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Contents

From the Editor

Red Wine, Research, and Technology Education

In the last issue, James Haynie presented an analysis and critique of the articles published in the *Journal of Technology Education* since its inception. Haynie argued that there is a dearth of experimental research, attributing it in part to the manner in which editorial reviewers consider research manuscripts. In this issue, Steve Petrina presents another critique of the *JTE*, addressing not only research, but the very nature of the scholarship of technology education as manifested by what has been published. Petrina takes aim at what he feels is the insular nature of our scholarship, pointing out the lack of connectedness with the broader educational community.

There is no doubt that our research and scholarship are lacking. In fact, there are few research findings upon which to justify what we do in practice in technology education today, nor the direction in which we seem to be headed in the future. In fact, there was little research evidence to support the abandonment of past practices.

When I began re-exploring the areas of science and mathematics a few years ago, I expected to be embarrassed about how much more “they” know about what they were doing in educational practice than we do. My face did not turn very red, for other subjects seem to be just as short of research-based knowledge as we are, at least relatively speaking. What’s more, there are inconsistencies and unanticipated outcomes in research results across the board. Even in this issue, there is an interesting, unexpected result in the article by Boser, Palmer, and Daugherty. Again, we should not be particularly ashamed about this, especially when we consider the medical community. The inconsistent research results in studies of the influence on health of red wine, along with aspirin, sodium, and coffee, are examples. Plus, these inconsistencies have occurred even with the resources necessary to tighten experimental control and to use larger, more representative samples.

As educational researchers, there is no doubt about our commitment to the scientific approach in our methodology. Ironically, though, we rarely repeat experiments, an equally essential ingredient in the quest for scientific theory and law. We encourage our research novitiate, our doctoral students, to strike out in new directions in their dissertations. In doing so, they build upon the work of others. Yet, the differences from one study to another are often significant enough to void any substantial addition to our theory. Encouraging, even expecting, doctoral research to be innovative is justified. However, when the most substantial portion of the research in a field is embodied in doctoral dissertations, it causes one to pause and ponder.

Over the past 20 years, I have asked a rather straightforward question of a number of experienced teachers with whom I have interacted: “Cite one example of your teaching practice that is based on research." My question has been answered only on rare occasions. In a lot of ways, it seems an even more formidable task to get research results infused into educational practice than doing the research itself.

We have some shortfalls and some challenges to meet. We need more experimental research upon which to base our practice and we need to connect ourselves with the larger educational community. Nonetheless, I am encouraged by how far we have come in this regard and *JTE*'s contribution to it. The international influence of the *JTE*, the breadth of scope of the articles that have appeared, the diversity of the authors who have contributed to it, and the number of people around the world who are accessing it via the World Wide Web are some of the things that come to mind. Once we get the teachers who are actually delivering our programs fully infused into our "community of inquiry," then we may begin to determine just how good that red wine is that we are now sipping and sharing with others.

JEL

Articles

Students Attitudes Toward Technology in Selected Technology Education Programs

Richard A. Boser, James D. Palmer, and Michael K. Daugherty

One of the goals of technology education is to promote technological literacy of a broad and encompassing nature (Technology for All Americans Project (TAAP), 1996; International Technology Education Association (ITEA), 1993). To achieve this goal, technology education must prepare students to understand, control, and use technology. Students need to learn how to adapt to technological change and how to deal with forces that influence their lives and potentially control their future (Waetjen, 1985).

The paradigms for teaching technology education are changing. Technology education teachers and curriculum experts recommend a variety of differing instructional approaches such as self-paced modules, interdisciplinary methodology, and problem solving to inform students about technology and its affects on society. These instructional approaches all have their advantages and disadvantages. Gloeckner (1990), Thode (1989), and others have argued that self-paced modular instruction is an appropriate method that best accommodates diversity in both learning styles and learning levels. Others (Illinois State Board of Education, 1992; Wicklein, Hammer, Balistreri, DeVore, Scherr, Boudreau & Wright, 1991) suggest that technology is interrelated to other disciplines and that students need to see the connection between math, science, technology, social studies, and English; therefore, teachers should use interdisciplinary instruction. Other educators, DeLuca (1992) and James (1991), plead the case for problem-centered instruction as an authentic way to focus on the development of students' higher-level cognitive skills.

Measuring Technological Literacy

Regardless of the instructional approach utilized, the purpose of technology education is to prepare students to become technologically literate citizens (TAAP, 1996). The recent TAAP rationale and structure document stated that technological literacy "…involves a vision where each citizen has a degree of knowledge about the nature, behavior, power, and consequence of technology from a broad perspective" (p. 1). Although technological literacy is a frequently used term, its broad and encompassing nature makes it difficult to define

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operationally or to attempt to measure. Technological literacy has been difficult to define because of a lack of consensus as to what comprises "technological literacy." TAAP defined technological literacy simply as "the ability to use, manage, and understand technology" (p. 6). Dyrenfurth, Hatch, Jones, and Kozak (1991) noted that technological literacy is a multi-dimensional concept that includes the ability to use technology (practical dimension), the ability to understand the issues raised by the use of technology (civic dimension), and the appreciation for the significance of technology (cultural dimension). Both of these definitions suggest the scope of technological literacy, but do not address content specifics nor begin to suggest how technological literacy may be measured.

It is clearly difficult to measure a construct if it has no readily agreed upon boundaries. To resolve this problem, many technology education programs limit the scope of their curriculum to "industrial" technology. Hayden (1991) developed the Industrial Technology Knowledge instrument to measure students' industrial technological literacy. Hayden concluded that there exists a construct of technological literacy that is a subset of general achievement. However, the construct can only be reliably measured by cognitive testing if there are similarities in the curriculum content of industrial technology programs.

Although there is no widely accepted standardized instrument suitable for assessing the broader construct of technological literacy, variations on the portfolio method are used to observe gains in students' technological literacy. Daiber, Litherland, & Thode (1991) described the following techniques to assess the technological literacy level of students in a specific technology education course or program: (a) analysis of taped one-on-one and group discussion that have similar topics at the beginning and end of the course, (b) observation of students involvement with problem solving activities, and the results of hand on activities, (c) utilization of paper and pencil exercises in the format of a pretest/ posttest design, and (d) development of a technology achievement test that includes major objectives of the course. Similarly, the British technological literacy framework used nine criteria to assist teachers in assessing the performance of 11 to 13 year olds in design and technology programs (Ager, 1992). The framework argued that an accurate assessment of technological capability of individuals is best conducted by teachers who have worked with students over long periods of time. These proposed methods for the assessment of technological literacy are time consuming and limited to specific curriculum content and concepts. The inability to measure technological literacy as practiced within the broad scope of technology education has led some educators to select measures in the affective domain as an alternative way to assess technological literacy (Bame, Dugger, de Vries, & McBee, 1993; Raat & de Vries, 1986).

Evaluating Affective Outcomes

In the educational arena, instruments designed to measure cognitive objectives have historically been emphasized over instruments that measure affective objectives (Krathwohl, Bloom & Bertram, 1964) because many researchers assumed that personality characteristics, such as motivation, develop relatively slowly and were visible in appraisal techniques only over long periods of time. New evidence challenges this position. Now it is thought that affective behaviors undergo far more sudden transformations than cognitive behaviors (Popham, 1994). It could be assumed that if students have a tendency to act positively toward a subject, for example, technology, then students will have more of an interest in that subject (Krathwohl et al., 1964). Thus, if one of the educational goals of technology education is technological literacy, then students exhibiting a positive attitude toward technology would be more likely to attain technological literacy through technology education (Bame, et al., 1993).

Raat and de Vries (1985) investigated the attitudes of middle school students toward technology in order to develop course materials that could apply technological concepts and practices in a physics curriculum. The project titled *Pupils' Attitudes Toward Technology* (PATT) sought to determine students' attitudes toward technology and their understanding of technological concepts. Raat and de Vries concluded that: (a) students had only a vague concept of technology, (b) the relationship of technology to physics was very obscure to students, particularly among girls, and (c) girls are less interested in technology and see it as less important.

The PATT questionnaire was revised for use in the United States (PATT-USA) and the questionnaire was tested and validated in seven states (Bame et al., 1993; Bame and Dugger, 1989). A description of the questionnaire and sample items are presented in the methods section of this paper. The results of the PATT-USA study indicated that: (a) students are interested in technology; (b) boys are more interested in technology than girls; (c) students in the U. S. think that technology is a field for both girls and boys; (d) girls are more convinced that technology is a field for both genders; (e) there is a positive influence of a parents' technological profession on the students' attitude, (f) U. S. students' concept of technology became more accurate with increasing age, (g) U. S. students are strongly aware of the importance of technology, (h) the U. S. has a rather low score on items measuring the concepts of technology compared to other industrialized countries, (i) students who had taken industrial arts/technology education classes had more positive attitudes on all sub-scales, and (j) the existence of technical toys in the home had a significantly positive impact on all attitude scales.

Although research on student attitudes in technology education has been used to assess student attitudes prior to curriculum development, a standardized attitude measure such as the PATT-USA has not been used to assess changes in attitude as the result of a treatment such as participation in a technology education program. It is logical that students who have a positive experience in a technology education program will develop a positive attitude toward technology and the pursuit of technological careers, and would therefore be more interested in studying about technology. As a result, students should become more technologically literate. This premise is grounded in research from the affective domain that indicates that students who exhibit a positive attitude toward a subject are more likely to actively engage in learning during and after instruction (Popham, 1994).

Research Problem

There are numerous methods and techniques that technology teachers can use in order to deliver technology education content to middle school students. Yet, it is difficult to measure the affect of these various instructional approaches on the development of students' technological literacy. The lack of accepted or standardized measures of technological literacy make it difficult to assess and compare various forms of instruction in technology education. In lieu of an assessment of students' cognitive ability, measures of students' attitudes toward technology may provide some insight into the teaching approaches that affect students' attitude toward technology in a positive way. The attitude measure may then be one indicator of effective teaching approaches for technology education.

The purpose of this study was to examine changes in students' attitudes toward technology among four teaching approaches typically used to deliver technology education in the middle school. The following research questions guided the study:

1. Do the students' attitudes change as a result of participation in technology education programs?
2. As per previous PATT-USA research findings, are there differences in the attitudes of male and female students as a result of participation in technology education programs?
3. Does the instructional approach used to deliver technology education affect students' attitude toward technology?

For the purposes of this study, the instructional approaches typically used in technology education are defined as follows:

1. *Industrial Arts Approach*: A body of related subject matter, or related courses, organized for the development of understanding about all aspects of industry and technology, including learning experiences involving activities such as experimenting, designing, constructing, evaluating, and using tools, machines, materials, and processes (American Council on Industrial Arts Teacher Education, 1979).
2. *Integrated Approach*: Instruction that incorporates other disciplines such as English, math, science, and social studies to show how technology is an integral part of other disciplines and vice versa. It also emphasizes the need for humans to apply knowledge from other disciplines to solve technological problems.
3. *Modular Approach*: Individualized, self-paced, action-based units of instruction that allow students to use current technologies to learn independently. The modular approach provides students with problems and activities that encourage them to use critical, higher-level thinking skills to solve problems and make value decisions.
4. *Problem Solving Approach*: An instructional approach that emphasizes critical thinking and is centered around students using a problem

solving process to find creative solutions to problems that are technological by nature.

Methods

The four instructional approaches investigated were selected because they are representative of the spectrum of instruction that is typically labeled as technology education. While the *integrated*, *modular*, and *problem solving* approaches are contemporary variations of technology education, the *industrial arts* approach is still widely practiced and offered a point of comparison with the newer curricula. Although the researchers pre-determined the instructional approaches to be studied, two experts who have observed classroom practices in technology education in Illinois were asked to nominate programs that were good exemplars of each approach. From the pool of nominated programs, four schools were selected to participate in the study based on the following criteria: (a) similar population demographics; (b) located in central Illinois or the Chicago metropolitan area; (c) recognized as effectively using one of the four types of instructional approaches: interdisciplinary, modular, problem solving, or industrial arts; and (d) the teacher was recognized as competent in delivering the instructional approach. These criteria for program selection were established to control extraneous variation between the approaches.

Teachers from the four identified schools were contacted by phone to solicit their participation. The sample included a total of 155 seventh grade students who were enrolled in a middle school technology education program that utilized one of the four instructional approaches defined above. The data were collected from intact classes at the four middle schools.

The PATT-USA questionnaire was administered to students being taught in the four identified approaches using a pre-test and posttest design. The PATT-USA is one page instrument that consists of four parts: (a) a short written description of technology, (b) eleven questions to gather demographic data and information about the technological climate of students' homes, (c) 57 statements (items 12-69) with a five part, Likert-type scale to assess students' attitudes toward technology, and (d) 31 statements (items 70 -100) with a three part, Likert-type scale to assess students' *Concept Of Technology*.

There are six sub-scales on the PATT-USA questionnaire. Five of the sub-scales are dedicated to attitude items and consist of 57 questions related to student perceptions of technology. Examples of these items are presented in Table 1. The five attitude sub-scales are: (a) General Interest in Technology, (b) Attitude Toward Technology, (c) Technology as an Activity for Boys and Girls, (d) Consequences of Technology, and (e) Technology is Difficult. The *Concept of Technology* items (questions 70 - 100) represent a single sub-scale. As opposed to attitudes, the concept items attempt to get at students' understanding of the role of technology in shaping our world. Examples of items from the *Concept of Technology* section include:

70. When I think of technology I mostly think of computers.
80. Elements of science are seldom used in technology.
97. Technology has little to do with daily life.

The pre-test was administered during the first week of the students' program and the posttest was administered during the last week of instruction. The time interval between the pre- and posttests was about nine weeks. The researchers traveled to all of the middle schools to administer the pre-test instruments to the students. Posttest data were collected by either the researchers or the classroom teacher who observed the initial pre-test administration. The standard administration protocol of the PATT-USA was observed during pre- and posttest data collection.

The completed PATT-USA data were color coded by instructional approach and numbered in order to assure the accuracy of data transfer. The data were initially entered into Excel, a spreadsheet from Microsoft, and then converted to SPSS (Statistical Package for the Social Sciences) files for additional statistical analysis. To assure the accuracy of data tabulation, 20% of the original instruments were compared to the entered data files. No data entry errors were identified during this procedure. Whenever possible, statistical analysis used the same procedures as previous PATT-USA studies (Bame & Dugger, 1989). Specific statistical analysis procedures included:

1. All attitude items, questions 12-69, were analyzed using a factorial analysis to validate item grouping of sub-scales.
2. All *Concept Of Technology* items, questions 70-100, were analyzed using a Guttman analysis to assess internal reliability.
3. Cronbach's Alpha internal consistency reliability test was run on all attitude and concept items.
4. *t*-tests were used to determine attitudinal changes on each sub-scale between the pre and posttest administrations.
5. *t*-tests and MANOVA were used to analyze differences on the attitude sub-scales that may be attributed to gender.

To establish the validity of the sub-scale categories, a factorial analysis was conducted on the pre-test data. The factorial analysis supported item loading and the sub-scale categories used on the PATT-USA questionnaire (Bame & Dugger, 1989). To help the reader understand the type of items that comprise the five attitude sub-scales, examples of high loading items from each sub-scale are presented in Table 1.

Results

A total of 287 pre- and posttest instruments were collected. Of the total, 282 usable instruments were available for analysis (155 pre-test and 127 posttest). Two factors explain the differences in pre and posttest returns. In one school, two classes received the pre-test, while only one class (n=23) took the posttest. Since students in one class had concluded their nine-week session there was no opportunity to administer the posttest to this class. Data analysis indicated equal variance between the pre- and posttest groups in spite of differences in sample size. In addition, five posttests were excluded from analysis because the students were not present for the entire nine-week treatment period.

The pre-test sample (n=155) was comprised of 86 boys and 68 girls (one student did not indicate gender). The posttest sample (n=127) was comprised of

66 boys and 59 girls. Two students did not indicate gender on the posttest instrument. Gender by instructional approach is presented in Table 4. All of the students were in the seventh grade and between the ages of 12 and 14. Other demographic data in questions 3 to 11 of the instrument were not germane to this study.

Table 1
Examples of PATT-USA Statements from Each of the Five Attitude Sub-scales

Item #	Statement
General Interest in Technology	
12.	When something new is discovered, I want to know more about it immediately.
16.	At school you hear a lot about technology.
17.	I will probably choose a job in technology.
56.	Technology is a subject should be taken by all pupils.
Attitude Toward Technology	
29.	There should be less TV and radio programs about technology.
54.	Technology causes large unemployment.
60.	Because technology causes pollution, we should use less of it.
55.	Technology does not need a lot of mathematics.
Technology as an Activity for both Boys and Girls	
13.	Technology is as difficult for boys as it is for girls.
30.	Boys are able to do practical things better than girls.
41.	Boys know more about technology than girls do.
53.	More girls should work in technology.
Consequences of Technology	
14.	Technology is a good for the future of our country.
20.	Technology makes everything work better.
25.	Technology is very important in life.
36.	Technology has brought more good things than bad.
Technology is Difficult	
15.	To understand technology you have to take a difficult training course.
21.	You have to be smart to study technology.
26.	Technology is only for smart people.
43.	To study technology you have to be talented.
49.	You can study technology only when you are good at both mathematics and science.

Table 2
Two-Tailed t-test Comparison of Pre and Posttest Means For Each Sub-scale by Instructional Approach

	Industrial Arts			Integrated			Modular			Problem S	
Sub-scales	Pre-test n=27	Post-test n=26	p value	Pre-test n=31	Post-test n=29	p value	Pre-test n=53	Post-test n=51	p value	Pre-test n=44	Post test n=21
Attitude Sub-scales*											
General Interest in Technology	2.87	2.72	0.478	2.31	2.44	0.388	2.92	2.86	0.714	2.47	2.48
Attitude Toward Technology	2.54	2.65	0.404	2.24	2.48	**0.048**	2.62	2.88	**0.025**	2.58	2.69
Tech. as Activity for Boys & Girls	1.81	1.79	0.870	1.61	1.67	0.650	1.80	1.93	0.385	2.04	2.11
Consequences of Technology	2.13	2.13	0.998	1.84	2.88	**0.004**	2.20	2.21	0.978	1.91	1.95
Technology is Difficult	3.70	3.46	0.265	3.89	3.42	0.058	3.57	3.43	0.357	3.84	3.08
*Concept of Technology***	0.52	0.58	0.195	0.69	0.67	0.535	0.53	0.45	**0.032**	0.61	0.53

Notes:
Statistically significant differences in **bold**.
Total n = 280, combined pre-test (n = 155), posttest (n = 125), and missing posttest cases (n = 2).
* Lower mean on the 5-point scale indicates more positive attitude for sub-scale.
**Higher mean indicates broader and more accurate concept of technology. Scale range 0 to 1.0.

A Guttman analysis was conducted on the sub-scale (items 70-100) to determine the index of internal consistency of students' responses to the concept items. The analysis indicated an alpha coefficient of .82 and .81 respectively on the pre- and posttests. A second reliability analysis, Cronbach's Alpha, conducted on the combined attitude and concept items yielded a coefficient of .79 and .72 on the pre-test and posttest respectively. These coefficients are considered acceptable in attitudinal instruments (Crocker & Algina, 1986).

Attitude Changes Within Approaches

Pre- and posttest data from each of the four instructional approaches were analyzed to determine change over the nine-week treatment period. To do this, *t*-tests were run on each of the six PATT-USA sub-scales. Differences were found in only 5 of the 24 sub-scales. In the *integrated approach*, statistically significant differences were found on the Attitude Toward Technology and Consequences of Technology sub-scale. Differences were also found on the Attitude Toward Technology and Concept of Technology sub-scales of the *modular approach*. In both approaches, the change was in a negative direction, indicating that students exhibited a more negative attitude toward the Consequences Of Technology on the posttest than on the pre-test. The *problem solving* approach showed a significant positive change in the Technology Is Difficult sub-scale. That is, students believed that technology was more difficult to work with at the beginning of the nine-week program than at the end. There were no statistically significant changes in any of the sub-scales for the *industrial arts approach*.

Gender Differences

The MANOVA procedure on the combined pre- and posttest data for all sub-scales and all instructional approaches was used to ascertain differences in responses that may be attributed to gender. The results indicated that statistically significant differences occurred on three of five attitude sub-scales: (a) General Interest in Technology ($p = .001$), (b) Technology As An Activity For Boys And Girls ($p = .000$), and (c) Technology Is Difficult ($p = .014$). These results are presented in Table 3.

The analysis suggested that female and male students perceived some aspects of technology differently. Female students consistently perceived technology to be less interesting than did male students. Females, more than males, perceived technology to be an activity for both boys and girls. With the exception of *industrial arts*, the instructional approach used did not cause this bias to improve over the duration of the nine-week period. Although all students perceived technology as less difficult as they experienced technological learning activities, females believed technology to be a more difficult subject than did males.

The *t*-test group procedure on the post-test scores was used to examine differences attributed to gender within each of the instructional approaches. Significant differences were found on three sub-scales (see Table 4). In the *industrial arts approach*, females responded more negatively on the Technology Is Difficult sub-scale which indicated that girls thought technology was more difficult to use and understand than did boys. In the *modular approach*, significant differences occurred on two sub-scales. Females scored higher than males on the Concept Of Technology sub-scale, indicating that girls in this approach had a better understanding of technology than did boys. The significant difference on the Technology As An Activity For Boys And Girls sub-scale implied that girls, more than boys, believed that gender did not affect the study of technology. Although data from the *problem solving* approach is displayed on Table 4, it was excluded from this analysis because of the unequal distribution of male and female students.

Table 3
MANOVA Analysis of Differences in PATT-USA Sub-scales Attributable to Gender

Sub-scales*	Mean Score Females *n*=127*	Mean Score Males *n*=152*	p value
*General Interest in Technology***	2.54	2.08	**.001**
Attitude Toward Technology	2.55	2.65	.192
Technology As An Activity For Boys and Girls	1.57	2.08	**.000**
Consequences of Technology	2.14	2.16	.899
Technology Is Difficult	3.71	3.45	**.014**
*Concept of Technology****	0.56	0.56	.969

Univariate F-tests with (1,277) degrees of freedom.
Statistically significant differences in **bold**.
Total *n*=279, missing cases *n*=3.
*Combined pre- and posttest totals from all approaches.
**Lower mean on the 5-point scale indicates more positive attitude for subscale
***Higher mean indicates broader and more accurate concept of technology. Scale range 0 to 1.0.

Discussion and Conclusions

The results of the study indicate that students' attitudes can be affected to some degree during a nine-week exposure to technology education. Significant differences between pre- and posttest results on one or more sub-scales were found in three of the four instructional approaches. This finding must be tempered by the fact that in total, statistically significant change occurred in only four of 20 attitude categories across the four approaches.

Table 4
Two-Tailed t-test Comparison of Posttest Means For Each Instructional Approach by Gender

Sub-scales	Industrial Arts Females n=13	Industrial Arts Males n=13	Industrial Arts p value	Integrated Females n=15	Integrated Males n=14	Integrated p value	Modular Females n=27	Modular Males n=23	Modular p value	Problem Solving Females n=4	Problem Solving Males n=16	Problem Solving p value
*Attitude Sub-scales**												
General Interest in Technology	2.78	2.67	.725	2.44	2.45	.975	2.98	2.70	.285	3.19	2.30	.020
Attitude Toward Technology	2.63	2.67	.799	2.43	2.55	.483	2.81	2.95	.470	2.56	2.68	.807
Tech. as Activity for Boys & Girls	1.59	1.98	.070	1.55	1.80	.256	1.62	2.33	**.001**	1.57	2.20	.192
Consequences of Technology	1.90	2.39	.079	3.01	2.74	.556	2.21	2.21	.995	1.60	2.01	.401
Technology is Difficult	3.78	3.14	**.030**	3.48	3.35	.759	3.41	3.39	.928	3.80	2.95	.141
*Concept of Technology***	.58	.58	.961	.65	.69	.516	.49	.37	**.041**	.40	.57	.151

Notes:
Statistically significant differences in bold.
Total n=125 (two posttest returns did not designate gender).
* Lower mean on the 5-point scale indicates more positive attitude for sub-scale.
**Higher mean indicates broader and more accurate concept of technology. Scale range 0 to 1.0.

Changing Attitudes

In all instructional approaches, students' belief that Technology Is Difficult was reduced through participation in technological activities. Students' Concept of Technology may be more difficult to enhance as only one instructional approach showed a significant change and it was in a negative direction. Oddly, students' Attitude Toward Technology became less favorable in two of four technology approaches, meaning that students would be more likely to agree with statements such as "there should be less TV and radio programming about technology" or "Because technology causes pollution, we should use less of it."

Perhaps the most dramatic attitude shift was found on the Consequences of Technology sub-scale. The curriculum of the *integrated approach* was designed to expose students to the positive and the negative consequences of technology through the exploration of topics such as waste handling. Although the pre-test scores were similar for all approaches on this sub-scale, the posttest mean score for the *integrated approach* showed a significant change over the pre-test mean. While the direction of the movement was toward the negative end of the scale, this does not necessarily imply that the students thought of technology as "bad," but rather that students had attained a more balanced view of technology. Students who participated in the other instructional approaches where the content was less controversial retained their more positive outlook toward technology. Perhaps middle schools students at the beginning of their first technology education class underestimated the complexity of technological operations and the potential for both positive and negative consequences of using technology. It follows that students' posttest scores would reflect these realities as they actually encountered various applications of technology.

The only sub-scale which did not change significantly within any of the instructional approaches was students' General Interest In Technology. Pre- and posttest mean scores for all instructional approaches remained close to 2.50, which on the 5-point scale is equal to the nominal value of "neutral." A student's general interest in technology may not be as easily affected as are the more immediate attitudinal impacts of studying the consequences of technology or overcoming the difficulty of a technological problem.

Gender Differences

As per previous PATT research findings, there were differences in the perceptions of technology attributed to gender. Independent of the instructional approach, the responses of female and male students were significantly different on three of five attitude sub-scales: (a) General Interest in Technology, (b) Technology as an Activity For Boys And Girls, and (c) Technology is Difficult.

Regardless of gender, participation in technology education programs did not significantly affect students' interest in technology. However, female students consistently perceived technology to be less interesting than male students did. The higher mean scores of females on the Technology Is Difficult sub-scale across all four instructional approaches also indicated that girls thought technology was more difficult to use and to understand than did boys.

The differences of interest in and difficulty of technology is likely related to Technology as an Activity for Boys and Girls. By indicating that technology was a more appropriate activity for boys than girls, it appears that male students continued to hold stereotypical views about the roles of females in technology. Conversely, female students indicated that they perceived an understanding of technology to be of equal importance for males and females. Moreover, visual analysis of mean scores indicated more gender bias on the posttest than the pre-test in three of the four instructional approaches. While these differences were not statistically significant, it is disturbing to think that technology education courses are not mitigating this bias.

It is also interesting to note that all of the technology teachers were male. This is not uncommon in the field. Zuga (1994) reported that the profession is overwhelmingly male and that the traditional content is designed to prepare "young middle-class men to fit into the industrial society" (p. 65). However, the content in the programs investigated ranged from a traditional materials-based project to very contemporary exemplars of technology education curriculum. Specifically, in the *industrial arts approach* students made a note pad holder using wood, plastic, and metal. The *integrated approach* examined problems dealing with waste management and the environment. Students in the *modular approach* explored units on transportation, communication, and structures. Students in the *problem solving* approach worked through a simulation on community planning. It is almost ironic that the only approach to show a positive change in the mean score on the gender sub-scale was the *industrial arts approach*.

The research literature offers some explanations for these findings. Jewett (1996) concluded that technology, mathematics, and science are still considered as nontraditional areas for women and that parental and societal perceptions, and teachers behavior and expectations, contribute to women's reduced interest in these fields. Silverman and Pritchard (1993a) suggested that middle school girls did not make the connection between what they learned in technology education and potential technological careers. In a related study, Silverman and Pritchard (1993b) found that emerging sexism among middle school peers began to influence girls' perceptions of appropriate career choices. Overcoming entrenched societal norms is obviously a huge challenge and it appears that participation in a nine-week technology education program did not affect these perceptions.

Differences Between Instructional Approaches

Even though an effort was made to include schools with similar demographic characteristics, there is no way to control all independent variables when investigating intact classes using different instructional approaches in four different school districts. The statistical analysis of attitudinal factors was conducted within each approach and the findings were presented in Table 2 for the convenience of the reader. In presenting the data in this way, some differences in the approaches appeared. In the *integrated approach*, students' perceptions were modified in two of five attitudinal categories (Attitude toward Technology and Consequences of Technology). Differences in the *modular* and *problem solving* approaches occurred in only one category (Attitude Toward Technology and Technology is Difficult respectively) and no statistical change in attitude occurred in the *industrial arts* approach. These differences between approaches suggest that instructional methods and curricular content can affect students' attitudes in some areas. However, none of the approaches affected students' General Interest in Technology or Technology as an Activity for Boys and Girls. A larger scale study would be needed to draw any meaningful inferences among instructional approaches.

Enhancing Technological Literacy

The premise of this research was that the demonstration of attitudinal changes toward technology might be linked to enhanced technological literacy and that the PATT-USA could measure that attitude change. Evidence to support this idea did not materialize from the data. Although some attitude change was observed, there was no significant change in students' Concept of Technology that might point to increased levels of technological literacy. Perhaps the treatment period was too short. Or like previous attempts to capture a measure of technological literacy, the instrument might have to be tailored more specifically to the curriculum to be useful.

Summary

In summary, the interpretation of the data suggests that:

1. Upon completion of the nine-week instructional period in technology education, students' interest in technology was not significantly altered, but their belief in the difficulty of working with and studying technology was reduced.
2. Independent of instructional approach, the responses of female and male students were significantly different on three of five attitude sub-scales.
3. Students who participated in the study had narrow concepts or misconceptions of what comprises technology on both the pre- and posttests.
4. As measured by the Concept of Technology sub-scale, there were no positive changes in students' technological literacy over the nine-week technology education program.
5. Although attitudes were affected, there was no clear direction of change in attitude that can be attributed to an instructional approach.
6. Students' attitudes toward technology and their concept of technology were generally consistent with previous PATT and PATT-USA studies.

Recommendations and Implications

In many school systems, there is only one opportunity during middle school to affect students' attitudes toward technology. Technology students will experience a lifetime of technological change and adaptation, but hopefully positive attitudes developed through technology education will remain to influence life and career decisions. To this end, technology educators should assess students in the affective domain to measure attitude changes that may be attributable to the instructional methods and curriculum. The PATT-USA appears to be a suitable instrument for this assessment.

If the profession is serious about enhancing students' technological literacy as a primary goal, there should be an effort to develop an acceptable procedure or instrument that will measure students' technological literacy. Attitude measures may eventually demonstrate some correlation with technological literacy, but they cannot replace a valid and reliable measurement protocol.

Finally, females have different perceptions of technology. Results from this study suggest that technology education programs may not be meeting the needs of female students. The profession should strive to develop curriculum materials and activities that meet the interest and technological needs of all students.

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Problem Solving in Technology Education: A Taoist Perspective

Jim Flowers

Problem solving and product design experiences can empower students by presenting unique learning opportunities. Although the problem solving method may have been important to technology education, as well as industrial arts, as far back as the 1920s (Foster, 1994), the movement to incorporate more problem solving and product design in technology education kept surfacing in the 1990s. For example, the Commonwealth of Virginia introduced a series of high school technology courses grouped together as *Design and Technology* (Virginia Department of Education, 1992); *TIES Magazine*'s web site offered 70 video tapes "that will support the teaching of design, problem solving and technology" (Ties, 1998); the use of design briefs was emphasized (Ritz & Deal, 1992); the popularity of a textbook titled *Design and Problem Solving in Technology* (Hutchinson & Karsnitz, 1994) continued to grow; and smiling students and their technological inventions were featured in articles (Edwards, 1996), at fairs, and in promotional materials. In the newer approaches to technology education that center on design, students are often asked to design new products. They creatively invent products like: pizza cutters with built-in flashlights; roller skates that work in sand; hats with built-in fans for cooling; and yet another way to store compact discs.

Subtly, the definition of technology education has evolved to reflect this movement, since "much technological activity is oriented toward designing and creating new products, technological systems, and environments" (International Technology Education Association, 1996, p.18). While there are many definitions of technology (Dyrenfurth, 1991), a number of them are oriented toward a product design and problem solving model. Some of these definitions of technology center on "control" over the "human-made and natural environment" to better meet "human needs and wants." For example, Wright and Lauda (1993) include these elements in their definition of technology as "a body of knowledge and actions, used by people, to apply resources in designing, producing, and using products, structures and systems to extend the human potential for controlling and modifying the natural and human-made environment" (pp. 3-5).

This is a shift in meaning from the days of the pump handle lamp and other woodshop projects. Back then, the student often began with a project idea, not with a problem to solve. As this shift in approach occurs, one problem faced by

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today's teachers of product design is that students tend to subvert a prescribed design process. For example, a typical teacher may ask a student to engage in such a design process, beginning with the student identifying a problem to solve. Often this is a need or want. Next, the student may be asked to gather information and then to formulate many possible solutions to the problem, eventually choosing the best. In reality, some students approach the activity with the thought, "I want to get a CD rack out of this class," or some similar sentiment that begins with one particular solution. In order to satisfy the teacher's requirements, they then craft a need to fit this product idea. While most of their designs are fanciful and lack practical application, a few do, in fact, make sense. However, the entire approach of asking students to design yet another product to satisfy our needs and wants may be misguided, for two reasons.

First, few, if any, of today's products are designed (by technology students or professional product designers) to meet actual needs. They are almost always designed to meet open markets, and then human wants can be engineered to meet the product availability. A common joke asks, "If necessity is the mother of invention, how come so many inventions are unnecessary?" The phrase, "The customer is always right," and its more cynical corollary, "Give the customers what they think they want," are not without merit, and have led to economic success for many capitalists. However, the result of product design activities for technology students is that these students learn materialism to an extreme. They are taught that just because something *can* be invented or produced, it *should be*. They are taught that creatively designing products is a good thing, regardless of the outcomes. The ultimate criterion for success is money.

Second, problem solving and product design are not the same; the best result of a sound problem solving process is often something other than a new product. Maybe the solution to a problem would be a change in corporate policy, new legislation, a consumer education program, or changes in how a product is marketed. These are each examples of design, but it is a system, not a product, that is designed or redesigned. Maybe the best solution is non-action, and acceptance of the situation without change. There have been numerous examples of technological products or "fixes," such as DDT, that have backfired. We need a global citizenry that can entertain a wider variety of solutions than merely a new technological product. Yet if students are told (even tacitly) that their solution must be a physical product or model, then we are restricting their diversity of solutions, and thereby asking them to choose what may not be the best solution. Maybe that approach to problem solving is part of how teachers are taught. Boser (1993) compared problem solving educational specialists in two groups, technology teacher educators (TECH) and other researchers who were not technology teacher educators (EXT). "Members of the TECH panel tended to rate most highly those procedures practiced within the field, such as design-based problem solving, R & D experiences, and innovation activities. EXT panelists considered techniques such as simulation and case study, which are perhaps more widely used in content areas outside of technology education, as appropriate delivery vehicles for the recommended problem solving procedures," stated Boser.

Some might point to a definition of technology and argue that the goal of technological acts is control over the environment to meet our needs and wants. But does technology really give control over the environment? Or is this just one western (or stereotypically male) approach? Surely technology education should accommodate people of different religions and belief systems. Yet, there may be a bias against certain belief systems because of the underlying and unquestioned assumptions inherent in a definition of technology and a rationale of technology education.

A Taoist philosophy is summarized in the Tao Te Ching, translated here from Lao Tsu's words (1972) from 6th Century BC China. The numbers in parentheses correspond to the reference numbers in the actual document. Lao Tsu suggested that less and less should be done "until non-action is achieved. When nothing is done, nothing is left undone. The world is ruled by letting things take their course. It cannot be ruled by interfering" (#48). The philosophy of Taoism, like some other belief systems, does not put humans on an adversarial battleground with nature. Instead, a harmonious existence is thought to be a proper relationship. "Do you think you can take over the universe and improve it? I do not believe it can be done. The universe is sacred. You cannot improve it. If you try to change it, you will ruin it. If you try to hold it, you will lose it" (#29). It is difficult to delineate the separation between human and nature, and just as difficult to find the real difference between the human-made and natural environments. It is nearly impossible to name any terrestrial environment that is all human-made (without having been affected by the sun, for example), or one that has not been influenced by humans. These distinctions seem to isolate people from the world around them in an "unnatural" way. Yet, definitions of technology often attempt to make just such a distinction. From a Taoist perspective, some definitions of technology seem more like creeds about the nature and purpose of humans.

A host of values dominant in much western culture are de-emphasized in Taoist texts, including materialism: "Having and not having arise together" (#2); "One gains by losing and loses by gaining" (#42); one "who knows that enough is enough will always have enough" (#46); and one "who is attached to things will suffer much" (#44). It is common for western students to strive to improve, to take pride in their work, and to expect and receive praise. Yet, Lao Tsu suggests, "Working, yet not taking credit. Work is done, then forgotten. Therefore it lasts forever" (#2), and "Not exalting the gifted prevents quarreling" (#3). Technology students are especially encouraged to be innovative, and to want to improve the current situation (or solve the problem): "Give up ingenuity, renounce profit, and bandits and thieves will disappear" (#19); "Without desire there is tranquility" (#37). It is especially difficult for educators to question the value of education itself, but Taoism does: "In the pursuit of learning every day something is acquired. In the pursuit of Tao, every day something is dropped" (#48); and "Give up learning and put an end to your troubles" (#20). While some Taoist doctrines may cause some to discount the entire philosophy, that would be a mistake. Instead, it would be better to see what questions are raised by such a stance.

The emphasis on design in technology education may be related to the current abundance and diversity of technical artifacts. Would more artifacts be an improvement? While there are positive and negative outcomes of nearly any technological change, we should question the assumption that more is better. Does a major league pitcher concentrate on new baseball prototypes? No. The pitcher practices and experiments with the art of pitching, often hoping to achieve just a fraction of the skill enjoyed by some of the great pitchers in the history of the game. The aim is “the essence of pitching.” However, technology is an important factor. As the clap-skate was introduced to Olympic speed skating competitions in 1998, the athletes altered their notion of “the essence of speed skating.” As technology becomes more transparent to the end user, the user is required to know less technical information to use the technology. A few decades ago, computer programming was being pushed in the public schools. Now, the emphasis is more on the use of professionally prepared programs. Software is updated so often that it can be difficult to develop comfort with one particular version. This has let to some computer users feeling more comfortable with an older, and sometimes more reliable, version of a program. Their goal may not be to use the most advanced word processing program, but to write.

Is the goal to achieve a sustainable future, or to keep accelerating? “There is no greater sin than desire, no greater curse than discontent, no greater misfortune than wanting something for oneself. Therefore [one] who knows that enough is enough will always have enough” (#46). Are there enough designs? Is there enough technology?

Would it be possible to reconcile technology, technology education, and a Taoist perspective? Yes. But technology would not be the essence of human control over others and the environment. It would not be a master, but a tool. The goal would not be materialistic or technological, but to live life on a harmonious path. Will that entail problem solving and technology? Yes, but the goal of the problem solving activity may not be what it seems.

Recommendations

Therefore, I suggest a different approach to teaching problem solving in technology education. Students should be encouraged to concentrate not on whimsical wants or fanciful products. They should apply their considerable problem solving skills to improving the human condition, and the condition of non-humans, sometimes in spite of what some people want or think they want. They should be encouraged to find solutions from a broad range of technological and non-technological realms. Effective and responsible national leaders and corporate executives are those with enough backbone to do what they believe is best for the nation or corporation, in spite of mass opinion. They are not afraid to upset people, even friends, if these people had to be upset by the leader’s pursuit of their course. While they may be mindful of the concerns of the workers, citizens, consumers, etc., they are willing to lose their job because they did what they thought was best, in spite of common opinion. The solutions (i.e., way) they choose are holistic, sometimes relying more on technology, other times involved with laws, communication, and other social arenas. They do not blindly accept the premise that their current product or service is the single best solution to a problem. They "know when enough is enough," and when the choice to not pursue a technological avenue is the wisest choice. If this is the type of person a technology teacher hopes their students will become, then specific educational experiences should be designed to empower students with those independent, risk-taking abilities where the goal is what is best, not necessarily only what the clients want or think they want. They must practice the skills involved in deciding when the best path may not be a new technological product.

Teaching problem solving in technology education will continue to offer students invaluable learning experiences. The suggestion is that the focus and procedure be allowed to shift. This can be directed by how the teacher helps the student select a problem and frame the context of a problem. Here are four examples of situations a teacher may pose for students.

- In Costa Rica, some of the urban-dwellers move into the dwindling tropical rainforest, clear an area of trees, and try to live a better life than they had in the city.
- In Ghana, there is a shortage of skilled industrial workers, yet many of the students in Ghana's trade schools consider such jobs beneath their qualifications.
- In New York, a woman who played guitar and piano for many years has to give up these instruments because the guitar causes problems with her neck and back, and both instruments have resulted in carpal tunnel syndrome.
- In Delaware, a wife and husband in their seventies were given their first VCR, but the instructions sounded too intimidating for them to actually play or record a tape.

In each example, there is a statement of a situation that might (or might not) be improved by a creative solution. Some solutions may be technological, but maybe the best solution is not technological. Students should examine such situations (both big and small, near and far, individual and societal) and use their creative problem solving abilities to try to plan what is best. This means weighing short-term gains and costs with long-term gains and costs. It means asking what is best: best for the individual, for the culture, for future generations, and for the environment. It means considering educational reform, personal lifestyle changes, new technology, and governmental action. The Japan External Trade Organization (1998) concluded that "a fundamental gap exists between the way Japanese companies and many of their overseas partners, especially in the West, view problems." Greater attention to both the diverse views of problem solving and to holistic approaches may improve the benefits of education in problem solving. Oddly, this more holistic approach to problem solving is contrary to popular belief and some research results:

> The tendency in education has been to employ the term "problem solving" generically to include such diverse activities as coping with marital problems and trouble-shooting electronic circuits. The results of this study suggest that such generalization may be inappropriate. Instead, problem solving should be viewed as nature specific. In other words, different types of problem situations (e.g., personal or technological) require different kinds and levels of knowledge and capability. This is substantiated by this study's findings that individuals manifest different style characteristics when addressing problems of different natures. (Wu, Custer, & Dyrenfurth, 1996, p.69)

However, the best solution to a technological problem may be non-technological. Students who are practiced in considering this wider range of alternatives will be better prepared to face the demands of global citizenry than those who merely make yet another CD rack.

A technology teacher can incorporate elements of a Taoist approach in subtle ways. These may include less emphasis on the product, less praise (from an external source), acceptance of some situations as they are, and an attitude of doing something because it needs to be done, and then moving on. There would certainly be less emphasis for some on solving problems by designing new products.

Finally, it is critical for a technology teacher to revisit their definition and philosophy of technology, analyzing its assumptions and bias. That definition should be individually crafted by that teacher, so that it is honest and accurate, and accommodates a variety of belief systems. That definition can lay the path for a wondrous technological journey for the student and teacher.

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The Politics of Research in Technology Education: A Critical Content and Discourse Analysis Of the *Journal of Technology Education*, Volumes 1-8

Stephen Petrina

In the fall of 1987, the *Journal of Technology and Society* (JTS) was launched as a semi-annual, "scholarly, refereed journal for professionals in technology education" (Blankenbaker, 1987, n.p.). This came on the heels of the change of name from the American Industrial Arts Association to the International Technology Education Association (ITEA). The new journal was intended to give scholarly direction to a profession in transition, and provide an outlet for addressing the increasing publishing demands on teacher education faculty. Kendall Starkweather, Executive Director of ITEA was Editor-in-Chief, and E. Keith Blankenbaker of The Ohio State University (OSU) served as Managing Editor. As the first journal of its kind in the U.S., committed entirely to technology education, the *JTS* survived in its original form only two years—three issues. Near the end of its first year of publication, the fate of the *JTS* would be shifted from OSU to Virginia Polytechnic Institute and State University (VPI).

Beginning October 1988, Mark Sanders became the Editor and James LaPorte the Associate Editor of what would become the *Journal of Technology Education* (*JTE*) in the spring of 1989. Like the short-lived *JTS*, the *JTE* would be co-sponsored by the ITEA and the Council on Technology Teacher Education (CTTE) (Sanders, 1995, pp. 597-598). And like the *JTS*, the *JTE* was invested with scholarly intentions beginning with its first issue. The *JTE* has matured in this form since that inaugural issue of 1989. The completion of the eighth volume of the *JTE* in the spring of 1997 ushered in the first change in the journal's leadership since its inauguration. James LaPorte was appointed the new editor, marking a time for anticipation and reflection. Sanders completed his duties as editor in fall 1997, ending with the first issue of volume 9.

The stability of the *JTE* alone over the past nine years might be enough to suggest its success. The journal has increased its constituency from an initial core of 57 subscribers to over 450 from across 13 countries. In the spring of 1991, the journal was made available for electronic access and has continued to be on the frontier of electronic journal publishing through the internet. During 1995-1996, the journal was accessed 99,553 times via the World Wide Web, and

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the journal's site received 157,111 electronic accesses in calendar year 1997. This growth has come at a time of a proliferation of publishing outlets and a dwindling number of technology teacher educators in the U.S. By most impressions, the *JTE* has matured qualitatively as well. Indeed, quantitative growth and quality are interrelated. Despite its relatively brief history, the *JTE* may be poised to rival the quality of peer disciplinary journals such as *Studies in Art Education* and *Science Education*. But how can the contents of the *JTE* be judged? Whose research and what has this journal published? Who and what should the *JTE* editors and reviewers be encouraging?

This is a meta-study of research in technology education as manifested between the covers of the first and sixteenth issues of the *JTE* published from 1989 to 1997. It is intended as a review of the Sanders years of the *JTE*, as well as an influence on the way the *JTE* will be shaped within the years to come. This study should be seen as a sign of maturity for the journal and should in itself provide a discourse for reflection and anticipation. Indeed, this is a study of a profession's *episteme* and its journal.

This study is cast in the larger framework of the politics of technology education and a concomitant politics of vision. The epistemological trajectory of the article is from the descriptive "what is?" - to the normative - "what ought to be?" In the final analysis it is argued that if technology education is going to overcome its past of conservatism and isolation to become a vibrant enterprise, researchers will necessarily have to critically engage with an epistemological world outside their immediate cultures. A critical turn in the practices of these researchers could make a difference in the participation of individuals belonging to the underrepresented groups of technology education, and technology and the trades, at large.

Researching Research in Technology Education

Research in technology education has been a site of contention for some time. Recent scrutiny seems particularly direct in addressing what has become a problematic enterprise. Research agendas have appeared through the 1990s with intention of reforming the enterprise (Foster, 1996; R. Hansen, 1995; Waetjen, 1991). These are in themselves problematic, and suggest a variety of responses to a variety of problems. Those who have done research on research in technology education, or the *episteme* of this profession, have described a malfunctioning practice (Foster, 1992; Zuga, 1994, 1995, 1997). If as Zuga described after an exhaustive study in 1994 (p. 8), research in technology education is "narrowly defined and inwardly focused," then what reform measures ought we consider?

Zuga's study of 220 reports of research, unpublished and published in the U.S. between 1987 and 1993, was incisive and insightful. About 68% of the research she studied was devoted to curriculum, and 63% dealt with the secondary levels of educational systems. About 59% used educators as subjects of research. With regard to methods, 83% were quantitative with 65% of these being descriptive. These data are similar to those of Foster (1992), who found that about 92% of 503 graduate research theses in industrial and technology education were quantitative, and 54% were of the survey type. McCrory's

(1987) data are also similar, although unreported as so. An important insight of both Foster and Zuga is that this predominance of quantitative, descriptive research reinforces the marginalization of qualitative, interpretive studies. This predominance informs only a limited range of problems within a limited context and depth of understanding. Zuga addressed these issues of quality in her sample, as the compiled statistics tell only part of the story.

Zuga's report provides a refreshing counter-narrative to the "progress" ideology inherent in much of the research she reviewed. She pointed out a number of contradictions between what was researchers rhetorically said about technology education and what was being studied and reported in research. For example, technology educators may speak in favor of a more equitable profession and curriculum, but a homogeneous group of researchers studying mostly homogeneous subject samples contradicts this concern. Zuga's conclusion is that there is little minority participation in research and little that translates into minority interests (p. 39). Women, like other visible minorities in technology education, are notably underrepresented in research. These demographic problems are considerable given the percentage of studies which use quantitative methods, be they experimental or survey. Curriculum development through research has relied on surveys of this uniform demographic leading to, as Zuga reports, "a closed circle of ideas" (p. 62). If technology education is perceived by young women as a masculine subject, it may be a reflection of the survey informants' gender biases (re)produced in curriculum over the past decade. It is here, with Zuga's critique of the means *and* ends of research in technology education where this study begins (Zuga, 1994, 1995, 1997).

This study is meant to complement the investigations of Foster and Zuga into the methodological issues of research in technology education. I deal with these and other structural patterns and, like Zuga, critically address issues of research content, ideology, and quality. The *JTE* is a sample of a different kind, albeit as representative, than has been reviewed. In inference, similar to Foster and Zuga, I evaluate the fidelity with which articles in the *JTE* represent research in the profession. In addition to the intentions of these two authors, this analysis aims to provide knowledge of the politics of research in technology education.

Researching Research: A Methodological Explanation

A pragmatic investigation might suggest that research in technology education is insubstantial and is not working. But what means would the pragmatist use to come to this conclusion? How can we come to understand research - its content, methods, and quality - in technology education? This study is a methodologically variant attempt to critically inform these epistemological questions. In the larger epistemological scheme, this meta-study draws on meta-ethnography and related methods in critically translating the textual world (Gitlin, 1994; McLaren & Giarelli, 1995; Noblit & Hare, 1988). Data from the JTE across eight volumes are triangulated through quantitative and qualitative analyses, with content and critical discourse analysis combined for this task (Jick, 1983).

Content analysis provides a quantitative treatment of issues of quality. It is a systematic method in the social sciences by which manifest and latent contents of spoken or written text are determined (Babbie, 1983; Krippendorff, 1980; Rosengren, 1981; Weber, 1990). Uses for this method in education have ranged from detecting textbook difficulty to exposing biases and propaganda. In simple form, this method involves identifying units of analysis and counting the number of times particular words, or units, are used, within semantic contexts. These units form categories which provide another level of analysis where coding frameworks can be used. Conceptual and operational codes, like conservative or radical, and economic or cultural help to give latent meaning to analysis of manifest content. The techniques of counting, categorizing and coding were used in this study.

After isolating references from articles for this study, 385,334 words in the first eight volumes of the *JTE* were searched using search engine software. Trend analysis across these eight volumes was not a purpose of this research, but the two most recent volumes were isolated for analysis of potential changes and continuities. With no glaring differences noted in authorship, methods, contents or citations, the eight volumes of the *JTE* were read and treated as a single, scholarly text for interpretation. Other than for the purpose of counting methods and subjects, guest and refereed articles were treated no differently than “From the Editor,” book review, editorial, and reaction articles. All were assumed to constitute the scholarly text of the *JTE* and used as units of analysis. Methodological and theoretical concepts such as ethnography and critical theory were counted, along with categorical words such as class, gender, race, sexuality, and skill. Methodological and theoretical terms and phrases were drawn from contemporary texts that deal with method and theory (Babbie, 1983; Gitlin, 1994; Jaeger, 1988; Lincoln & Guba, 1985; McLaren & Giarelli, 1995; Mertons, 1998; Palys, 1997). In all, 46 concepts relating to research categories of content, method and theory were counted in the *JTE* text. Authors (145) and references (2,073) were also searched to inform author typologies and citation patterns. Names of seven of the most often cited authors in education *and* Science and Technology Studies (STS) journals between 1986 and 1997 were searched in the *JTE* references. This list of authors was drawn from the *Social Science Citation Index*, volumes 1986-1997. In total, 19 author names and concepts were counted in the *JTE* references for an analysis of citation patterns. Counting and categorizing provided provisional data for a coded, deeper analysis. In this way, a grasp of the journal’s manifest content facilitated an interpretation of latent meanings through discourse analysis.

Critical discourse analysis provides a means of dealing with latent issues of text quality, such as ideology and symbolic meaning. Discourse refers to recurrent statements, themes and wordings across texts, which represent orientations to the world. Discourse analysis is a method of text analysis in which the “text” can represent the spoken or written word, an image, narrative or media; text is the artificial representation of the world (Ettinger & Maitland-Gholson, 1990; Janks, 1997; Lindkvist, 1981; Luke, 1995; Patterson, 1997). It is a method that assists the researcher in linking text to structural formations and relations of power. Questions central to critical discourse analysis are: "How is the text positioned or positioning? Whose interests are served by this positioning? Whose interests are negated? What are the consequences of this positioning?" (Janks, 1997, p. 329). This method draws historically from hermeneutics, linguistics, rhetoric, and semiotics, or more generally from critical and post-structuralist theory. On one level, this involves a critical reading of how texts are constructed. On another, it involves a critical reading where text and context are culturally located and interests identified. Critical discourse analysis is a means of tying texts together and of demonstrating the political and powerful nature of seemingly mundane statements and symbols. In education, uses have ranged from demonstrating how schools govern through surveillance and moral regulation to how textbooks embody sexist and racial discourses and structure thought processes (Janks, 1997; Luke, 1995).

In this study, discourse analysis was used on its macroanalytical level to substantively address issues of the politics of research in technology education. Discourses of class, economics, gender and race were analyzed with regard to marginalized and minority discourses. These discourses were read against the codes of the content analysis, where manifest content was carried as empirical evidence of latent meaning. As discourses mirror content, they provided a second level of data for coding and decoding the *JTE* text.

While valid for the purposes of the research, content and discourse analysis present particular challenges to validity and reliability. Are concepts counted in the *JTE*, such as economic competition or scientific subjugation, indicators of codes such as conservatism? Are concepts such as class, ecology, gender, labor, race or sexuality indicators of critical politics? Are certain discourses indicators of these codes? For unobtrusive research, these are the most productive methods for addressing text quality and latent meaning (Babbie, 1983; Luke, 1995). They make the arrangement of empirical data possible where other methods fall short; they allow for a quantification of qualitative data. They have facilitated a micro-level of analysis that complements the macro-level of Foster (1992) and Zuga (1995). The concreteness of these data offers a fairly high degree of reliability. Articles were randomly read and counted 'by-hand' as a cross-check on the computer searches. It was assumed that the counts would not change from researcher to researcher. Categories were drawn from current literature, and categorizing was done by the researcher. Categories such as authors, citations, research methods, and theories are common to meta-studies of research. The category "Analytical Units of Substance" was created to assist in identifying unit indicators of content. It was assumed that another researcher would use similar categories and units for analyzing the inherent biases or politics of research in technology education. Analytical units, or concepts, counted for comparison were of the same kind. For example, the number of times a unit such as "math" or "science" was counted could be compared with the number of times "art" or "ecology" was counted. Units were counted in semantic context. For example, a unit such as "industry" was counted if the intended meaning referred to commerce or trade and not to the subject "industrial arts." After categorizing and counting, units were coded. For example, the relatively high frequencies of "math," "science," and "industry" compared to the low frequencies of "gender," "labor," and "race" indicated a conservative code, or discourse. Researchers can code, decode and recode the units of the content analysis, but this is somewhat of a matter of interpretation. Reliability is improved when, in addition to unit scoring, meaning is derived through analysis of contents in their semantic contexts, or through discourse analysis. Here, the researcher must make a persuasive argument that a code such as conservatism can be read from particular counts of manifest data *and* from analysis of latent meaning. It is open to debate whether the *JTE* data are valid units of analysis for a meta-study of research in technology education. Regarding this issue, which is also one of generalizability, conclusions of this analysis are consistent with similar analyses by Foster (1992) and Zuga (1994). There is a high degree of intersubjectivity among meta-studies of research.

While content and critical discourse analysis configured the analysis of the *JTE*, they did not provide some foolproof progression from problem to data with the researcher distanced in some remote objectivity. My own biases in selecting units for analysis and in coding discourses for interpretation reflect my experiences and concerns with the politics of technology education. The relation between myself as researcher and the text is one of familiarity and pride, but also uneasiness. I know the *JTE* text, its editors, and many of its authors. I've published four of the articles reviewed and feel as uneasy with these as with the others. As an Editorial Board member who reviews manuscripts, I want to be proud of what is published and I want the *JTE* to be different in the future. As a teacher educator in a Canadian university, I want the *JTE* to make a difference in my own research and teaching practices and to reflect an international audience. As a 39-year-old white male, I want the journal to be more youthful, responsive to feminism, and colorful. To this analysis, I also bring an understanding of cultural and critical studies, weave this into the research design, and look forward toward an era of critical discourse in the *JTE*. The journal is thoroughly a product of its profession. In the final analysis, I'll argue that the relationship ought to be - and can be - reversed.

Contents Without Contention: But Who's Counting?

Who is authoring, what is their status, and where are they from? What methods and theories are, and are not, being used? What units, categories and terms of analysis are and are not prevalent in the research published in technology education? This section is a descriptive and categorical analysis of the contents. Codes of analysis of the discourse in the *JTE* will be addressed in a later section.

Descriptive statistics describe a state of affairs in the *JTE* where 68% of the authors are teacher educators, 84% are from the U.S., and 87% are male (Tables 1-3). As would be anticipated in a scholarly journal in education, a majority of authors are teacher educators. This group accounted for 68% of all articles or reviews (Table 1). The second most active group of authors was graduate students. This group of students have been involved in 23 published articles or reviews. Four of the 19 book review authors, two of the 15 editorial authors, and one of the three reaction authors were graduate students. Graduate students certainly have a presence in the *JTE*, but without comparative data, it is difficult to comment on their productivity. Given that the *JTE* was initiated in the US, it is not surprising to see that 84% of the authors are from the U.S. (Table 2). Twenty articles were published by international authors, with Canadian and English authors accounting for just over half of these. Of the seven guest authors, two were from outside the U.S. and one was a woman.

Table 1
Status of Authors of Articles in the JTE

Status	Frequency (All articles*)	Percentage of Total
Technology Teacher Educators	99	68%
Graduate Students	23	16%
Other University Faculty	10	7%
Center or Project Directors	4	3%
Teachers	3	2%
State Supervisors	2	1%
Independent Researcher	1	--
Museum Researcher	1	--
ITEA Representative	1	--
CTTE Representative	1	--
Total	145	

*Authors of "From the Editor" articles were *not* counted except for issue 1(1).

Table 2
Country of Authors of Articles in the JTE

Country	Frequency (All articles*)	Percentage of Total
US	125	84%
All International	20	16%
Canada	(6)	
England	(5)	
Australia	(2)	
Hong Kong	(2)	
The Netherlands	(2)	
Taiwan	(2)	
Japan	(1)	
Total	145	

*Authors of "From the Editor" articles were *not* counted except for issue 1(1).
Fewer than 5% are recognized by the researcher as persons of color.

The women's percentage (13%) of articles in the *JTE* is above their representation in the industrial and technology education professoriate in the U.S., where about 94% of faculty are men (Erekson & Gloeckner, 1988; Erekson & Trautman, 1995) (Table 3). The percentage of women authors is about the same across the 76 guest and refereed articles and the 36 book review, editorial and reaction articles. This is an improvement over the track record set by the *Journal of Technology and Society*, in which there was one woman out of 25 authors in its three year existence. It is also a higher representation than in the ITEA, where women represent only about 2% of the approximately 5,600 members.

Table 3
Sex of Authors of Articles in the JTE

Sex	Frequency (All articles*)	Percentage of Total
Men	126	87%
Women	19	13%
Total	145	

*Authors of "From the Editor" articles were *not* counted except for issue 1(1).

Authors in the *JTE* are not self-identified as belonging to any racial group, and my estimate is that fewer than 5% are non-white. This multicultural demographic appears to be very similar to that of the industrial and technology education professoriate, where 91% are white. Demographics of the authors are also somewhat similar to the membership of the ITEA. Of these, about 6% are African American or other visible minorities (Ulatowski, 1993; Volk, 1995). Only so-called "developed" or financially enfranchised countries are represented in the *JTE*. Authors from African, Middle Eastern, or Central and South American countries, for example, are not represented.

A descriptive analysis of the contents of the articles indicates that 62% of the research methods used are either conceptual or descriptive and 35% of these articles involve human subjects (Tables 4-5). Of the 96 articles published, 36, or 37%, are conceptual in method and deal with curriculum (Table 4). About 25% of all articles were descriptive, drawing on surveys, Delphi panels, or documents for analysis. The balance of articles were distributed over ten different types of methods with the largest percentages being conceptual (37%) and descriptive (25%). These data differ slightly from Foster's (1992) review of research in industrial education, where 53% of 503 dissertations and theses were descriptive. The data also differ slightly from Zuga's (1994) review which found that 65% of 220 research reports in technology education were descriptive. This majority of articles in the *JTE* dealing conceptually with curriculum is reflective of Zuga's finding of what she termed a "curriculum fascination" (p. 11) in her sample. The *JTE* data are similar to those in Foster's and Zuga's research in that few researchers have used historical, quasi-experimental and experimental, and philosophical methods (see also Hoepfl, 1997; Zuga, 1987). It is evident that technology educators have yet to make the interpretive shift that other researchers with "practical" pasts have made. For example, home economists have embraced interpretive methods as central to their research questions (e.g., Hultgren & Coomer, 1989). None of the studies in the *JTE* reflects the sustained commitment to subjects that ethnographic, hermeneutic, and phenomenological research requires. As indicated in the *JTE*, researchers are not stepping back to analyze conceptual and methodological issues in research. There has not been a thematic meta-study of research (e.g., problem solving), and only one methodological study (Pannabecker, 1995) appeared in the first eight years of the *JTE*. Hoepfl's methodological study published in volume nine was a welcome addition to Pannabecker (1995).

Table 4
Methods Used in JTE Articles

	Frequency of Methods*				
Method	V.1-6	V.7	V.8	Total	Percentage
Conceptual (Curriculum)	27	3	5	35	37%
Descriptive (Survey)	10	2	1	13	14%
Descriptive (Documentary)	6	0	1	7	7%
Descriptive (Delphi)	4	0	0	4	4%
Descriptive (Correctional)	1	0	0	1	--
Quasi-Experimental	5	2	1	8	8%
Discourse Analysis	5	1	2	8	8%
Case Study	5	1	0	6	6%
Historical	4	1	0	5	5%
Philosophical	1	0	1	2	2%
Ex Post Facto Analysis	2	0	0	2	2%
Causal-Comparative	1	0	0	1	--
Content Analysis	1	0	0	0	--
Experimental	1	0	0	0	--
Instrument Validation	1	0	0	1	--
Methodological (Historiography)	0	1	0	1	--
Total				96	

*"From the Editor" and "Book Reviews" not included.

Just over one-third of the articles in the *JTE* involved human subjects (Table 5). Although there were few descriptive demographic data provided by a large majority of *JTE* authors who dealt with human subjects, there are data that describe the status of their subjects. And about two-thirds of these studies involved teachers, university teachers and students, or state supervisors and industrial representatives, or other adults. The remaining third involved middle or secondary school students. Hence, 11% of the total articles in the *JTE* involved students in the schools. There are not comparative data, but evidence is suggestive that relatively little time has been spent investigating the practice of technology at the local, school-based level. In regard to research with human subjects, 26% of the 34 studies reviewed provided sufficient demographic data for meaningful analysis. The remaining 74% of the studies included little descriptive data other than status (i.e., student, teacher, principal, etc.). Given the demographics of the *JTE* authors, is it just common sense that the subjects are white, male and of a middle class background?

Table 5
Human Research Subjects in JTE Articles

Human Subject	Frequency of Articles with Human Subjects* V.1-6	V.7	V.8	Total	Percentage
Teacher Educators	7	0	1	8	24%
Secondary Students	7	0	0	7	21%
Teachers	5	1	0	6	18%
University Students	2	2	0	4	12%
Middle School Students	2	0	2	4	12%
Mixed groups (Adults)	2	1	0	3	9%
State Supervisors	1	0	0	1	2%
Industrial Representatives	1	0	0	1	2%
Elementary School Students	0	0	0	0	0
Total				34	

Percentage of all articles using human research subjects=35%
Percentage of these articles providing demographics other than status=26%
*"From the Editor" and "Book Reviews" not included

It is not clear why authors have concealed, or not collected, sufficient demographic data. To be sure, the demographic mystery left by these authors diminishes the reliability and validity of the subject-oriented research of the *JTE*. There is also an absence of authorial demographics and positionality, making the subject-oriented research suspect as presented. This research should *not* have been published without basic demographic data of author and subjects necessary for interpretation, and a bracketing of sampling biases.

About 45% of the articles focus on practices in junior and senior high schools (i.e., grades 7-12) (Table 6). Another 42% focus on practices in teacher education institutions and the balance of articles are general. Two articles out of 96 deal with elementary school practices. Little is surprising about these data. Over 90% of the *JTE* authors are affiliated with secondary teacher education and probably taught in secondary schools at one time. The vast majority of these deal with student teachers in the secondary programs and typically have few affiliations with student teachers in the elementary schools. Referring back to Table 5, we can see that 11 of the 43 studies that address school practice at the 7-12 grade level, or 26%, involved students. Although the lack of demographic data for this group has made interpretation difficult, the studies that were locally school- or district-based were most likely done in mainstream schools in middle to upper class, white, suburban communities. Only one of these studies problematized gender (Siverman & Pritchard, 1996). Hence, there is not evidence to suggest that *JTE* researchers have ventured to study alternative schools, rural or urban schools, summer camps, same-sex, or same-race programs.

It is evident that a very small percentage of *JTE* researchers used a theoretical framework which would enable a substantial interpretation of, and critical insight into, their data (Table 7). The atheoretical nature of the *JTE* articles is reflected in the types of subjects and sites of research chosen, as indicated in the discussion of Tables 5 and 6. The data suggest a very minimal engagement with educational or social science theory and evident engagement is limited to a single author in places. For example, O'Riley's (1996) work accounted for all uses of feminist, Foucauldian, and post-structural theory. Pannabecker's (1995) work accounted for 13 of 14 references to social constructivism. Three of four of the references to Marx were in book reviews and the fourth reference was to a context of the 1930s. For all the studies that dealt with learning, there were few that drew on contemporary learning theory. While there were a few references to constructivist learning theory, only one conceptual article referred to situated learning, a more current theory (Wicklein, 1997). Learning theories such as constructivism and sociocultural theories like enactivism and situated cognition have been very useful in education and social science research circles, but are not used by the *JTE* researchers (Lewis, Petrina & Hill, in press). Zuga noted this problem in her sample of research practices (1995; 1997, pp. 210-212). We could reason that since there were not any studies that were ethnographic, hermeneutic, or phenomenological, there would be few studies where theories informing these methods would be used (Table 4). But this would be faulty reasoning as the relevance of critical ethnography has been demonstrated far beyond strict anthropologies (Anderson, 1989; Darrah, 1996; Lakes & Bettis, 1995). Neither are there references to critical pedagogy and its constituent theories, which are in no way specific to particular methods.

An understanding of the interplay among data, method, theory, and substance has not been demonstrated by a large majority of *JTE* authors. Issues of gender are nearly incomprehensible without insight given through feminist and masculinity theories. There is the same relationship between race, social justice and equity theories, and post-colonial theory.

Table 6
Research Subjects of JTE Articles

	Frequency of Research Subjects*				
Category	V.1-6	V.7	V.8	Total	Percentage
7-12 Curriculum Practices	37	3	3	43	45%
Teacher Education Practices	29	7	4	40	42%
General	8	1	2	11	11%
K-6 Curriculum Practices	0	0	2	2	2%
Total				96	

*"From the Editor" and "Book Reviews" not included

Table 7
Analytical Units of Method and Theory

Unit	Frequency of Terms (All articles) V.1-6	V.7	V.8	Total
Social constructivism (ist, constructivism)	13°	0	1	14
Constructivism (-ist)	6	1	1	8
Phenomenology (ical)	6	0	0	6
Feminism (ist)	0	5*	0	5
Ethnographic	3	1	0	4
Marx (ist/ism)	4	0	0	4^
Hermeneutic (s)	3	0	0	3
Post-structural	0	3*	0	3
Foucault	0	2*	0	2
Post-modern	1	0	1	2
Reflexive	1	0	1	2
Sociology (not subject)	0	1	0	2
Situated Cognition/Learning	0	0	1	1
Actor-network theory	0	0	0	0
Critical Pedagogy	0	0	0	0
Critical Theory	0	0	0	0
Distributed Cognition	0	0	0	0
Queer Theory	0	0	0	0
Sociocultural Theory	0	0	0	0

*All counted in O'Riley (1996)
°All counted in Pannabecker (1991)
^3 of 4 counted in book reviews

Table 8 provides a sense of the relationship among method, subject, theory, and substance. For example, O'Riley used a critical discourse analysis as a method for her study and she problematized gender and race as substantial issues of content. Outside of O'Riley's and Silverman & Pritchard's (1996) work, gender appears as a minor concern given the low frequency of indicators such as feminism and masculinity (Tables 7 and 8). Kohlsmith's framing of gender was done in regard to a review of *Teaching Peace*. Lakes' (1990) conceptual work problematized labor as a substantial analytical unit in technology education. Hansen (1996) used class to frame his analysis of technology education. But these authors account for over 60% of the references to class, gender, labor and race, and for over 90% of the references to gender or racial equity. Empirical work on sexuality and queer theorizing have not been attended to by *JTE* researchers.

Aside from a few researchers' work, the *JTE* studies have been insubstantial with regard to critical issues of appropriate technology, class, ecology, gender, labor, race, and sexuality; and the *JTE* is insubstantial to an understanding of the way inequities play out in technology and the trades. As indicated in Table 8, sociological methods and theories, which are essential to understanding these inequities, are not used. Indeed, critical theory is antagonistic to an uncritical alignment with conservative, economic interests and the maintenance of *status quo*.

Table 8 also provides an indication of the degree to which an alignment between math, science and technology education has been manifested in the content of a research journal. This table also indicates the degree to which *JTE*

Table 8
Analytical Units of Substance

	Frequency (All articles)			
Unit	V.1-6	V.7	V.8	Total
Scien(ce) (tific, tist)	901	141	166	1208^
Math(ematics)	374	42	54	470
Vocation (al)	258	24	15	297
Industry (not subject)	245	17	10	272
Design (Not Design & Technology, Curriculum, Instructional, Research)	162	29	79	270
Engineer (ing)	160	55	18	233
Economic (s) (not socio-economic, Home Economics or efficiency)	122	16	24	162
Cooperation (Student)	131	6	8	145
Business (commerce, not subject)	51	13	6	70
Art (Not industrial arts)	38	6	9	53
Gender (not sex, gender gap)	2	19*	6	27
Compete (ition)(national, advocacy)	37	0	2	39
Compete (ition)(student, advocacy)	25	3	2	30
Labor (not -force or -dept)	13˚	2	2	17
Class (not school)	5	4'	0	9
Race (ial)	7	8~	1	16
Aesthetic (s)	4	1	4	9
Equity (Racial)	0	7	1	8
Ecology (ical)	1	1	4	6
Equity (Racial)	2	2	0	4
Masculine (ity)	0	3	0	3
Appropriate Technology	0	0	2	2
Cooperation (National)	0	0	0	0
Sexuality (Gay, Lesbian)	0	0	0	0

*14 counted between Kohlsmith (1996) and O'Riley (1996)
˚All counted in Lakes (1990)
'All counted in Hansen (1996)
~All counted between Hansen, Kohlsmith and O'Riley
^If references to the National Science Foundation or other science associations are removed, the total is 1008.

researchers have aligned themselves with industrial and economic needs. This may be an indication of the degree to which this has happened at the expense of alignments with art, labor and ecology. Few authors in the *JTE* have been critical of this. Whereas science and math have received substantial attention, as suggested by the 1,208 and 470 respective references, attention to art and ecology is insubstantial. Attention to economic issues, as suggested by the 162 references that were counted, has been much more substantial than attention to environmental or cultural issues as indicated by counts of class, ecology, gender, labor, race, and sexuality. References to industry (272 counted) and national economic competition (39 counted), especially during the first 6 volumes, suggest substantial attention. The content of the *JTE* is insubstantial with reference to cooperation between countries. Although references to cooperation (145 counted) learning out-paced the references to competition between students by almost five to one (30 counted), this is underwritten by a substantial productivity content. In other words, students should learn to cooperate so their country is more economically competitive.

Given this issue of national productivity, it is not surprising that a substantial amount of attention has been paid to skill (Table 9). General skills have been the most popular of the types of skill counted, and along with problem-solving skills, received 220 references. A bit more attention has been paid to technical and work force skills, supporting the findings on national productivity. Although technology is differentiated from vocational education in the references made to vocation (Table 8), these differences may be exaggerated. Over 38 different types of skill were referred to in the *JTE* suggesting confusion, which could be resolved through attention to an analytical framework of technological practice (Jones, 1997; McCormick, 1997; Olson & Hansen, 1994; Petrina, 1998).

Table 9
Analytical Units of Substance (Skill)

	Frequency (All articles)			
Unit	V.1-6	V.7	V.8	Total
Skill (general)	115	3	37	155
Skill (technical)	70	16	35	121
Skill (work force and occupational)	107	6	5	118
Skill (problem solving & critical thinking)	52	8	5	65
Skill (social)	13	0	4	17
Skill (teaching)	6	0	2	8
Skill (design)	3	0	1	4
Skill (computer)	0	0	1	1
Skill (total of all types)	523	46	107	677

Number of different types of skills referred to in articles=>34.

Analysis of 2,073 references in the *JTE* supports the findings included in Tables 7 and 8 (Table 10). Science appears in 227 author, title, or publisher names; this is over 17 times more than the number of references containing art. Design appears in one-half of the number of references to science and provided a substantial content in the text (Table 8). Given that over 25% of these references had “design and technology” in the titles, this may be an indication of the interests of the international authors in the *JTE*. The names of seven of the most often cited theorists in education *and* STS journals between 1986 and 1997 were also searched in the *JTE* references. Yet as indicated, the work of these theorists has been utilized by only one or two *JTE* authors. UNESCO publications were used only four times in the 2,073 references, which reinforces the notion that cooperation between nations is not a concern as reflected in the *JTE*.

Table 10
Analytical Units of Substance in References

Unit	Frequency (All References)
Science	227
Design	111
Math	58
Art	13
Dewey, John	13
UNESCO (United Nations)	4
Marx (-ist/ism)	3
Apple, Michael	3
Foucault, Michel	2
Giroux, Henry	1
Haraway, Donna	2
Harding, Sandra	2
Lave, Jean	2
Latour, Bruno	0

The authors that have been cited 20 or more times and used to inform *JTE* research are technology educators (Table 11). This is *not* necessarily as it should be. Savage & Sterry’s *Conceptual Framework for Technology Education* appears to be an obligatory passage point for the U.S. authors studying curriculum. The international author most commonly cited was Robert McCormick who received 12 citations. The only real surprise here was the number of times Bonser and Mossman appeared in the references. This is a reflection of the revival that historical research has had over the past four volumes in the *JTE*, apparently spearheaded by Patrick Foster.

Of course, citation and utilization of scholarly work can be political, and one gets a sense of this in a recent yearbook of the Council on Technology Teacher Education. Just one of the 852 references made in the *Foundations of Technology Education*, a 639 page survey of recent curriculum and institutional changes in the U.S., is to Karen Zuga. However relevant to the “foundations” conversation, her work in curriculum, gender, and history was evidently bypassed for less critical texts (Petrina, 1998a).

The Technology Teacher (*TTT*) and its earlier moniker *Man/Society/Technology* were counted nearly twice as many times as the next popular journal, the *JTE*. They were counted more than three times as often as two other research journals related to technology education, the *Journal of Industrial Teacher Education* (*JITE*) and the *Journal of Technology Studies* and its earlier moniker, the *Journal of Epsilon Pi Tau*. The duration of time over which *TTT* was published explains a part of this popularity. Although the *International Journal of Technology and Design Education* has been published since 1990, it appears only three times in *JTE* references. This is surprising, considering that 16% of the *JTE*'s authors are from countries other than the U.S. Journals in general education were also referenced only a few times. For instance, the *Educational Researcher* was counted seven times, *Harvard Educational Review* three times, *Journal of Educational Research* six times, and the *Teachers College Record* was counted only twice in its post-1930s form. This lack of engagement with the larger educational research enterprise is characteristic of technology education as a whole (Petrina, in press)(see Table 12).

Table 11
Authors Cited in References 19 or More Times

Author	Frequency (All References)
Bonser, Frederick	22*
DeVore, Paul	20
Maley, Donald	23
Mossman, Lois	19*
Savage, Ernest & Sterry, Leonard	22
Wright, R. Thomas	21
Zuga, Karen	22

The Politics of Data - The Data of Politics

In the preceding content analysis, a variety of problematic issues were pointed out which are manifested in a number of problematic discourses shaping the epistemological enterprise of technology education. That analysis was basically descriptive as it dealt with empirical indications of manifest content, yet it enabled us to penetrate the contents of the *JTE* for latent meanings and explanation. If these contents and meanings are to be understood in larger (con)texts and on qualitative terms, further interrogation of discourses is necessary. In the following sections, the *JTE* will be critically interpreted as a text where discourses and distortions circulate and mediate among individual authors and their cultural contexts.

In the inaugural issue of the *JTE,* the lead article articulated and generated an uncritical, conservative discourse of progress from a crude era of industrial arts to a refined era of technology education. In this article are most of the logics of a discourse that tie many of the *JTE* articles together over the first eight volumes. Clark (1989) argued that industrial arts was in a paradigmatic crisis (c.f., Petrina, 1994). He placed the locus of his “crisis” in the public schools, distorted history, and practice to fabricate a gaping distance between industrial and technology education, and aligned the latter with an economic agenda of American competitive supremacy in a global market (pp. 9,11,13). For Clark, professional progress would not be judged from a perspective of the representation of maligned or marginalized groups. It was incontestable that white men would continue to be in control. At about the same time in 1989, the ITEA published *Technology: A National Imperative*, which articulated the same discourse - a discourse that already had over five years of momentum in education, fueled by conservative American politics (Hlebowitsh & Wraga, 1989; Shea, Kahane and Sola, 1989).

Table 12
Technology Education Journals Cited in References

Journal	Frequency (All References)
The Technology Teacher	78
Journal of Technology Education	47
Journal of Industrial Teacher Education	29
Journal of Epsilon Pi Tau	12
School Shop	12
Journal of Technology Studies	10
Man/Society/Technology	11
TIES Magazine	6
Industrial Education	5
International Journal of Technology And Design Education	3
Journal of Vocational Education Research	2
Journal of Technology and Society	1
Innovations in Science and Technology Education	1
Journal of Design and Technology Education	0

This discourse was circulated through the *JTE* in a variety of ways from the explicit to the subtle. Authors of conceptual articles such as Johnson (1991) and Baker, Boser & Householder (1992) explicitly articulated this conservative, economic discourse. Economic concerns were explicitly mentioned 162 times in the *JTE*. This discourse, serving an ideological function for a majority of authors, was naturalized through the 1990s - it went unquestioned for these authors (Petrina, 1998). For example, in some articles in the *JTE*, “technological literacy” and “math-science-technology” can be read as unquestioned codes for American economic supremacy (e.g., Satchwell & Dugger, 1996). Johnson (1991) and Baker, Boser & Householder (1992) conflate technological literacy and knowledge in math and science with economic supremacy, as does the recent Technology for All Americans project (Dugger, 1995, p. 14). The naturalization of this discourse helped make a preoccupation with science appear natural and pedagogical, rather than economic or a brokerage of power. Science and its derivatives were given 1,215 references in the *JTE* text, industry's needs were mentioned about 272 times, and the necessities of business 70 times. Competition among nations, mostly on terms of U.S. economic supremacy, was mentioned 39 times, whereas cooperation was not mentioned at all.

As suggested by the content analysis data, it is as important to pay attention to what is *not* said as it is to what *is* said. The missing demographic data of the subject-centered research can be read as an approval of, or capitulation toward, gross inequities in technology education. The missing analytical discussions of class, gender, labor, and race can be read as the same.

Research, which was postured as objective, through its uncritical conceptualization is complicit with this conservatism. For example, Paige & Wolansky's (1990) survey of all chairs and heads of departments that offer degrees in industrial and technology education does not mention equity. One wonders if even one respondent was a woman or person of color since the demographics were not provided. Attention to equity was not included as an administrative task of these chairs and heads. In the sample of 104, less than ten would have represented a visible minority group; and, the researchers had to be aware of this before their survey. By declining to confront equity as an issue, and by avoiding a reflexive turn on their sources, these researchers infer from white men a knowledge for all men and women. In effect, they helped to perpetuate an inequitable system and *status quo* power. In the same volume, the survey research of DeLuca (1991), Householder & Boser (1991), and Smallwood (1991) falls prey to the same fallacy and complicity without bracketing the biases of their subjects. This uncritical inferencing from a uniform demographic, or a biased sample, can be found in the survey and Delphi studies across eight years of the *JTE*.

The one experimental study and seven of the eight quasi-experimental designs exhibit the same fallacy (e.g., Childress, 1996; Dugger & Meier, 1994; Haynie, 1994). Wu, Custer & Dyrenfurth (1996) helpfully identified the age and sex distribution of their experimental sample, but did not indicate the racial demographics or bracket their sampling biases. The experimental researchers fail to attend to a fundamental principle of this type of research: "Any sampling bias present in a study should be fully described in the final research report" (Gay, 1981, p. 102). Without the acknowledgment that the sampling in these studies is not robust enough for parametric statistics and inference, this is either simply bad research or inadequate reporting. They also do not acknowledge the most basic importance of the interactions among socio-economic status, gender, race, and educational achievement. Without this knowledge, there is little power - or sociological reason - for interpretation. Despite Haynie's lament over the "meager" percentage of experimental studies in the *JTE*, all but one of those that have been published appear extremely flawed by design or report (Haynie, 1998, p. 79). Without bracketing gender, socio-economics, and race in their design, experimental researchers in the *JTE* come across as complacent and their inferences or recommendations as suspect.

The apparent systematic exclusion of visible minorities from subject-oriented research is central to the maintenance of *status quo* power and conservative whiteness in technology education. The samples used in survey and experimental research are evidently *not* representative of the demographics of student or teacher populations. What this means is that knowledge normed to a uniform sample can only inform a similar uniform sample or population. There is an indication of, for the sake of administrative convenience, an interest in sampling white men and white, male students. This knowledge is generalizable only to groups of young or adult white men. Yet in 74% of the 34 studies using human subjects, the readers were to assume that demographics are unimportant, and that knowledge can be reduced universally by sampling white men. These interests as they are shaped through a conservative discourse could be shrugged off as irrelevant lest for the fact that they were not confronted - they were not countered by a critical cultural, ecological, or social sensibility.

Concerns typically associated with critical workers in education - class, ecology, gender, labor, race, and sexuality - were conspicuously absent against this conservative discourse. Class was not problematized outside of Hansen's (1996) conceptual study, and racial equity was an issue only for Jeria and Roth (1992) and in O'Riley's critical discourse analysis. Only in O'Riley's (1996) work was race grounded in post-colonial theory and gender made problematic through feminist theory. Labor was mentioned just four times outside of Lakes' (1990) conceptual article. Critical social science theorists - Apple, Foucault, Giroux, Haraway, Harding, Lave and Latour - were rarely, if at all used. Ecology was mentioned only six times in eight volumes of the *JTE*. The critical, ecological discourse of researchers such as McLaughlin (1995, 1996) and Elshof (1998) have yet to be represented in the *JTE* as counter to the globalizing, economic discourse. Queer theory and issues of sexuality have not been brought into the critical discourse of the *JTE*. Technology education is not a project of equity, justice, and tranquillity as represented by most authors in the *JTE*. Although the social science methods which can ground these concerns, as well as the theorists which inform them, are under-represented, there is a critical discourse to acknowledge in the *JTE*.

The critical discourse in the *JTE* circulated in contra-distinction to the conservative discourse. In the same inaugural issue that Clark (1989) kicked off conservatism, Zuga (1989) initiated a critical discourse on curriculum. Through content analysis and attention to discourse and texts, she provided evidence of the dominance of a technical, or conservative, curriculum design model in technology education. In so doing, she pointed out the inherent contradictions of curriculum in a larger context of practice in teacher education. Contrary to conventional wisdom she argued, there were alternatives to technical models - there was no "one best way" of curriculum development and organization. While she has been arguing for an acknowledgment of this in the preparation of teachers since the late 80s, her work has not been understood by those who she contradicted (Petrina, in press). This critical discourse on curriculum was reinforced at a different level in the *JTE* in her 1991 survey research, and in other places (Zuga, 1993, 1994, 1996).

Later articulations of a critical discourse in the *JTE* are indebted to Zuga's work. Pannabecker's (1991) discourse analysis was a critique of the over-utilization of an "impact" metaphor and deterministic thinking by technology educators. My response to this was the first step to dialogue through the "reaction" section of the *JTE*, but suffered for a lack of a framework more firmly grounded in Marxist theory and cultural studies (Petrina, 1992). A second dialogic article, in response to Thomas Wright (1992), picked up on Zuga's critical work in curriculum, but failed to provide a strong theoretical critique of disciplinarity (Petrina, 1993a, c.f., Petrina, 1998). A third focused on the conservative, corporate influence that had taken hold of curriculum through "modules," but did not take the next step to clearly demonstrate how this control was racist, sexist, and anti-labor (Petrina, 1993b). These three articles, and Pannabecker's critique, failed to adequately address, and ground theoretically the inequities of class, gender, labor, and race. Similarly, while Volk's (1993, 1997) critical analyses of teacher education enrollments implicated industrial technology in a decline of programs, he failed to adequately respond to inequity in the history of those programs.

Foster (1994, 1995a, 1995b) ushered a critical, historical discourse into the *JTE*, and resituated contemporary, ahistorical notions of technology education in their early 20th century contexts. Drawing from arguments made by Zuga, he argued for the acknowledgment of women's work that shaped the direction of technology education. He was able to weave the maligned work of Lois Coffey Mossman back into the fabric of technology education. His study (1995b) should have been cast in a larger context of the marginalization of women in the U.S. during the 20th century. If informed through a sociology of professions, his work could link up much more forcefully with current inequities.

O'Riley's (1996) work demonstrated how these socio-historical, gendered, and racial structures are manifested in today's curriculum practices. She used a critique of the normalizing, universalizing efforts of the Technology For All Americans project to get her point across. Similar to Zuga, she pointed out constructive and sustainable alternatives to these curriculum enterprises. Feminist, post-colonial, and post-structural theory helped her get an effective, analytical purchase on her data. Her work could have been extended toward a critique of the class biases also inherent in projects like Technology For All Americans.

When we weigh the evidence, there has not been a critical mass to counter balance the conservative discourse of the *JTE* which is heavily reinforced by the profession. It is true that a bit of critical discourse goes a long way in this profession, but progress is often overshadowed by a wave of backlash. In a context of the politics of research and vision, toward whom ought we turn for direction into the future of the *JTE* and the research enterprise of technology education?

Whose Agenda?—Who's Paying Attention to What?

As indicated in the preceding sections, there is a political dimension to research that technology educators have not readily acknowledged. A cognizance of the politics of contents and discourses circulating through the research enterprise of technology education is necessary for normative action. Yet generally those who have attempted to direct research have not positioned technology education in the larger nexus of the politics of education and technology. Most have been narrowly fixated on effects (i.e., What effect is technology education having on employment, test scores, students, and the state?) They have been fixated on proof and in this way, on a positivistic fallacy that somehow key studies will persuade some decision-maker to support some method or program. Of course, the politics of technology education are not this simple. These research directions have been shaped through the same causal mentalities that shape the main of directions for vocational educators (Griggs, 1990). At the same time, researchers in technology education have isolated themselves from the main currents in education and the social sciences (Petrina, 1998a). This isolation has been physical as well as ideological and has been historically conditioned over the past 80 years in the U.S. So what ought we do to (re)direct research in this profession?

A number of researchers or groups of researchers have addressed this question during the 1990s at the macro-level or *episteme* (Foster, 1992; Olson & Hansen, 1994; Zuga, 1994) or the micro-level of thematic reviews (e.g., Jones, 1997; Lewis, Petrina & Hill, in press; LaPorte & Sanders, 1995). My estimation that the entire *episteme* of technology education is problematic concurs with Zuga. At least seven researchers or groups had ventured during the 1990s to give parameters and direction to research in technology education.

Their research agendas or recommendations are considerable. Lewis' (1990) model was intended for vocational educators but has relevance for technology educators. Lewis suggested studies be situated among three areas: (1) program justification, philosophy, and design; (2) milieu or ethos (e.g., curriculum & pedagogy); and (3) impact assessment (e.g., clientele's life experiences). Waetjen (1991) suggested technology educators' research agenda involve studies of: (1) behavioral changes in students; (2) teaching; and (3) the political, decision making environment. A group working out of Leeds University indicated four central areas of an agenda (Anning, et al., 1991): (1) conceptualization and realization of technology education; (2) students' competence in and attitudes to technological studies; (3) training of teachers of technology; and (4) policy studies. Zuga (1994) recommended technology educators' research focus on: (1) the inherent value of technology education; (2) cognition and conceptual attainment; (3) ideology and biases of practice; (4) public attitudes toward technology education; (5) evaluation of curriculum materials and development; and (6) effectiveness in professional development. Wicklein (1993) and Wicklein & Hill (1996) recommend four areas for research: (1) curriculum development; (2) public relations and positioning; (3) perceptions of teachers; and (4) integration with other subjects. Foster (1996) suggested that a research agenda consist of: (1) integration with other subjects; (2) the role of technology education; (3) rationale; (4) technological literacy; (5) technological "impact;" and (6) evaluation of instructional effectiveness. Finally, Hansen (1996) suggests four areas and focus questions for a research agenda: (1) technological education as a field of study (Is the field well conceived?); (2) cultural centrality of technology (How central are cultural and social phenomena to the technology curriculum?); (3) learning and technology (How do people learn the components of technological achievement?); and (4) theoretical frameworks (How can research on curriculum and schooling be optimized?).

These agendas, models, and recommendations are short-sighted on one or several counts. Most significantly, not one of these provide a grounding in the politics of research or an indication of *how* research is to be done. On this latter issue, K. H. Hansen (1995, p. 42) and Zuga (1994) argue that research ought to be expanded from instrumental approaches to include those that are critical and emancipatory. Given that the question of *how* research has been done is a major, epistemological site uncovered in this article, we need to expand on the contentions of Zuga and Hansen. A second point is that these agendas, models, and recommendations are more comprehensive than others, but all are less comprehensive than is necessary for direction. A third point is the ideological function of them. It is clear that not all see the same end of research, nor are similar problems seen in the same light; indeed, not all construct an agenda with the same agenda. A proactive and responsive vision spelled out in the next section is nonetheless indebted to those who have ventured to reform the research enterprise of technology education.

A *fin de millenium* Research Vision for Technology Education

If technology education is to have substance and inform educational practice outside of its field, researchers are going to have to reconsider their work and its immediate context in the politics of research practice. For this to occur, research problems, methods, and theory will have to be re-centered within education and science and technology studies (STS). To be relevant to education and STS, research will have to have a distinct theoretical component and be cast within particular areas of research practice.

Informed through this analysis of the politics of research in the *JTE* and a review of existing research agendas, the following "research vision" is intended to give shape and direction to a problematic enterprise (Donmoyer, 1997, p. 2). Research areas of engagement are listed below each central framing question to indicate how a question may be approached for study. Each research area has a grounding in education and the social sciences, which includes methods and theories for inquiry. Research ought to be shaped to inform one or several central framing questions and be situated within one or several areas of engagement. This meta-study of research for instance, informs questions I, II, III, and VII, and is situated in the axiology, epistemology, and politics of technology education.

Research Areas of Engagement

- Anthropology and Sociology of Technology Education
- Axiology and Epistemology of Technology Education
- Comparative Studies of Technology Education
- Cultural and Social Psychology (including Learning Theory) of Technology Education
- Curriculum and Pedagogy (including Critical and Eco-Pedagogy) in Technology Education
- Design, Cultural, Labor, Technology, or Workplace Studies

- Economics and Politics of Technology Education
- Genealogy, History and Historiography of Technology Education
- Organizations and Micropolitics in Technology Education

Central Framing Questions

I. How do I, students, teachers, teacher educators, and the general public come to practice, use, *and* understand education *and* technology? What and how do we and they know?
   - Anthropology and Sociology of Technology Education
   - Axiology and Epistemology of Technology Education
   - Comparative Studies of Technology Education
   - Cultural and Social Psychology (including Learning Theory) of Technology Education
   - Curriculum and Pedagogy (including Critical and Eco-Pedagogy) in Technology Education
   - Design, Cultural, Labor, Technology, or Workplace Studies
   - Economics and Politics of Technology Education

II. Toward what end are we committing technology education? Whose end and why? What means have we chosen to move us in that direction? Should we be heading in that direction?
   - Anthropology and Sociology of Technology Education
   - Axiology and Epistemology of Technology Education
   - Economics and Politics of Technology Education
   - Genealogy, History and Historiography of Technology Education

III. What is and ought to be the nature of knowledge in technology education?
   - Anthropology and Sociology of Technology Education
   - Axiology and Epistemology of Technology Education
   - Cultural and Social Psychology (including Learning Theory) of Technology Education
   - Economics and Politics of Technology Education
   - Design, Cultural, Labor, Technology, or Workplace Studies
   - Curriculum and Pedagogy (including Critical and Eco-Pedagogy) in Technology Education

IV. How should this knowledge be organized, what ought to be selected for teaching, how should it be taught, and for what end?
   - Anthropology and Sociology of Technology Education
   - Axiology and Epistemology of Technology Education
   - Comparative Studies and Anthropology of Technology Education
   - Cultural and Social Psychology (including Learning Theory) of Technology Education
   - Curriculum and Pedagogy (including Critical and Eco-Pedagogy) in Technology Education

V. How was technology education practiced in the past? Who said so, and how does that link up to current power structures and values?
   - Anthropology and Sociology of Technology Education
   - Genealogy, History and Historiography of Technology Education
   - Comparative Studies of Technology Education

VI. How is or was technology education practiced in subcultures and in other cultures? Who says so, and how does that link up to current power structures and values?
   - Anthropology and Sociology of Technology Education
   - Comparative Studies of Technology Education
   - Genealogy, History and Historiography of Technology Education

VII. Who participates in technology education and why or why not? What has been or ought to be done to change this?
   - Anthropology and Sociology of Technology Education
   - Curriculum and Pedagogy (including Critical and Eco-Pedagogy) in Technology Education
   - Cultural and Social Psychology (including Learning Theory) of Technology Education
   - Design, Cultural, Labor, Technology, or Workplace Studies
   - Economics and Politics of Technology Education
   - Organizations and Micropolitics in Technology Education

For example, the question "Who participates in technology education and why or why not?" can be informed through a number of different areas of engagement. One may be curious about gender and race at the organizational level of technology education. The ITEA's Board of Directors, which is a decision-making and policy arm of this Association, has been controlled for the past three years by a board of twelve men. Every "Teacher Educator of the Year" award given by the CTTE and ITEA for the past 44 years has gone to a white man. Two of the 71 editors of CTTE yearbooks published over the last 46 years were women. This particular question of participation can be best informed by engaging with the area of research in organizations and micro-politics of education (Bacharach & Mundell, 1993; Hoyle, 1985). Gender and racial equity theory used in context of organizational and micropolitical theory would help ground the question. These theories problematize gender and race while providing a powerful base through which to gain an understanding of the question of participation and the politics of representation. By situating in the research practices of education and the social sciences, researchers necessarily situate themselves in a theoretical landscape - a historical and socio-political terrain where the currency is relevance and engagement with the turbulent epistemology of the day.

Final Analysis: Speaking Out Against 'the Man'

> All too often, on the long road up, young leaders become servants of what is rather than shapers of what might be. In the long process of learning how the system works, they are rewarded for playing within the intricate structure of existing rules. By the time they reach the top, they are likely to be trained prisoners of the structure. . . .But no system can stay vital for long unless some of its leaders remain sufficiently independent to help it to change and grow. (John Gardner, 1986, p. 25)

In the final analysis, the *JTE* comes across as a text where conservative voices are favored and critical voices the exception. In this regard, the *JTE* is representative of the *episteme* of technology education. Where discourses and distortions of American supremacy, disciplinary subjugation, and scientific elitism are prevalent, there are few discourses that run counter to these. Yet the *JTE* has supported a critical discourse that cannot be found in any of the other technology education media. Given their record, the position of Mark Sanders and James LaPorte should be acknowledged. They will publish critical work if authors place manuscripts in their hands.

Why are not more than a few authors interrogating class, ecology, gender, labor, race, or sexuality in a context of this profession? Most researchers publishing in the *JTE* do not bring an internal criticism to their work; reflexive practice is not demonstrated. While discourses circulate among *JTE* issues and across volumes, there is very little dialogue among the authors. The isolation of technology education researchers from each other and from education and the social sciences has to be overcome. For example, at annual American Educational Research Association meetings, there have been few, if any, technology educators from the U.S. present over the past 6 years. Graduate students are facing a much different educational culture than did most of their advisors, and have to necessarily engage with the issues pointed out in this analysis. Those of us who do critical pedagogy and studies know the politics of recognition all too well - and the backlash that results from publicly speaking out. As indicated by the citations in the 1995 CTTE yearbook, there is an unhealthy politics of what and whose work gets read, referenced, published, and used (Petrina, in press). What is and what is not a significant issue to address in research, or what is progress, has generally been in the hands of ITEA policy-makers and *not* independent researchers. Still, it can be said: "We have met the enemy and he and she is us."

My contention is that if we are to move this *episteme* out of a conservative quagmire, we have to pay close attention to the politics of data, methods, subjects, theories, and epistemological visions. Editors and reviewers of book and journal manuscripts in technology education will have to be much more aggressive, proactive, and vigilant in shaping the research enterprise of technology education. Whereas Sanders was confronted with the challenge of establishing the *JTE* as a scholarly journal, his successor, LaPorte, should tackle the issues of representation and scholarly dialogue. LaPorte ought to encourage dialogue and a counter to the conservatism which is dominant in the profession of technology education. *JTE* discourse can be improved by reaching out to under-represented groups and marginalized voices. Unlike Sanders, he should use the "From the Editor" space to attend to inequities in technology education. Karen Zuga, beginning a tenure as Editor of the *JITE*, is facing similar challenges.

Would a more balanced demographic of reviewers make a difference in what and whose concerns and views are represented in the *JTE*? For example, until volume eight, the *JTE* had either one or two women reviewers appointed to an Editorial Board of 15 to 17 people, depending on the issue. Chances were good that a manuscript was accepted without ever having been reviewed by a woman (or a person of color). Although the current *JTE* board has four women, we should not assume that it is the task of women to attend to issues of gender and representation. For systemic change, all reviewers will have to be vigilant in attending to demographic sampling and a neglect of underrepresented groups and ideas in *JTE* manuscripts. Regardless of the current population of reviewers, teachers, and teacher educators in technology education, it seems essential that we practice with the interests and voices of underrepresented groups in mind.

It may be presumptuous to call for a moratorium on publishing any research that conceals the demographics of subjects or sites and feigns normality, does not reflect a reflexive turn toward internal criticism, or research that does not engage with theoretical issues of education and social science. But what is to be lost by calling for a moratorium? This profession can and should be different. Inequities (re)produced and strengthened over the past decade might begin to dissolve if researchers gain the courage to confront them instead of acting as "servants" or "prisoners" of the system (Gardner, 1989, p. 25).

The politics of research in technology education may be reduced to two questions for dialogue. Can the *JTE* be shaped to become less a product of its profession and more an intervening model of force for positive, systemic change? And, is the *episteme* and minority demographic of technology education best served by uncritical, insular research, or by critical, outward-looking studies?

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Why They Want to Teach: Factors Influencing Students to Become Technology Education Teachers

Michael D. Wright and Rodney L. Custer

Introduction

Identifying and recruiting prospective technology education teachers has been an ongoing concern for more than two decades. Considerable research was conducted during the late 1970s and early 1980s relative to teacher recruitment (Craft, 1979; Devier, 1982). These studies were prompted by declining enrollments in university programs and reported shortages of industrial arts teachers in forty-one states (Miller, 1980; Tomlinson, 1982; Wright, 1985). In some cases, this shortage of teachers led to high school programs being closed or cut back, the utilization of under-qualified personnel, and the abandonment of planned expansion. Simultaneously, university programs experienced significant drops in industrial arts teaching majors as students increasingly selected industrial technology or management options over teaching (Devier & Wright, 1988).

This trend of declining enrollments has continued and has now reached critical proportions (Volk, 1997). Current data suggest that a large number of university technology education programs have been, or are being, closed (Daugherty & Boser, 1993; Todd, Bame, Berry, Hacker, Hanson, Karsnitz, Radcliffe, Sanders, Ritz & White 1996; Householder, 1992; Volk, 1997; Weston, 1997; Wright, 1992). Many technology teacher education programs that remain are extremely vulnerable because of low enrollments and budget cutbacks.

Technology education professionals have spent a great deal of time and energy focused on defining the mission of technology education and redefining the curriculum. However, the technology education profession has made only limited efforts at recruiting students into technology education teacher preparation programs. While these efforts are to be commended, they have stopped short of the effort and results needed to address the teacher shortage. In a research presentation at the 1992 Mississippi Valley Industrial Teacher Education Conference, a warning was issued that, “As a profession, we are no closer to addressing the problem of declining enrollments than we were a decade ago. Nor have we made any significant progress toward identifying the

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factors that influence students' decisions to become technology education teachers" (Wright, 1992 p. 2). In an effort to address this concern and as part of its Strategic Plan, the International Technology Education Association created a task force specifically charged with examining this phenomena. The authors were part of that task force.

Literature Review

Education in the United States (specifically teachers and teacher education) has been the focus of considerable concern and scrutiny over the past decade. For example, the National Commission on Teaching and America's Future (1996) stated that teachers are at the core of the mission to improve schools. The report noted that (a) minorities compose only a small percentage of the teaching force, (b) 22% of teachers leave the profession within the first three years, and (c) teachers are often hired without proper qualifications and training. These factors are true of technology teachers as well.

According to Darling-Hammond and Rustique-Forrester (1997), two million teachers will be hired over the next decade. Because of the large teaching force that will be required, they assert that changes should be made within the profession in order to attract and retain teachers. They offer several strategies for recruiting teachers, including extending state-supported scholarships, recruiting minorities and those in other careers, offering better incentives, and improving licensing agreements. They also offer several strategies for retaining good teachers, including better professional development and rewarding teachers' knowledge and skill.

Despite these good intentions, Weston (1997) reported that technology teacher education programs are graduating fewer people when compared to previous years, while the demand for technology teachers is increasing. Two factors affecting this supply and demand problem include increasing student enrollments in public schools and an aging teaching force that is heading toward retirement. According to Weston (1997), the technology teacher shortage can be resolved only when administrators and the public at large become more aware of the need for teaching technology in our schools.

Todd et al. (1996) observed that not only is there a critical shortage of technology educators, but there is also a critical shortage of technology teacher education programs. However, rather than viewing this situation as a problem, these shortages may be seen as an opportunity to strengthen the profession by injecting new thinking and approaches. They cite teacher recruitment as the root cause of this shortage and suggest that secondary school programs may be a key place to begin to recruit potential teachers.

Johnson (1997) offered a multi-faceted way of "marketing" technology education as an option to students. According to Johnson, in order to combat the teacher shortage, teachers should not only *encourage* students to consider technology education as an occupation, but more importantly they also should *show* their students that they enjoy teaching technology education.

Daugherty and Boser (1993) proposed that the shortage of qualified technology education teachers results in part from an image problem. In order to improve the image of the profession, they proposed that secondary and post-secondary technology education personnel should engage in public relations and recruiting activities on a regular basis. Some of their suggestions included: targeting Technology Student Association chapters, developing program awareness and respect in the community, as well as promoting technology education in local high schools. Most importantly, they emphasized the importance of teachers being enthusiastic about their work. They should tell students, parents, and the community why they like teaching technology.

Volk (1997) sounded a sharp warning to the field, predicting a bleak future if action is not taken to reverse this downward trend in preparing technology education teachers. He suggested some ways to combat this problem, including offering economic incentives, increasing public awareness, and requiring technology education courses in secondary schools.

Research Questions

Two factors must be understood if technology education teachers are to be effectively recruited: (a) what recruitment strategies are perceived as most effective by those who are currently electing to become technology education teachers, and (b) what factors influenced them to become teachers? Demographic data for technology education students on a national scale are very limited (Wright, 1992). Similarly, empirical data regarding the effectiveness of various recruitment practices, as well as the factors that influenced students to select teaching technology education as a major, are not widely known. The following research questions were formulated to address this problem:

1. What are the basic demographic characteristics of the university technology teacher education student population in the United States?
2. What factors influenced students to select technology teacher education as a major and what was the magnitude of these influences?
3. What university recruitment practices did these students experience, and what was the perceived extent of influence of these activities?

Method of Study

A survey instrument was utilized to collect data to answer the research questions. The instrument was adapted and modified from an instrument used in Ohio by Devier (1986) and nationally by Wright (1992). The revised instrument was reviewed by the ITEA task force charged with exploring recruitment. The instrument was then reviewed by a panel of experts comprised of six technology teacher educators. The combined suggestions were incorporated into the instrument to the fullest extent possible.

The sample for this study consisted of all technology education teaching majors enrolled in universities that graduated five or more technology education students per year as reported in the *1995-96 Industrial Teacher Education Directory* (Dennis, 1995). This criterion was selected because it increased the likelihood of identifying a program with a critical mass of students. In the event that no university in a given state reported five graduates, the program reporting the most technology education graduates was included in the sample to ensure that all fifty states were represented. A total of 101 programs were selected. It is acknowledged that the selection process was only as valid as the accuracy of the reports submitted to the *Industrial Teacher Education Directory*.

Copies of the instrument, along with a cover letter, were mailed to either the individual known to be responsible for technology teacher education or to the department chair at each selected institution. These contact persons were asked to forward the survey to an individual who would administer the instrument to technology education teaching majors. Analysis was completed with SAS software (SAS Institute, Inc.) and consisted of descriptive statistics.

Findings

Fifty-two (51.5%) of the 101 universities selected responded for a total of five hundred thirty-seven usable surveys, representing 32 states. Several schools reported that they no longer had undergraduate technology teacher education programs. One university returned 43 (8%) surveys, while 35 schools (34.7%) returned less than 10 surveys each. Seven programs accounted for 35.9% of the sample.

Demographics

The mean age of the respondents was 26.6 years. Sixty-seven percent (67.5%) of the students were 25 years old or less, while 17.9% were over 35 years of age. The range was from 18 to 57 years.

The sample was 87.8% male and 12.2% female. Nearly one half of the students (42.5%) indicated that they had attended a community or technical college prior to entering the university program. A large number of students (33.8%) reported a time lapse between the time they graduated from high school and when they started college. Of these, the majority had either been working (60%) or had been in the military (30.2%).

A high percentage of students (65.4%) did not select technology education as a major when they first entered the university. Their backgrounds were extremely varied, with some preference for technology-related majors (e.g., engineering, engineering technology, industrial technology, etc.). The first majors for these students are shown in Figure 1.

For each grade (7-12), at least 47% of the students reported having been enrolled in an IA/TE course. Sixty-one percent reported taking these courses in grade 12. The highest percentage of students (36.5%) first became interested in teaching technology education *after* having enrolled at the university, although a substantial percentage (28.5%) also became interested during their years in high school (See Figure 2).

Most students indicated that their original intention was to become an industrial arts teacher (43.9%) while 21.6% believed that they would become a technology education teacher. About 20% indicated that they did not know the difference when they enrolled in the teacher education program.

Regarding family background, many technology education students indicated that their father's primary occupation was "Construction," while the highest percentage of mothers were "Homemakers." "Teacher" was the next most common occupation for both father and mother. The data regarding parents' primary occupations are reported in rank order in Table 1.

Influential Factors

The list of possible factors that may have influenced students' decisions to become technology education teachers are listed in Table 2. The respondents were asked to indicate whether they felt an item was a factor in their decision to become a technology education teacher and if so, to rate its degree of influence. The students also were given the opportunity to list additional factors and rate their influence as well. A five-point Likert-type scale was used on all items, with "1" representing "Not Influential" and "5" representing "Highly Influential."

The students cited "Personal interests or hobbies" most frequently (75.3%) as an influential factor in their decision to become a technology education major. The survey instrument provided three blank spaces to provide the respondents the opportunity to indicate what activities they referred to when they rated this factor. Nine hundred fifty-eight responses were given. The "Personal interest or hobbies" listed most frequently were "sports" (listed by 13.5% of the respondents) and "Woodworking" (listed by 12.9%). "Cars/auto mechanics" and "Outdoor activities (hunting, fishing, camping)" were the third most popular choices (each listed by 7.9%). One plausible interpretation of the "sports" influence could be that many individuals are motivated to pursue teaching careers through participation and interest in sports. Teaching is one of the few careers that not only allows, but encourages, participation in sports through coaching. Indeed, it is common knowledge that an ability or interest in coaching is frequently a contributing factor when teachers are selected for employment at the junior or senior high school level. The authors believe that

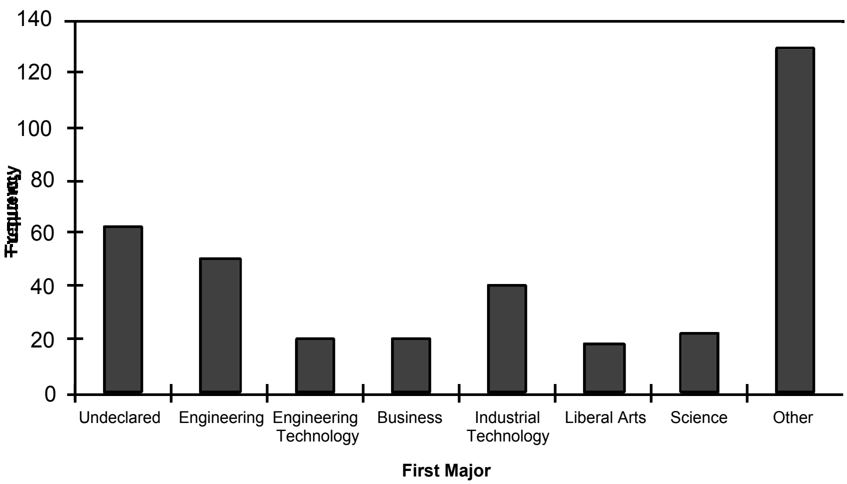

Figure 1. Majors of students who were not originally majoring in technology education.

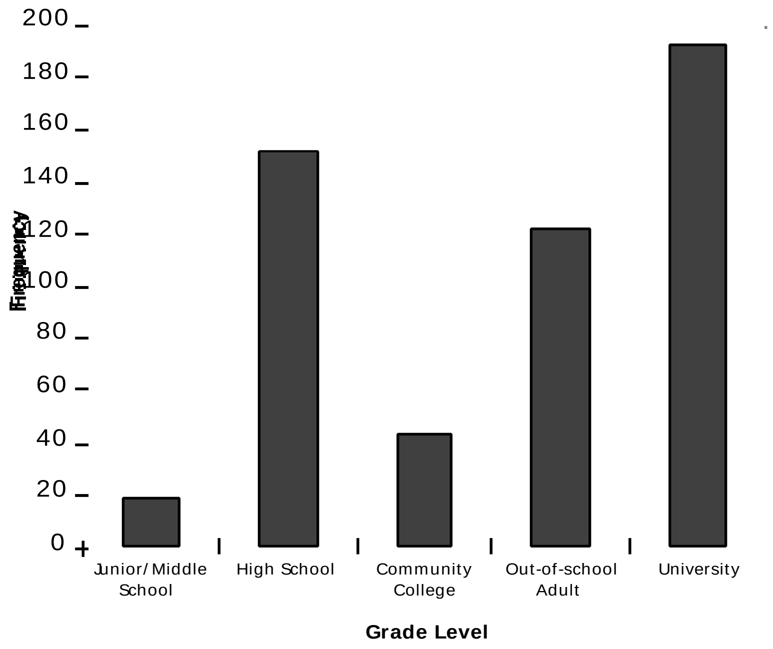

Figure 2. Grade level in which individuals first became interested in teaching technology.

this factor would tend to be true for secondary teachers in general, and is not necessarily specific to technology education.

After "Personal interests or hobbies" the next most frequently cited influential factors were "High school industrial arts/technology education course(s)" (48.1%) and "Admiration of a high school industrial arts/technology education teacher as a role model" (46.1%). These factors were followed by "Extra-curricular IA/TE activities" and "Encouragement by high school IA/TE teacher" as the next most frequently cited influential factors.

The most frequently cited factors are not necessarily the most influential, however. The mean rating of the perceived influence by those students who indicated the factor was influential is also presented in Table 3. There was a virtual three-way tie for the most influential factor. Both "Encouragement from high school industrial arts/technology education teacher" and "Encouragement from other community personnel" were rated as the most influential factor ($\bar{x}$ = 4.40), followed closely by "Encouragement from college/university professor" ($\bar{x}$ = 4.39). However, "Encouragement from other community personnel" is essentially a "non-factor" since it was cited by only two percent (2.6%) of the sample. The least influential factors were "Encouragement by university coach" ($\bar{x}$ = 2.89) and "Secondary school IA/TE extra-curricular activities" ($\bar{x}$ = 2.30).

Table 1
Primary Occupations for Parents of Technology Education Majors

Occupation	Frequency	Percent
Father	170	31.7
Construction	88	16.4
Teacher/Educator	87	16.2
Other	79	14.7
Management	78	14.5
Farmer/Rancher	56	10.4
Sales	50	9.3
Service Occupation	35	6.5
Professional	33	6.1
Military	29	5.4
Homemaker	6	1.1
Mother		
Homemaker	207	38.5
Teacher/Educator	106	19.7
Service Occupation	67	12.5
Management	41	7.6
Sales	39	7.3
Technical Occupation	32	6.0
Professional	26	4.8
Construction	20	3.7
Farmer/Rancher	16	3.0
Other	77	14.3
Military	0	0.0
Total	537	100.0

The data indicate that although other community personnel were not as commonly involved in the students' decisions, they were quite influential when they *were* a factor. Conversely, "extra-curricular activities" was frequently a factor, but was not as influential.

Recruitment Practices

The list of recruitment activities that students may have experienced is presented in Table 4. The respondents were asked to indicate whether they had been exposed to the recruitment activity, and if so, to rate its effectiveness on a five-point Likert-type scale. The students were also provided space to list any other recruitment activities they might have experienced.

Table 4 lists the students' frequency ratings for recruitment activities. "Personal interaction with university faculty" was cited most frequently (37.7%), followed by "Modern lab facilities" (30.2%). The least cited recruitment activity experienced was "Personal letter from someone in the university technology education program" (6.1%).

Table 2
Frequency Cited for Influential Factors

Influential Factors	Frequency	Percent
Personal interests or hobbies	403	75.3
I enjoyed secondary school IA/TE course(s)	258	48.1
I admired a high school IA/TE teacher as a role model	247	46.1
Secondary school IA/TE extra-curricular activities	190	35.4
I was encouraged by high school IA/TE teacher	160	29.9
I was encouraged by parents	146	27.2
Previous teaching experience (other field, military, teacher aide, etc.)	125	23.4
I was encouraged by college/university professor	120	22.3
Business or industry personnel encouraged me	116	21.6
I was encouraged by college/university advisor	116	21.6
I was encouraged by college classmates	86	16.1
I was encouraged by other adults (non-university)	84	15.7
I was encouraged by other relatives	82	15.3
I was encouraged by high school teacher-other	74	13.8
I was encouraged by college/university department chair	69	12.9
I was encouraged by siblings	61	11.4
I was encourage by high school classmates	55	10.2
I was encouraged by high school guidance counselor	46	8.6
I was encouraged by high school coach	43	8.0
I was encouraged by community professional	30	5.6
I was encouraged by church leader	27	5.0
I was encouraged by other college/university personnel	22	4.1
I was encouraged by high school principal	22	4.1
I was encouraged by college/university dean	20	3.7
I was encouraged by youth organization leader	17	3.2
I was encouraged by other community personnel	14	2.6
I was encouraged by college/university coach	12	2.2

Table 3
Comparison of Frequency Cited and Effectiveness Rating for Influential Factors

Influential Factors	Mean Rating	Percent
I was encouraged by high school IA/TE teacher	4.40	29.9
I was encouraged by other community personnel	4.40	2.6
I was encouraged by college/university professor	4.39	22.3
I was encouraged by college/university department chair	4.32	12.9
I enjoyed secondary school IA/TE course(s)	4.26	48.1
I was encouraged by siblings	4.23	11.4
Personal interests or hobbies	4.22	75.3
I admired a high school IA/TE teacher as a role model	4.20	46.1
I was encouraged by community professional	4.19	5.6
I was encouraged by parents	4.18	27.2
I was encouraged by high school coach	4.13	8.0
I was encouraged by other adults (non-university)	4.11	15.7
I was encouraged by other relatives	4.10	15.3
I was encouraged by high school teacher-other	4.06	13.8
I was encouraged by other college/university personnel	4.06	4.1
I was encouraged by college/university advisor	4.04	21.6
I was encouraged by college classmates	4.02	16.1
Previous teaching experience (other field, military, teacher aide, etc.)	3.93	23.4
I was encouraged by youth organization leader	3.93	3.2
I was encouraged by high school classmates	3.88	10.2
I was encouraged by church leader	3.75	5.0
I was encouraged by college/university dean	3.71	3.7
I was encouraged by high school principal	3.58	4.1
Business or industry personnel encouraged me	3.53	21.6
I was encouraged by high school guidance counselor	3.48	8.6
I was encouraged by college/university coach	2.89	2.2
Secondary school IA/TE extra-curricular activities	2.23	35.4

The perceived effectiveness of the various recruitment practices is presented in Table 5. Again, "Personal interaction with university faculty" and "Modern lab facilities" were the most effective recruitment strategies ($\bar{x}$ = 4.14, and $\bar{x}$ = 3.63 respectively). Those recruitment activities rated as least effective were "Video or audio-visual presentation about technology education" ($\bar{x}$ = 2.71), and "Brochures distributed at the high school or community college" ($\bar{x}$ = 2.61).

In general, the more frequently encountered recruitment activities experienced by the students were also the most effective, with the exception of "Audio-visual presentations" which were the third most frequent, but nearly last in perceived effectiveness. Apparently, videos are frequently employed, but do not appear to be effective for recruiting purposes.

Discussion

There may be little that can be done to capitalize on the most frequently cited influence (i.e., students' personal hobbies) when recruiting students, except perhaps to highlight the positive relationship between enjoyment of one's daily job when it coincides with personal hobbies. For example, recent research on job satisfaction of outstanding technology teachers found that the "enjoyment of working with technology" was a major satisfier for these teachers (Wright & Custer, 1998).

However, the most influential factor, "Encouragement from high school IA/TE teacher" ($\bar{x}$ = 4.40), which was cited by nearly one-third (29.9%) of the sample, can be specifically addressed. Given that high school technology teachers appear to be so influential, it is curious that less than one third of the students indicated that they experienced encouragement from this source. This suggests that technology teachers should become more actively involved in advocating technology teaching as a viable and rewarding career option. This is underscored by the fact that nearly one-half (46.1%) of the students reported that they admired their high school technology teacher as a role model, and that this perception had been quite influential in their decision to become a teacher ($\bar{x}$ = 4.20). Combined with the knowledge that nearly one-half indicated "Enjoyment of high school IA/TE courses" (48.1%) as an influential factor ($\bar{x}$ = 4.26), it is clear these two factors (i.e., technology education teachers and courses) are those over which the profession has considerable control.

"Personal interaction with university faculty" was also highly rated ($\bar{x}$ = 4.14), and was the most frequently cited (39.7%) recruitment practice. Clearly the time and energy that some university faculty have invested in recruitment, as well as time spent with students is perceived to have been highly effective. Specifically, it is the most frequently cited university recruiting activity experienced by these students. When combined with the item "I was encouraged by college/university professor," which was cited by 22%, and which tied for the highest rated factor ($\bar{x}$ = 4.39), one recruitment strategy should be quite clear: person to person interaction and encouragement is highly effective. If university faculty and high school teachers were to unite in their recruitment efforts, their combined effort would likely have a substantial impact.

Table 4
Frequency Cited for Recruitment Practices

Recruitment Practices	Frequency	Percent
Personal interaction with university faculty	201	37.7
I was impressed by modern lab facilities and programs at the high school or university	162	30.2
I was impressed by a video or audio-visual presentation about Technology Ed.	98	18.3
Feature articles or stories on technology	97	18.1
Career days, open house, or other university on-campus activities	77	14.4
Brochures distributed at high school or community college	76	14.2
I was impressed by a technology education display	54	10.1
General education course offerings at the university such as "Technology & You"	51	9.5
Personal letter from someone in the technology education program at the University	33	6.1

Table 5
Comparison of Frequency Cited and Effectiveness Rating for Recruitment Practices

Recruitment Practices	Mean Rating	Percent
Personal interaction with university faculty	4.14	37.7
I was impressed by modern lab facilities and programs at the high school or university	3.63	30.2
I was impressed by a technology education display	3.43	10.1
Feature articles or stories on technology	3.37	18.1
Career days, open house, or other university on-campus activities	3.23	14.4
Personal letter from someone in the technology education program at the University	3.14	6.1
General education course offerings at the university such as "Technology & You"	3.02	9.5
I was impressed by a video or audio-visual presentation about Technology Ed.	2.71	18.3
Brochures distributed at high school or community college	2.61	14.2

It is equally important to note what is *not* happening. Based on the findings of this study, it seems that students are not being counseled into technology teaching by high school coaches, principals, guidance counselors, or college coaches, all of whom were cited by less than 10% of the sample. Similarly, recruiting strategies that typically have been (and continue to be) used widely, such as brochures and video presentations, were the two lowest-rated recruitment activities. Perhaps more surprising was the low rating given to "Secondary IA/TE extra-curricular activities (TSA, VICA, etc.)" ($\bar{x} = 2.30$), which received the lowest rating in terms of influence, yet was cited by 35% of the students (the fourth most frequently cited factor). Equally disappointing was the number of students who had received a personal letter from someone in the technology education department at the university (6.1%).

Several comments returned from faculty who were mailed the surveys indicated that their university no longer had an undergraduate teacher preparation program in technology education. One cannot help but wonder how many more programs have been eliminated and thus the faculty did not bother to respond. In addition, several individuals reported that their student numbers were so low that they were concerned about their survival for another year.

Several unsolicited institutional responses indicated that the demand for technology teachers has generally surpassed the supply. Letters returned with the surveys indicate widespread shortages nationally. Conversely, only a few institutions volunteered information to indicate that their programs had experienced growth.

Perhaps the most important result of this study is the indication of the need to meet personally, face-to-face, with prospective students in order to have maximum impact. Secondly, we must work closely with secondary teachers in recruitment efforts as they were one of the most influential factors in students' decision processes. We *must* use these findings to influence and attract into the teaching profession the hundreds of students who participate in technology classes of dynamic technology education teachers.

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Book Review

Frye, E. (1997). ***Engineering problem solving for mathematics, science, and technology education*****. Hanover, NH: Trustees of Dartmouth College. $15.00 (spiral-bound paper paperback), 135 pp.**

Reviewed by Vincent Childress

Engineering Problem Solving for Mathematics, Science, and Technology Education appeals to the reader on several levels. It is a guide for teachers, including technology teachers, who want their students to learn authentic strategies for solving real-life, discipline-based problems. It focuses on an engineering problem solving method, and it touches on interdisciplinary team management, instructional management, and student assessment. More importantly, this resource provides practical examples of how teachers have used the method successfully and why industry leaders believe the method is relevant to the skills they require on the job. *Engineering Problem Solving for Mathematics, Science, and Technology Education* will provide the technology teacher educator with a resource for problem solving instruction in both technical and methods classes. At the same time, the book is unsettling to the technology educator because it omits some concepts that are fundamental to the field, and it illustrates the importance of issues that technology education must face at both the national and grassroots levels.

Engineering Problem Solving for Mathematics, Science, and Technology Education was written by Ellen Frye and was an outgrowth of a project at the Thayer School of Engineering at Dartmouth College. John Collier, D. E., a professor in the School of Engineering, incorporated an engineering problem solving method into a hands-on, introductory course. The practical nature of the course made it very popular. The engineering school began offering workshops to mathematics and science teachers, and with major funding from the John Brown Cook Foundation and others, this service grew to become the Dartmouth Project for Teaching Engineering Problem Solving. The method of instruction taught in the workshops is so popular with mathematics and science teachers that the book was written for those who are not able to attend the workshops.

The book is well-written and easy to understand. Frye has avoided using technical jargon, and her prose flow smoothly for the reader. It is well organized, starting first with an engineering problem solving cycle. It identifies and explains the process that engineers use to solve a host of practical problems. The method is a step-by-step process, and the reader is encouraged to demonstrate the steps of the process to students. After providing detailed

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examples of researching and documenting each step, the teacher becomes the facilitator, and students become the engineers who solve problems that they identify.

Johnson (1994, pp. 27-26) cited criticism on the use of stage models for solving problems where the model is over simplified and linear. He cited studies that provided strategies that should be taught to students for problem solving. The engineering problem solving cycle in Frye's book is depicted as a spiral process with complex activities within most of the steps of the process. While student intuition and metacognition are inherently important to develop in this problem solving process, each decision that a team of students makes is intended to be based on documented, quantitative analyses. The model appears to include those strategies that Johnson identifies, while at the same time providing structure that is designed to help the engineer create a structured problem from an ill-structured problem. It is both divergent and convergent, but the greatest emphasis is on the convergence of the process (See Shaw & Reeves, 1978; Dugger, 1994, p. 20).

Frye provides excellent examples of engineering problem solving that illustrate how engineers use a matrix that rates possible solutions in relation to the specifications that the engineers determined earlier in the process. Once each idea is researched, the engineers apply ratings to each. The top scoring idea is retained and the others are dropped. The team proceeds to take the chosen idea and define it further into subordinate alternatives which are again applied to the matrix and rated. The process is logical and iterative, and it spirals toward a workable design. Ideally, once the team of engineers believes it has a workable solution, they will implement it as a prototype.

Frye provides useful advice for the classroom teacher that is based on the experiences of the mathematics and science teachers that adapted the method to their classrooms. This experience is noteworthy because it tends to validate the experience of technology education teachers in curriculum integration projects such as the Technology, Science, Mathematics Integration Project at Virginia Tech (See Childress, LaPorte & Sanders, 1994, p.34). Frye includes a wide range of ideas teachers used to make room for the innovative method in the curriculum. Teachers are trying to use interdisciplinary teams without students in common, teach the process for the first 10 minutes of class each day, or have students work on problems after school or for homework. It appears that the struggle to implement meaningful reform is a problem experienced across the curriculum.

At the Thayer School of Engineering, Collier noticed that the engineering curriculum was so theoretical that some students were less motivated than they would have been if they had the opportunity to work on real-life engineering. He developed the aforementioned course so students could employ engineering problem solving in a fun and relevant way. The students proceed from a theoretical phase to a hands-on phase in which real product prototypes are developed. It is interesting to note the similarity between Collier's motivation to include hands-on instruction in the Thayer School's engineering program and Calvin Woodward's motivation to open the Manual Training High School of

Washington University in 1879. Woodward wanted aspiring engineering students to benefit from practical experience (Coates, 1923, p. 10).

Teaching the engineering process is fundamental to technology education, and doing real technology is also fundamental. One of the criteria that is applied to engineered technological solutions is that they work. In technology education, part of the learning process is engineering these simulated or working prototypes. Perhaps through no fault of the Dartmouth Project or Frye, the book provides little evidence that the participating mathematics and science teachers are really getting their students to implement authentic technological solutions. Some fully implemented technological solutions are presented, but Frye describes only two scenarios in which the technology education teacher participates. In one example, the technology education teacher is the science class's consultant on how to build prototypes, and in the other he or she is team teaching science class with the science teacher. It is good to know there exists the need for technological literacy, yet it is troubling to realize that relatively few colleagues and students can capitalize on the importance of technology education.

If technology educators at all levels do not quickly secure a recognizable position in technological education, then mathematics and science education will teach technology without them. Frye includes a section in the book that provides problem solving ideas that do not require tools. This would not be considered unusual except for the fact that the focus is on engineering problem solving and is inspired by the notion that it is important to proceed beyond the theoretical.

For the technology teacher, the book is useful and compelling. The problem solving method represents a refreshing opportunity to balance the need to address both cognitive development and authentic instruction. Reading this book tends to validate recent experience in technology curriculum innovation and reform. And, it certainly reminds technology education of the need to continue positioning itself and develop working relationships with wonderfully innovative educators such as those who are so well described in *Engineering Problem Solving for Mathematics, Science, and Technology Education,* a practical resource for the technology teacher who accepts the challenge of authentic instruction.

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Miscellany

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