Articles

Students Attitudes Toward Technology in Selected Technology Education Programs

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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

	Industrial Arts			Integrated			Modular			Problem Solving		
Sub-scales	Females n=13	Males n=13	p value	Females n=15	Males n=14	p value	Females n=27	Males n=23	p value	Females n=4	Males n=16	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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