acts of technological creation. Technology as a context for creativity is an important area of research. Much of the theorizing and research here has focused upon problem solving. The standard problem solving model called “the technological method” was proposed by Savage & Sterry (1990), in a work that had the imprimatur of ITEA. A facsimile of this model was subsequently proposed by Pucel (1992). The approach calls for identifying a need, developing a solution strategy, producing a solution, modifying that solution, and implementing it. An important advance here is the model set forth by Custer (1995). Custer classified types of problem solving activities in terms of complexity and goal clarity. He shows that all problem solving activities are not of equal creative merit. Troubleshooting is not of the same order of creativity as inventing. Custer’s model could be an important research tool in helping researchers classify problem-solving activities they see in practice. While some problems may lend themselves to algorithms, others may respond only to heuristics. A second work of importance here is that of Hill (1997), who designed an instrument that could gauge the mental processes that students employed as they solved technological problems.

Writing in the context of art education, Johnson (1995) suggested that “the elements and principles of art are not written in stone at all, but in something perhaps more like finger jello: loose, pliable, and hard to pick up” (p. 58). This kind of thinking is needed with respect to creativity and technology. Also needed are constructivist notions which hold that students may bring uniqueness to how they approach problems. For example, Wu, Custer & Dyrenfyrth (1996) explored whether personal style might be a variable in solving problems. McCormick, Murphy & Hennessy (1994) found that students do not solve problems following the traditional steps of design (see also Hennessy & McCormick, 1994). There is thus the need for research that tries to find out just how students actually solve technological problems in classrooms. An important illustrative work here is that conducted by Glass (1992), in which the “think-aloud approach” was used to gain deep insight into children’s creative thought while they solved problems.

It can be argued that the most creative aspect of problem solving is problem finding (or problem posing). And research that can probe the depths of the imagination of children as they propose problems that require technology as solution would add much to our understanding of creativity and technology. Lewis, Petrina & Hill (1998) argue for greater attention to problem posing in the teaching of the subject, and propose constructivism and situated cognition as conceptual frames that can be utilized as backdrops for such studies.

Within science education are examples of how constructivism and situated cognition approaches are used in the examination of problem posing as children do science. For example, Roth (1995) videotaped children as they worked on solutions to engineering structures problems, subsequently analyzing the dialogue employed by them as they worked cooperatively to solve the problems. It was found that students exhibited flexibility in framing and re-framing the problems. The process was not linear. In a like vein Appleton (1995) studied how students explored the problem space in solving discrepant event problems in science. The social context of the classroom, and encouragement to the students by the teacher to find their own solutions, were key factors in learning.

From the realm of mathematics, Cobb, Yackel & Wood (1989) raised the prospect that affect may be a factor in how children solve problems. This is interesting, suggesting that teachers have a role to play in influencing affective behavior. Teachers who provide encouragement and support may get better results or response from children than those who do not. Interesting questions here include: How do students solve technological problems? What kinds of problems requiring technology as solution would children pose if given the opportunity? What tends to inhibit or enhance problem solving and creativity? What can we learn from the talk of children as they solve technological problems? What do we know about those children who are successful in producing creative products? Is affect a determinant of creativity in the technology classroom? What actions on the part of teachers are more likely to promote creative behavior?

Questions pertaining to gender

Technology is a gendered subject, associated essentially with males. This is a major stigma for the subject, and thus a natural and high priority area of research. What prevents girls from being attracted to the subject? Zuga (1996) examined historical reasons for gender bias in the field, pointing out that important memory has been erased here in the form of the silent voices of female pioneers. There is need for historical research aimed at telling the story of women in the field more fully. O'Riley (1996) called for research in technology education from the point of view of women. This gender focus bears inquiry. How do girls feel about the subject? Do they see it as the domain of boys? What concerns or reservations do they have regarding their taking of technology classes? How do technology teachers treat girls in technology classrooms? Are girls treated differently than boys? Do girls approach the subject differently than boys? Do girls and boys show the same preferences for activities or projects? What perceptions do boys and girls have about each other within the realm of technology education classes? What social patterns emerge in coed technology classes?

There is much we can learn here from inquiry in science education where girls have comparable problems with respect to participation. A key issue is the empowerment of girls so that they see themselves as being capable of pursuing technology as elective courses, or pursuing technology-related careers (see Haggerty, 1995 for perspectives from science). Also from science, Harding & Parker (1995) point to the need for gender inclusive practice.

A good example of needed research relating to gender and technology education is the work of Silverman & Pritchard (1996) who studied gender differences in pursuing technology education elective courses. Though girls appeared to enjoy required technology education courses, they were less likely to continue taking such courses as electives. McCarthy & Moss (1994) also found that girls and boys liked the subject equally. These researchers found that the shift away from the emphasis on craft made the subject more palatable to girls. Thus, does the modular approach to the subject make it more accessible and appealing to girls?

Questions pertaining to curriculum change

Though curriculum has been the prime area of inquiry in technology education in the United States, little is known about the pragmatics of the curriculum change process. What the change from industrial arts to technology education entails in actual schools or school districts has been studied very little. There is rich literature in the field on curriculum. Within this literature the difficulties inherent in the change process have been examined, pathways available for curriculum designers explored, and commentaries made on curricular trends (e.g. Hansen, 1995; Herschbach, 1989; Johnson, 1989; Kuskie, 1991; Lewis, 1994; Petrina, 1994; Raizen, 1997; Shield, 1996; Zuga, 1993). But there is need for an empirical counterpart to this literature, the greatest of which might be for case studies that focus upon actual instances of attempts at curriculum change, where school districts, schools, or particular teachers could be the unit of analysis.

A good example of the type of studies needed is that reported by Treagust & Rennie (1993). This was an evaluation of how six schools in Western Australia implemented the new curriculum area of technology education. Questionnaires, school visits, and document analysis were aspects of the methodology. The focus included obstacles to implementation, and factors that contributed to successful outcomes.

There is need for studies that probe into why some teachers might be more prone to change than others. Are there contextual factors? Personal factors? Is it a matter of availability of resources? Is it a matter of leadership in school buildings? One impediment to examining change from industrial arts to technology education might be that we try to hold schools to a curricular ideal, from which they must work *backwards* to their practice. This requires whole-scale change. But perhaps another way to approach this question is incrementally; that is, the researcher works *forward* from practice towards the ideal. Every increment of change along the way counts. Thus, there is need for subtle methods to measure change. Small changes might be more typical in practice, and it would be a mistake for the field to overlook them. For example, instead of changing the entire curriculum, a school might decide to introduce one or two new courses that reflect technology. Or courses may retain their traditional names, but within them there is new content. Such an approach to curriculum change would require on-site data collecting. The researcher would not be able to discern such change without a close-up examination of programs, inclusive of conversations with the teachers in question.

In looking at change then, there are macro and micro possibilities. Macro possibilities include examination of the context of change, where principals, school-board members, parents, and teachers of other subjects, are potential key informants. Micro possibilities include examination of curriculum documents such as curriculum rationales, textbooks, course outlines, and tests; observations of laboratory equipment; observations of classes in session; and conversations with technology teachers and students.

What does curriculum change entail, in practical terms? What are the optimum conditions under which change best takes place? These are kinds of inquiry that can be pursued.

Questions pertaining to curriculum integration

If schooling is to have desired meaning for children, then the various elements of the curriculum must cohere. Lessons learned in one subject must be amplified in others. To take its place squarely in school curricula, technology education must establish itself not just in its own right, but crucially in relation to other subjects. Thus, the relationship of technology to other subjects in the curriculum is a fruitful area of inquiry. The field has to understand integration better. Within the research literature of the field can be found theoretical examination of integration (e.g. Dugger, 1994; Foster, 1995; LaPorte and Sanders, 1993). Further, there has been published empirical work, especially with regard to combinations of technology, mathematics, or science (e.g. Childress, 1996; Dugger & Meter, 1994; Scarborough & White, 1994). Dugger & Meter (1994) as well as Scarborough & White (1994) explored whether integration led to improved achievement in physics. Childress explored the influence of integration on technological problem solving ability.

One framework that can be of worth here is that of situated cognition, which calls for social learning and learning in authentic contexts (e.g. Brown, Collins, & Duguid, 1989; Lave & Wenger, 1991). Further, useful models for integrating curriculum and for framing related research questions are provided by Fogarty (1991). In the process of studying technology and learning technological concepts, other aspects of the curriculum can become more accessible for students. While science and mathematics have been more typical allies, it is conceivable that such alliances can extend across the curriculum, first with more natural allies, such as art, agriculture and home economics, then with others such English, music, and social studies. Needed are good case studies or evaluative studies that focus upon attempts at integration. Much can be learned from such studies that can be of benefit in improving the chances of integration projects achieving their goals.

The kinds of questions that can be pursued within the realm of curricular integration include: (a) does integration with technology help improve student learning of technological concepts and processes? Does such integration improve learning of collaborating subject areas? What models of integration bear the most promise? What strategies are more likely than others to lead to the success of curriculum integration projects?

One key area of opportunity for integration is the relationship between technology education and vocational education. Many aspects of these two fields coincide, including the situated nature of instruction (laboratory focus), and learning by doing. There are also historical alliances here, and natural possibilities for crossing curricular borders (see a discussion in T. Lewis, 1996). Further, the nature of work is changing, and one important dimension of such change is the new emphasis on knowledge work (e.g. Frenkel, Korczynski, Donoghue & Shire, 1995). Pointing to such workplace change, Layton (1993) asserted that vocational education was becoming more generalized, and general education was becoming more vocationalized. Technology education, he pointed out, would be an important context for the general curriculum—a way to connect it with the human-made world.

It is pointless to conceive of technology education purely as liberal education, when the true strength of the subject may lie in its real-world connections. Context helps students give meaning to school knowledge, and work is an important context for technology in the real world. Technologists are workers.

Technology education scholars have been exploring relationships with tech-prep (e.g. Betts, Welsh, & Ryerson, 1992; Roberts & Clark, 1994). This kind of inquiry should be promoted. By tradition, technology in the upper grades tends to be focused upon careers. But in the very earliest grades too, technology can be the vehicle for helping children understand the nature of work, and catching their first glimpses of careers. This natural affinity of technology education and vocational education gives the former a head start on school-to-work initiatives in schools. It needs to be remembered that it is connection with vocational education that gave to the field the halcyon period of the 1960s. Projects such as IACP, American Industry, and the Maryland Plan, were all rationalized in terms of the career possibilities of technology education. These funding possibilities have returned with the school-to-work movement and tech-prep. The natural career implications of studying technology education ought to be exploited. It is possible, and justifiable, to teach about careers as one teaches technology, at any grade level.

Useful frameworks for inquiry that explore integration of academic and vocational education are provided by Grubb, Davis, Lum, Plihal, Morgaine (1991); and Beck, Copa, & Pease (1991). Interesting questions in this realm of inquiry include: Does integration with vocational education improve student understanding of technology? Does such integration engender both vocational and technological literacy? Does integration of technology education and vocational education enhance student learning of the skills employers want? One approach to inquiry of this order would be to study cases of technology and vocational integration. Exemplary programs of technology education and vocational education integration can be studied as cases.

Questions that focus upon teachers

One further line of needed inquiry relates to the teachers of the profession. This research can be conceived from many angles, the following being but three areas of fruitful possibility: (a) the work and professional lives of teachers, (b) the experiences of beginning teachers, and (c) exemplary teachers.

Just what teachers of technology do in their classrooms—the practical and professional knowledge they draw upon, and the contextual factors that impact upon how they perform, needs to be examined. The voices of these teachers need to be heard. How do they feel about the level of support they get from their school boards, principals, and fellow teachers? What thoughts do they hold about their profession? How do they feel about the curriculum they must teach? What pedagogical thoughts and judgements do they harbor? How do they feel about the students who take their courses? What impediments do they identify as hindrances to their work?

Little & Threatt (1994) provide an excellent example of inquiry into the work of teachers, in their interpretive study of the travails of selected high-school vocational teachers in one state. Conceptual frameworks for such work are set forth in Little & McLaughlin (1993). Clandinin & Connelly (1996) provide an excellent model of inquiry into the professional knowledge of teachers, and the contexts that help shape such knowledge.

The experiences of beginning teachers in technology education represent a special case of the work of teachers. Understanding what it's like to be a beginning technology education teacher can be an important precursor of teacher education reform. This is an area where we know little. One line of such inquiry could focus on the effects of mentoring on the beginning teacher's performance (see Wildman, Magliaro, Niles & Niles, 1992). Another can examine the efficacy of structured beginning experiences (such as internships) (e.g. Johnson, Ratsoy, Holdaway, & Freisen, 1993). The kinds of help sought by beginning teachers could be examined (e.g., Tellez, 1992; or Veenman, 1984).

A counterpart to studying the circumstances of beginning teachers—novices—is to study expert or exemplary teachers. What are the behaviors exhibited by expert technology teachers? What do such teachers do that make them stand out? What do they believe about the curriculum, pedagogy, or children? What do students say about such teachers and about the classes they have taken from them? The need here would be especially for qualitative type studies that are classroom based and that extend over meaningful periods of time. The individual teacher could be the unit of analysis.

A Word on Methodology

The proposals I have set forth above are amenable to a range of research approaches and traditions. There are times when the researcher can conduct inquiry from a remote campus location, but to get primary evidence, first-hand, on-site observations are essential. The key to how the field views research priorities in the future will depend on the willingness of researchers to range beyond the traditional positivistic paradigm toward phenomenological and critical modes. In particular, teachers would have to be encouraged to be researchers in their own right, or collaborators in research.

Arguing the case for the acceptance of new paradigms for research in art education, Eisner (1993) pointed out that those in the arts would find qualitative approaches to be better suited to their core values than was possible with positivistic approaches. He argued, "…I can think of no more important research agenda for art education than the fine grained study, description, interpretation, and evaluation of what actually goes on in art classrooms" (p. 54). He went on to point out that there is "room in the educational research community for many mansions…Different methods make different forms of understanding possible." (p. 54). This is wise counsel. Applied, it means that we in technology education must employ the paradigm that can best answer the questions we wish to have answered. If we stick to tried and true paradigms, the consequence is that certain key kinds of questions will not be asked or answered.

Hoepfl (1997) has taken the important step of providing the field with a primer on how qualitative studies might be approached. Likewise, Petrina (1998) and Zuga (1994) have sought to push the field in this direction. It is a direction that would open up unlimited possibilities for inquiry.

Conclusion

The thoughts that have been set forth here are meant to contribute to a dialogue in the field regarding frontiers that need to be expanded next. Research is fundamentally a creative enterprise, with the most creative aspect arguably being the ability to find challenging and interesting problems. Any framework that purports to encompass all of the questions will militate against itself by stifling creativity. We have to talk about research needs in a way that engenders ever more possibilities. Rather than boxing in the researchers, we must see ways to push the limits and explore new and different frontiers. Researchers in the field are encouraged to use what has been presented herein as food for thought or starting points for new lines of inquiry. But the challenge is to find their own questions, well beyond those imagined and described here. Many areas of our field were left untouched by the research questions I have set forth for attention. For example, little attention was given to teacher education or elementary school technology. But I believe that a focus on the classroom, on students and teachers, and on the subject matter itself, such as what has been proposed, can lead to relevant and fruitful inquiry.

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