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Research Supporting Technology Education- Task Force 2.4 Final Report

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Research Supporting Technological Literacy

ITEA's Board of Directors convened a task force in 2006 to identify research on technology teaching and learning. The resulting database is designed to help teachers, supervisors, and anyone that needs to show research support for technology education. The research was compiled by the following task force members:

- Dr. Philip A. Reed, Chair
- Jim Carlson
- Fred Figliano
- Hal Harrison
- Hyuksoo Kwon
- Johnny Moye
- Phyllis Opare
- Dr. John M. Ritz, DTE
- Roger Skophammer
- Dr. John Wells

The research is organized around six categories:

- Curriculum
- Instruction
- History, philosophy, and literature
- Design/Technology
- Elementary technology education
- Return on investment

Each category is listed below with a brief description. Individual research entries contain a direct hyperlink, when available, and a brief description. It is hoped that other categories and research will be added over time.

Curriculum

Standards for Technological Literacy, technical and social/cultural, appropriate technology, sustainable technology, etc.

- Lewis, T. (2006). Design and inquiry: Bases for an accommodation between science and technology education in the curriculum? *Journal of Research in Science Teaching*, *43*(3), 255-281. Available Online: http://www3.interscience.wiley.com/cgi-bin/abstract/112315771/ABSTRACTc

  Examined through this research are the merits behind the proposition that design and inquiry are conceptual parallels and that there is potential for this parallelism to serve as an avenue for discourse regarding common pedagogical understandings. Points of divergence and convergence are identified, followed by a discussion on the implications for curriculum design and instruction across both fields.

- Peters, J. M. (1997). *A Survey of Architects and Engineers in the State of Virginia to Determine if Traditional Drafting Skills Should Continue to be Taught in Virginia's High Schools*. Un-published Research Paper. Norfolk, VA: Old Dominion University. Available Online: http://www.lib.odu.edu:8000/dspace/handle/123456789/5

  This study asked architecture and engineering firms the skills that should be taught in technology education drafting and design courses. The highest priorities were sketching and CAD.

- Petrina, S. (2004). *Change and technology in the United States: A resource book for studying the geography and history of technology*. Available online: http://www.teched.vt.edu/ctte/ImagesPDFs/Petrina.Change.TechInUS.pdf

  This comprehensive text researches inventions, technological events, innovation, labor, and historical trends spanning 1787-1987. Additional information includes a cross references of standards, Internet resources, and a list of articles, CDs, books, and videos.

- Wells, J. G. (1994). Establishing a taxonometric structure for the study of biotechnology in secondary school technology education. *Journal of Technology Education, 6*(1), 58-75. Available Online: http://scholar.lib.vt.edu/ejournals/

  This seminal research provided a foundational content structure for incorporating biotechnology, a newly identified content area, into technology education curricula. The research design employed a classic Delphi methodology and panel members from the science and technology disciplines in discerning an appropriate structure for teaching biotechnology content in secondary technology education. The resulting structure provided a basis for developing design-based biotechnology curricula and instructional approaches for both technology and science education.

Instruction

Teaching methods, technology teacher preparation, facilities/environment, student organizations and competitions, integrative approaches including STEM, etc.

- Arnold, J. S. (1986). *Determination of the need for and curriculum design of a doctoral program in industrial technical education*. Unpublished Doctoral Dissertation, Colorado State University. Dissertation Abstracts Online Accession No: AAT 8625084

  The study had a target sample of 297 full time instructors, out of which 177 responded to a mail survey to constitute the final sample for the study. The purpose of the study was to determine the perceptions of vocational/technical instructors in an eight-stat area about their interest in returning to school to obtain a doctorate. The results indicated instructors' perceptions of needs and requirements for obtaining degrees, such as costs and aid availability, reputation of an institution, equipment and facilities availability, coursework in teaching specialty as well as availability of summer courses. Respondents also indicated that the following areas were important for curriculum design, refresher courses in math and science, personnel management, new trends and issues in higher education, internships in industry as well as coursework in teaching specialty.

- Begley, J.R. (1997). *Determination If the Major Virginia School Systems Are Teaching Middle School Technology Using Modular or Traditional laboratory Arrangements*. Unpublished Research Paper. Norfolk, VA: Old Dominion University. Available Online: http://www.lib.odu.edu:8000/dspace/handle/123456789/29

  This study found that 51% of Virginia schools systems used modular laboratories to teach technology education. The researcher concluded that modular technology arrangements should be included in teacher preparation programs so that graduates would be better prepared to work in these environments.

- Bensen, T. D. (1993). *Leadership attributes addressed in industrial technology/technology education doctoral programs as perceived by faculty and recent graduates*. Unpublished Doctoral Dissertation, Iowa State University. AAT 9334961

  The purpose of the study was to examine the perceptions of faculty and recent graduates of industrial technology/technology education doctoral programs, in a bid to discover what they perceive as being important leadership attributes and whether current programs were providing training in those attributes for graduates. The researcher sampled 22 faculty and 81 graduates and administered a two-part survey. The results indicated that both faculty and students rated leadership attribute importance equally, and agreed on the level of attention attributes receive in various programs. However, they differed significantly in ratings of the level of attention the attributes should be receiving, and further analysis indicated that the graduates rated a fairly large number of attributes higher than faculty.

- Bissette, M. (1998). *Investigation of technology integration in a rural school district.* Unpublished Doctoral Dissertation, The University Of New Mexico. Dissertation Abstracts Online Accession No: AAG9826602

  The sample for the study was made up of twenty graduate education students in a four semester technology education program. Sixteen of the participants were from a small rural northern New Mexico district. The study was an investigation of the effect of the Integrating Technology into Schools (ITS) project on attitude toward the use of technology in the classroom, as well as the changes in instructional strategies of participants as a result of their participation in the ITS initiative.

  The study found that ITS affected teacher attitude towards the use of technology, and also that the teachers who used the program eventually changed their instructional strategy from teacher centered to student centered approaches.

- Childress, V. W. (1992). *The effects of technology education, science, and mathematics integration upon eighth graders' technological problem solving ability*. Unpublished Doctoral Dissertation, Virginia Polytechnic Institute and State University. Dissertation Abstracts Online Accession No: AAG9500831

  This research used a quasi-experimental, nonequivalent control group design to compare the performance of eighth grade students receiving correlated technology, science, and mathematics (TSM) integration to those not receiving integration in an adapted Technology, Science, Mathematics Integration Project Activity (LaPorte & Sanders, 1993). There was no significant difference between the treatment and control groups for technological problem solving, however, evidence suggested that students were applying science and mathematics concepts in their technological problem solving.

- Duffey, J.B. (2004). *The Equipment Needs of the Standards for Technological Literacy*. Unpublished Research Paper. Norfolk, VA: Old Dominion University. Available Online: http://www.lib.odu.edu:8000/dspace/handle/123456789/107

  Ten CATTS state leaders were surveyed to determine if they had recommended equipment lists for technology education. These lists were sought in an attempt to determine facility needs for implementing the Standards for Technological Literacy at the elementary, middle, and high school levels. The research developed a straw list of equipment to implement the standards.

- Estepp, J. M. (1998). Succession planning in university-level technology programs. *Journal of Technology Studies*, 24(2), 48-51. Available Online: http://scholar.lib.vt.edu/ejournals/

  To explore the extent and effectiveness of succession planning at the university level, a five-item questionnaire was e-mailed to 121 higher education practitioners in the areas of Industrial Arts and Technology Education. Of the 55 (45%) participants returning completed surveys, 33 (60%) indicated they believed that a succession-planning model would be successful in a higher education structure. Although 76% of respondents revealed they had no knowledge of succession planning implemented on their campus, less formal practices such as memberships and workshops did appear. The study concluded with there being no strong evidence that succession planning supported the preparation of individuals for particular positions in higher education.

- Hicks, Jr., C. (2005). *The Demand for Industrial Technology and Technology Education Faculty Professors at United States Universities*. Un-published Research Paper. Norfolk, VA: Old Dominion University. Available Online: http://www.lib.odu.edu:8000/dspace/handle/123456789/5

  This study analyzes the need for future faculty members in technology education. The study used five years of flyers sent to university departments electronically or via U.S.

mail. It was found that the need for faculty was increasing each year; more faculty were sought with technical than pedagogical skills.

- Hill, R. B. & Wicklein, R. C. (1999). A factor analysis of primary mental processes for technological problem solving. *Journal of Industrial Teacher Education, 36*(2). Available Online: http://scholar.lib.vt.edu/ejournals/

This study was conducted in an effort to systematically identify themes or key constructs representative of mental processes necessary for solving technological problems. Applying survey methodology, useable questionnaire responses from a random sample of 212 (58.7% of 361) participants selected from a database of 3,818 professional members of the International Technology Education Association were analyzed. Using a factor analysis process, five major themes were identified that are typically employed when solving technology-related problems. Factors identified from this study provided technology education teachers with a stable and workable platform for establishing a strong curriculum with mental processes used by technologists as a central feature.

- Kimball, C. (2005). *Technology Education in Virginia's Private School System.* Un-published Research Paper. Norfolk, VA: Old Dominion University. Available Online: http://www.lib.odu.edu:8000/dspace/handle/123456789/5

Of the 35 Virginia private schools that responded to the survey, twenty-two schools identified themselves as offering technology courses. Four schools listed computer courses; however, the remainder listed courses included in the Virginia Department of Education Program of Studies for technology education.

- McLaren, S., Stables, K., & Bainb, J. (2007). Exploring creativity and progression in transition through assessment is for learning. In J. Dakers, W. Dow, & M. De Vries (Eds.), *Teaching and learning technological literacy in the classroom* (pp. 143-151). PATT-18 Conference. Glasgow, Scotland: University of Glasgow. Available Online: http://www.iteaconnect.org/Conference/pattproceedings.htm

This research gathered baseline and follow-up data from teachers and students using questionnaires to gauge attitudes toward creativity, structured conceptual design activities to assess performance, learner evaluations, and teacher interviews. The research team concludes that there is scope for adopting the tools explored to support formative and sustainable assessment strategies and approaches to gathering meaningful indicators that can be embedded into teaching and learning for design and technology education.

- Merrill, C. (2001). Integrated technology, mathematics, and science education: A quasi-experiment. Journal of Industrial Teacher Education, 38(3), 45-61. Available Online: http://scholar.lib.vt.edu/ejournals/

Conducted at the high school level, this research investigated the validity of using integrative instructional approaches for teaching and learning technology, mathematics, and science (TMaSe) education as one that leads to improvements in student learning of TMaSe content. The study followed a modified (comparison groups) quasi-experimental nonequivalent control group design on a purposeful sample (71 of 225) of suburban students enrolled in technology education classes. Although results indicated no significant differences were observed between the treatment and comparison groups, the research presents a baseline of methodology and instrumentation for follow-on investigations into the benefits of integrative instruction of TMaSe content.

- Nash, R.A. (2005). *Tidewater Virginia Technology Education Teacher Professional Development Needs*. Un-published Research Paper. Norfolk, VA Old Dominion University. Available Online: http://www.lib.odu.edu:8000/dspace/handle/123456789/268

  This survey research sought to: 1) Determine the types of professional development being sought by Southeastern Virginia public school technology education teachers, and 2) Recommend specific types of professional development that should be made available to Southeastern Virginia technology education teachers.

- Ritz, J. & Reed, P. (2007). Graduate study in technology education, state-of-the-art. In J. Dakers, W. Dow, & M. De Vries (Eds.), *Teaching and learning technological literacy in the classroom* (pp. 406-414). PATT-18 Conference. Glasgow, Scotland: University of Glasgow. Available Online: http://www.iteaconnect.org/Conference/pattproceedings.htm

  Survey research used to provide a view of graduate study across the world. MS and PhD programs were identified, including their curriculum, methods of delivery, student research requirements, and faculty needs.

- Rohann, E., Taconis, R, & Jochems, W. (2007). Examining teachers' pedagogical content knowledge of technology with a multiple choice test. In J. Dakers, W. Dow, & M. De Vries (Eds.), *Teaching and learning technological literacy in the classroom* (pp. 129-136). PATT-18 Conference. Glasgow, Scotland: University of Glasgow. Available Online: http://www.iteaconnect.org/Conference/pattproceedings.htm

  This research illustrates how teachers' pedagogical content knowledge (PCK) could be assessed with a multiple choice test. The advantages and disadvantages of this methodological approach, the procedure of test item construction, preliminary results, and possible implications of the test are discussed.

- Settar, S.C. (2006). *The Relationship between Pre-engineering Courses and Increased Success on the Virginia Algebra II and Geometry Standards of Learning Examinations.* Un-published Research paper. Norfolk, VA: Old Dominion University. Available Online: http://www.lib.odu.edu:8000/dspace/handle/123456789/429

  The following hypotheses were developed to guide this study: 1) Students who complete the pre-engineering program at West Springfield High School will perform higher on the

Virginia Algebra II Standards of Learning examination than students who do not enroll in the pre-engineering program; 2) Students who complete the pre-engineering program at West Springfield High school will perform higher on the Virginia Geometry Standard of Learning examination than students who do not enroll in the pre-engineering program. It was found that students who completed the pre-engineering courses score significantly higher on state mathematics tests than students who did not enroll in technology education courses.

- Scarborough, J. D. & White, C. (1994). Phys-ma-tech: An integrated partnership. *Journal of Technology Education*, 5(2), 28-43. Available Online: http://scholar.lib.vt.edu/ejournals/

  The population for this study was the students of five high schools in northern Illinois that participated in the PHYS-MA-TECH and Physics courses. The students taking the PHYS-MA-TECH course who would not have normally taken a Physics course were considered the "average" students and the students taking the Physics course were considered the "high achievers." The results were that the "average" group and the "high achievers" group, had similar levels of increased physics related knowledge. The results indicated that integrated teaching offers a learning experience that "average" students can understand and learn.

- Warner, T. G. (2005). *Middle School Equipment Needs to Teach the Standards for Technological Literacy*. Un-published Research Paper. Norfolk, VA: Old Dominion University. Available Online: http://www.lib.odu.edu:8000/dspace/handle/123456789/5

  This study used state technology education facility plans to identify suggested equipment for the middle grades. Surveys were sent to CATTS member state leaders to have them validate an equipment list developed by J. Duffey in earlier research. The recommended equipment list is provided.

- Weber, K., & Custer, R. (2005). Gender-based preferences toward technology education content, activities, and instructional methods. *Journal of Technology Education, 15*(2), 55-71. Available Online: http://scholar.lib.vt.edu/ejournals/

  This study explored the types of learning activities, topics, and instructional methods in technology education that are preferred based on students gender. One survey (*The technology Activity Preference: **TAP** Inventory*) identified the students' preferences toward activities in technology education while a second (*Technology topics and Instructional methods Preference Inventory: **TIP** Inventory*) examined students' preferences toward content topics and instructional methods in technology education. This study recommends gender based studies are needed for technology education curriculum development in order to better understand the dynamics of student preferences for technology related topics, activities, and pedagogical approaches. Furthermore, it is suggested that standards based curricula be used for instructional delivery of agricultural, biotechnology, medical technologies activities.

- Zubrowski, B. Integrating science into design technology projects: Using a standard model in the design process. *Journal of Technology Education, 13*(2), 48-67. Available Online: http://scholar.lib.vt.edu/ejournals/

  This research provides a pedagogical model to address the design and inquiry process by advocating a special type of integration. It introduces a "standard model" with a case study of a 4th grade students building and investigating a model windmill. A design project using model windmills was presented to illustrate the three phase pedagogical model based on a standard model. This study proposes that design projects at the elementary and middle school levels are much more enriching and build a firmer pedagogical foundation if it presented in a design technology context.

History, Philosophy, and Literature

Reviews and syntheses of research, research supporting technology education philosophy and literature, etc.

- Daugherty, M. K., & Wicklein, R. C. (1993). Mathematics, Science, and Technology Teachers' Perceptions of Technology Education. *Journal of Technology Education, 4*(2), 28-43. Available Online: http://scholar.lib.vt.edu/ejournals/

  The population for this study was two groups, the technology education teachers and the secondary education faculty (mathematics and science teachers). The study revealed the feelings and significant differences that technology education, mathematics, and science teachers had concerning technology education.

- Garmir, E. & Pearson, G. (2006). *Tech tally: Approaches to assessing technological literacy*. Washington, DC: National Academies Press.

  This report from the Committee on Assessing Technological Literacy in the United States defines technological literacy and reviews instruments and methods. Findings and recommendations outline assessment opportunities, research on learning, innovative measurement techniques, framework development, and a definition of technology.

- Halfin, H. H. (1973). *Technology: A process approach*. Unpublished Doctoral Dissertation, West Virginia University. Dissertation Abstracts Online Accession No: AAT 7323867

  This groundbreaking dissertation is an analysis of the writings of ten key technologists (e.g., the Wright Brothers, Goodyear, Edison, Fuller, Frank Lloyd Wright, among others) to identify the processes of renowned technologists. Seventeen processes were identified and outlined.

- Hamby, M.C. (2003). *The Attitudes of Core Subject Teachers Toward making Technology Education a Required Subject.* Un-published Research Paper. Norfolk, VA: Old Dominion University. Available Online: http://www.lib.odu.edu:8000/dspace/handle/123456789/168

  This study sought opinions of academic teachers toward technology education offered in their high school. All subjects understood the goals of technology education and were able to differentiate it from instructional technology. The teachers also agree that technology education can reinforce the concepts taught in the academic disciplines. The academic teachers believed that technology education should become a core subject.

- Hoover, G.T. (2003). *A Study to Determine the Relationship between Parent's Work and Their Concern for Their Children Becoming Technologically Literate*. Un-published Research Paper. Norfolk, VA: Old Dominion University. Retrieved January 14, 2008 from: http://www.lib.odu.edu:8000/dspace/handle/123456789/189

  This study obtained responses from 131 parents to determine their feelings about the importance of technological literacy for their children. Ninety percent of the parents thought that a study of technology was important at all levels of society. They believed that technology should become a part of the regular curriculum for all students.

- Martin, G. E. & Martin, C. M. (2006). Best practices in technology education. A collection of 21st century best practices in technology education. Glen Ellen, IL: Technical Foundation of America. Available online: http://www.teched.vt.edu/ctte/ImagesPDFs/BestPracticesInTE.pdf

  Fourteen technology educators identify over one hundred best practices to help bring about purposeful change in student learning, teaching effectiveness, and program effectiveness. The practices are classified into three sections: national and state initiatives, local initiatives, and classroom initiatives.

- Pavlova, M. (2006). Comparing perspectives: Comparative research in technology education. In M.J. de Vries & I. Mottier (Eds.) *International handbook of technology education* (pp. 19-32). Rotterdam: Sense Publishers.

  This research reflects on the history of comparative education research in technology education. Global trends and appropriate units of analysis were discussed. Purposes of technology education supported by literature of authors of different countries are described, i.e., creation of a better society or preparation for work.

- Sanders, M. (2001). New paradigm or old wine? The status of technology education practice in the United States. *Journal of Technology Education*, *12*(2), 35-55. Available Online: http://scholar.lib.vt.edu/ejournals/

Using the *Technology Education Programs Survey (TEPS)* instrument in a nationwide data collection effort, this study addresses the substantive changes in technology education practice, particularly with respect to program names, purposes of the field, students served, and instructional methods employed. According to survey results, the perceived purposes of technology education focus on the teaching of problem-solving as the most important purpose of the field. Significant demographic shifts in the faculty and students of technology education were revealed, along with the recognition that many technology education programs reflected the content areas found in the *Standards for Technological Literacy* (ITEA, 2000).

- Snyder, M. R. (1992). *The transition from industrial arts to technology education in the United States: a historical perspective*. Unpublished Doctoral Dissertation, Virginia Polytechnic Institute and State University. Dissertation Abstracts Online Accession No: AAG9233632

  This historical study documents the change from industrial arts to technology education. The study examines the philosophical foundation of both disciplines and explains the transition between the two programs in great detail. The study also discusses significant events and key people involved in the transition from industrial arts to technology education, as well as the intended goals of each program in the United States.

- Valentine, E. F. (1998). Gender differences in learning and achievement in mathematics, science, and technology and strategies for equity: A literature review. ERIC Document: ED 446 915.

  This study investigated literature focusing on gender differences in math, science, and technology. Findings indicate that girls think and learn differently as well as interact with equipment differently. Strategies are suggested for rethinking gender biases in the classroom and professional organizations.

Design/Technology

International design and technology, the design process, engineering design, creativity, etc.

- Compton, V. & Harwood, C. Enhancing technological practice: An assessment framework for technology education in New Zealand. *International Journal of Technology and Design Education (13)*, 1–26,

  This article introduces the Technology Assessment Framework (TAF) as an organisational tool for the development and delivery of technology programmes that focus on increasing students' technological literacy through the enhancement of their technological practice across technological areas and contexts.

- Harris, M. & Wilson, V. (2003). *Designs on the curriculum? A review of the literature on the impact of Design and Technology in schools in England*. London: Department for children, schools, and families. Available online: http://www.dfes.gov.uk/research/data/uploadfiles/RR401.pdf

The Department for Education and Skills (DfES) commissioned the Scottish Council for Research in Education to review the literature on the impact of Design and Technology (D & T) in schools. The review was conducted between August and November 2002. It draws mainly on UK literature published over the past decade. Overall the searches reveal a subject that has come a long way in the twelve years since its inception. Many articles enthuse about what D & T can offer students; unfortunately few test these theories. Much of the research literature available is based upon very small-scale case studies and concentrates on a narrow area of research interests.

- Mehalik, M. M., & Doppelt, Y., & Schunn, C. D. (2008). Middle-school science through design-based learning versus scripted inquiry: Better overall science concept learning and equity gap reduction. *Journal of Engineering Education*. 9(1), 968-970. Available Online: http://www.lrdc.pitt.edu/documents/MehaliketalJEE2008.pdf

  Designed to compare science learning outcomes resulting from traditional scripted inquiry versus a design-based, systems approach, this study investigated eighth grade urban students over a four week period as they designed and built electrical alarm systems to learn electricity concepts. Using a paired experimental/contrast design, instructional outcomes from 10 teachers (587 students) in 26 science classes employing the systems instructional approach were contrasted with the scripted inquiry approached used by five teachers (466 students) in 20 science classes. Results suggested that the systems design approach to teaching science concepts demonstrated superior performance with respect to promoting gains in student knowledge of core science concepts, engagement, and retention when compared to a traditional inquiry approach. Of particular note was the finding that the systems design approach was especially helpful to low-achieving African American students.

- Norton, S. J. (2007). The use of design practice to teach mathematics and science. *International Journal of Technology and Design Education. 18*(1), 19-44. Available Online: http://commerce.metapress.com/content/102912/?p=7ee257ce3f5b47459ad6d958457c8592&pi=0

  To offset student perceptions of mathematics not being intrinsically useful and difficult to understand, an intervention using a technology and design project to integrate the study of math was implemented. Using a case study methodology with a composite (years 1 – 7) class of 12 students, integration tools were incorporated into instruction to facilitate positive cognitive discourse among students. Results indicated that students immersed in the integrated design project demonstrated functional understanding of mathematics concepts, reported a broader and more applied understanding of the nature of mathematics, and believed that integration helped them to make more sense of mathematics.

- Rauscher, W. (2007). Inquiry into technological knowledge in an educational context . In J. Dakers, W. Dow, & M. De Vries (Eds.), *Teaching and learning technological literacy in the classroom* (pp. 8-17). PATT-18 Conference. Glasgow, Scotland: University of Glasgow. Available Online: http://www.iteaconnect.org/Conference/pattproceedings.htm

  This is a quantitative and qualitative analysis, based chiefly on engineering frameworks, of the categories of technological knowledge used by design and technology education students in the designing and making of technological artifacts. The population was 43 university students. It found that the students utilized all of the categories of technological knowledge and used knowledge from these categories to a similar extent in two different content areas.

- Seiler, G. (2001). Design, technology, and science: Sites for learning, resistance, and social reproduction in urban schools. *Journal of Research in Science Teaching, 38*(7), 747-767. Available Online: http://www3.interscience.wiley.com/cgi-bin/abstract/85012081/ABSTRACT

  Situated in an inner-city neighborhood school, this study explored the discourse and practices of students and co-teachers as a new curriculum was implemented to teach about the physics of motion through designing, building, and testing a model car. Analysis of in-class interactions revealed the potential for the emergence of a science-like discourse and diverse outcomes. This case study found evidence of student resistance to this line of instruction and that an ongoing struggle for respect exists within the study population between their school and daily lives.

- Stables, K., Rogers, M., Kelly, C. & Fokias, F. (2000).*Enriching literacy through design and Technology evaluation project: Final report*. Goldsmiths College, University of London.

  This project aimed to explore the potential for using design and technology (D&T) related activities as a vehicle for developing children's levels of attainment in literacy and in D&T. The project made an important and valuable contribution to the children, their teachers and (in certain aspects) their schools, in terms of improving literacy skills, D&T skills and approaches to linking the two curriculum areas in ways that are mutually enhancing.

- Welch, M., & Lim, H. S. (2000). The strategic thinking of novice designers: Discontinuity between theory and practice. *Journal of Technology Studies*, 26(2), 34-44. Available Online: http://scholar.lib.vt.edu/ejournals/

  Twenty (two groups of ten) Grade 7 students participating in a design and making activity were studied using protocol analysis of transcribed audiotapes to examine their conversations while engaged in project activity. Researches found that untutored novice designers do engage in the sub-process of the theoretical models, but do not follow the same order in which the sub-processes maybe outlined in many textbooks and documents. The research concluded that instructors must acknowledge the many ways students approach design and consider how the unrefined strategies of students can be used as a foundation for their educational development.

Elementary Technology Education

Research support for elementary technology teaching and learning, teacher preparation, history, philosophy, literature, etc.

- Benson, C. & Lunt, J. (2007). It puts a smile on your face! What do children actually think of design and technology? Investigating the attitudes and perceptions of children aged 9-11. In J. Dakers, W. Dow, & M. De Vries (Eds.), Teaching and learning technological literacy in the classroom (pp. 297-305). PATT-18 Conference. Glasgow, Scotland: University of Glasgow. Available Online: http://www.iteaconnect.org/Conference/pattproceedings.htm

  This research reports on a pilot study conducted with 304 children aged 9-11. Data were collected through a questionnaire designed to elicit learners' attitudes to design and technology, their preferences within the subject, and the value they ascribe to it. The evidence suggests that both boys and girls enjoy design and technology; they enjoy making the most but many children also value designing. They perceive it as a subject that provides challenge and opportunities to develop their creativity and thinking abilities. They also perceive it as being useful for their adult lives.

- Berryman, Howard G. (1999). *The effects of technology education labs on third-grade math scores.* Unpublished Doctoral Dissertation, University Of Sarasota. Dissertation Abstracts Online Accession No: AAG9920887

  The population for this study was made up of third grade students from two elementary schools from which a random sample of 300 male and female students was selected. They were placed in four categories, two of males and females who participated in technology education labs and another two of males and females who did not participate in technology education labs. The study sought to discover the effect of technology education labs on the students in ITBS math tests scores.

  The results were significant for males who participated in technology education labs and those who did not, but there were no significant differences between the score of females who participated in the technology education labs and those who did not, and between the combined groups of male and female who participated in technology labs and those who did not.

- Foster, P. N. (1997). The benefits of elementary school technology education to children. Unpublished Doctoral Dissertation, University of Missouri - Columbia. Dissertation Abstracts Online Accession No: AAT 9841141.

  The purpose of this qualitative study was to identify the benefits of elementary-school technology education (ESTE) to children. Two classrooms, one 2nd and one 4th grade, were studied. Teachers were provided with ideas and advice to implement ESTE into their curricula. Three major classifications of benefits were found: academic, technology-education, and social and life skills.

- James, D. L. (2002). *Project UPDATE-Technology Education Impacts on Virginia Standards of Learning Achievement*. Un-published Research Paper. Norfolk, VA: Old Dominion University. Available Online: http://www.lib.odu.edu:8000/dspace/handle/123456789/207

  This was a study of two classes of fourth grade students. One group studied design and technology and the other did not. They were compared on their fifth grade academics standards tests. Those who studied design and technology showed significant differences in standardized test scores in English, science, and mathematics, but not in history or computer technology.

- Kirkwood, J. J. (2000). The status of technology education in elementary schools as reported by beginning teachers. *Journal of Industrial Teacher Education, 37*(3). Available Online: http://scholar.lib.vt.edu/ejournals/

  This study evaluated the benefits of a required pre-service course dealing with elementary school technology education (ESTE). The study surveyed elementary school teachers in the Midwest, primarily in Indiana, and found that a majority of teachers were not using ESTE activities and had a poor understanding of ESTE.

- Ramey-Gassert, Linda Kay. (1993). *A qualitative analysis of factors that influence personal science teaching efficacy and outcome expectancy beliefs in elementary teachers*. Unpublished Doctoral Dissertation, Kansas State University. Dissertation Abstracts Online Accession No: AAG9402712

  The study sought to discover teachers' perception of their personal science teaching efficacy (PSTE) as well as science teaching outcomes expectation (STOE) for the students they teach. The sample for the study was a preexisting group of 27 elementary teachers who were participants of a pre-service teacher education project. Findings indicated that teachers' PSTE correlated with the variables, attitude toward science, educational degree level, choosing to teach science, and self-rated effectiveness in science teaching, while STOE corresponded with the number of college science courses taken and choosing to teach science.

- Thomson, C. (2004). What are the unique and essential characteristics of technology education in the primary school? A study based in the USA. In I. Mottier & M. J. de Vries (Eds.), *Pupils' decision making in technology: Research, curriculum development and assessment.* Proceedings Patt-14 Conference. Available Online: http://www.iteaconnect.org/Conference/pattproceedings.htm

  This Delphi study evaluated what experts and teachers in the U.S. believed to be unique and essential about ESTE. The study identified areas believed to be unique to ESTE, and in general found ESTE methodology as unique and essential to ESTE. The study also found that most experts agreed that methodology was more important than content in ESTE.

Return on Investment

Technology education's contribution to general education, student retention, employment, the economy, etc.

- Bolt, M. A. (2005). *Effects of Technology Education on Middle School Language Arts (Reading) Achievement*. Un-published Research Paper. Norfolk, VA: Old Dominion University. Available Online: http://www.lib.odu.edu:8000/dspace/handle/123456789/5

  This study looked at the relationships of student's state standards examination for reading after students enrolled in a semester of technology education offered through a modular approach to technology education. There were no observed improvements in reading from those who studied technology education at the middle school level.

- Dugger, J. & Johnson, D. (1992). A comparison of principles of technology and high school physics student achievement using a principles of technology achievement test. *Journal of Technology Education*, 4(1), 18-25. Available Online: http://scholar.lib.vt.edu/ejournals/

  The population for this study was the fifteen high schools in Iowa where the vocational programs offered the Principles of Technology course. The researchers found that the Principles of Technology students scored significantly higher on post – tests than did first year high school Physics students and students who did not take either the Principles of Technology or Physics courses.

- Dyer, R., Reed, P. A., & Berry, R. Q. (2006). Investigating the Relationship Between High School Technology Education and Test Scores for Algebra 1 and Geometry. *Journal of Technology Education*, *17*(2), 6-16. Available Online: http://scholar.lib.vt.edu/ejournals/

  The population for this study was composed of students in the 10th, 11th and 12th grades who had taken the Algebra I and/or the Geometry end-of-course examinations in a southeastern Virginia high school. Researchers found a significant difference between the standardized end-of-course test scores of students who took Illustration and Design Technology courses and those that did not. However, there was not a significant difference between students taking Illustration and Design Technology courses and a student's ability to pass a retake examination for those that did not initially pass.

- Mehrotra, S., Khunyakari, R., Chunawala, S., & Natarajan, C. (2007). Using pictures and interviews to elicit Indian students' understanding of technology. In J. Dakers, W. Dow, & M. De Vries (Eds.), *Teaching and learning technological literacy in the classroom* (pp. 152-161). PATT-18 Conference. Glasgow, Scotland: University of Glasgow. Available Online: http://www.iteaconnect.org/Conference/pattproceedings.htm

  This research aimed to elicit students' understanding of technology. It studied 200 grade 6 students using pictures depicting technological artifacts. Analysis indicated that objects and activities related to communication and transportation gadgets were often considered technological. Objects presented with humans were perceived more related to technology than objects alone.

- Sontos, D. A. (2005). *Directions of Dissertation Research at Universities Preparing Future Technology Education Teacher Educators*. Un-published Research Paper. Norfolk, VA: Old Dominion University. Available Online: http://www.lib.odu.edu:8000/dspace/handle/123456789/5

  This study spoke with graduate program leaders at 10 US PhD granting institutions and summarized their dissertation topics for the past five years. The study found that PhD research in technology education is not theme or focused organized like PHD programs in the sciences. Recommendation was that technology teacher education institutions become know for the focus of their advanced student research.

- Stout, H.L. (2006). *The Relationship of Gender to Grades in a General Education Technology Course.* Un-published research paper. Norfolk, VA: Old Dominion University. Available Online: http://www.lib.odu.edu:8000/dspace/handle/123456789/447

  Forty students were studied in a general education, post-secondary technology course at a major eastern university to determine if there was a correlation between a student's gender and the achievement of academic excellence. There was not significant difference found in the academic performance between females and males in the course.