Mathematics, Science, and Technology Teachers' Perceptions of Technology Education

Michael K. Daugherty & Robert C. Wicklein

After a decade of accelerated change in the technology education discipline, curriculum and philosophical changes are evident throughout many of the programs in America. Few individuals in the profession are not aware of the new emphasis being placed on presenting mathematics and science concepts in a technological framework. However, there seems to be persistent confusion outside the discipline, particularly in the disciplines of mathematics and science, as to what characteristics exemplify technology education. If technology education is to assume its stated role of providing interdisciplinary settings for the application of mathematics and science concepts, efforts must be made to understand and inform those disciplines with which we choose to associate (e.g., mathematics, science).

In March 1990, President Bush and the nation's 50 Governors established a set of six national education goals for the United States to reach by the year 2000 (Miller, 1990). These national goals addressed perceived major problems in the country's educational systems. One of the six goals called for a concerted effort toward increasing the mathematics and science proficiency of America's student body (Stern, 1991). Barry Stern, Deputy Assistant Secretary of Vocational and Adult Education of the U.S. Department of Education, reported that: "If the United States is to achieve these goals, especially the goal on mathematics and science, technology education is likely to play an important role" (p. 3). Stern continued, "If we are serious about improving mathematics and science achievement, and indeed, the overall educational performance of our students, we must explore different ways of teaching and organizing curricula. Technology education is one of those ways...." (p. 3).

The technology education discipline has undergone revolutionary changes in the past decade (e. g. Snyder and Hales, 1982, Savage and Sterry, 1990). Professionals within the field have called for a discipline more closely aligned with mathematics and science (Maley, 1985, 1989; Welty, 1990; Lauda, 1989). In the Project 2061 Technology Panel Report, F. James Rutherford (1989), Project Director, stated that: "America has no more urgent priority than the

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Michael Daugherty is Assistant Professor, Department of Industrial Technology, Illinois State University, Normal, IL. Robert Wicklein is Assistant Professor, Program of Technological Studies, University of Georgia, Athens, GA.

reform of education in science, mathematics, and technology" (p. vii). Rutherford further implied that the task ahead for the United States is to develop a new system of education that will prepare young people who are literate in science, mathematics, and technology. Rutherford concluded that the sciences and mathematics are important to the understanding of the processes and meaning of technology and their integration with technology education is vital for a technologically literate student. Fagan (1987) suggested that the technology education curriculum should be guided by the technological literacy needs of students instructed in an interdisciplinary setting. The International Technology Education Association (ITEA) strategic plan outlines, as one of the association's major goals, the establishment of technology education as the primary discipline for integrating curriculum towards the advancement of technological literacy (International Technology Education Association, 1990). While many outside of technology education support this notion (Boyer, 1985; Selby, 1988; Roy, 1989), it is apparent that the shift in emphasis within the profession must be matched by emphases from complementing disciplines (Renzelman, 1989).

Recent research indicates that there is considerable confusion in adjoining disciplines as to what characteristics exemplify technology education (Maley, 1989; Wenig, 1989). The past decade has been marked by many changes and reforms in the technology education discipline. However, establishing technology education as a viable school subject within the public schools will be a major challenge facing technology education (Maley, 1989). Wenig (1986) suggested that for the discipline of technology education to survive and thrive, moves must be made to clear up any confusion adjoining disciplines have about technology education and proceed towards a coordinated curriculum of complementary subject matter. While technology education has made considerable strides in curriculum and program development in the past decade, it is not clear whether the impact of this evolution has been felt or understood by the educational decision makers and the members of complementing disciplines. Betts, Yuill, and Bray (1989) point out that: "The problem appears to be that those who make decisions affecting our program do not have a positive image of our program" (p. 27). Stone (1989) emphatically pointed out that: "Unless there can be an awakening of the true role of technology education in the minds of these decision makers, there will not be any shift in the focus of education. Instead there will be new wine in old bottles" (p. 40). Selby (1988) indicated that outmoded ideas and misguided perceptions are the common enemy of all disciplines. Similarly, Dyrenfurth (1987) suggested that while technology education is considered an essential characteristic of quality education, there are often misinterpretations and misrepresentations associated with technology education. Throughout the literature on technology education, misrepresentations and stereo-typical perceptions of technology education can be found. Boyer (1983), in his study of technology in schools, found a disturbing trend of equating technology education with computer literacy programs. Similarly, Stone (1989) found that one serious misconception is the confusing of technology education with educational technology. Technology must make a concerted effort to erase these widely held misconceptions, assuming the task of educating the masses about the role and function technology education plays in the total educational curriculum.

Purpose

The purpose of this research was to determine the perceived characteristics affiliated with the technology education discipline as discerned by technology education professionals and associated secondary education faculty (i.e., mathematics and science teachers). The efforts to integrate technology education into secondary education school curriculum can not be effectively implemented until there is clear understanding of the purpose of technology education by all members of the technology education, mathematics, and science faculties.

Based on the purpose of this study, the following research questions were developed for investigation:

1. What are the characteristics that exemplary technology education classroom teachers identify with technology education?
2. What are the characteristics that associated secondary education faculty (mathematics and science) identify with technology education?
3. Is there a significant difference between the perceptions of the exemplary technology education classroom teachers and the perceptions held by associated secondary education faculty in science and mathematics?

Methodology

The population for this study consisted of two primary groups, (1) Exemplary technology education teachers and (2) Associated secondary education faculty (i.e., mathematics teachers, science teachers). The exemplary teachers of technology education were identified by prior research conducted by Wicklein (1992). Through the use of a mailed questionnaire, Wicklein surveyed representatives from all 50 states, these representatives consisted of 64 university professors and department heads of technology education as well as 50 state supervisors of technology education. The 154 exemplary technology education teachers identified by Wicklein were used to establish the exemplary technology education teacher sample of this research.

The associated secondary education faculty participant sample was drawn from representatives of the disciplines of mathematics and science and were located within the same school as the previously identified exemplary technology education teachers.

Instrumentation

Due to the relatively large size of the population, the instrument chosen for the study was a mailed questionnaire. Fink and Kosecoff (1985) suggest that the mailed questionnaire is the most reliable and valid method of economically obtaining large amounts of information from people. This study utilized a mailed questionnaire developed by the researchers and was based on the content model for the study of technology, *A Conceptual Framework for Technology Education* (Savage & Sterry, 1990).

The objective of the questionnaire was to allow all respondents the opportunity to express their perceptions of the characteristics exemplifying the technology education discipline in the following categories: (1) Methodological characteristics, (2) Curriculum content characteristics, (3) Integration perceptions, and (4) Action plans. The methodology category was utilized to collect data concerning the methodological approaches perceived to characterize the technology education discipline, while the content characteristics category was utilized to identify course content for technology education. The third section of the questionnaire sought to identify perceptions of how integration may occur within the technology education, science and mathematics curricula, and the fourth section represented selected actions that the technology education profession may take to improve the perceptions of the discipline. Demographic information, necessary to form the basis for a comparative analysis of the respondent perceptions, was placed on the first page of the instrument in order to allow respondents an opportunity to answer the more objective questions prior to answering questions requiring more subjective analysis (Fink & Kosecoff, 1985). The demographic information requested included age, level of education, years of teaching experience, number of years at present school, and professional discipline area of expertise. The three groups of participants responded to identical statements concerning technology education characteristics presented on the instrument. The responses were made by marking each statement according to a five point Likert scale. Participant agreement or disagreement with each statement was coded on a Likert scale as follows: Strongly Disagree (1), Disagree (2), No Opinion (3), Agree (4), and Strongly Agree (5). The mean group score ranking of each statement was based on the following breakdown of the Likert scale: 1.000 to 1.499 - Strongly Disagree; 1.500 to 2.499 - Disagree; 2.500 to 3.499 - No Opinion/Neutral; 3.500 to 4.499 - Agree; and 4.500 to 5.00 - Strongly Agree. The 38 item questionnaire was mailed to a total of 462 teachers; 154 technology education teachers, 154 associated mathematics teachers, and 154 associated science teachers.

The Cronbach's Alpha Test and the Scheffe' analysis were used to establish reliability and internal consistency for the questionnaire and were utilized as a part of the pilot study with a resulting reliability index of .82.

Analysis of Findings

The results of this research were based on a 52 percent return of the mailed survey. The returned instruments represented 40 percent of the mathematics teachers, 45 percent of the science teachers, and 70 percent of the technology education teachers surveyed.

Along with descriptive data pertaining to the perceptions of the various characteristics associated with technology education, the exemplary technology education teachers and the associated secondary faculty (science and mathematics) perceptual responses were analyzed using a mixed model analysis of variance (ANOVA). The ANOVA identified the significant differences in perception within and between teacher responses and distinguished possible interactions between the groups. The mixed model analysis ANOVA used a 3 X 4 analysis (3 teacher groups X 4 categories of technology education characteristics) of data. These categories included: (1) a comparison of the mathematics, science, and technology education teacher perceptions of methods utilized in technology education; (2) a comparison of the mathematics, science, and technology education teachers perceptions of the curriculum content of technology education; (3) a comparison of the mathematics, science, and technology education teachers perceptions of need to integrate the three disciplines; and (4) a comparison of the perceptions of the associated faculties with regard to appropriate actions for the technology education discipline to take in order to affect change in overcoming stereo-typical attitudes and opinions of technology education. The interaction with the main effect of perceived characteristics was significant at the $p<.01$ level. Table 1 summarizes the results of this mixed model ANOVA, with $F=7.77$, $p<.01$. There was a significant statistical difference between the perceptions of the technology, science, and mathematics teachers. The significant interaction effect indicated that part of the differences in the main effect was caused by differences between groups of teachers and could not be accounted for by sampling error alone.

Table 1
Summary of Mixed Model Analysis of Variance by Teacher Groups and Technology Education Characteristics

Source	df	SS	MS	F
Between Subjects				
Teacher Groups	2	83.22	41.61	28.11*
Error	235	347.82	1.48	
Within Teacher Groups				
Perception	3	29.84	9.95	32.74*
Interaction	6	14.16	2.36	7.77*
Error	705	214.18	.30	

* $p < .01$

To better illustrate the patterns of main effect differences in perception, the four categories of technology education characteristics were separated and analyzed using a one-way mixed model ANOVA.

Methodological Characteristics

The methodological characteristics section of the questionnaire sought to identify the perceived methods that were being used in the technology education programs analyzed in this study. Ten (10) items on the questionnaire were devoted to this section. Mean representations indicated that the majority of the teacher evaluators agreed that the methods identified on the questionnaire were used in the technology education program. See Table 2 for a breakdown of each of the designated methods and descriptive data regarding each method characteristic. A further analysis of the teacher groups, however, indicated that technology teachers had a significantly higher estimation of the methods that were being used in the technology education programs in comparison with the mathematics and science teachers, $F=26.19$, $p<.01$ (see Table 3 for an ANOVA on teacher groups and method characteristics). The Tukey HSD test of significant F value indicated that there was a significant difference (difference = .72, $p<.01$) between the technology teachers and the mathematics teachers and a significant difference (difference = .64, $p<.01$) between the technology teachers and the science teacher mean scores. Both the science and the mathematics teacher groups perceived that the utilization

Table 2
Perceived Technology Education Teaching Methods

	Technology (n= 107)		Science (n= 69)		Math (n= 61)	
Topic	X	SD	X	SD	X	SD
Emphasis on problem solving	4.62	.65	3.90	1.00	3.79	1.16
Provides exploratory activities	4.69	.54	4.19	.67	4.23	.95
Instruction is goal oriented	4.17	1.03	3.74	.83	3.86	.99
Cooperative learning encouraged	4.17	.76	4.09	.68	3.92	1.05
Verbal activity emphasized	3.93	1.02	3.36	.95	3.08	1.08
Cognitive strategies developed	3.86	.93	3.07	.98	3.13	1.03
Interdisciplinary activities	4.38	.84	3.78	1.01	3.55	1.10
Broad range of assess. strategies	4.44	.82	3.64	1.01	3.57	1.08
Lessons are hypothesis driven	3.47	1.01	3.13	.90	2.97	1.02
Activity oriented laboratory inst.	4.12	.61	3.91	.10	3.89	1.15
Grand Means	4.22		3.68		3.60	

Table 3
Summary of Technology Education Teaching Methods
One Way Mixed Model Analysis of Variance

Analysis of Variance

Source	df	SS	MS	F
Between	2	27.34	13.67	26.19*
Within	235	122.67	.52	

Tukey HSD Test

Comparison	Difference
Technology Education vs. Mathematics	.72*
Technology Education vs. Science	.64*
Mathematics vs. Science	-8.40

* $p < .01$

of the methodological characteristics within the technology programs to be significantly lower than those of the technology education teachers, therefore exemplifying the perception problem external to the profession.

Table 4
Perceived Curriculum Content Characteristics of Technology Education

	Technology (*n*= 107)		Science (*n*= 69)		Math (*n*= 61)	
Topic	X	SD	X	SD	X	SD
Content is uniquely technological	4.28	.87	3.35	1.12	3.26	1.12
Based on know.of tech. develop.	4.43	.74	3.51	.98	3.39	.10
Based on the use of biological organ.	3.52	1.22	2.61	.10	2.84	1.16
Based on transferring information	4.44	.82	3.90	.75	3.73	.94
Based on modifying resources	4.56	.57	3.62	.84	3.53	.78
Based on the study of transportation	4.51	.71	3.26	.97	3.74	.81
Assists students in developing insight	4.69	.59	4.03	.82	3.98	.95
Apply tools, materials, processes	4.67	.63	4.28	.75	4.00	1.02
Aids in develop. of individ. potential	4.65	.60	3.77	.97	4.05	.97
Aids develop. of prob. solving skills	4.71	.55	3.78	.91	3.87	.97
Prepares students for lifelong learning	4.68	.58	3.64	1.03	3.90	.97
Utilizes math and science skills	4.54	.62	3.81	.96	3.89	1.12
Allows connect. of math & science	4.50	.74	3.65	.92	3.68	1.27
Grand Means	4.48		3.63		3.68	

Curriculum Content Characteristics

Data regarding the perceptions of the curriculum content characteristics for technology education were secured from the three teacher groups. Thirteen (13) items on the questionnaire were designated for this section. Table 4 depicts a complete categorization analysis of the teacher groups' appraisal of the perceived curricular content being used in technology education. Mean representations again indicated that the majority of the teachers within the three teaching disciplines agreed that the curriculum content was being appropriately utilized within the technology programs being evaluated. An ANOVA was conducted to compare the differences between the teacher groups relating to perceived curriculum content. A significant difference was found between these groups, F=53.63 $p<.01$ (see Table 5). A further analysis using the Tukey HSD test of significant F value indicated that there was a significant difference in the perceptions of the curriculum content between the technology education faculty and the mathematics faculty (difference = .80, $p<.01$) and a significant difference between the technology teachers and the science teachers (difference = .85, $p<.01$). Again, both the science and mathematics teacher groups discerned that the specified curricular content of the technology programs was utilized significantly less than was perceived by the technology education faculty, implying that either the curricular content was not as strong as indicated by the technology education teachers or that the curricular content was not perceived to be as strong.

Table 5
Summary of Curriculum Content Characteristics for Technology

Education - One Way Mixed Model Analysis of Variance

Analysis of Variance

Source	df	SS	MS	F
Between	2	39.80	19.90	53.63*
Within	235	87.19	.37	

Tukey HSD Test

Comparison	Difference
Technology Education vs. Mathematics	.80*
Technology Education vs. Science	.85*
Mathematics vs. Science	5.00

* $p < .01$

Perceptions of Integration Needs

The integration needs referred to the teacher groups' perceptions of how the technology education discipline could/should integrate with science and mathematics disciplines to better serve students. Five (5) items on the questionnaire were designated for this section. Again, there was general agreement among the teacher groups concerning the need for integration of the three disciplines (see Table 6 for item and group analysis). However, an ANOVA of the three teacher groups indicated that there was a significant difference in the perceptions of the need to integrate technology education with science and mathematics, F=26.31, $p<.01$ (see Table 7). Further analysis, using the Tukey HSD test of significant F value indicated that the differences between teacher groups were similar to the methodological characteristics and the curriculum content characteristics with a significant difference in the perception of integration between the technology teachers and the mathematics teachers (difference = .66, $p<.01$) and a significant difference between the technology teachers and the science teachers (difference = .69, $p<.01$). As stated in the methodological characteristics and the curriculum content characteristics, both the science and mathematics teacher groups determined that the in-

Table 6
Perceived Integration Needs of Mathematics, Science, and Technology Education

	Technology (*n*= 107)		Science (*n*= 69)		Math (*n*= 61)	
Topic	X	SD	X	SD	X	SD
Provides ave. for applying concepts	4.70	.52	4.04	1.01	4.15	.93
Should be available for all M/S stud.	4.84	.52	4.00	1.14	4.02	1.02
Tech. Ed. is an applied science	4.54	.76	4.12	.92	4.08	.98
Curriculum reflects ind. & tech.	4.43	.74	3.86	.97	3.71	1.22
Guided by tech. literacy needs	4.36	.70	3.42	1.22	3.61	1.16
Grand Means	4.57		3.91		3.89	

Table 7
Summary of Integration Needs for Technology Education
One Way Mixed Model Analysis of Variance

Analysis of Variance

Source	df	SS	MS	F
Between	2	26.82	13.41	26.31*
Within	235	119.78	.51	

Tukey HSD Test

Comparison	Difference
Technology Education vs. Mathematics	.66*
Technology Education vs. Science	.69*
Mathematics vs. Science	2.60

* $p < .01$

tegration needs for technology education with science and mathematics were significantly less than what were perceived by the technology education teacher group. This may suggest that the technology education teacher group was addressing the integration movement more adequately than the mathematics and science teacher groups.

Action Plans

The action plan segment of the questionnaire was designed to identify strategies and activities that may lead to improving the overall impression of the technology education discipline. Five (5) items were used to solicit the perceptions from the teacher groups pertaining to plans of action that may be helpful in improving the understanding of technology education (see Table 8). The technology education, science and mathematics faculty groups indicated that they were in general agreement with the specified action plan items on the questionnaire. An ANOVA was conducted to determine if the differences in perceptions was statistically significant; the recorded F value was not significant, F=1.73, $p > .01$ (see Table 9).

Table 8
Perceived Action Plans to Improve Perceptions of Technology Education

	Technology (*n*= 107)		Science (*n*= 69)		Math (*n*= 61)	
Topic	X	SD	X	SD	X	SD
Form interdisciplinary committees	4.48	.65	4.03	.94	4.13	1.06
Revise curriculum strategies	4.33	.77	4.19	.91	4.18	.97
Make presentations at nat. conf.	4.47	.74	4.28	.86	4.07	.94
Conduct research on integration	4.34	.84	4.17	.80	4.29	.95
Dev. strat. to overcome stereo-types	4.74	.60	4.12	.51	4.21	.99
Grand Mean	4.47		4.16		4.17	

Table 9
Summary of Action Plans to Improve Perceptions of Technology Education - One Way Mixed Model Analysis of Variance

Source	df	SS	MS	F
Between	2	3.42	1.71	1.73
Within	235	232.36	.99	

* $p < .01$

The perceptions of the teacher groups indicate that there were significant differences in each of the four categories, except the plans for action to improve the image of technology education. The technology teachers were consistently higher in their perceptions ranking on each of the categories. This again, suggests that the science and mathematics teachers do not understand the technology education movement or they do not generally agree with its overall scope and purpose.

Interactions

Table 1 reported that the interaction between independent variables (teacher groups) was significant (F=7.77, $p<.01$), suggesting that part of the differences in the significant main effect was due to differences between the three groups of teachers. After discovering the significant interaction, the four categories of technology education characteristics were plotted across the independent variables of the technology education, science, and mathematics teachers. The plot line slope is indicative of a significant interaction effect (see Figure 1), and, because it is rather flat, a simple main effects comparison was performed. This post-hoc comparison indicated a significant interaction for each line across the four categories of characteristics. The simple main effects post-hoc comparison is summarized in Table 10.

Figure 1. Post-hoc interaction comparison of technology, science, and mathematics teachers

Table 10
Summary of Simple Main Effects Comparison of the Significant Interactions Between Mathematics, Science, and Technology Education Responses

Source	df	MS	F
Technology Ed. & Science	3	1.15	3.80*
Science & Math	3	7.77	25.55*
Technology Ed. & Math	3	11.68	38.44*

* $p < .01$

Conclusions

Research Question One

In looking at the findings related to research question one, an analysis of the data revealed that, as a group, exemplary technology education teachers strongly agreed with the characteristics identified with technology education. This result held true for the three categories of characteristics: technology education methodology, technology education curriculum content, and the need to integrate the disciplines of mathematics, science, and technology education. The data revealed that the exemplary technology education teachers perceive the need for action to overcome stereo-typical perceptions as critical. Technology education was perceived as providing exploratory activities which emphasize problem solving through the utilization of small and cooperative group activities. Technology education was further perceived as a discipline which develops student insight, understanding, and application through technological study. The respondents indicated a strong need for integrating the discipline as well as utilizing mathematics and science concepts towards the preparation of lifelong learning skills.

Research Question Two

An analysis of the data revealed that, as a group, secondary mathematics and science teachers moderately agreed with the characteristics of technology education. While the mathematics and science teachers agree that these are characteristics of technology education, they do not strongly agree with any of the four categories of characteristics. At the same time the mathematics and science teachers perceived interdisciplinary instruction, activity based laboratory instruction, and problem solving to be characteristic of technology education, they do not perceive technology education as a discipline in which cognitive strategies have been clearly developed, or where lessons are hypothesis driven. These two groups perceived a curriculum where application of insight and understanding of tools, materials, and processes in production and communication are characteristics of technology education. Similarly the mathematics and science teachers characterized the development of creative abilities through problem solving and the enhancement of decision making skills as being fundamental to technology education. The use of mathematics and science skills and the connection between mathematics, science, and technology education were also perceived as a characteristic of technology education. However, the mathematics and science teachers did not perceive the study of the development of technology, biological systems, and transportation as being characteristic of technology education. There was agreement for the need to integrate mathematics, science, and technology education. However, the need for integration was not strongly agreed upon. As with the exemplary technology education teachers, the mathematics and science teachers perceived a strong need for the technology education discipline to develop strategies to overcome stereo-typical perceptions often held by associated faculty members.

Research Question Three

The findings reveal that there was a significant difference between the perceptions of the exemplary technology education teachers and the perceptions held by the teachers of mathematics and science. The findings were based on the mixed model ANOVA results and post-hoc examination. The significant interaction implied that the difference between group mean scores was due to differences between technology education, mathematics, and science teacher perceptions. Interpreting the findings as a whole, the results indicate that the characteristics perceived to exemplify technology education are not constant across all three disciplines. Exemplary technology education teachers strongly agree with the identified characteristics, while the mathematics and science teachers had significantly different perceptions of the characteristics which exemplify technology education.

Implications and Recommendations

The overall results indicate that the characteristics perceived to exemplify technology education are not constant across disciplines. The technology education discipline has a definite need to alter the image it projects in order to improve the overall perception of what technology education is, what it hopes to accomplish, and how it fits within the general education curriculum of primary, middle/junior high, and secondary schools. To understand the critical nature of this issue, it must be recognized that the technology education teachers which were identified in this study were selected based on their expertise and exemplary approaches to technology education within their schools (Wicklein, 1992). With this as a basis, the findings of this research take on a much larger impact. If associated faculties of these exemplary teachers of technology education identify the significant degree of disparity between perceived methods, curriculum content, and integration needs, then what can be expected from the rank-in-file teachers of technology education and their associated faculties? The issue of how technology education is perceived has influenced, and will continue to influence, the development of the technology education discipline.

Based on an interpretation of the data relative to this study, the following conclusions and recommendations were drawn:

1. The technology education profession should develop strategies to overcome stereo-typical perceptions of the discipline.
2. Technology education potential can not be fully reached until there is a clear understanding across disciplinary boundaries as to what characteristics exemplify technology education.
3. Technology education can more effectively emphasize the connections between mathematics, science, and technology education.
4. Coordinated planning that includes professionals from mathematics, science, and technology education is a critical component for the future of integrated curriculum among the three disciplines.
5. Workshops and presentations should be provided for mathematics and science teachers in an effort to improve their perception of the technology education discipline.
6. Further study should be conducted examining the public perception of technology education as a discipline in the secondary school.
7. Research should be conducted investigating methods of overcoming stereo-typical perceptions often held by associated secondary education faculty members.

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