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ABSTRACT

A pre- and posttest research design was used to ascertain whether instructional approaches used by technology teachers affected the attitudes of 155 seventh-grade students toward technology. It also determined whether males and females responded differently to these instructional approaches. A validated attitudinal instrument, the Pupils' Attitudes Toward Technology-USA version (PATT-USA), was administered to intact classes of technology education students in four middle schools at the beginning and end of a 9-week class session. The students were enrolled in technology education programs using one of four instructional approaches: interdisciplinary, modular, problem centered, and industrial arts. A multivariate analysis of variance was used to investigate differences among the four instructional approaches. Follow-up procedures included an analysis of variance and Tukey post-hoc test. Similar analysis procedures were used to ascertain whether gender affected students' attitude toward technology. Results indicated the following: (1) the instructional approach did affect students' attitude toward technology, with the interdisciplinary approach changing attitudes the most and industrial arts having the least impact; (2) male and female students had different attitudes toward technology in regard to gender appropriateness, difficulty, and interest, with males having stereotypical views of females' abilities; (3) although attitudes were affected, there was no clear direction of change; (4) students perceived the benefits of technology but had narrow concepts of what comprised technology; and (5) students' attitudes toward technology were generally consistent with previous PATT and PATT-USA studies. (Contains 34 references.) (Author/YLB)

The Effect of Selected Instructional Approaches in Technology Education on Students' Attitude Toward Technology

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Abstract

This study used a pre and post-test research design to ascertain if selected instructional approaches used by technology teachers affect the attitudes of middle school students toward technology (first research question) and to determine whether males and females respond differently to these instructional approaches (second research question). A validated attitudinal instrument, the PATT-USA was administered to intact classes of technology education students in four selected middle schools at the beginning and end of a nine week class session (n = 155). The students were enrolled in technology education programs using one of four instructional approaches: (a) interdisciplinary, (b) modular, (c) problem-centered, and (d) industrial arts. A MANOVA was used to investigate differences between the four instructional approaches. Follow up procedures included an ANOVA and Tukey Post-hoc test. Within program differences were analyzed with pre and post treatment *t*-tests. Similar analysis procedures were used to ascertain if gender affected students' attitude toward technology.

The results of the study indicated that (a) the instructional approach did affect students' attitude toward technology, (b) male and female students have different attitudes toward technology in regard to gender appropriateness, difficulty, and interest, (c) although attitudes were affected, there was no clear direction of change, (d) students, in general, perceived the benefits of technology but had narrow concepts of what comprised technology, (e) students' attitude toward technology were generally consistent with previous PATT and PATT-USA studies, and (f) attitude measures may be used as one indicator of the effectiveness of instructional approaches.

Introduction and Background

Technology education is a K-12 curriculum designed to help individuals understand the impacts of technology on society. One of the goals of technology education is to promote technological literacy in a broad and encompassing nature (International Technology Education Association, 1993; Technology Education Advisory Council (TEAC), 1988). To achieve this goal, technology education teaches students to understand, use, and control technology. Students 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 technology education are changing--technology teachers are moving from the age of teaching wood shop and metal shop to the contemporary age of teaching problem solving and technological application. Stacy and Tobin (1991) suggested that changing the instructional approaches used in technology education to more accurately reflect technological methods is a critical problem for the profession. The increased national and international emphasis on new and different teaching approaches has created a serious dilemma for the technology educator-- What are the most appropriate instructional approaches for technology education? Currently, technology teachers use a variety of instructional approaches such as interdisciplinary technology education, self-paced modular technology education, and problem-centered technology education to inform students about technology and its affects on society.

Many authorities (Gloeckner, 1990; Illinois State Board of Education, 1992; Thode, 1989; and Wicklein, Hammer, Balistreri, DeVore, Scherr, Boudreau & Wright, 1991) have emphasized the need for technology teachers to use instructional approaches that enable students to become critical thinkers, able to make the difficult decisions that are often associated with technological applications.

Some technology educators (Gloeckner, 1990; Thode, 1989) argued that self-paced modular instruction is the most appropriate method. These authors emphasized that this method 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, as well as the world, is interrelated to other disciplines, and 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 (1990), plead the case for problem-centered instruction. These authors contend that the world is full of problems, in fact many people consider life as one big problem, and that students need higher-level cognitive skills and the ability to reason, analyze, synthesize, and evaluate.

Regardless of the instructional approach utilized, it is clear that students have an innate desire to use contemporary technology like cellular telephones, lap top computers, and virtual reality to make their lives more pleasant. Johnson (1985) suggested that technology education provides an avenue for teaching students about the nature of a technological society and the benefits and burdens the technological society creates. Technology education is one the best avenues, if not the best, for students to become literate about technology (Hayden, 1991). Numerous educators (Dyrenfurth, Hatch, Jones, and Kozak, 1991; Hayden 1991; TEAC, 1988), have focused their research on acquiring information on technological literacy and have attempted to answer the questions "How can we prepare students who are technologically literate and how can we measure technological literacy?"

Measuring and Assessing Technological Literacy

The stated purpose of technology education is to prepare students to become technologically literate citizens (ITEA, 1995; TEAC, 1988). Although technological literacy is a term frequently used, its broad and encompassing nature makes it difficult to define operationally or to attempt to measure. Technological literacy has been very hard to define because of a lack of consensus as to what comprises "technological literacy." Dyrenfurth et al. (1991) stated that technological literacy is a multi-dimensional concept that necessarily includes the ability to use technology (practical dimension), the ability to understand the issues raised by or use of technology (civic dimension), and the appreciation for the significance of technology (cultural dimension). TEAC (1988) defined technological literacy more simply as, "that understanding of technology- its evolution, its utilization and its significance, which would enable the individual to function effectively as a citizen as well as in those specialized roles that one plays in a given society" (p. 10). Hayden (1991) viewed technological literacy as "general knowledge, abilities, and behaviors concerning technology" (p. 30). These definitions suggest the scope of technological literacy, but do not address content specifics or begin to suggest how technological literacy may be measured.

To resolve this problem, many technology education programs limit their scope to "industrial technology". The Industrial Technology Knowledge (ITK) was developed to measure students grasp of industrial technological literacy (Hayden, 1991). Although technological literacy is a more encompassing concept, the instrument focused on industrial technology because there is more agreement on content. The ITK consist of three areas: (a) human adaptive systems, (b) application of other disciplines to solve technological problems, and (c) interpretation of written and graphical materials having a technological theme.

Hayden concluded that there exists a construct of technological literacy and that technological literacy is a subset of general achievement. This conclusion implies that technological literacy is interdisciplinary in nature. Further, Hayden suggested that technological literacy can be measured reliably, that students have misconception about technology, and that technology education content and pedagogy is the most appropriate way to increase technological literacy. Technology education was believed to be the most suitable means of assisting students in attaining a higher level of technological literacy because it provides students with experiences using current technologies, solving technological problems, and developing an understanding of the interrelationship of technology to other disciplines (Hayden, 1991; Waetjen, 1985).

Although Hayden (1991) indicated that industrial technological literacy can be reliably measured, there is no widely-accepted standardized instrument or method suitable for assessing the broader construct of technological literacy. Daiber, Litherland, & Thode (1991) suggested that certain assessment methods can be used to assess the technological literacy level of students in a specific technology education course or program. The recommended methods were: (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 hands on activities, (c) utilization of paper and pencil exercises in the format of a pre-test/post-test design, and (d) development of a technology achievement test that includes major objectives of the course. (pp. 209-210). In each of these assessment methods, the emphasis is placed on observing students gains in technological literacy development (Daiber et al., 1991). Similarly, the British technological literacy framework used nine criteria to assist teachers in assessing the performance of 11 to 13 years old in the design and technology program (Ager, 1992). The framework argued that an accurate assessment of technological capability of individuals is best conducted by teachers who have worked with students for long periods of time.

Again, 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 asses 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, and Bertram, 1964). Krathwohl, et. al. suggested that many educational researchers have failed to investigate the affective measures, such as motivation, because interests, attitudes, and personality characteristics were assumed to develop relatively slowly and to be visible in appraisal techniques only over long periods of time, but 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, e.g. technology, then, students will have more of an interest in that subject (Krathwohl). Thus, if the educational goal 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 into the physics curriculum. The project titled, Pupils' Attitudes Toward Technology (PATT), sought to determine students': (a) attitude toward technology, (b) concept of technology, and (c) understanding of fundamental elements of technology. In 1988, the PATT was revised for use in the United States, and the PATT-USA was tested and validated in seven states (Bame et al., 1993). The results of the PATT-USA study indicated that:

1. Students are interested in technology.
2. Boys are more interested in technology than girls.
3. Students think that technology is a field for both girls and boys.
4. Girls are more convinced that technology is a field for both genders.
5. A positive influence of a parents' technological profession on the students attitude.
6. Students concepts become better with increase in age.
7. Students are strongly aware of the importance of technology.
8. The U.S. has rather low score on concept items compared to other industrialized countries.
9. Students who had taken industrial arts/ technology education classes made a positive significant difference on all attitude scales.
10. 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 gather comparative data on the various approaches used to teach technology education. The purpose of this study is to examine four typical teaching approaches in technology education and to determine if the different teaching approaches have differential affects on middle school students' attitude toward technology. The premise of the study is that students with a more positive attitude toward technology and the pursuit of technological careers would likely be more interested in studying about technology and would, therefore, become more technologically literate. This position is supported by Popham (1994) who suggested that students who exhibit a positive attitude toward a subject are more likely to actively engage in learning during and after instruction.

Research Problem and Purpose

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 very difficult to measure the success or failure of any one of the various instructional approaches. There has been no accepted examination adopted by the profession that will accurately measure the level of technological literacy achieved by students. 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 and technology education may provide some insight into the teaching approaches which affect students' attitude toward technology in a positive way. The attitude measure may then be one indicator of effective teaching approaches for technology education.

Therefore, the purpose of this study was to examine four teaching approaches typically used to deliver technology education content and to determine if various teaching approaches used by technology teachers affect the attitudes of middle school students toward technology. Based on the problem and purpose identified for this research the following research questions were investigated: (1) Are there differences in middle school students' attitude toward technology based on instructional approaches used to deliver technology education content? (2) Do males and females respond differently to the instructional approaches used to deliver technology education content in the middle school?

Methods

The population consisted of all middle school students enrolled in a technology education courses in the State of Illinois. The sample included a total of 155 seventh grade students who were enrolled in one of four distinct instructional approaches (see Table 1 for program definitions). Schools were selected according to the following criteria: (a) similar population demographics, (b) located in central Illinois or Chicago metropolitan area, (c) recognized as effectively using one of the four types of instructional approaches: interdisciplinary, modular, problem-centered, or industrial arts and, (d) teacher recognized as competent in delivering the instructional approach. Teachers from four programs identified were contacted by phone to solicit their participation, and all willingly agreed to participate.

The PATT-USA was administered to students in the four programs using a pre-test and a post-test design. The PATT-USA is a one page instrument that consists of four parts: (a) a short written description of technology, (b) eleven questions to gather data on 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. The researcher traveled to all of the middle schools to administer the pre-tests instruments to the students. The standard administration protocol recommended in the PATT-USA documentation was observed.

Data from students' test scores were collected on scantron sheets. The scantron sheets were color coded and numbered in order to assure accuracy in data transferring from text files to excel files The data was parsed using Excel for Windows and then converted to SPSS files. The researchers conducted a random check of the data conversion process through which it was determined that all instruments (20 %) matched the original data files. Whenever possible, statistical analysis used the same procedures as previous PATT-USA studies. Specific statistical analysis procedures are presented in Table 2.

Table 1

Program Types

Industrial Arts: A body of related subject matter, or related courses, organized for the development of understanding about all aspects oi industry and technology, including learning experiences involving activities such as experimenting, designating, constructing, evaluating, and using tools, machines, materials, and processes (American Council on Industrial Arts Teacher Education, 1979).

Interdisciplinary Technology Education: Instructions that incorporate other disciplines such as English, math, science, and social studies to show how technology is integral part of other disciplines and vice versa. Also, stress the need for humans to apply knowledge from other disciplines to solve technological problems.

Modular Technology Education: Individualized, self-paced, action-based unit of instruction which allows students to use current technologies to assist themselves in educational process. The modular approach provides students with problems and activities that encourage students to use critical higher level thinking skills to solve problems and make valuable decisions.

Problem Centered Technology Education: An instructional approach that emphasize critical thinking and is centered around students using a problem solving process to find creative solutions to problems that are technological by nature.

Table 2

Statistical Analysis Procedures

1. All attitude items, questions 12-69, received a factorial analysis to validate grouping of subscales.
2. All concept items, questions 70-100, received a Guttman analysis to assess internal reliability.
3. Cronbach's alpha internal consistency reliability test was run on all attitude and concept items.
4. Items 1-10, received a frequency analysis and descriptive statistics to assessed the technological climate of students' homes. Responses to question 11 were not germane to the study.
5. MANOVA on items 12-69 ascertained differences in the attitude subscales and concept scale across the four programs. An ANOVA and Tukey post-hoc test were used to isolate differences.
6. *t*-tests to determine attitudinal changes on each subscale between pre and post test scores.
7. MANOVA with follow-up ANOVA to determine differences in attitudes by gender across the four instructional approaches.
8. *t*-tests were used to analyze differences on the attitude subscales that may be attributed to gender.

There are six subscales on the PATT-USA. The attitude items included 57 questions related to student perceptions of technology on five subscales (See Table 3). The concept of technology items (questions 70 - 100) represent a single subscale. To establish the validity of the subscale categories, a factorial analysis was run on the pre-test data. The factorial analysis identified similar loadings and subscales as previous PATT studies. Questions that did not fall into one of the five subscale categories were excluded from the analysis. Table 4 outlines examples of high loading items along with other statements from each of the five attitude subscales used to assess students attitudes and perceptions of technology.

Table 3

Five Attitude Subscale

1. General Interest in Technology,
2. Attitude Toward Technology,
3. Technology as an Activity for Boys and Girls,
4. Consequences of Technology, and
5. Technology is Difficult.

On the concept subscale (items 70-100), a Guttman analysis was run to determine the index of internal consistency of students' responses to the concept items. The alpha coefficient was .82 and .81 respectively on the pre- and post-test. A second reliability analysis, Cronbach's Alpha, was conducted on the combined attitude and concept items. The analysis indicated an alpha of .79 and .72 on the pre-test and post-test which is thought to be sufficient when testing attitudinal surveys for reliability (Crocker & Algina, 1986).

Table 4

Statements From Each of the Five Attitude Subscales

Interest in Technology

Item # Statement

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 as a subject should be taken by all pupils.

Other statements falling in this factor group were: (18, 23, 28, 34, 38, 39, 44, 45, 50, 52, 63, 69).

Technology as a Activity for Both Boys And Girls

Item # Statement

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.

Other statements include: (19,24,35, 47).

Table 4 continued

Consequences of Technology

Item # Statement

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.

Difficulty of Technology

Item # Statement

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.

Attitude Toward Technology

Item # Statement

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.

Other statements include: (33, 48, 58, 60, 64).

Results

A total of 287 instruments were received from the administration of the PATT-USA. Of this total, 155 pre-test and 132 post-test instruments were collected from the intact classes at the four middle schools. There was an attrition rate of 28 students between the pre and post-tests. In one school, two classes received the pretest, while only one class (n = 23) took the post test. Since students had concluded their nine week session there was no opportunity to administer the post-test to this class. Data analysis indicated equal variance between the pre and post-test groups in spite of differences in sample size. In addition, the researcher excluded five tests from students from the other three schools who were not present for the whole nine week period. This step was taken to insure that the results weren't skewed by students who had not received the full treatment. In total, 282 usable instruments were available for analysis for a response rate of 98% (n=282 of 287). The sample was comprised of 55.5% male and 43.9% female with 0.6% missing cases. All of the students were in the seventh grade and were between the ages of 12 and 14.

The qualitative portion of the instrument asked students to give a brief description of technology. A summary of students revealed that most students thought that technology involved computers, building, or machines. Student descriptions typically identified various components of technology and only a few students wrote descriptions that referenced the broad nature of technology. It should be noted that the students who wrote more encompassing descriptions of technology referred to the Jackson's Mill Curriculum organizers of communication, construction, manufacturing, and transportation and energy. It seems clear that these students had been exposed to the breadth of industrial technology in their class work prior to the pre-test data collection.

Technological Climate

The majority of students, 63%, indicated that their father's job had "much" or "very much" to do with technology. Only 10% felt that their father's job had "nothing" to do with technology. In contrast, 40% of the students thought that their mother's job involved technology while 57% believed that their mother's job had "little" or "nothing" to do with technology. Most students, 76%, had some type of technical toy such as a Tinkertoy, Erector Set or LEGO in the home. About two-thirds of the students, 63%, noted that they had a personal computer in their home and 38% of the students indicated that a technical workshop existed in their home. Only 47% of the students expected to select a technological profession. This percentage is consistent with previous PATT-USA findings which suggested that about 50% of students expected to pursue technological careers

The students in this study reported slightly higher percentages of technological devices in their homes than in previous PATT-USA studies. It is possible that the small sample in this study that was selected from one geographic area was more affluent than the averages for the much larger PATT-USA sample. Also, the number of personal computers in homes has increased significantly since the PATT-USA data was collected in 1989. At that time, only 47% of students reported a personal computer in the home. The information on the technological climate of students' homes and their desire to pursue technological careers indicates that the sample in this study is similar to the students surveyed in the much larger PATT-USA study. Also, it appears that many students in this study have access to technological toys, workshops, and personal computers; and that they are aware that their parents jobs involve technology. Given the prevalence of technology in students' environment, the fact that only 47% of students expect to have technological professions may suggest that students do not really understand the persuasiveness of technology in most professional occupations.

Differences Between Instructional Approaches

To determine whether students' attitude toward technology were affected by the instructional approach, a MANOVA was run on the five attitude sub-scales and the concept scale. Statistical significant differences occurred on the following subscales: (a) attitude toward technology (b) consequences of technology, and (c) concept of technology. An ANOVA and Tukey post-hoc test were used to find differences between the instructional approaches. All pretest and post-test subscale mean scores are presented in Table 5.

The ANOVA on the *attitude toward technology* subscale found that the integration program only differed significantly from the modular program on the post-test means. The mean score for the integrated approach was the most positive. While students attitudes in general became less favorable toward technology, the greatest change over the nine instructional periods was in the integrated and modular programs. In the industrial arts and problem solving groups there was about half the amount of change on the attitude toward technology subscale.

For the *consequences of technology* subscale, the integration program again differed significantly from the rest of the programs on the post-test mean scores. Students in the integrated program grew significantly more negative about the consequences of technology while there was little or no change in students' scores in the other three programs. This difference may be related to the topics studied in the four programs. Students in the integrated approach studied social issues related to waste management and other environmental issues, while students in the other three programs were not dealing with such controversial topics. On the average, however, after participating in a nine week technology education session, mean scores from all four programs indicated that students continued to believe that the consequences of technology were generally positive.

The ANOVA also identified significant differences between the instructional approaches on the *concepts of technology* subscale. The integration program was significantly different from the problem solving and modular programs on the post-test. In addition, industrial arts was significantly different from the modular approach. The industrial arts program was the only program to have a change in the positive direction, however, students in this program also had the lowest pre-test mean score.

Attitude Changes Within Programs

Pre and post-test data from each of the four instructional approaches were analyzed to determine change within the programs over the nine week treatment period. *t*-tests were run on all of the PATT-USA subscales and on the combined attitude subscale that comprised items 12-69. This pre-post test analysis found no significant differences on the *combined attitude* subscale on any of the instructional approaches. Two subscales in each of the integrated and modular programs showed significant change. In both programs the change was in a negative direction. The problem solving approach showed a significant positive change in the *technology is difficult* subscale. Students believed that technology was more difficult to work with at the beginning of the program than at the end of the nine weeks. There were no statistically significant changes in any of the subscales for industrial arts. Although there were some changes in students' attitudes on specific subscales over the nine week treatment period, as a whole the length of time did not appear long enough to affect significant change.

Gender Differences

There were 59 female students and 66 male students in the post-test sample. T-test group procedures on the combined attitude scale indicated that there were no significant differences between males and females within each program. However, there were significant differences on four subscales within the selected programs as reported in Table 6. T-test results suggested that females thought technology was more difficult than boys which is supported by females responding more negatively on the *technology is difficult* subscale. In the modular group, a significant difference occurred on two subscales. Females responded more favorable than males on the *concept of technology* scale and the *technology as an activity for boys and girls* subscale. Data from the problem solving instructional approach was excluded from this analysis due to the disproportionately low number of females in this class.

Table 5

Comparison of Pre-and Post Test Means For Each Subscale by Instructional Approach

	Instructional Approaches											
	Industrial Arts			Integrated			Modular			Problem Solving		
Subscales	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=2	p value
Attitude Subscales*												
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	0.963
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	0.579
Tech. as Activity for Boys &	1.81	1.79	0.870	1.61	1.67	0.650	1.80	1.93	0.385	2.04	2.11	0.726
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	0.823
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	**0.004**
Combined Attitude Subscales*	2.62	2.57	0.643	2.31	2.45	0.086	2.65	2.69	0.618	2.51	2.51	0.972
Concept of Technology** (Items 70-100)	0.52	0.58	0.195	0.69	0.67	0.535	0.53	0.45	**0.032**	0.61	0.53	0.164

Notes:
Statistically significant differences in bold
* Lower mean indicates more positive attitude for subscale
**Higher mean indicates broader and more accurate concept of technology

Table 6

Comparison of Four Instructional Approaches by Gender

Comparison of Post-Test Means For Each Instructional Approach by Gender

Subscales	Industrial Arts Female n=13	Industrial Arts Male n=13	Industrial Arts p value	Integrated Female n=15	Integrated Male n=14	Integrated p value	Modular Female n=27	Modular Male n=23	Modular p value	Problem Solving Females n=4	Problem Solving Males n=16	Problem Solving p value
Attitude Subscales*												
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 &	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
Combined Attitude Subscales*	2.55	2.60	.706	2.42	2.50	.558	2.66	2.74	.555	2.69	2.43	.317
Concept of Technology** (Items 70-100)	.58	.58	.961	.65	.69	.516	.49	.37	**.041**	.40	.57	.151

Notes:
Statistically significant differences in bold
* Lower mean indicates more positive attitude for subscale
**Higher mean indicates broader and more accurate concept of technology

A MANOVA procedure on the combined pre and post test data for all subscales was used to ascertain differences in responses that may be attributable to gender. The results of the MANOVA indicated that statistical significant differences occur on three subscales: (a) technology is an activity for both boys and girls, (b) technology is difficult, and (c) technology is interesting. Results are displayed in Table 7.

Table 7

ANOVA Results Based on Gender

Differences in the Perception of Technology Attributed to Gender

Subscales	n=127 Mean Score Females	n=152 Mean Score Males	p value
Technology as an activity for boys and girls	1.57	2.08	.000
Technology is difficult	3.71	3.45	.014
Technology is interesting	2.54	2.82	.001

This procedure revealed that female and male students perceived technology differently. Females, more than males, perceive technology to be an activity for both boys and girls. With the exception of the industrial arts class, the instructional approaches used did not cause this perception to improve over the duration of the nine week program. 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.

Discussion of Findings

A MANOVA and follow up procedures indicated significant differences between instructional approaches on three subscales ($p < .05$): (a) *attitude toward technology*, (b) *concept of technology*, and (c) *consequences of technology*. ANOVA and post-hoc analysis found that the integrated approach was most frequently different from the other instructional approaches. Some trends were identified through visual examination of the data. All four instructional approaches affected students' attitude to some degree. Typically, their attitude toward technology became less favorable. This movement toward the negative end of the scale does not necessarily imply that the students thought of technology as "bad," but rather that students had attained a more balanced view of technology. Perhaps middle school 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' post test scores would reflect these realities as they actually encountered technology.

The attitude of the students in the integrated classes changed the most with significant changes on two of five attitude subscales. This may have been caused by the nature of the curriculum which was designed to expose students to the positive and the negative consequences of technology. This was not always the case with the other three instructional approaches. Industrial arts, for example, focuses on the materials and equipment needed to constructed a specific project.

On the *consequences of technology* subscale, the pre-test scores were similar for all programs. On the post-test, the curriculum of the integrated approach appeared to dramatically affect students' perceptions regarding the consequences of technology. These students were much less ready to accept the consequences of technology as benign. Meanwhile, students who participated in the other instructional approaches where the content was less controversial retained their more positive outlook toward technology.

On the *concept of technology* subscale, the integrated program also differed significantly from the modular and problem solving programs. Students in the integrated program appeared to have a better understanding of the breadth of technology. This finding seems logical given the fact that the integrated program is designed to explore the relationships between technology and other subjects such as math, science, social studies, and English. Perhaps surprisingly, students in the industrial arts program had a better developed concept of technology than their counterparts in the modular program. The significantly higher mean score on the *concept of technology* subscale by industrial arts students may indicate that students who experienced hands-on industrial processes to complete a project are more aware of the encompassing nature of technology than students who experience simulations at workstations. Perhaps in some areas, there is no substitution for real life applications of technology.

No clear directions emerged from the analysis. The post-test MANOVA and follow-up procedures identified on three subscales that were attributable to the instructional approach: (a) *attitude toward technology*, (b) *concept of technology*, and (c) *consequences of technology*. However, a pre-test MANOVA procedure undertaken to determine the homogeneity of the sample also found significant differences on three of the subscales: (a) *attitude toward technology*, (b) *interest in technology*, and (c) *concept of technology*. On both the pre and post-test, most of the variance resided in the integrated approach which indicated that the students in this program were different from the students in the other three programs from the onset of the study. What is interesting is the two subscales that did change over the duration of the study. Students' *interest in technology* was significant on the pre-test but not on the post-test. Across the programs, there seemed to be a leveling affect related to interest as students experienced technological studies. Indeed, the combined attitude subscale revealed a greater range of mean scores on the pre-test (2.31 to 2.65) than on the post-test (2.45 to 2.69). The second major difference between the pre and post-tests occurred on the *consequences of technology* subscale. As previously discussed, the content studied clearly affected students perceptions as to the advantages and disadvantages of technology.

An analysis of the findings indicated that perceptual and attitudinal responses of male and female students differed significantly. It should be noted that when the attitude subscales were combined, *t*-tests by gender within each of the four programs indicated that female and male students do not respond differently to instructional approaches used to deliver technology education. However, a MANOVA procedure by gender and independent of instructional approach found that the responses of female and male students were significantly different on three of six subscales: (a) *technology as an activity for boys and girls*, (b) *technology is interesting*, and (c) *technology is difficult*.

These findings were also consistent with previous PATT-USA studies. Male students continued to hold stereotypical views about the roles of females in technology by indicating that technology was a more appropriate activity for boys than girls. Conversely, female students indicated that they perceived an understanding of technology to be of equal importance for males and females. These attitudes were statistically significant in the modular program ($p < .001$). It appeared that participation in any of technology education program investigated did not alter students' gender biases and may have actually exacerbated the issue. While not statistically significant, students responses on the *technology as an activity for boys and girls* subscale in all programs indicated more gender bias on the post-test than the pre-test.

Female students were significantly different from males in their belief that technology as a subject was difficult to grasp. The higher mean scores of females on the *technology is difficult* subscale across all four classes indicated that they thought technology was more difficult than did the male students. This difference in perception between male and female students may be attributable to many societal factors. For example, males may have more previous exposure to technology and technological devices, or at least to those technological issues commonly studied within technology education.

Regardless of gender, participation in technology education programs did not significantly affect students interest in technology. Students' interest increased somewhat in the industrial arts and modular programs, decreased in the integrated programs, and remained unchanged in the problem solving program. However, female students consistently perceived technology to be less interesting than male students. The differences in perceptions between boys and girls might be due to a past culture where men held most of the technological jobs and women were usually employed in more domestic occupations. This cultural perception might still influence students' perceptions as to whether to actively engage themselves in technological pursuits. For example, females might form an opinion that technology education courses such as construction and manufacturing focus on careers for males by observing that only men are constructing a building or a majority of factory workers are males. Inversely, females might see only women in the bakery or fashion design business and believe home economics to be a course for women because of the gender ratio in those professions.

In general, the students who participated in the research had positive perceptions of the benefits of technology. As they experienced increased amounts of technology--they began to understand its difficulty. The overall results suggest that the perceptions of students enrolled in the integrated program changed the most. These changes were not always positive however, many of the changes may be due to a greater understanding of the ramifications and side-effects of technological implementation.

Conclusions

Based upon the interpretation of the data collected for this study, the following conclusions were drawn:

1. The instructional approach did affect students' attitude toward technology. Statistically significant differences were found on three of six post-test subscales across programs and five of 24 within program subscales. The integrated approach to technology education changed the students' affective outcomes the most, while the industrial arts approach had the least impact on student attitudes.
2. There are differences in attitudes toward technology between male and female students. Male students continued to hold stereotypical views about female students' abilities to interact with technology. These views were not mitigated by participation in any of the technology education programs. Female students also perceived technology to be more difficult and less interesting than male students.
3. Although attitudes were affected, there was no clear direction of change in attitude that can be attributed to instructional approaches. At the completion of the nine week course 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.

4. Students in technology education programs generally perceived the benefits of technology, but they had narrow concepts or misconceptions of what comprises technology on both the pre and post test.
5. Participation in technology education programs did not significantly affect students interest in technology. Students in the industrial arts program exhibited a positive change on the *general interest of technology* subscale, but students in the other three programs showed a small decline in interest.
6. Attitude measures may be used as one indicator of the effectiveness of an instructional approach. If the program goal was to help students understand the consequences of technology or to increase students' interest in technology, differences should be found on these pre and post-test comparisons.
7. Students' attitude toward technology were generally consistent with previous PATT and PATT-USA studies.

Recommendations and Implications

Based on the finding, conclusions, and implications of this study, the following recommendations are suggested:

1. Regardless of the instructional approach, technology educators should assess students in the affective domain to measure attitude changes that may be attributable to the curriculum methods and content.
2. The PATT-USA should be updated and/or modified to insure that it remains current and is measuring students' attitudes and perceptions toward technology.
3. The profession should develop an acceptable instrument that will measure students' technological literacy level by assessing their cognitive skills and/ or attitude toward technology.
4. Technology teachers should strive to develop curriculum that meets the interest and technological needs of all students including females.

Recommendations for Future Research

This study gathered data about students attitudes toward technology. The research completed in this study might be expanded and complemented in future studies that include:

1. Research designed to narrow the focus of study to one instructional approach, thus comparing and contrasting findings from various sites that use a singular instructional approach to deliver technology education.
2. Research replicated with a larger sample to add more power and validity to the study. Further, a geographically representative sample would allow more generalization to be made from the findings.
3. Research designed to use a similar pre and post-test treatment attitude assessment replicated internationally and compared to the results of this study.
4. Research using similar methodology completed in other settings such as high schools, technical schools, and colleges that teach technology education or technology teacher education.
5. Research investigating parents, who have students in a technology education program, comparing parents perception and attitudes toward technology to those held by their children.
6. Research designed to examine the perceptions of minorities students' attitude toward technology and determine whether they differ from majority students' attitude toward technology by the instructional approach used to deliver technology education.
7. Additionally, a research analysis could be conducted on the relationship between the technological climate of student's homes and their attitudes toward technology.

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