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The Status of Research in Technology Education

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Chapter 1

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INTRODUCTION

Standards and accountability have been a central focus for all levels of education over the past two decades. The intent has been to increase academic rigor, raise student achievement levels, and insure that highly qualified teachers are in all classrooms. However, questions are now being raised whether we have gone too far. There is evidence that students are memorizing material but they are having difficulty with higher levels of cognition. Additionally, there are reports of cheating by students, teachers, and administrators due to the pressures of attaining performance measures. Such evidence is now swaying some initial proponents of high stakes standards and accountability to re-think educational policy and practice (Ravitch, 2010).

It would be naïve and dangerous, however, to relegate the importance of standards and accountability in education to a lower level of importance. If ever there was a profession that must be based on standards and accountability, it is the education of our children, teachers, and other school personnel. Research, not politicians, philosophers, or other influences, should be the primary force behind all aspects of the educational process (see Figure 1). Research on teaching and learning is a multi-faceted enterprise that draws upon the physical sciences as well as the social sciences. Discipline-specific research is necessary to highlight both the synergistic contributions and unique qualities that a field contributes to the educational endeavor.

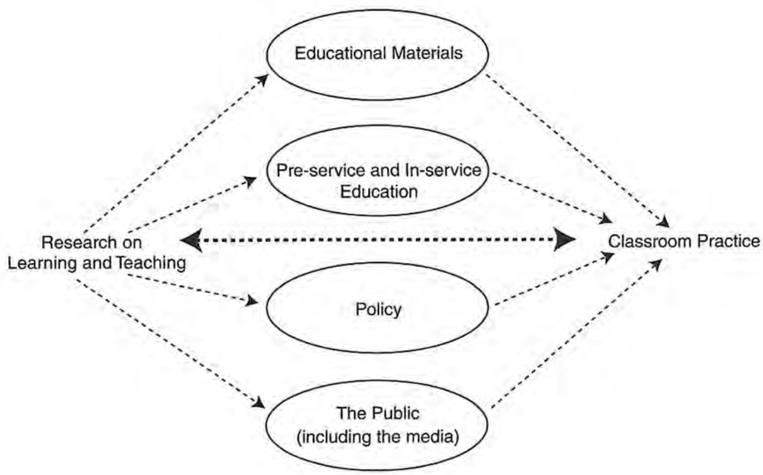

Figure 1: Paths through which research influences practice (National Research Council, 2000).

Technology education has a detailed history grounded in general education as well as discipline- specific philosophies, research, and practice (Barella & Wright, 1981; Martin, 1979, 1995; Rowlett, 1966; Van Tassel, 1960). Despite this record, there have been considerable calls to strengthen technology education research (Cajas, 2000; Foster, 1992a; Garmire & Pearson, 2006; Johnson, 1993; Lewis, 1999; Pearson & Young, 2002; Passmore, 1987; Petrina, 1998; Reed, 2002; Sanders, 1987). This chapter is designed to provide an overview of the historical trends and the contemporary status of technology education research. The chapters that follow focus on specific areas of teaching and learning in order to provide recommendations for technology education scholars.

RESEARCH REVIEWS

The technology education profession has a long history of reviewing and synthesizing its research. The initial published review was the American Council on Industrial Arts Teacher Education (ACIATE, now the CTTE) Yearbook Nine (Van Tassel, 1960). This volume outlined significant research in industrial arts, procedures for scientific research, a theoretical framework, and research needs for both teacher educators and supervisors. The dearth of research recognized in the ninth Yearbook, however, prompted the ACIATE to dedicate the fifteenth Yearbook to the status of research (Rowlett, 1966). This second volume included chapters on the achievement of industrial arts objectives, evaluation, research and experimentation, teacher education, staff studies/non-degree research, and securing funding. Like all of the reviews and syntheses that would follow, the fifteenth Yearbook included areas of needed research.

During the same timeframe, the Center for Vocational and Technical Education (CVTE) at Ohio State University received funding from the U. S. Office of Education to develop a review and synthesis of research in industrial arts education. This review encompassed the period 1960-1966 and was conducted to set a baseline of research (Streichler, 1966) but, similar to ACIATE Yearbook fifteen (Rowlett, 1966), the report was critical regarding the lack of research and the rigor of the research being conducted. A second review and synthesis conducted by the CVTE just two years later, however, claimed:

> Industrial arts appears to have come of age academically and intellectually. The profession has matured to the point where it is willing to undergo a careful self-appraisal of its basic beliefs, fundamental practices, and educational procedures. As a result, critical yet objective investigations have been conducted on a wide variety of important topics in industrial arts (Householder and Suess, 1969, p. 51).

Clearly these early reports identified weaknesses but they also set a solid research foundation for the field by providing comprehensive bibliographies, reviewing the current state-of-the-art, and setting priorities. Additionally, the classifications established in the initial study were, for the most part, used throughout all five studies: philosophy and objectives, curriculum development, instructional materials and devices, learning processes and teaching methods, student personnel services, facilities and equipment, teacher education, administration and supervision, evaluation, and research (Streichler, 1966).

The third and fourth studies (Dyrenfurth and Householder; 1979; McCrory, 1987) spanned longer periods than the preceding reports but they were also supported by the National Center for Research in Vocational Education (formerly the CVTE) so there were many similarities including format and overall classification schemes. The scope for these studies was broadened and included new data such as international studies, the number of funded projects, and funding agencies. The number of studies reviewed was cited as impressive (Dyrenfurth and Householder, 1979) but the quality of research was still questioned in both reports. Other issues that were starting to be recognized as areas of need included improved access to research through database development, consensus on definitions of terms (including technology education), development of a comprehensive research agenda, and more classroom research (McCrory, 1987).

The fifth and final report supported by the (currently titled) Center on Education and Training for Employment was undertaken by Zuga (1994). This study found that the research spanning 1987-1993 focused on curriculum, was conducted mostly by graduate students, and was centered on teachers, teacher educators, and supervisors. Several other noteworthy characteristics were identified by Zuga (1994) including the overwhelming lack of females and minorities in the field, the reliance on survey methods, and the lack of research on technological literacy. Overall recommendations were to expand research methods, demonstrate technology education's inherent value, research the ideology and biases in content and practice, develop innovative curricula, and to promote professional development (Zuga, 1994, p. 67).

A more recent review by Johnson and Daugherty (2008) focused exclusively on research published in scholarly journals associated with technology education. The journals and the number of empirical articles spanning the review period 1997-2007 are listed in Table 1. Consistent with Zuga's (1994) study, teaching and curriculum were primary research areas during the period under review by Johnson and Daugherty (2008). Recommendations from this analysis include the need for more scientific research as defined by Weiss, Knapp, Hollweg, and Burrill (2002) and a stronger balance between qualitative and quantitative methodologies. Engineering, integrative practice (e.g. STEM), cognitive science, creativity, and problem solving were identified as areas of needed research.

Table 1: Number of empirical articles examined in each journal (Johnson & Daugherty, 2008)

Title of Journal	**Years Reviewed**	**Empirical Studies**
International Journal of Technology and Design Education	1998-2007	68
Journal of Industrial Teacher Education	1998-2007	48
Journal of Technology Education	1997-2006	54
Journal of Technology Studies	1997-2006	29
Total Number of Articles Reviewed		199

Similar, but narrower reviews of published research have been conducted on the *Journal of Technology Education* (LaPorte, 2007; Petrina, 1998) and the *International Journal of Technology and Design Education* (Vries, 2003). Published research and graduate studies in the United States have also been reviewed to see how critical problems and issues (e.g. Wicklein, 1993, 2005) are being addressed (Reed, 2006). This study, like all other reviews, found that scholars are addressing key research topics but the need for more synergy and focus among researchers continues to be a pressing issue.

GRADUATE RESEARCH

Research conducted by graduate students clearly documents the history of the profession and provides the foundation for technology education. Laborious efforts have been made by Jelden (1981), Foster (1992b), and Reed (2001) to track graduate research since much of this work goes unpublished. These researchers searched databases and relied on students and advisors to compile comprehensive lists of graduate research. Reed (2001) assembled these efforts into an electronic list titled the Technology Education Graduate Research Database (TEGRD). Additionally, Dissertation Abstracts Online (ProQuest) was searched using the following terms: Manual training, industrial arts, industrial education, technology education, industrial technology, trade & industrial education, and industrial vocational education. The TEGRD initially contained 5,259 entries spanning 1892-2000, however, this database has been updated for this chapter and Figure 2 displays graduate research by year. Several points are interesting to note. First, there is consensus with Dyrenfurth and Householder's (1979) review that research output increased considerably during the decade encompassed by their review. Secondly, graduate research appears to have leveled off during the past decade with approximately twenty studies being conducted annually.

Although a large amount of graduate research is not published, the proliferation of electronic databases, websites, and other tools has provided an increased level of access. Jelden (1976) was a pioneer in this area by compiling graduate research and helping others retrieve information from early information systems. Foster's (1992b) bibliography was the first effort placed online (see http://scholar.lib.vt.edu/ejournals/JTE/) and the TEGRD built on this effort and remains accessible through the CTTE website (see http://www.ctteonline.org). A logical step is to house full-text graduate research papers online. Common databases such as UMI/ProQuest and ERIC have housed full-text documents for years but a concerted effort should be made to provide wider access to technology education graduate research. An example has been developed by Ritz and Reed (2006) that contains master's research papers, not theses and dissertations which is a requirement for inclusion in the TEGRD. Nevertheless, this database contains over thirty-five years of full-text papers, many that investigate contemporary technology education issues:

- The Effects of Technology Education on Science Achievement (Filossa, 2008).
- Effects of Technology Education on Middle School Language Arts (Reading) Achievement (Bolt, 2005).
- Middle School Equipment Needs to Teach the Standards for Technological Literacy (Warner, 2005).
- The Demand for Industrial Technology and Technology Education Faculty Professors at United States Universities (Hicks, 2005).
- Directions of Dissertation Research at Universities Preparing Future Technology Education Teacher Educators (Sontos, 2005).

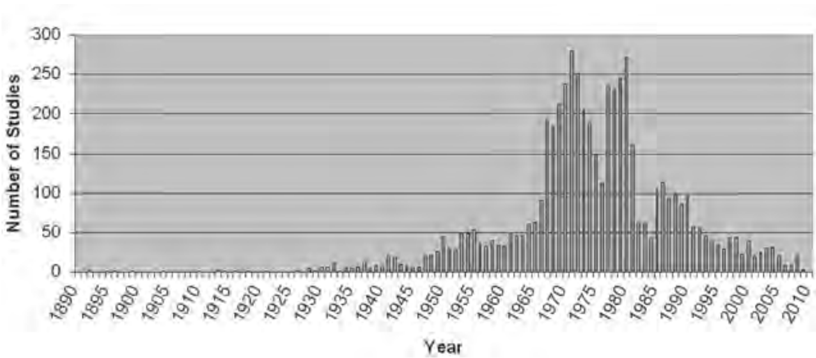

Figure 2: Graduate Research by Year

Efforts to broaden access to graduate research are important since traditional graduate universities (e.g. land grant institutions) in the United States are shrinking and regional institutions are expanding their graduate offerings (LaPorte, 2002). A recent survey of International Technology and Engineering Educators Association (ITEEA) university members, PATT participants, and universities listed in the *Industrial Teacher Education Directory* (Schmidt, 2004) investigated the state of graduate technology education. Seventy-eight institutions were contacted and sixty-three (80.7%) responded. Forty-five of these institutions offer graduate programs with forty-three offering master's degrees, six offering specialist degrees, and eighteen offering doctoral degrees in Australia (2), Canada (1), France (1), South Africa (1), and the United States (13) (Ritz & Reed, 2008).

Graduate research related to the profession is often conducted at universities that do not have programs in technology education (Reed & Sontos, 2006). This highlights the importance of not only tracking the quantity of graduate research but also the methods and topics in order to help reduce repetition and fragmentation in the research being conducted. For example, Table 2 highlights a study that analyzed graduate research over a recent five-year period using classifications similar to those used by Zuga (1994). Sontos (2005) discovered an increase in the research being conducted on instruction and a decline in curriculum studies. Trend analysis such as this must continue to help build on the reviews and research of the past and to help guide future research.

Table 2: Technology education dissertations in the United States, 2000-2005 (Sontos, 2005)

Categories	Number of Studies	Percentage
Attitudes	7	12%
Instruction (how)	17	29%
Curriculum (what)	5	8%
Continuing Education	2	3%
Professional Develop.	8	14%
Foreign	11	19%
Work-based Education	9	15%

PUBLICATIONS

There has never been a more opportune time for technology educators to publish their research: New journals have emerged, electronic publishing has come-of-age, and other disciplines are broadening the scope of their journals to reflect STEM research. Table 1 above gives an overview of published research in major technology education journals and Chapter 13 provides a comprehensive review of publications in several of these scholarly journals. This section is designed to highlight many of the publishing opportunities and challenges facing technology education researchers. Readers seeking a more detailed history of specific publications are encouraged to review Sanders' (1995) chapter on professional technology education publications.

The *Journal of Technology Education* (JTE), *Journal of Technology Studies* (JTS), and *Journal of Industrial Teacher Education* (JITE) have been cornerstone journals for peer reviewed research in technology education. Additionally, these publications made an early transition to electronic publishing by joining the Virginia Tech Digital Library and Archives (DLA) EJournals (see http://scholar.lib.vt.edu/ejournals/). The DLA "provides access to scholarly electronic serials that are peer-reviewed, full text, and accessible without charge" (Digital Library and Archives, 2010, ¶1). The *Journal of the Japanese Society for Technology Education* is also available on the DLA EJournals site as well as these journals that have ancillary goals to technology education: *Techné: Research in Philosophy & Technology*, *Career and Technical Education Research*, and the *Journal of Career and Technical Education*.

There are many other online tools such as Google Scholar (http://scholar.google.com/) and JSTOR (http://www.jstor.org) as well as subscription databases (e.g. ProQuest, EBSCOhost, FirstSearch, etc.) that provide full text theses, dissertations, and articles. Publications from the *International Journal of Technology and Design Education* (IJTDE), *The Technology Teacher* (TTT), *Technology and Children*, *Tech Directions*, *ties*, and *Techniques* can be accessed using one or more of these online tools. The availability and search capabilities of these databases has many advantages and can even lead to extensive reviews of research such as that produced by Petrina (1998).

Publishers and organizations are increasingly using their websites to publish and market research. These arrangements vary from complete open access, restricted access for fee/members, or a combination between the two. The Council on Technology Teacher Education (CTTE) is an example of an open access provider with its monographs and other publications are available to anyone[1]. The *Journal of Design and Technology Education: An International Journal* (formerly *The Journal of Design and Technology Education*) is an example of a subscription-only publication (see http://www.trentham-books.co.uk/). A mixed approach for electronic publishing and marketing is used by the International Technology and Engineering Educators Association (ITEEA). Some research is available to anyone but the majority of ITEEA's monographs, task force reports, and other publications are available only to members.

Technology educators must make a concerted effort to publish research outside the professions' main journals in order to broaden exposure and help advance the discipline. Research from McLaughlin (2005) found over ninety journals that were considered to be receptive to technology education scholarship. Many publications such as the *Journal of STEM Education* (see http://www.auburn.edu/research/litee/jstem/index.php), which is in its tenth year, have a clear mission that encompasses technology education. However, other publications such as *Technology and Culture* and American Heritage's *Invention and Technology* also have a compelling contribution to technology education but one would be hard pressed to find a manuscript that focuses on technology education in these journals. Such a dilemma poses a challenge for the profession: In addition to focusing on what to research, the same amount of attention should be placed on where to publish.

CONFERENCES

The amount of scholarship exchanged at conferences, like publishing opportunities, is at an all-time high. The Mississippi Valley Conference is recognized as the oldest continuing technology education conference, having started in 1907 (Barlow, 1967). The conference chair assigns topics months in advance and proceedings take place in a single-session format where the presenters are thoroughly questioned by the membership. The Southeastern Technology Education Conference (STEC), established in 1962, is also a single - session scholarly conference but presentation proposals are submitted and reviewed Both of these conferences have strong histories of scholarship but one limitation is that proceedings are not widely shared beyond the conference participants.

1 The exception remains the CTTE Yearbook which is provided to members and sold to non-members. However, the CTTE Yearbook Committee and the CTTE Executive Committee both agreed at the 2010 ITEEA conference that all Yearbooks should be openly available on the Virginia Tech Digital Library and Archives website. The *Council* was researching the feasibility of this initiative at the time this Yearbook went to press.

Several conferences provide limited access to conference proceedings. The American Industrial Arts Association (AIAA, later ITEA and now the ITEEA) annual conference was started in 1938 and published selected proceedings through the 1970s. In the 1980s and 1990s some ITEEA conference papers were offered through the association's product catalog. Currently, the ITEEA collects presentation materials and archives them on the Member's Only section of its website. A twenty-five year content analysis of the AIAA/ITEA conference program looked at the number of research presentations (Figure 3). During the period under review, 1978-2002, there was an average of 10 research presentations over the first twenty years and an increase to an average of 17 during the last five years (Reed & LaPorte, 2004).

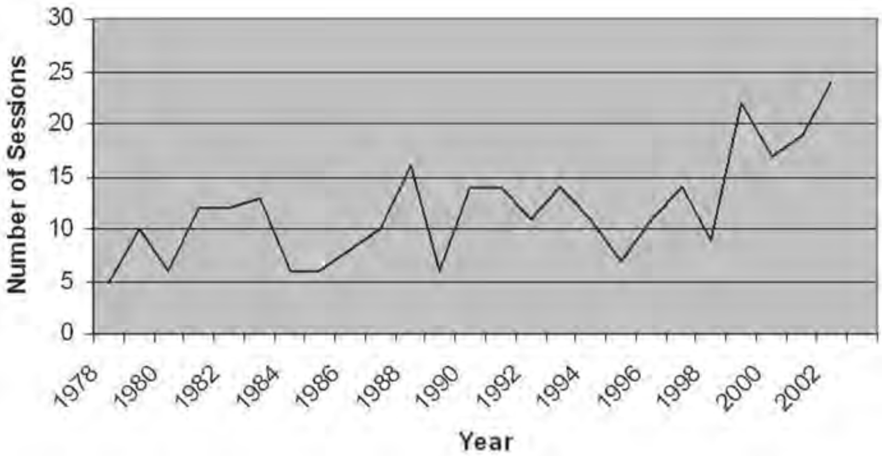

Figure 3: Research presentations by year (1978-2002) at the annual conference of the ACIATE/ITEEA (Reed & LaPorte, 2004).

Two other conferences that provide varying access to their proceedings are the Technology Education New Zealand (TENZ) Conference and the Technology Education Research Conference (TERC). The TENZ conference is a biennial conference that occurs on odd years. Early conference papers were provided on disk to participants but the past two conference archives are available online (see http://www.tenz.org.nz/). The TERC is also a biennial conference which is held on even years. Proceedings are provided to participants on CD and select proceedings are archived on the CTTE website (http://www.ctteonline.org). TERC program and other information may be found on the conference website (http://www.griffith.edu.au/conference/technology-education-research-conference-2010).

Several conferences maintain comprehensive archives of their proceedings. The International Conference on Design and Technology Educational Research

(IDATER) was held annually from 1988-2001 and then went online. Archives for the traditional and electronic conferences are available at http://www.lboro.ac.uk/departments/cd/research/groups/ed/idater/. Additionally, the PATT conference has partnered with the ITEEA to host conference materials and proceedings back to 1988 (see http://www.iteea.org/Conference/pattproceedings.htm).

Several other organizations host conferences pertinent to technology education. The American Society for Engineering Education (ASEE) hosts regional division conferences, an annual conference, and an annual global colloquium. Research papers are reviewed for these conferences and accessible on the ASEE website (http://asee.org/conferences/paper-search-form.cfm). More detail on the ASEE and engineering education research in general is provided in chapters five and eight. The American Association for the Advancement of Science (AAAS) has also hosted two conferences on technology education research. The first conference in 1999 was held "to consider what kind of research would enhance the goal of achieving universal technological literacy" (AAAS, 2010, ¶2). The second AAAS conference in 2001 was to help set research priorities in order to establish a research agenda for technology education. The proceedings of both AAAS conferences are available online and establish a solid foundation for a research agenda (see http://www.project2061.org/events/meetings/technology/default.htm).

RESEARCH PRIORITIES, FRAMEWORKS, AND AGENDAS

The technology education profession has been in existence for well over 100 years yet it continues to dance around the issue of establishing unified research priorities and carrying them out in a systematic manner. The preceding sections of this chapter document that research has effectively been reviewed and synthesized, published, and is shared among scholars in increasing ways. These foundations provide an opportunity for the profession to move forward with a focused research agenda. This section is intended to show how existing recommendations can build upon this foundation and set the course for a unified research agenda.

Several notable organizations have published research priorities, frameworks, and agendas for technology education. The proceedings of the two AAAS conferences previously mentioned were synthesized into research categories and priorities (Householder & Benenson, 2001). Additionally, the National Academies have published a general research agenda as far back as 1985 (Committee on Research in Mathematics, Science, and Technology Education). More recently, the National Research Council published *Investigating the influence of standards: A framework for research in Mathematics, Science, and Technology education* (Weiss, Knapp, Hollweg, & Burrill, 2002). Figure 4 illustrates this framework and shows how contextual forces, channels of influence, teachers, and teaching practice all impact student learning. The National Academies also have publications concerning research on undergraduate STEM teaching (Fox & Hackman, 2003) and technological literacy (Garmire & Pearson, 2006). Unfortunately much of the research has never come to fruition, despite the detailed organization and researchable questions outlined in these publications.

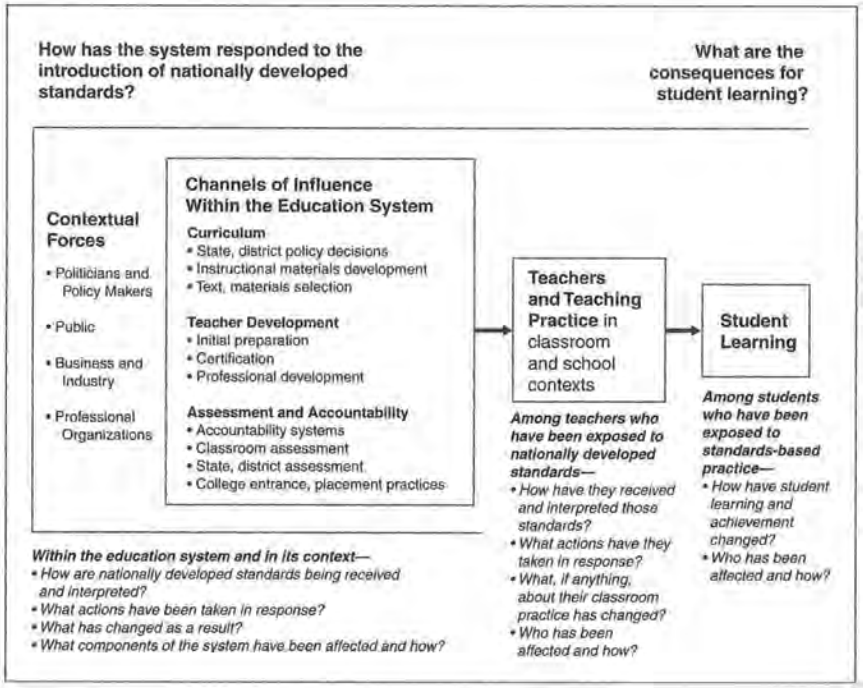

Figure 4: A framework for investigating the influence of nationally developed standards for mathematics, science, and technology education (Weiss, Knapp, Hollweg, & Burrill, 2002).

There are also compelling priorities, frameworks, and agendas within the technology education literature. Waetjen (1991) outlined research priorities focused on student impact, teaching, and educational decision makers. Broad research topics were also identified in the literature and prioritized through a survey of technology education scholars by Foster (1996). The ten research recommendations (highest to lowest priority) are:

Integration of educational disciplines.
The role of technology education as general education for all students.
Rationale for technology education.
The capability (i.e. effectiveness) of technology education programs to deliver technological literacy.
Nature of technological literacy.

Need for technological literacy.
Impacts of technology on people and society.
The nature and effectiveness of applied instructional techniques.
Effectiveness of various instructional techniques
Definition of constructs (Foster, 1996, pp. 32-33).

Hoepfl (2002) also created a framework for research in technology education that contains themes (skills development conundrum, process of design, and science/technology interface) as well as strands (teachers, students, assessment, and content). A matrix (Figure 5) demonstrates the interaction of the themes and strands. Additionally, sample research questions were developed from the literature and placed in the matrix to highlight the use of this framework.

Themes	Strands			
	Teachers	Students	Assessment	Content
Skills Development Conundrum				
Process of Design				
Science/Technology Interface				

Figure 5: Themes and strands for a research framework in technology education (Hoepfl, 2002).

The National Center for Engineering and Technology Education (NCETE) also developed a research framework with three main themes, each with several sub-themes:

1. How and What Students Learn in Technology Education
   Sub-themes: Learning and Cognition, Engineering Processes, Creativity, Perceptions, Diversity and Learning Styles
2. How to Best Prepare Technology Teachers
   Sub-Themes: Teacher Education and Professional Development, Curriculum and Instruction, Diversity, and Change.
3. Assessment and Evaluation
   Sub Themes: Student Assessment, Teacher Assessment (NCETE, 2005).

The NCETE framework, like Hoepfl's (2002) and the NRC's (Weiss, Knapp, Hollweg, & Burrill, 2002) frameworks, contains multiple research questions in each area.

The Council on Technology Teacher Education (CTTE) *Strategic Plan* (2004) established five priorities with one on research and scholarship to "develop a research agenda to serve as a foundation for curriculum, program, and professional development as well as assessment through research and scholarship" (p. 2). The 2007 CTTE Yearbook, *Assessment in Technology Education* (Hoepfl & Lindstrom), and Johnson, Burghardt, & Daugherty's chapter, *Research Frontiers – An Emerging Research Agenda*, in the 2008 Yearbook (Custer & Erekson) help to address this priority but do not provide a comprehensive agenda. These publications, as well as the previously mentioned priorities, frameworks, and agendas, should be used to create a comprehensive agenda for the profession. Several publications from other disciplines would also aid technology education in the creation of a research agenda. Mathematics and science education each have two comprehensive handbooks on research (for mathematics, see Grouws, 1992; Lester, 2007; for science, see Gabel, 1994; Abell & Lederman, 2007). These handbooks are discussed in more detail in chapters nine and ten because of the many connections between mathematics, science, and technology education. However, even an un-related discipline such as dance education provides a useful model (see Bonbright & Faber, 2004) for setting research priorities and developing an evaluation matrix that could be emulated by technology education.

CONCLUSIONS

The continued push for higher standards and accountability in education requires everyone involved to use scientific principles and focus their research (National Research Council, 2004). For technology education, this must be more comprehensive than past efforts. The profession does have a sustained history of research, over 40 years of research reviews, and increasing access to research, publications, and conferences, but it is no longer sufficient to hedge our future on disjointed research efforts that are mostly conducted by graduate students. A focused and sustained effort must be made, one using accepted scientific principles that:

1. pose significant questions that can be investigated empirically,
2. link research to relevant theory,
3. use methods that permit direct investigation of the question,
4. provide a coherent and explicit chain of reasoning,
5. replicate and generalize across studies, and
6. disclose research to encourage professional scrutiny and critique (Shavelson & Towne, 2002, pp. 3-5).

Such an effort will require scholars within technology education to not only develop a research agenda but to implement an action plan. The chapters that follow indicate that the foundations for a comprehensive research agenda have been laid. Key areas of technology education research as well as research from areas that inform technology education are analyzed. It is now time for all of us to come together and not rely on others to define our future.

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