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ABSTRACT

This monograph presents a compilation and review of selected technology education research literature published from 1980 through 1986. The paper seeks to reflect the breadth and variety of disciplined inquiry during this important period as the profession changed its name and focus from industrial arts to technology education. The review is divided into sections representing major topic categories likely to be of interest to researchers. Major sections are history, philosophy, and objectives; human resources related studies; status studies; curriculum; learning process variables; instructional media, materials, and methods; student personnel and guidance; facilities; evaluation; teacher education; administration and supervision; and professional concerns. Each section ends with a summary and inferences related to the studies included in the section. A concluding section discusses general findings and recommendations. A 21-page listing of references is appended. (SK)

Information Series No. 325

TECHNOLOGY EDUCATION: INDUSTRIAL ARTS IN TRANSITION

A REVIEW AND SYNTHESIS OF THE RESEARCH, FOURTH EDITION

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David L. McCrory
West Virginia University

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ERIC Clearinghouse on Adult, Career, and Vocational Education
The National Center for Research in Vocational Education
The Ohio State University
1960 Kenny Road
Columbus, Ohio 43210-1090

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National Center for Research in Vocational Education
1960 Kenny Road
Columbus, Ohio 43210-1090
Telephone: (614) 486-3655 or (800) 848-4815
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FOREWORD

The Educational Resources Information Center Clearinghouse on Adult, Career, and Vocational Education (ERIC/ACVE) is 1 of 16 clearinghouses in a nationwide information system that is funded by the Office of Educational Research and Improvement, U.S. Department of Education. This paper was developed to fulfill one of the functions of the clearinghouse—to interpret the literature in the ERIC database. This review and synthesis should be of interest to industrial arts/technology education teachers, administrators, researchers, graduate students, and policy makers.

The profession is indebted to David L. McCrory, Professor, Technology Education Program, West Virginia University (WVU), for his scholarship in the preparation of this paper. Dr. McCrory chairs the Technology Education Department at WVU. He has over 20 years of teaching experience in industrial arts/technology education and is the author of numerous publications on such topics as curriculum design and development and the debate over industrial arts versus technology education. Dr. McCrory has served as Chair of the International Technology Education Association's Publications Review Board, and he was selected by the American Industrial Arts Association as an outstanding young educator in industrial arts in 1983.

Recognition is also due to Thomas R. Winters, Vocational Education Supervisor, Pennsylvania Department of Education; Everett N. Israel, Head of the Department of Industrial Technology, Eastern Michigan University; and to Jay Smink, Senior Research Specialist; Betty Rider, Research Specialist; and Steven J. Gyuro, Associate Director, Programs, of the National Center for Research in Vocational Education, for their critical review of the manuscript prior to publication. Wesley Budke and Susan Imel coordinated the publication's development, with editorial assistance from Sandra Kerka. Abby Hurd, Jean Messick, and Clarine Cotton typed the manuscript; Janet Ray served as word processor operator. Editorial review was performed by Elizabeth Martin of the National Center.

Ray D. Ryan
Executive Director
The National Center for Research in Vocational Education

EXECUTIVE SUMMARY

During the past 6 years, the field of industrial arts, stimulated by rapid technological changes, has changed its name and its focus to technology education. This monograph presents a review and synthesis of research literature in the field published between 1980 and 1986, plus selected studies from 1979 and 1987. Materials cited were found in the ERIC database and the Dissertation Abstracts online database, supplemented by publications of the American Industrial Arts Association/International Technology Education Association.

Studies that focused on technology education (TE) were selected for review, although in some cases research from other fields was included if findings were relevant to TE. The term "technology education" was used throughout the paper; however, it was sometimes necessary to use the same terminology employed by the researchers of cited studies, such as "industrial arts," "industrial education," and "industrial technology."

This publication covers the following aspects of TE: (1) history, philosophy, and objectives; (2) human resources related studies; (3) status studies; (4) curriculum; (5) learning process variables; (6) instructional media, materials, and methods; (7) student personnel and guidance; (8) facilities; (9) evaluation; (10) teacher education; (11) administration and supervision; (12) professional concerns; and (13) recommendations for further research.

As the profession rethinks its traditional goals, historical studies chronicled the evolution of industrial arts into TE in the United States. Other studies revealed philosophical differences about the purposes and objectives of the field and about the nature of technology, science, and technological literacy. A significant gap was also evident between the goals perceived by leaders of the profession and those perceived by practitioners.

Human resources issues, including equity, special needs, and the needs of industry, received relatively little attention in the literature. Although the number of female instructors has declined, the number of black male faculty members has increased. Stereotypes about female roles still prevailed, but several equity guides provided strategies for eliminating biases. Similarly, guides for mainstreaming special needs students and adapting instruction for them were produced. Employer surveys illustrated industry's expectations of TE graduates.

Status studies of the state of the art in TE included international perspectives from Great Britain, Japan, and Korea and national studies, primarily the Standards for Industrial Arts Programs Project, which provided a significant amount of data about TE in the United States.

Curriculum research revealed the significant reconceptualization of the profession's curriculum structure. The Jackson's Mill curriculum theory model was being accepted as the content model for the next decade. Numerous studies also implied that the new TE curriculum structure is being effectively disseminated.

Few research reports were found on the topics of problem solving, creativity, and organizational patterns in instruction. A number of studies investigated learning process variables related to students with special needs. Several studies focused on performance domains and learning theory, including cognitive styles, field dependence/independence and Piagetian developmental levels.

The substantial research literature in media, methods, and materials provided mixed findings on their effects. Studies of textbook content and selection are becoming more important as the content structure of TE changes. Demonstration proved to be the most highly regarded teaching technique, and computer-assisted instruction was also a popular and useful means of instruction.

Little research was found related to student personnel and guidance. Most studies in this category were concerned with occupational awareness, career choice, and personality characteristics of students.

Although laboratories are an integral part of TE, very little research was found on facility planning and laboratory safety and equipment. Much research is needed, especially about adapting equipment and labs to accommodate the new curricula and keep pace with technological change.

Little research was found on evaluating student learning and teacher knowledge. Several studies of program effectiveness showed that many different criteria were being applied, and suggestions for verifying and modifying the criteria produced by the Standards Project were made.

Substantial research on teacher supply, recruitment, and retention produced a profile of the typical TE teacher: a white, middle-aged male with a master's degree. Low salary and unsupportive administrators were major reasons for dissatisfaction. Teacher training programs continued to be a focus of research; findings, however, showed how few graduates actually become teachers.

Studies of administrators' and citizens' attitudes indicated strong support for TE. Obtaining funding for TE programs continues to be a major concern.

Given the concern expressed in the literature generally, there was surprisingly little research on professional issues such as the role of associations and leadership. Analysis of professional research activity illuminated some problems in research design and interpretation.

The montage of the evolving TE profession provided by this review and synthesis identified the following weaknesses in the literature: (1) research problems such as faulty design, small sample size, and overdependence on surveys; (2) lack of communication of findings through abstracts: and (3) a paucity of research in many important areas. Significant strengths included the amount and breadth of research, the stimulus provided by the Standards Project, and the attention paid to philosophical foundations and conceptual bases.

Recommendations included (1) improvement of research methods, (2) improved access to research findings through database building, (3) consensus on definitions of terms, (4) development of a comprehensive research agenda, and (5) more classroom research.

Information on industrial arts/technology education research may be found in the ERIC system using the following descriptors: *Curriculum Design, *Curriculum Development, Educational Philosophy, Educational Research, *Industrial Arts, *Industrial Arts Teachers, Laboratories, Learning Processes, Postsecondary Education, Research Methodology, Research Problems, School Shops, Secondary Education, State of the Art Reviews, Teacher Education, Teaching Methods, and *Technology. Asterisks indicate descriptors having particular relevance.

INTRODUCTION

This monograph presents a compilation and review of selected technology education research literature published from 1980 through 1986. The paper seeks to reflect the breadth and variety of disciplined inquiry during this important period as the profession changed its name and its focus from industrial arts to technology education. For analyses of research published prior to 1980, the reader is encouraged to review the ERIC information analysis papers compiled by Streichler (1966), Householder and Suess (1969), and Dyrenfurth and Householder (1979).

As did its predecessors, this review is intended to establish a benchmark for reference, the validation of opinion, and the stimulation of further research in technology education. Findings should be of interest to researchers, teachers, teacher educators, supervisors, and administrators of technology education and related programs.

The review is divided into sections representing major topic categories likely to be of interest to researchers. The major sections include history, philosophy, and objectives; human resources; status studies; curriculum; learning process variables; instructional media, materials, and methods; student personnel and guidance; facilities; evaluation; teacher education; administration and supervision; and professional concerns. Each section ends with a summary and inferences related to the studies included in the section. A concluding section discusses general findings and recommendations.

Terminology

Although the name change from "industrial arts" to "technology education" was controversial during the years represented in this study, a consensus developed around use of the latter term. One of the national associations (International Technology Education Association) and many of the state associations now employ the new name. Likewise, many academic departments in public schools, colleges, and universities have adopted a new name. Following contemporary usage, the term "technology education" is used wherever possible throughout this paper to refer to the profession and the curriculum area it represents. However, some of the studies cited in this review employed other terms including "industrial arts," "industrial education," and "industrial technology." Because it was not always possible to determine precisely what meanings the investigators ascribed to these terms, it was often necessary in this analysis to use the same terms employed by the investigator of the works cited. It is hoped that the reader will note the context of the discussions and will not be confused by the various terms used in this paper.

Selection Strategies

Studies selected for this Educational Resources Information Center (ERIC) paper appeared in the literature of the profession during the period 1980 through 1986, plus selected studies published in 1979 and 1987. A computer search of the ERIC database and the *Dissertation Abstracts Online* database was conducted using the keyword descriptor phrase "industrial arts or technology education or industrial education." The ERIC search resulted in 435 studies and the *Dissertation Abstracts* search identified 295 studies, not all of which were selected for review in this paper.

To supplement the computer search, a manual search was made of publications of the International Technology Education Association (formerly the American Industrial Arts Association), including yearbooks and monographs of the association's various councils.

Only studies that focused on technology education were selected for review. In some cases, research from other fields of study was included if findings included data relevant to technology education. For the purpose of this paper, the term "research" was broadly defined to include historical and analytical studies that drew findings based on disciplined inquiry. To restrict citations to experimental and other quantitative research methods would have excluded some literature that had significant impact on the profession during this important transition period. Although it is possible that this search and selection strategy left out some important literature, the intent was to include only those documents that best illustrated the changing nature and state of the art of research in the profession during the 7-year period. Subjective judgments invariably come into play in a task such as this, and it is hoped that authors of works not included will understand the need to make difficult choices.

There was no attempt to provide an exhaustive, in-depth review of all research, but rather to illustrate the range and nature of research that characterized the period under review. Before drawing major conclusions from the summaries contained in this paper, readers are cautioned to study the original documents.

HISTORY, PHILOSOPHY, AND OBJECTIVES

The large number of studies related to this category revealed a rethinking of the traditional goals of technology education (industrial arts) in the context of a changing society. Studies ranged from reviews of the purposes of education to position papers suggesting new program objectives. The section includes research on the historical development, philosophy, and objectives of technology education.

History of Industrial Arts and Technology Education

The 30th yearbook of the American Council for Industrial Arts Teacher Education (Barella and Wright 1981) described the influence of Comenius, Pestalozzi, Froebel, Salomon, Della Vos, and other leaders of education in 18th- and 19th-century Europe whose thinking was instrumental in forming industrial education programs in the United States. The yearbook provided background information about significant social and philosophical changes during the colonization of the New World, the evolution of the manual training movement, the vocational education movement, and the development of industrial arts as a field of study. In addition to the social/political influences, the yearbook also highlighted two perennial issues that remain unresolved: a lack of consensus on curriculum content and a large gap between curriculum theory and instructional practice.

Educational leaders such as Frederick Bonser in the late 1800s and William E. Warner in the early 20th century had a major impact on the development of industrial arts and technology education (Herschbach, McPherson, and Latimer 1982). A study of the social efficiency movement in the late 1800s noted that a massive increase in the numbers of public school students in the late 1800s forced public schools to adapt curriculum offerings to meet the needs of children of the working class (Herschbach 1979a). Because many students were dropping out of school, some educators argued that industrial education was needed to prepare youngsters for the world of work, whereas others argued that the purpose of industrial education should be to erase social inequities. As a result of these distinctly different views of solutions to social problems, two ideological camps emerged: industrial arts, with a goal toward social reform and an emphasis on the developmental psychology of the learner; and vocational education, with an aim toward social efficiency using behavioralist psychology (Herschbach 1979b).

Luetkemeyer (1982, 1985) traced the social reform group, which included John Dewey, Charles Richards, Frederick Bonser, and William E. Warner, and discovered that Richards' conceptualization of industrial arts was based on a prevailing "social service philosophy." It was found that Richards used socioeconomic analysis to identify the content categories of manufacturing, transportation, and communication 50 years before similar categories were used in the Jackson's Mill curriculum model developed in 1981. In another paper, Luetkemeyer (1984) provided an etymological study of the term "technology" and concluded that "industrial arts" is the most inclusive term for the field of study, whereas "technology" denotes a theory dimension and is academic in nature. The name change to technology education, he pointed out, has serious historical and philosophical implications.

Schurter (1982) explored the social efficiency movement as evidenced by the Russian system of tool instruction, which linked technical training in the schools to the perceived needs of industry. He noted that from 1876 to 1893 the Russian system gained brief renown in connection with engineering education in the United Sta' ' merican educators melded the Russian system with elements of the Arts and Crafts move ,reate a system of occupational analysis based on systematic group instruction that beca . nown as manual training.

Two studies focused on the historical development of college-level programs. Ezell (1982) found that the industrial arts education program at the Ohio State University had its beginnings in he manual training movement of the 1870s. The program's initial purpose was to prepare manual training teachers, but early in its development the program changed to reflect an industrial technology or industrial training orientation, and the teacher preparation program was allowed to lapse. After the turn of the century, the program was revitalized with major emphasis again placed on teacher education. Under the leadership of William E. Warner, a graduate program that had a major impact on developments in the profession evolved.

In another study, Isaacs (1986) traced the history of the industrial education department at Miami University (Ohio), which was created in 1906 as component of the Normal School at Miami. After being maintained for several years under a very conservative philosophy and curricular conception, according to Isaacs, the department was dissolved in 1982 by order of the University Senate, citing severe budget cuts as the major reason. The 13 faculty members in the department were reassigned or retired. Facilities, which had been deteriorating, were split among other divisions and resources were sold or destroyed. The study notes that, although the department served high numbers of students, most were involved in service courses. Failure to align with an existing industrial technology program and underfunding were cited as factor that contributed to the department's decline. In a related work, Savage (1985) examined possible causes for elimi. . ı of the Miami University program along with three other industrial arts teacher educatio programs that were dissolved in the 1980s. Declining student enrollment, insufficient scholarly productivity by faculty, aging equipment, and a lower number of graduates were found to be major factors in the closings.

Other studies traced the history of practical arts education programs in primarily black institutions. Warlick (1980) focused on the history of Negro colleges in North Carolina to investigate the proposition that there were two philosophical camps—a liberal education camp favoring comprehensive education for blacks and a practical arts camp favoring industrial education courses. The majority of presidents of Negro colleges considerc 'ndustrial training to be valuable, but not sufficient, education for black students. Finkenbine's (1982) research focused on the effect of the Slater Fund, which was formed to assist black institutions of higher education between 1881 and 1903. It was found that the northern philanthropists who were Slater Fu d board members feared black supremacy and used their infl. nce over the industrial education curriculum at Hampton Institute and Tuskegee Institute in effect to control the education of black students. The study concluded that control of the Slate Fund allowed this small group of men to manipulate higher education for blacks by funding only those schools that implemented industrial education programs.

Two studies focused on the development of industrial education in specific public school systems. In Fitchburg, Massachusetts, the manual training and industrial education program initiated in 1908 was patterned after a program developed at the University of Cincinnati (Ringel 1980). Using data from alumni files, high school records, and interviews with graduates and family members, Ringel found that the majority of the graduates found themselves in upscale, white-collar occupations in contrast to the blue-collar occupations of their parents. Altadonna's (1983) historical study of industrial education in the Philadelphia schools determined that the program, which began in 1876, was closely interrelated with progressivism and other educational reform issues of the time.

Philosophical Foundations

Studies of philosophical foundations of industrial arts generally focused on a social problems orientation, as illustrated by the 29th yearbook of the American Council on Industrial Arts Teacher Education (Anderson and Bensen 1980). The yearbook authors examined how the term "technology" evolved as a descriptor of one of the most powerful social forces in our society. The term "social technology" was used in the yearbook to describe numerous examples of how technical means have been employed throughout history in the hope of solving social problems. A number of contemporary technological/societal problem areas were described as possible themes for new instructional programs. In a related study, Maley (1983a) cited four major factors—environmental change, a changing society, population growth, and the individual—that will likely influence life in the 21st century. He proposed that future directions in technology education should be based on a holistic frame of reference in order to prepare young people to deal with these problems.

Herschbach's (1984) study revealed that the history of technology education is replete with competing philosophical camps; the differences among the philosophies are most noticeable in proposals for what ought to be the content of curricula. Luetkemeyer (1983) cited Brown's (1977) tripartite model of curriculum content sources as an example of confusion in curriculum thinking. Brown's model noted that contemporary industrial arts curricula should be based on one of the following sources of content: the mechanical trades, American industry, or technology. According to Luetkemeyer, Brown and other curriculum theorists have erroneously argued that one or the other of these curriculum sources should be the basis of industrial arts programs. In contrast, John Dewey believed that three sources (individuals, society, and subject matter) should be equally represented. It was noted that an overemphasis on any one of the three sources of the curriculum has caused divisiveness and has retarded progress in the profession.

The term "technological literacy" became somewhat of a buzzword in the early 1980s and served as the focus of several studies. Hatch (1985) defined technological literacy as a three-dimensional construct that includes (1) functional ability to use tools, (2) an understanding of the issues raised by technology, and (3) appreciation of the significance of technology. Using the science test from the National Assessment of Educational Progress, Hatch identified items representing behaviors from each of these dimensions and established norms for assessment. Herrington (1982) searched the history and philosophy of technology, social sciences, and education and found that the most-often cited objective of industrial arts is to foster technological literacy. A study by Dyrenfurth and Lemons (1982) defined technological literacy as knowledge of consumer products, how they are made, and how to use them. However, Streichler (1980) asserted that despite strong claims to the contrary, there is no evidence that industrial arts contributes to the solution of technological and social problems.

Several studies reviewed for this paper noted that the meaning of technological or scientific literacy depends largely on one's definition of science and technology. Lux (1983), for example, stated that science observes nature in order to derive principles, laws, and generalizations, whereas technology practices in order to test or refine theories of efficient action. DeVore (1985) noted that, although there is much disagreement about the meaning of the terms "science" and "technolgy," practitioners who are designing technological literacy programs should avoid the seemingly unreasolvable controversy and instead determine what constitutes the science of technology.

Objectives of Industrial Arts/Technology Education

The research literature illustrated a wide variety of perceived goals for industrial arts and technology education. Evans (1982) reviewed the literature and found that industrial arts programs were fragmented into courses designed around (1) cottage arts and crafts, (2) vocational education for potential dropouts, (3) exploration of the world of work, (4) exploration of technology, and (5) practical arts. Dyrenfurth (1983) noted that because industrial arts programs promote vocational and technological exploration, they also contribute to the goals of vocational programs. Worthington (1982a,b) described industrial arts education as a comprehensive program concerned with development of job skills and familiarization of students with occupational clusters; he noted that career guidance is not "beneath" the purposes of industrial arts education. Carrying the career education theme even further, Dyrenfurth (1979, 1980, 1981) reviewed objectives for industrial arts and concluded that there was strong justification for industrial arts to play a much larger role in postsecondary/adult education.

The technique of opinion polling seems to be a popular method used to determine the goals of industrial arts. Isbell (1980), for example, used the Delphi technique to solicit goal statements from a nationwide sample of 24 industrial arts experts who reported that industrial arts should (1) make greater use of public relations; (2) teach broadly based courses in construction, manufacturing, energy/power, communications, and transportation; (3) continue emphasis on special needs students and individualized instruction; and (4) provide more inservice training. Winek (1981) used the Delphi technique with a sample of teacher educators and nonteaching energy experts to generate a list of goals for energy education programs in industrial arts. In another study (Kosak and Trapp 1983), 168 industrial arts teacher education department chairpersons were asked to rank the purposes of industrial arts as they saw them at the time of the study in contrast to how they might have ranked them 5 years earlier. Responses were compared to those from school teachers, school department heads, and school supervisors as reported in the Standards for Industrial Arts Programs Project. (A description of the Standards Project is included in the Status Studies section of this paper.) Findings showed that teacher educators in 1983 placed higher priority on creative problem-solving skills, whereas 5 years earlier they would have ranked acquisition of tool skills highest in priority (which corresponded with the Standards Project results).

Another study (Bame and Miller 1980) surveyed a nationwide sample of principals, industrial arts chairpersons, and guidance coordinators regarding the purpose of industrial arts. Developing skills in using tools and machines was the highest-ranked item. Likewise, tool and machine skills and occupational information were ranked high by a sample of industrial arts students, parents, teachers, and school administrators in Virginia, leading to the conclusion that traditional industrial arts values remain dominant among those close to public schooling (Bonfadini 1982). These findings were echoed in a study in which industrial arts teachers and teacher educators in Kansas, Missouri, and Oklahoma reported that existing curriculum goals were satisfactory and that the profession should be "doing the same, only more of it" (Frey 1985).

A group of parents, school board presidents, superintendents, and counselors in Nebraska ranked tool skills third behind the study of conservation methods and basic mathematics skills (Buskirk 1984). Smith (1986) found that industrial arts teachers in Boston wanted more emphasis on electricity, woodworking, metals, and drafting, leading the researcher to conclude that there is strong agreement among Boston industrial arts teachers in favor of traditional curriculum goals. These opinions contrast with Maley's (1984) conclusion that the overarching goal of industrial arts should be to develop the talents and abilities of each person to the fullest and that research on excellence in business could provide educators with guidance for developing educational programs.

Summary

Historical studies reviewed in this section chronicled the development of technology education in the United States, beginning with the introduction of manual training in the late 1800s and the influence of European practical arts education including the Russian system and the Sloyd system. Several studies traced the evolution of specific technology education (industrial arts) programs in higher education and the public schools.

Other studies revealed that philosophical differences in the technology education profession run deep and have been closely related to beliefs about what should be the purpose of education. Studies revealed that one predominant philosophical position (social reform) has its roots in the philosophies of John Dewey, Frederick Bonser, and Charles Richards, whereas another (social efficiency) has been represented by a focus on technical training. It was noted that contemporary leaders in the profession differ in their views of the nature of technology, science, and technological literacy.

Studies of the avowed purposes of the field of study concluded that there were differences of opinion among members of the profession regarding what should be the major goals of technology education. It was also evident that there was a significant gap between the goals as seen by leaders of the profession and as seen by practitioners.

HUMAN RESOURCES RELATED STUDIES

Research related to human resources received relatively little attention in the research literature. Studies in this section are divided into comprehensive efforts, equity, students with special needs, and human resource needs in industry.

Comprehensive Efforts

The 31st yearbook of the American Council on Industrial Arts Teacher Education provided a comprehensive review of several topics related to human resources (Maley and Starkweather 1982). Organized to illustrate how industrial arts contributes to several areas of education, the yearbook included literature reviews and discussions of such topics as the education of students with special needs, reading, career education, and consumer education. In another study of the general issues, Sredl (1983) explored the concept of human resource development and drew implications for industrial education.

Equity

Boben's (1985) publication of guidelines for equity issues signaled the profession's growing awareness of and concern for racial and gender fairness. Boben's work included a summary of legal and moral bases for equity and specific suggestions concerning language used in curriculum documents and teaching methods. A related publication, a sex equity guide (Dugger et al. 1981a), provided practitioners with specific strategies to eliminate gender bias. The equity guides raised the need to know how many females were enrolled in technology education programs. Several years before the guides were published, a national survey of secondary schools' industrial programs (Bame 1980b) showed that enrollment of female students was increasing.

Attitudes about sex equity were also of concern to researchers. Yager (1983) surveyed 233 teachers in industrial arts, home economics, and several academic subjects regarding their attitudes toward nonsexist teaching. Results showed that female teachers had more positive attitudes than male teachers, and home economics teachers and teachers of academic subjects had more positive attitudes than industrial arts teachers. A related study of vocational and practical arts teachers in Missouri (Kellett 1980) found that male teachers tended to have more stereotypes about the work and educational roles of men and women.

Technology teacher education programs were included in a study of the gender and racial structure of technical education faculties represented in the *Industrial Teacher Education Directory* and a list of engineering technology programs (Spence 1980). Questionnaire responses in 1979 were compared with those compiled 4 years earlier from the same institutions. The 1979 responses revealed that there were 156 females accounting for 5.8 percent of the total number of faculty. The number of female faculty members declined by 28 percent from 4 years earlier, whereas the number of male faculty members increased by 21 percent during the same period. Regarding racial balance, the 1979 figures showed that over 4 years the black, nonhispanic male portion of the faculty population had increased by 20 percent (5.3 percent of the population). During the same period, the number of Asian males had decreased by 8 percent.

Students with Special Needs

Reviewing data from the Report of Survey Data portion of the Standards Project (see the Status Studies section of this paper for a description of the Standards Project), Rieber (1981) found that industrial arts programs enrolled more students with learning disorders than students who were identified as gifted and talented. Teachers reported higher concerns about instructing students in these two groups than concerns about students with physical disabilities such as speech or hearing impairments. The majority of special needs students were enrolled in manufacturing courses. Over half of the schools received additional funding for special needs students. The most-often cited facility change was related to making the environment barrier free.

Dugger et al. (1981b) developed a special needs guide related to standards for industrial arts. Steczak and Shackelford (1980) and Buffer and Scott (1986) produced guides for mainstreaming students with special needs. In addition, the American Council for Elementary School Industrial Arts published a monograph illustrating the implications of Public Law 94-142 on public education at state and local levels (Calder and Horvath 1979). Included were examples of how elementary industrial arts experiences can be integrated in the Individualized Educational Program (IEP) for all handicapped children. Taylor (1980) surveyed industrial education teachers and building principals in Maine and derived a set of objectives and competencies for teaching handicapped students. In a related study, Lenti (1981) described a teaching package designed to familiarize industrial arts instructors with the nature and needs of special students.

Erekson and Cole (1986) provided a review of literature dealing with the unique career-related educational needs of gifted students, pointing out that gifted students have multipotentiality and are often under pressure to make complex career choices at an early age. The authors suggested that math/ science/technology activities hold promise for such students and that teachers will need to offer challenging, high quality programs in order to attract and hold students with special talents.

Human Resource Needs in Industry

Bjorkquist (1985) explored the changing nature of the workplace, including the shift in jobs from the production sector to the service sector and the related influences of technology, quality of work life, and the world economy. A survey by Miller and Usoro (1981) showed that employers of postsecondary industrial and technical program graduates expect a significantly higher degree of effective work competency than students expect to display when they are employed. Kozak and Richards (1981) surveyed businesses and industries in the Dallas-Fort Worth area to determine what topics should be emphasized in a college-level general academic curriculum and in an industrial technology curriculum. Responses placed high priority on English, applied math, production management, cost analysis, and quality control. Woodworking, foundry, and drafting (including computer-assisted drafting) were viewed as less important. When asked to name the major characteristics of successful employees, respondents identified attitude. people skills, punctuality, and loyalty. In another study, Tutor (1985) surveyed technology teacher education faculty members to identify the content currently being taught in robotics courses. Responses were compared with robotics experts' recommendations for what should be taught. Findings showed that the two groups generally agreed on the knowledge and skills needed by robotics technicians, but course content was lagging behind developments in robotics technology.

Summary

Due in part to the Standards Project, data were generated pertaining to the number of females and minority students enrolled in technology education programs. A study of higher education institutions revealed that, although the number of female instructors had declined, the number of black male faculty members had increased. Attitude surveys showed that stereotypes about female roles still prevail among teachers. Several equity guides were made available documenting the need and strategies for adjusting content and methods to eliminate racial and gender biases. Practitioners now have much-needed suggestions for adapting their instructional programs to accommodate all students.

Studies of students with special needs showed that technology education programs enrolled more students with learning disorders than those who were classified as gifted and talented. Significantly, one study reported that teachers were more concerned with students with learning difficulties.

There were no studies to indicate which practices are being implemented to improve the educational experience of students with learning disabilities or those with physical handicaps. Nor was there research to identify what kinds of programs attract and challenge gifted and talented students or what programs work best with students to whom English is a second language. Also missing were investigations of equity issues regarding nonwhite students although in many schools nonwhites are in the majority.

STATUS STUDIES

Data about existing curriculum offerings, faculty, student enrollments, and facilities are central to a profession's knowledge of the state of the art of its field. This section includes studies of international, state, and local technology education programs.

International Studies

Studies of technology education in Great Britain (Davison and Gaster 1985; Hutchinson 1986) noted that traditional trade-oriented technology education programs in metalworking, woodworking, and technical drawing are slowly giving way to an emphasis on problem solving. Labeled Craft, Design, and Technology (CDT), the new programs are generally taught using "design briefs," which are short descriptions of a technical problem, along with some criteria and design limitations. Working at times individually and at other times in small groups, students are expected to document each step in the solution of the problem by using drawings, photos, and daily logs. The purpose of CDT is to encourage creative problem solving and to introduce students to basic concepts of technical devices and systems. The British government is providing funding for inservice training to orient teachers to the new CDT programs.

Two studies of technology education in Japan illustrated different programs for different age levels. Dillon and Dillon (1983) observed a program called "technical process" required of all Japanese students in grades 7-9. The program investigated was part of a general curriculum that included woodworking, metalworking, machinery, electricity/electronics, and cultivation. Scarborough's (1986) report on Japanese education in the higher grades noted that technical (job-related) education is denied to Japanese students until they reach the designated vocational age (16-18). It was found that because there are no technical courses in comprehensive high schools, students desiring to enroll in technical courses must attend a separate school. Scarborough noted that many of the vocational/technical schools offer traditional crafts courses in poorly equipped laboratories and are taught by instructors who have had very little inservice training.

Lux and Lee (1979) reported on technology education in Korea, where, by law, programs must be provided for all secondary school students. The investigators found that the national curriculum plan has been slowed by a shortage of qualified teachers, inadequate facilities, poorly defined content, and lack of public understanding of the program's importance.

National Studies

One of the benchmark studies of the status of industrial arts was reported by Schmitt and Pelley in 1966. A followup study, the Standards for Industrial Arts Programs Project (Standards Project), was conducted in the late 1970s by faculty at Virginia Polytechnic Institute and State University (Dugger et al. 1980). The major purpose of the project was to establish baseline data for the development of standards for industrial arts programs. The industrial arts standards were later revised and published by the International Technology Education Association (1985b) under the title *Standards for Technology Education Programs.* The *Report of Survey Data* (Dugger et al. 1980) provided an analysis of responses from supervisors of industrial arts in 54 states and territories and 2,235 public school principals, industrial arts chairpersons, and guidance coordinators. Findings related to specific issues and concerns are reported in other sections of this paper.

Summary reports of the Standards Project survey data were published in the Fall 1980 issue of the *Journal of Industrial Teacher Education*. One summary (Bame 1980b) reported that (1) there is a major shortage of industrial arts teachers, (2) program content has not changed appreciably since the Schmitt and Pelley study in 1966, (3) enrollment of female students has increased, and (4) most school laboratories are equipped to accommodate the handicapped. Reviewing other findings from the survey data, Dixon and Dugger (1980) found that the major characteristics of exemplary programs, as identified by administrators, included well-prepared teachers, good laboratories, a variety of teaching methods, and a well-rounded curriculum.

The Standards Project survey data also revealed some information about student organizations, student enrollments, and program expenditures. Dixon (1980) reported on the size of industrial arts student organizations, activities offered to organization members, and administrators' perceptions of student organizations. Young and Holmes (1980) found that most industrial arts students were enrolled in the seventh and eighth grades, the number of female students had increased since 1966, and over 25 percent of the responding teachers participated in Individualized Educational Programs (IEPs) for handicapped students. Young and Pesce (1980) reported that 28 states and territories received no federal money for industrial arts in 1978-79.

Sarapin (1981b, 1983) reported a decline between 1979 and 1981 in the number of states including industrial arts in the state vocational plan, the number of states assigning a state supervisor to industrial arts, and the number of states spending federal monies for industrial arts. However, Dyrenfurth's (1980) study suggested that federal data may be incomplete and misleading. Reviewing U.S. Department of Education (USDE) and National Center for Education Statistics records, Dyrenfurth analyzed data on enrollment, institutions, faculty, funding, and student organizations. The study found many inconsistencies in reporting data, and it was noted that the USDE figures do not include nonvocationally funded industrial arts programs. In his nonstatistical overview of the federal role in technology education, Worthington (1982a) noted similar precautions about interpreting data from federal reports.

Findings from the second annual School Shop magazine survey of readers (Dugger et al. 1986) corresponded with findings of the Standards Project survey data regarding curriculum offerings. Readers identified woodworking, drafting, and metalworking as the courses offered most frequently. They also predicted future enrollment growth for courses in robotics, computers, numerical control, and communication technology. Enrollment losses were forecast for textiles, general metals, sheet metals, and machine shop courses. Increased academic requirements, lack of adequate funds, and poor quality of students were identified as problem areas.

State and Local Studies

In contrast to numerous national studies, only three state-specific status studies were found in the literature. In one, Tomlinson, Pontius, and Kolesar (1981) reported on a pilot study to establish a data base of the number and types of industrial education programs in Illinois. A similar study by Borchers (1986) attempted to establish a baseline of information on existing industrial arts programs in Wyoming. In a third study, Ryan (1985) surveyed industrial arts programs in New Mexico and found a strong need for curricula to be updated.

Only two studies of local programs appeared in the literature: a description of a new technology education program at Rice Lake, Wisconsin (Fisher 1984), and a description of a revised program at Racine (Wisconsin) Unified School District (Pitts 1985).

Summary

The studies of technology education programs helped to provide a perspective from which to view the state of the art in the United States. Specifically, the study of CDT programs in Great Britain provided an example of a national effort toward curriculum change.

Largely due to collection of data for the Standards for Industrial Arts Programs Project (Dugger et al. 1980), a significant amount of information was provided about the nature of technology education programs in American public schools in the 1970s. It was found that the types of courses taught and the condition of laboratories are virtually identical to those described in the Schmitt and Pelley study 15 years earlier. This finding is all the more significant when noting that Schmitt and Pelley lamented in 1966 that programs in place at that time were already decades behind the times. According to two researchers (LaPorte 1982; Sanders 1985), the apparent lack of progress in curriculum revision can be explained by the finding that teachers seem to be satisfied with their traditional programs. A positive note was evidenced by data that showed an increase in females enrolled in technology education courses.

Some studies concluded that the federal reports (excepting the Standards Study) are fraught with inconsistencies and may be unreliable sources of data. In addition, it should be noted that the Standards Study data were collected in 1978-79, and there have been no recent studies to update the data. Since 1980, significant statewide curriculum projects have been implemented that may have brought about changes in the types of courses offered and the types and numbers of students enrolled.

CURRICULUM

Perhaps more than any other category, research studies included in this section reflect the transition from industrial arts to technology education. The research literature revealed that between 1980 and 1986 the profession underwent a significant reconceptualization of its curriculum structure. Included in this section are studies related to comprehensive efforts, content, courses and units, learning activities, and curriculum development and implementation.

Comprehensive Efforts

Unit II of the 28th yearbook of the American Council on Industrial Arts Teacher Education (Martin 1979) provided a comprehensive picture of curriculum theory and practice in technology education over two decades ending in 1980. During this period, there were many curriculum projects that had significant impact on the profession. Chapter Nine of the yearbook described how the changing nature of technology has influenced curriculum thinking, leading to the development of new technology-based programs for the 1980s.

The Jackson's Mill Industrial Arts Curriculum Theory document (Snyder and Hales 1981) had a far-reaching influence on curriculum revision in the 1980s and will likely do so for some time to come. The document was prepared by 21 selected curriculum leaders in industrial arts and technology education who convened for the purpose of reconciling divergent opinions about whether industry or technology should be the major source of curriculum content. The resulting document drew upon conceptions of society and culture (human adaptive systems) and the domains of knowledge and identified four major curriculum content categories: manufacturing systems, construction systems, communication systems, and transportation systems. A summary of the model was published as a two-part series in *Man/Society/Technology* (Hales and Snyder 1982a,b).

To facilitate implementation of the Jackson's Mill curriculum theory, the Technical Foundation of America funded a project that resulted in a guide for developing contemporary technology education programs (Wisconsin Department of Public Instruction 1984). The guide summarized the philosophical foundations of the Jackson's Mill model and offered detailed taxonomies of the content in each of the technical systems areas, including scope and sequence models for small, medium, and large schools. Recognizing the need for a grass-roots level interpretation of the new curriculum proposals, Jones (1984) prepared a paper using a question-answer format that addressed the concerns of practitioners faced with the prospect of curriculum revision.

Content and Instructional Units

Focusing on industry as the major content source for industrial arts, Swanson (1983b) reviewed the literature of business, economics, and industry and developed a curriculum content model consisting of four clusters: manufacturing, construction, communication, and power. Proposals by Wright (1982) and Meyers (1985) also suggested that industry be the content base. Other studies of contemporary industry found implications for changes in curriculum to include service industries (Umstattd 1979), modern agriculture (Pytlik and Scanlin 1979), consumer topics (Sharpe and Baker 1982), materials and processes (Jacobs and Ritz 1981), and robotics (Seaman and Steck 1985).

In contrast, Ritz (1981) reviewed contemporary trends and concluded that technology, not industry, should be the content base for technology education. Sparked by the technology versus industry controversy, a debate on the issue was published in the *Journal of Epsilon Pi Tau* (Lauda 1982; Swanson 1981, 1983a). Additional proposals suggested an emphasis on the history of technology (Maley 1983b) and focus on a systems model for understanding and interpreting technology (Hacker and Barden 1983; Mietus 1981). In related studies, Lauda (1983) offered a version of a technology-based scope and sequence model for grades K-12, and McCrory (1980) provided a structure of content for deriving technology education curriculum models.

The Jackson's Mill model was swiftly adopted by many curriculum theorists and developers, resulting in a number of content designs expanding on the four technical systems of communication, transportation, manufacturing, and construction. Fales and Kuetemeyer (1982) reviewed curriculum content for transportation systems and recommended adding an economic and human behavior emphasis to balance what was viewed as the mechanical orientation proposed by other educators. Bentley (1984) organized the subject matter of graphic communication technology based on Ausubel's and Hill's conceptualizations of cognitive learning. Competency tasks for communication were identified and validated by Ritz (1979). Gindele and Gindele (1984) reviewed the communication technology literature and identified present and future trends relevant to industrial arts. In a study of computer-aided drafting and design (CADD), Laird (1985) found that although many industrial personnel used CADD, it was not required in most college industrial education programs and was not even available in some. Hendricks (1986) used the Delphi technique to derive a taxonomy of subconcepts in communication technology relating to those posited in the Jackson's Mill model. Dybas (1980) conducted a Delphi study of experts in industry, engineering, education, and the military to determine a content structure for an electronics curriculum for teacher education.

Several studies found disagreement among teachers, teacher educators, and technologists regarding what should be the content of educational programs. Foley (1985) surveyed industrial arts teachers and energy experts in New Hampshire to identify energy curriculum content and found that, although the experts stressed conceptual foundations, economic justifications and scientific bases of renewable energy, teachers focused on wood-burning technology, educational strategies, and the more popular alternative energy sources such as windpower, hydropower, photovoltaics, and biomass. Sanders (1984) polled graphic communications programs and found that screen printing was ranked as top priority even though the screen printing industries account for only 5 percent of the graphic arts industry.

Several studies described projects undertaken to develop instructional units. Among them was a project in which instructional materials were developed to supplement existing textbooks for industrial arts (McCrory and Maughan 1983), a series of modules about consumer topics (Baker and Dugger 1982; Baker, Sharpe, and Renzelman 1981), a study unit about service industries (Squier 1982), a technology assessment unit (Murwin 1981), and an energy/power unit (Litowitz 1986).

Learning Activities

Although the periodicals aimed at industrial arts/technology education teachers regularly included descriptions of learning activities for classroom use, there was no evidence of research on the nature of appropriate activities, methods for their design, or their effectiveness. However, an interesting approach was offered by Maley's (1985) illustration of student activities that incorporate principles of math, science, and social studies. In another paper, Maley (1986) presented a rationale and description of student activities using research and development methods.

Curriculum Development and Implementation

A substantial number of studies focused on the process of developing curricula and implementing them in the schools. Bensen (1979) discussed three predominant methods by which curriculum content is often selected: the cluster approach, the trade analysis approach, and the concept approach. The investigator noted that each approach results in distinctly different curriculum structures, although similar curriculum content may be identified. Following a similar theme, Israel (1981a,b) traced various types of industrial arts programs developed in the 20th century and addressed several implications of each approach. Ritz (1980) outlined a systematic process for curriculum that consisted of curriculum foundations, curriculum content, and curriculum evaluation. Sarapin (1981a) suggested a conceptual analysis process for curriculum development that would lead to the organization of content and learning activities for specific courses. Skaine (1985) proposed six principles of curriculum planning in an age of technological change, and Hacker (1982) presented a future-oriented curriculum approach based on global issues including energy management, resource management, technological advancement, and international relations.

As new curriculum models began to emerge, the International Technology Education Association (1985a) published a guide for program implementation that summarized rationale, goals, and courses and showcased exemplary school programs where new technology education programs were being implemented. Likewise, the National Association of Secondary School Principals (NASSP) published two special curriculum reports with similar information (McCrory and Bame 1986; NASSP 1985). The American Council on Industrial Arts Teacher Education's (ACIATE) 35th yearbook (Jones and Wright 1986) included chapters focusing on implementing technology education programs at various levels, kindergarten through graduate school. ACIATE (1979) published abstracts of 26 curriculum development activities at the college level, and the American Council for Elementary School Industrial Arts published two monographs detailing suggestions for program development and implementation of industrial arts in the elementary school (Hoots 1980; White 1980).

The literature search used for this paper identified numerous curriculum guides, far too many to be synthesized here. Analysis of a sample of the guides showed many similarities, with some appearing to be only slight modifications of those developed in neighboring states or districts. Readers who wish to locate curriculum guides in specific content areas should consult a directory of curriculum guides published by the International Technology Education Association (1985a) or the Sredl and Everett (1981) review of state-level comprehensive planning guides.

Published curriculum guides rarely expose the rationale, criteria, or process used for development, but the literature review revealed several curriculum project reports that included descriptions of methods and procedures. These selected project reports could be instructive to those who wish to assess organizational structures and methods used by others. A curriculum project in Virginia, for example, developed competency-based instructional resource guides for technical, engineering, and architectural drawing (Thomas Nelson Community College 1983). Heggen (1981) described a "fast-track" model used in Florida to develop an industrial arts curriculum suitable for handicapped students, and Dopkin (1979) reported on a New Jersey project to produce curriculum plans to promote sex equity in industrial arts and home economics. The literature included reports of state curriculum development projects in Iowa (Iowa State University 1982, 1984), Virginia (Ritz and Joyner 1979), and Louisiana (Louisiana Department of Education 1982).

Summary

The comprehensive studies and those related to curriculum content gave evidence that a consensus has formed accepting the Jackson's Mill Industrial Arts Curriculum Theory model as the curriculum content model for technology education for the next decade. The Jackson's Mill document, in concert with the implementation guide sponsored by the Technical Foundation of America, has provided significant momentum for curriculum change. Just as important, numerous studies implied that the new technology education curriculum structure is being effectively disseminated to school administrators and other decision makers.

Although several state departments of education and individual school districts are known to have developed new curriculum guides based on the Jackson's Mill model, none was found in the literature search for this paper. Documents such as these should be submitted to a major data base. Likewise, the ERIC search uncovered numerous instructional units, but there was no evidence that they were developed from a research base. It appears that, as yet, specific course outlines and student activities have not been developed to implement the new technology education curriculum designs.

LEARNING PROCESS VARIABLES

Learning process variables have a significant impact on the effectiveness of instructional programs. This section identifies research related to problem solving, organizational patterns, special needs, and learning theory.

Problem Solving and Creativity

Wey (1983) developed a guidebook to facilitate creative thinking abilities of industrial arts students. An experimental population of 80 college students in industrial arts courses scored higher on selected measures of creativity after using the guidebook for one month as a supplement to regular coursework. Micklus (1984) described the Olympics of the Mind (OM) program, which is aimed at encouraging creativity in gifted and talented students. In a related paper, Lolla and Miller (1980) described a problem-solving activity in which industrial arts students inventoried available materials to design and produce a ceramic container.

Organizational Patterns

In the only study to focus on organizational variables, Bruns and McMillen (1979) compared student achievement in 2-hour graphics courses at a comprehensive high school with student achievement in similar 3-hour courses at a vocational school. Student achievement in the 2-hour time block was comparable to the 3-hour block; this time frame also had a favorable effect on the dropout rate and absenteeism.

Special Needs Aspects

Buffer and Scott (1986) updated their 1981 edition of a special needs guide for technology education to include program standards, identification of special needs students, suggestions for IEPs, and options for instructional practice. Miller and D'Amore (1979) and Ferris (1984) explored teachers' concerns about the implications of federal legislation for mainstreaming. Ferris' survey of industrial arts teachers and administrators determined that mainstreaming had a negative impact on teaching but that the problem could be alleviated through inservice education. A study of 377 handicapped students in Illinois industrial arts and vocational programs (Cobb 1983) revealed that numbers of handicapped student enrollments were higher than previously thought and that handicapped students generally received differential treatment.

Scott et al. (1985) suggested using activity-oriented instruction and peer tutors, developing problem-solving skills, and involving a special educator in technology education classes. Other papers described examples of integrating visually handicapped students (McConnell 1984) and mentally retarded students (Horton 1983; Joyce and McFadden 1982) into industrial education classes.

Performance Domains and Learning Theory

Two yearbooks published by the American Council on Industrial Arts Teacher Education focused on learning variables. The 33rd yearbook (Jennings 1984) explored affective learning, and the 34th yearbook (Shemick 1985) provided an overview of perceptual and psychomotor learning in industrial arts education. The concept of cognitive styles received attention in several studies, including one that described a project to create a teacher-student learning situation that would identify and maximize divergent learning potential of students (Hicken 1981). Poirier (1980) searched for relationships among learning styles of college freshman industrial arts students and freshman business students and concluded that (1) cognitive style in itself was not an effective predictor of academic success, (2) industrial arts and business students had similar cognitive styles, and (3) there were no differences in cognitive styles between male and female students. Jacobs and Gedeon (1982) found significant differences in social behaviors of field dependent and independent college students in a personalized system of instruction course in cybernetics. Because learning achievement did not differ, it was concluded that social behavior may be one way students adapt to various instructional settings. Guster (1981) found that field independent students are higher achievers in drafting; on a related topic, Bame and Gatewood (1983) presented a review of research on hemispheric brain functioning and its implications for industrial arts programs.

Several studies investigated the effect of developmental levels as theorized by Piaget. Sarapin (1979) noted that the concept of developmental tasks can provide the curriculum developer and educational practitioner a useful tool to help identify what students are internally attempting to accomplish at their specific stage of development. Dahl (1979) and Barker (1982) provided overviews of Piaget's theory and implications for elementary school industrial arts. Scanlin (1984) compared industrial arts students with nonindustrial arts students and found no support for the hypothesis that industrial arts classes help students to develop higher Piagetian levels of cognitive ability. A study by Kanagy (1980) concluded that approximately 20 percent of students in eighth-grade drafting classes are developmentally limited in their ability to do multiview drawing.

Summary

Although problem solving is often mentioned as a major goal of technology education programs, there were only a few research reports on the topic. In general, the studies found that the learning activities designed to enhance creative problem solving were effective. The small number of studies on this seems odd, especially when it was noted elsewhere in this paper that the challenge of meeting the needs of gifted and talented students was a significant concern.

The only study of organizational patterns found that a shorter time block (two hours) was just as effective as a longer class period (three hours) for teaching graphics. There was no evidence of research on the effect of sub-grouping within a standard 1-hour time period. Nor were there studies of individual instruction compared to group lecture or demonstration.

A bright note in the research literature was evidenced by a number of studies related to students with special needs. Even in this area, there were no studies of the effect of implementing strategies offered by the numerous guides for working with special students.

Several studies investigated relationships among performance variables and learning theory, though the findings were often vague and ambiguous. Missing were studies to determine the implications of split-brain research, personality differences, and learning styles on teaching techniques.

INSTRUCTIONAL MEDIA, MATERIALS, AND METHODS

As might be expected, the literature search uncovered a substantial amount of research related to instructional media, materials, and methods.

Several studies investigated relationships between textbooks and instructional practice. Chang (1984), for example, developed a model to evaluate the interface of technology education textbooks and curriculum. When the model was applied to middle school textbooks in Korea, little correlation was found between content suggested in the curriculum guide and content included in textbooks being used. The investigator concluded that the textbooks were more appropriate for training technical skills than for understanding the nature of technological systems in modern industrial societies. A study of industrial arts textbook selection in Georgia (Matt 1983) found that teachers' most important criteria for selecting textbooks included technical vocabulary, accurate representation of symbols, illustrations, visual quality, content, cost, and copyright date. Humphrey (1980) found that the gender of narrators of slide series had no effect on the cognitive development of learners, whether they were girls or boys.

The use of computers seemed to be a popular subject of interest among some investigators. Sarapin and Post (1984) reviewed contemporary computer literature and presented an overview of basic concepts of computer literacy, hardware, software, and potential uses for industrial arts/technology educators. Green's (1983) study in Indiana high schools showed that computer use in industrial arts compared favorably with other school subjects except for math and science, where computer use was as much as 10 times greater. However, Foell's (1984) survey of 83 cooperative training teachers showed that more than one-third use microcomputers primarily for inventory control and student recordkeeping, suggesting that some technology educators may be using computers more for classroom/laboratory management than for instructional purposes. Part of the reason for industrial education teachers' limited use of computers in the classroom may be due to limited experience with computers while in college. A survey of technology teacher education institutions, for example, found that although computers are available to most industrial arts teacher education students, only half take computer programming courses. Moreover, teacher trainees are generally not required to develop competencies relating to educational applications, and less than one-tenth are required to write or evaluate computer-assisted instruction programs (Carson 1983).

If teacher attitudes are a reliable indicator of practice, then Pendleton's (1981) study suggests that industrial arts teachers are primarily using traditional methods. Survey respondents rated teaching methods in decreasing order of importance as follows: demonstrations, individual projects, lectures, audiovisual materials, group projects, class discussions, assigned readings, self-instructional materials, and grading contracts. Role playing/simulation was rated of little value.

Cooperative learning, allowing teams of students to help each other complete an assignment, was the topic of two studies. Perreault's (1982) study of junior high school students in drafting class found that students in teams increased their knowledge and comprehension over those who worked on an individual basis, but no difference was found in application of knowledge. However, students in Lauderbach's (1986) study performed no better on visualization of orthographic projections than students who worked individually.

A survey of teachers of manufacturing courses in Ohio (Colelli 1985) determined that most teachers' content and methods were based on college laboratory courses, curriculum packages, and work experiences, suggesting that changes in teacher training courses might help effect change in teaching practices. Mullen (1983) experimented with two versions of computer-assisted instruction (CAI), one being a drill-and-practice program with sequencing dependent on user response and the other with user-determined sequencing. He concluded that learners do better when given a low degree of control over sequencing and that field orientation (field dependent or field independent learning style) of the learner did not affect performance. Harris' (1983) study of methods to teach wood laboratory safety found that CAI resulted in better learning than did the lecture-demonstration method. Kovac (1985) conducted a study of junior high school mechanical drawing students and determined that students learned spatial ability skills equally well from a CAI program as they did from the instructor's informal instruction.

Horton (1985) investigated the effectiveness of brainstorming, sketching, and modeling on junior high school students' creativity and found that the techniques enhanced creativity when applied to three-dimensional products but had no effect on creative thinking as measured by the Torrance Test of Creative Thinking. In contrast, Schotta's (1984) study of college students in engineering graphics courses determined that visual thinking was not improved by tactual-visual perception and idea sketching, and Johnson's (1984) study found that freehand sketching resulted in better learning than the use of drafting instruments. Knudsen (1983) tested the impact of left-brain right-brain theories on an industrial arts woodworking class and found that instruction directed to the right brain (the creative abilities) resulted in higher student achievement. Barnett (1982) compared nondirected instruction to directed methods in a residential construction course and got mixed results on tests of achievement and knowledge retention. Constructional (hands-on) units for teaching math and social studies content to elementary students resulted in higher student motivation than nonconstructional methods (Kowal 1984).

Cunningham (1982) found that the use of jigs, fixtures, and templates improved the psychomotor performance of nonhandicapped as well as educable mentally retarded and learning disabled junior high school students in a manufacturing unit of study. Dorner (1981) concluded that analogies related to students' personal experience resulted in higher motivation and moderately higher learning of physical science principles in an electronics course than did traditional methods. In another study (Darrow 1980), advanced organizers based on Ausubel's theories were found to be no more effective than conventional overview methods for introducing a junior high school unit on material processing.

Kroon (1985) found that student achievement increased when instruction was introduced through each student's most preferred perceptual learning style (auditory, visual, tactile) when followed by reinforcement through either secondary or tertiary perceptual preferences. Results of Woodward's (1985) study, however, suggested that teachers' preferred methods and students' preferred learning modes may not always be congruent. In a study of reading methods, Lee (1981) reviewed reading problems encountered in industrial arts courses and provided suggestions for how to deal with them. In a related study, Luparelli (1980) used a functional reading strategy with reading guides in an eighth-grade graphic arts class. The method improved comprehension of graphic arts concepts but had no effect on learning of technical vocabulary.

Summary

In general, research in this section provided mixed, although promising, findings related to the effect of media and methods. It was found that student use of computers in technology education programs is at least equal to that in other subjects. As computers become more available in laboratories and classrooms, it seems likely that there will be even more studies of the methods and results of using this medium. The studies on textbook content and methods used to select textbooks exhibited a step in the right direction. As new textbooks become available, they will likely reflect the technology education content structure, and effective criteria for book selection will become more important than ever. With one exception, there were no studies on the effect of textbooks or audiovisual media. If new curriculum programs require new content for teacher and student alike, studies of textbooks and other media would seem to be a fruitful area for further research.

The substantial number of studies on instructional methods revealed a continuing concern for research in that area. Findings snowed that the demonstration method remains the most highly regarded and perhaps the most-used teaching technique. Computer-assisted instruction was shown to be a useful means of instruction, even though gains in learning were no greater than learning resulting from traditional means. Several studies of teaching methods with handicapped learners produced encouraging results.

There is still much to be learned about the effectiveness of computer-assisted instruction, nondirected group instruction, and other alternatives to the traditional group lecture-demonstratio method. There were no investigations, for example, of whether the principles of robotics are best learned from desktop simulators or from other means. Nor was there any research to indicate whether drafting students need to become proficient with instruments before progressing to computer-assisted drafting programs.

STUDENT PERSONNEL AND GUIDANCE

Little research was found related to student personnel and guidance. In the few studies related to this category, most were concerned with occupational awareness and personality characteristics of students.

Occupational Choice and Guidance

Gemmill (1984) reviewed stated objectives for technology education and industrial arts and developed a list of 30 learning activities to assist students with occupational exploration and choice. Two studies (DeLucca 1985; Vines 1983) confirmed the assertion that industrial arts courses have a positive effect on employment success. In addition, the DeLucca study found that, compared to general education students, former industrial arts students earn more money and are unemployed for a shorter length of time. The same study found that industrial education students attended the first 4 years of college in the same percentage as general education students.

The need for a balanced occupational preparation was pointed out by a Canadian study (Morrow 1980), which found that 2 years after graduation fewer than one-fourth of the population sampled were employed in jobs related to their high school training. Industrial arts courses, along with English and mathematics, were identified by former students as the most useful. In a different study, Nelson (1985) polled postsecondary program directors to determine which competencies were most important for success in 1- and 2-year postsecondary programs. Among the 10 competencies derived were problem-solving skills, effective work habits, responsibility, and ability to work effectively with others.

Several studies reported conflicting findings regarding the effect of industrial education on the student's capacity to make informed career decisions. Although Somers (1980, 1981) found no evidence that junior high school industrial arts courses improve students' scores on the Career Maturity Inventory (CMI), the CMI scores increased among students enrolled in a career exploration course that included industrial arts (Simpson 1982). The CMI scores of industrial arts students in a 2-year study by Kapes and Baker (1983) increased, but at a lesser rate than the control group of "academic" students. As a partial explanation, the investigators noted that although academic students probably had received some career instruction integrated with other courses, industrial arts courses may not have focused on the specific knowledge tested by the CMI.

Fox (1983) found that industrial arts students had serious deficiencies in occupational vocabulary related to the trades. It was suggested that more emphasis should be placed on instruction in word recognition and conceptual meaning. Baker, Somers, and Sharpe's (1982) study of female high school seniors' career selections indicated that experience in industrial arts courses leads to more informed career decisions, but Somers (1981) found no correlation in a similar study. In a study of black students, Azzarano (1981) concluded that dropout rates were more accurately predicted by age and educational aspiration than by the Career Maturity Inventory.

Student Characteristics

Schultz (1985) found differences in Jungian and Keirseyan temperament traits between industrial arts students and the general school population, but concluded that the instruments used were not reliable indicators of learning styles. Waite (1981) determined that female students in college industrial arts programs enter with less cognitive technical knowledge compared to males, but much of the deficit is made up during the undergraduate educational program. Parsons (1984) found that industrial arts majors in college have similar personality traits within the group, but the traits were different from personality traits of other subject majors. A study of college students' biorhythms (Chobar 1980) concluded that there was no correlation between biorhythms and educational performance.

An enlightening study by Schoonmaker (1982, 1984) surveyed college freshmen to explore differences in attitude between those who had taken industrial arts in high school and those who had not. Those who had not taken industrial arts were more likely to agree with the following statements about industrial arts: (1) teachers did not challenge student abilities, (2) courses did not develop problem-solving skills, (3) facilities were undesirable, (4) peer students tended not to take the courses, (5) courses did not reflect well on high school records, and (6) respondents would feel out of place in the courses. Another study of high school students (McMillan 1981) found a high correlation between math ability and drafting ability, but no differences in either ability across gender.

Summary

Studies to determine the effect of instructional programs on job success generally illustrated that technology education students are better prepared than those who do not enroll in the program. It was also shown that technology education students attend college in the same percentage as nontechnology education students. Research on the ability of occupational education programs to increase students' career awareness was less conclusive.

It must be noted that in several of the studies, the number of intervening and uncontrollable variables caused findings to be viewed with suspicion. Findings might have been more convincing if there had been more followup studies of graduates, such as Morrow's (1980) study, to determine the kinds of competencies needed in the world of work or the professions. There remains a need for reliable data showing whether or not technology education is effective for all students, regardless of their career aspirations.

Regarding studies of student characteristics, Waite's research seems to exemplify a fertile area to be explored. Schoonmaker's study presented disquieting data about the negative attitudes of students toward technology education (industrial arts) courses in high school. More data about the constants and variables of student abilities and interests, especially among females and minority groups, would allow educational programs to be developed to fit the needs of students.

There was little research on the attitudes and competencies of students who enter technology education programs and what happens to them over time. Attitude studies are important if we are to know why some students enroll in technology education and others do not.

FACILITIES

Only a few studies were found to relate to laboratory facilities. This section includes research literature on facility planning, laboratory safety, and laboratory equipment.

As with several other topics, the Standards for Industrial Arts Programs Project provided interesting data regarding the state of the art of industrial arts facilities. Bame's (1980a) survey results showed that the most commonly reported industrial arts laboratories were woodworking laboratories, drafting laboratories, general laboratories, and metalworking laboratories, in that order. Only one-fourth of the department chairpersons surveyed reported facility modifications for handicapped students. On that topic, Shackelford and Henak (1982) authored a monograph focusing on suggestions for designing and modifying industrial arts facilities to make them more accessible to individuals with physical disabilities.

Zeloof (1983) found that teaching machine safety separately from machine function was no more effective than teaching machine safety along with machine function. A more important factor affecting safety performance was found to be students' self-perceived anxiety. Those with low levels of anxiety tended to perform better than those with high anxiety levels. Marcus (1982) reviewed safety-related laws, statutes, and court cases and offered several recommendations that might help protect industrial arts teachers from litigation. A related paper (McDole 1983) emphasized the need for industrial arts teachers to keep their laboratories and their instructional practices consistent with safety regulations. With the same purpose in mind, DeLucca (1979) provided a self-instructional package to be used in pre-student teaching classes in safety instruction. According to one study by speech and hearing specialists (Woodford and O'Farrell 1983), sound levels in some school laboratories constitute a hazard to hearing.

In a study of methods used to select laboratory equipment, Klapp (1982) found that teachers generally agreed with supervisors about brand names and quality indicators of equipment. Although most of the purchasing was done by teachers, they were less informed about recommended selection and purchase procedures than were their supervisors. In studies related to mobile facilities, Fowler and Peters (1983) reported positive results with a Mobile Manual Arts Unit used in Australia, and T! achuk (1982) described a feasibility study to assess the potential for mobile laboratories in rural portions of Canada.

Summary

Because laboratories are an integral part of industrial arts and technology education, it seems strange that there was so little research on the topic. As might be expected, there were some studies relating to laboratory safety, but the lack of research in other facets such as facility planning and equipment selection is a serious problem.

Absent were studies to indicate what is being done to modify existing equipment and laboratory space to accommodate the new curricula. Likewise, there were no studies of new equipment, such as that designed for robotics, telecommunication, electronics, or computer-assisted drafting.

EVALUATION

Little research was found to be related to this category. Because they differed in focus, evaluation studies were divided into two subcategories to include evaluation of student learning, and teacher knowledge and evaluation of program effectiveness.

Student Learning and Teacher Knowledge

In a study of student learning achievement, Ronda (1984) presented a method of grading for use in junior high industrial arts and high school vocational education. A related study by Skulkhu (1983) explored 194 college teachers' attitudes about student grading and found that younger, less experienced faculty were more student-oriented and norm-referenced in their grading whereas veteran faculty tended to be more criterion-referenced.

In the only study of teacher knowledge uncovered by this literature search, Emshousen (1983) administered an energy knowledge test to a sample of Indiana high school teachers of home economics, agriculture, and industrial arts. In general, it was found that teachers had limited energy knowledge: they knew more about energy conservation, conversion, and policy issues than about energy sources.

Program Effectiveness

In 1980, the American Industrial Arts Association published *Standards for Industrial Arts Programs and Professionals*, designed to serve as an instrument with which to assess secondary school industrial arts programs. The rationale and procedures used to develop the standards were reported by Dugger et al. (1981c). To field test the standards, McEvoy (1984) presented written descriptions of 3 industrial arts sample programs to a jury of 177 teachers, supervisors, and administrators and asked them to apply 30 of the 235 standards. The wide range of ratings obtained for each of the three sample programs suggested that there was very little agreement among the respondents regarding application of the standards.

A slightly different version of program standards was developed by Stoudt et al. (1985) for the purpose of identifying outstanding programs in industrial arts. Standards statements were grouped in categories that included purpose, administration and supervision, learning resources, finances, instruction, equipment, facilities, instructional staff, leadership training, safety and health, recordkeeping and evaluation, and student populations served.

In 1985, the existing standards document for industrial arts was revised and published under the title *Standards for Technology Education Programs* (International Technology Education Association 1985b). The new standards document included sections on philosophy, instructional programs, student population served, instructional staff, strategies, public relations, safety and health, and evaluation. Pinder, Bame, and Dugger (1985) described methods used for revision. Bradley's (1986) was the only attempt at verifying the technology education standards that was found. This investigator slightly modified the new standards and used them in interviews with 32 program chairpersons of Missouri school industrial arts programs, concluding that the standards did not serve as an effective instrument for program evaluation.

As noted in another section of this paper, the Industrial Arts Curriculum Project (IACP) was one of the major curricula developed and implemented in the 1970s. LaPorte (1980) surveyed a sample of 292 schools from an estimated 935 that originally adopted the curriculum and found that although few of the schools were still using all of the materials, there remained a great deal of adaptation and variability in the extent to which IACP was used.

The literature included several studies of program evaluations based on teachers' assessment. One study (Hammer 1982) analyzed survey responses from 123 industrial arts instructors in Idaho schools and concluded that most programs have adequate program philosophy, objectives, goals, and qualified instructors but that the standards in areas of safety and student groups were in need of attention. Berghauser's (1982) study of Missouri industrial arts programs found that most reported a low level of technology but that teachers and administrators were satisfied with the existing curriculum. A study of electronics programs in New York State (Gates 1981) concluded that current programs were not reflecting changes in industry. Slack and Hughes (1979) evaluated Utah junior high school programs in career exploration and concluded that teachers were the single most significant influence on a successful program.

A self-study of graduates from a Texas industrial arts teacher education program (Lambert 1980) concluded that the curriculum had prepared them adequately for their present employment, but graduates currently employed in industry were less satisfied with their training than those in education. Patterson (1980) surveyed school administrators who were employing graduates of a particular university and found that teachers were rated above average in some areas of preparation but needed better preparation in project development, organization, inventory control, laboratory management, and oral and written communication. A similar survey of industrial education graduates of a university in Tennessee (Harrison 1983) concluded that graduates were reasonably satisfied with their preparation. Readers concerned about teacher shortages should note that Harrison's respondents rated industrial arts teacher education valuable because it enables individuals to pursue work not only in education but also in industry, which was clearly reinforced by the finding that 62 percent of the respondents were employed outside of education.

Summary

It would appear that research on evaluation of student learning is in short supply, although opportunities abound. There were no studies of methods being used by teachers to assess student achievement in group activities such as team problem solving or mass production. Nor were there investigations of how students with learning disabilities or physical handicaps are being evaluated.

Evaluation of teacher knowledge is another area needing far more attention. According to conventional wisdom, older teachers are unfamiliar with newer technologies being included in contemporary curriculum models, but there was no evidence of research on this or related topics. With new technology-based curricula being implemented, research is needed to determine if teachers with limited work experience in business and industry have an adequate knowledge of today's technologies.

Research on program evaluation revealed mi ed findings regarding the employment of program standards. Studies of program effectiveness showed that, although generally teachers and students were satisfied with the status quo, many different types of criteria were being applied. Several studies suggested that the program criteria produced by the Standards Project need to be verified and perhaps modified to improve their validity and consistency. Measuring against external standards is, of course, only one way to assess program effectiveness. Research also is needed to develop and verify methods of measuring the program results against stated goals.

TEACHER EDUCATION

A substantial number of studies dealt with teacher preparation. For the purposes of this paper, they were divided into groups that focused on teacher supply (including recruiting and retention), undergraduate programs and field experience, graduate programs, and inservice training.

Teacher Supply

Pinder and Rieber (1980) reported demographic data from the Standards Project demonstrating that during the period 1975-1978, approximately 56,000 industrial arts teachers were employed in the 44 states reporting. Nearly half of the teachers held Master's degrees, the average years of experience were 11.5, and women made up 1 percent of the total. Among 34 states reporting, teacher vacancies increased from 812 in the 1976-1977 school year to 1,077 in the 1978-1979 school year. Styles (1985) applied general forecasting techniques to births, daily attendance figures, and other demographic data in Georgia schools and found that the demand for industrial arts teachers will remain relatively stable through 1995. At the college level, Kerekgyarto (1982) surveyed 200 industrial arts (IA) teacher education institutions and found that undergraduate enrollments in IA were increasing more than graduate enrollments and that one-third of the IA faculty will retire before 1992. It was also determined that faculty vacancies in teacher education were highest in electricity/electronics, power mechanics, graphic arts, and woodworking.

Nall (1982) surveyed teachers who had taken positions within the past 3 years in industrial arts and other subjects with teacher shortages. When asked why they had chosen a particular school district, teachers listed the following reasons (in decreasing order of importance): spouse's job, friendliness of administration, discipline, salary, facilities, personal growth, philosophy of school, competence of staff, chance to use special skill, friendliness of staff, and teacher workload.

Pontius (1981) studied 34 individuals who had left industrial arts teaching positions in two school districts in Illinois during calendar year 1979 and found that 17 were employed in business and industry and 11 had taken industrial arts teaching positions in other districts. Of the remaining six, two were in administration, one was in graduate school, one retired, one was a minister, and one was unemployed. The primary reasons for making a position change were financial, administrative, and student problems. These findings were generally consistent with those of another study (Edmunds 1982), in which former teachers named salaries and other compensation, administrative support, and insufficient resources and facilities as the major reasons for leaving the profession. Similar factors were cited in a study of why industrial arts teachers decide to stay in teaching (Bloemker 1983). None of these studies found years of experience, teaching specialty, years of formal schooling, or work experience to be significant factors in teachers' decisions to stay or leave.

Several studies attempted to find how many potential industrial arts teachers were in training and why they chose the profession. Sharpe (1981) polled 668 undergraduate majors in industrial arts teacher education in 24 institutions and determined the typical student to be a white single male, 21 years old, with part-time work experience, who had made a decision to teach while enrolled in high school industrial arts. The three most influential sources of recruitment information came from visits to university facilities, contact with university personnel, and recruitment literature. The most influential persons identified were industrial arts teachers, parents, and university personnel. These findings closely paralleled those from Cecere's (1980) survey of 240 teaching majors in Texas institutions, Dillon's (1985) study of 25 industrial arts students graduating from North Carolina universities, and Devier's (1981) survey of majors in Ohio industrial arts teacher training programs.

In a study of 242 older students (over 25 years old) in teacher training programs, Harden (1981) found that most were preparing for a second career. Half of them decided while working to study industrial arts, and they did not perceive recruitment practices used by colleges to be effective. However, personal contact with industrial arts professionals was considered effective.

A number of studies investigated job satisfaction of teachers. Wright (1985) conducted telephone interviews with a stratified sample of 45 industrial education teachers in Illinois and found the majority planned to continue to teach traditional woodworking, metalworking, or drafting. The subjects reported personal pride in their profession and general satisfaction with their jobs but not with their salaries and benefits. Of those who planned to quit teaching, salary was not a reported factor. A. D. Davis (1981) studied teachers who had received industrial arts teacher certification in North Carolina in the years 1975-1979 and found that only 25 percent were teaching industrial arts. Personal satisfaction derived from working with young people and from working in an industrial arts laboratory was cited most often as the positive aspects of teaching. Negative aspects included salary levels, student behavior, and advancement opportunities. A related study of 183 Iowa industrial arts teachers (Chen 1985) found that most were satisfied with their teaching positions. Those who were dissatisfied identified salary and benefits, school administration, and teacher status as the primary reasons.

In a study of 558 industrial arts teacher education faculty (Wolfson 1986), respondents were predominantly white males and averaged 47 years of age. Over 84 percent indicated some degree of satisfaction, with the mode being in the slightly satisfied range. Jones' (1984) survey of 639 doctoral degree graduates in industrial arts and industrial-vocational education found only 63 percent employed in educational institutions. Only half of the graduates were satisfied with their jobs.

Undergraduate Programs and Field Experience

Three studies of undergraduate teacher preparation appeared in the research. MacDonald (1981) conducted a survey of teacher educators and citizens of Nova Scotia to determine their opinions about knowledge and skills that would be needed by Nova Scotia citizens in the years 1980-2000. Findings indicated that existing industrial arts teacher education programs were too narrow in scope. Kozak, Devier, and Harrington (1982) conducted a literature review and developed a catalog of professional and technical competencies needed by industrial arts teachers in Texas in visual communication technology, energy/power technology, and production technology. In another study, Andrews (1984) investigated industrial arts teacher education program design models and concluded that nearly half of the programs are still composed of traditional subjects of industrial arts, although the courses were categorized within contemporary curriculum clusters.

Several studies investigated practices related to early field experience and student teaching. Clark (1985) examined five exemplary university field experience programs and determined that the model program called for 100 contact hours of early field experience; a semester-long, full-time student teaching experience; and a first-year teacher program to provide support for new teachers. In a Delphi study of student teaching (Foster and Kozak 1986), panelists ranked the following characteristics as most important: (1) supervision is conducted by subject matter specialists with at least 3 years of successful teaching experience; (2) the university supervisor is a qualified industrial technology teacher educator who visits the student teacher at least three times during the field experience; and (3) the student teacher is given proper orientation to each field experience. In a followup study, Foster, Kozak, and Price (1985) developed a guidebook for use in implementing model field experiences in industrial arts programs. In a related study (Parnell 1981), university supervisors, student teachers, and cooperating teachers named curriculum, types of activities, budget control, class and lab organization, and class size as the most important variables in selecting student teaching sites.

A study of early field experience (pre-student teaching) requirements among 141 industrial arts teacher education programs (Kuetemeyer and Udofa 1986) found that early field experience was most often provided in the sophomore year, required 20-30 contact hours, and was coordinated on the college level, not the department level. In a related study, Whelan (1985) used the Delphi technique to derive 59 student learning experiences recommended for pre-student teaching experience in industrial arts teacher education programs.

Graduate Programs

The American Council on Industrial Arts Teacher Education (ACIATE) (1980) published standards and guidelines for graduate degree programs in industrial arts. At the doctoral level, Koble (1981) reported opinions of randomly selected members of ACIATE regarding the characteristics of quality in doctoral programs. A related study of industrial education doctoral program characteristics revealed that there is little difference between Ph.D. and Ed.D. programs, that newer programs were modeled on existing ones, and that students in either category had similar experiences and employment patterns (Wolansky and Miller 1981; Wolansky and Resnick 1982). Ugonabo (1981) sampled faculty, doctoral students, and recent doctoral graduates from 16 institutions and concluded that the major determinants of quality were faculty, students, curriculum and instruction, and facilities.

Arnold (1986) polled vocational/industrial education instructors in colleges and universities in the Rocky Mountain region to determine their interest in obtaining the doctoral degree. Items identified as being of most importance when obtaining the doctoral degree were financial aid, tuition cost, reputation of the institution, modern facilities, availability of coursework in the teaching specialty, and available courses in summer. A study of black doctoral students and doctoral degree recipients in industrial education (R. J. Davis 1981) revealed that admissions into the 34 doctoral programs were largely based on grade point average, letters of recommendation, and standardized test scores, respectively. Data showed that doctoral programs did not give preference to black applicants through testing and that the attrition rate for blacks was no different than for nonblack doctoral students. Chairpersons in predominantly white institutions rated blacks' professional preparation, leadership potential, and teaching abilities as weaker compared to those of whites. Chairpersons in predominantly black institutions rated blacks stronger in each category except "scholars/researchers."

Inservice Training

Knold (1981) surveyed 37 teachers in Seattle and found their propensity to participate in voluntary inservice training was positively related to their job satisfaction. Smink (1983) found that teachers generally preferred inservice education on days when they were being paid under contract and prior to the beginning of their classroom responsibilities. A study of the need for inservice training for working with handicapped students (Doty 1982) found that although over 77 percent of the 300 teachers sampled indicated a need for it, only 40 percent had received such training.

Summary

Due to a substantial amount of research on teacher supply, recruiting, and retention, the typical industrial arts/technology education teacher was found to be a white male, 44 years old, holding a master's degree, with 11 years of teaching experience. The typical teacher was satisfied with his teaching position, but was frustrated with his low salary and unsupportive administrators. Although most technology education teachers were satisfied, the major reasons for lack of job satisfaction were low salaries, unsatisfactory job conditions, and lack of administrative support. The research also revealed how few teacher training graduates actually become teachers. These data are alarming, and they hold important implications for inservice training, state curriculum implementation, and teacher education.

Teacher training programs continued to be a focus of research, most of which was descriptive in nature. There were few studies of the effects of different types of field experience, and although the general literature on teacher education contains many studies on student teaching variables, it would seem that the nature of technology education might be important enough to warrant specific research on instructional variables. For example, research is needed on laboratory facilities and their effect on student teachers. Research is also lacking on possible effects of student supervision by general education personnel versus supervision by technology education professionals.

There were some studies of graduate programs, but longitudinal studies are needed that would include information on how many teachers change positions in the first few years after graduation, what additional training is received, and how it relates to perceived needs.

Research on inservice training was one of the weakest categories in this section. Although the few studies cited here added to the knowledge base, more research is needed. With an impending emphasis on curriculum implementation of new technology education programs, it would be useful to know more about what kinds of inservice programs are already in place, who receives the inservice training, how it is conducted and what the outcomes are.

ADMINISTRATION AND SUPERVISION

A small number of studies were found to relate to this category, most of which reported attitudinal data. This section includes studies of the attitudes of administrators and citizens as well as studies of the roles and practices of administrators.

Attitudes

The American Council of Industrial Arts Supervisors (1985) recommended a set of qualifications, duties, and responsibilities for state and local administrators of technology education. Guidelines included personal characteristics, administrative responsibilities, supervisory duties, and public relations functions. A survey of industrial arts state supervisors (Cox and Young 1980) found that most respondents thought industrial arts should play a role in both general education and prevocational education. Respondents also indicated that junior high school programs should promote a broad awareness of industry and technology and high school programs should emphasize prevocational and technical content. Among major issues identified by the study were lack of curriculum definition, professional identity, and teacher professionalism. Benson (1982) polled the attitudes of school principals, counselors, and vocational supervisors in Georgia and found that most had generally favorable attitudes toward industrial arts.

Assuming that the public often influences the administration of school programs, Bebee (1985) conducted a telephone survey of 400 Ohio citizens and found (1) support for inclusion of all industrial arts content, especially that related to consumerism and career awareness; (2) greater support for the "know" component than the "do" component; (3) support for technology studies to be of equal importance to science studies; and (4) support for including more study of technology.

Roles and Practices

In Hwang's study (1983), department heads of 148 industrial arts teacher education programs rated their administrative functions in the following order of importance: recruitment and selection of faculty, communication between department head and faculty, liaison between central administration and department, public relations, and search for new equipment. In a related article, Israel (1984) offered a definition of scholarship and service that might be used by industrial education department chairpersons to evaluate faculty productivity.

One of the major tasks of administrators is related to funding. Dyrenfurth (1984) analyzed the Carl D. Perkins Vocational Education Act of 1984 and noted considerable opportunities for funding of industrial arts, including innovative programs that stress new technologies and development of special courses and teaching strategies to teach math and science through practical arts. Also noted were opportunities for support of research, conferences, and assessment of program effectiveness. In a discussion of sources and strategies for obtaining funds for industrial arts (Almeida et al. 1985), four state supervisors identified the importance of obtaining federal vocational funding to help pay for curriculum development and new equipment.

Summary

Studies of school administrators' and citizens' attitudes indicated strong support for technology education programs. These findings should bolster efforts to upgrade technology education programs in the schools. It is important to note administrators' expectations that industrial arts and technology education play a dual role in fostering general education as well as prevocational preparation. Studies of administrative roles and practices hold implications for technology education supervisors and department heads of teacher education programs. Dyrenfurth's study pointed out the need to investigate additional vocational education funding sources that could support technology education programs.

PROFESSIONAL CONCERNS

Given the large amount of interest expressed in the general literature of the profession, it was surprising to find little research on professional concerns. Studies in this category include research about professional associations, professional leadership, and professional research activity.

The literature search uncovered one research effort related to professional associations. Oaks (1985) surveyed industrial arts teacher preparation programs to determine how many had a technology education or industrial arts college club and in what way they were involved in professional leadership activities. Most of the 88 institutions with college clubs reported membership involvement in conducting state conferences, although much of the activity was related to preconference duties such as arranging for participant housing and transportation. Only 20 of the 88 clubs were affiliated with the Technology Education College Association (American Industrial Arts College Student Association), and few of the 20 reported active recruiting of new members.

In the only study devoted to the topic of leadership, Wenig and Matthews (1983) edited an American Council on Industrial Arts Teacher Education yearbook focusing on professional leadership issues, theories, models, strategies, and recommendations for action. The yearbook included a review of leadership theory models, characteristics of creative leadership, and application of creative leadership to professional activities.

On the topic of profes[illegible]search activity, Dyrenfurth and Householder (1979) provided a synthesis of research in in[illegible] arts reported during the period 1968-1979. The report included an overall evaluation of the [illegible]rch and an analysis of studies within each of the major topic categories. Strengths and weaknesses of research were identified as well as recommendations for improving research methods. It was noted that there was an overall increase in the amount of research, especially postdissertation studies, and a general diversification of types of people who engage in research. On the other hand, the synthesis found a general weakness in the experimental rigor, especially regarding poor choice and use of research designs, such as sampling techniques.

In a related study, Gill, McNamara and Skinkle (1980) analyzed research reported in the first 15 volumes of the *Journal of Industrial Teacher Education* and noted a tendency among researchers to base interpretations of [illegible]a entirely on the results for statistically significant differences. The investigators proposed that more attention be given to measures of practical significance such as the omega-squared statistical index. DeVore (1983) reviewed the professional literature and concluded that there was too much focus on teaching methods and not enough on curriculum content. He recommended that a new research agenda be derived from problems grounded in technology and pedagogy.

As a guide to improving research, the 36th yearbook of the Council for Technology Teacher Educators (Israel and Wright 1987) offered a comprehensive overview of strategies for conducting technical research with applications for technology education. Swanson (1984) edited a monograph containing papers that resulted from a National Association of Industrial and Technical

Teacher Educators symposium on research. Noting that data collected about industrial arts programs tend to be fragmented and inaccurate, Young (1982) sought to determine the data needs of state industrial arts supervisors. A continuous data-based information system model was then developed to provide better data for decision making. In a three-part series, Lolla (1983a,b,c) provided a rationale and strategies to help teachers do more classroom research.

Summary

No research was found on professional associations for teachers. Many questions remain about what roles professional associations might play in developing leadership skills or in contributing to the profession's goals. A survey of college student organizations indicated that a relatively small percentage of students hold membership and those who do so are not participating in meaningful ways.

The yearbook edited by Wenig and Matthews went beyond the literature of technology education to include related literature of the social and managerial sciences. Individual chapters traced the development of leadership theory and practice in other professions and suggested applications in technology education.

Studies of research activity identified a number of concerns about the quality of research. Specifically, problems were found in research designs and interpretation of data. The studies also illuminated some areas that have been overlooked and provided guidance for improving the quality of research. Additional research in this area could investigate the specific causes of such problems and suggestions for improvement. Other studies noted that there is a need for more accurate data bases for the profession.

SUMMARY AND RECOMMENDATIONS

Studies reviewed in this synthesis paper provide a general picture of the types of research reported in the 6-year period under investigation. Taken as a whole, the studies provided a montage of the technology education profession during an important period of evolution.

In general, it can be said that the comparatively young technology education profession is maturing in its efforts to build a more adequate research base. Although difficult to quantify, the amount of research during the period of 1980 through 1986 was impressive. Perhaps spurred by the questions and criticisms of proposals for a change in the content base from industry to technology, greater research attention was given to identifying the philosophical foundations and conceptual bases for new directions. At the same time, a great quantity of information was provided about what was actually happening in the laboratories and classrooms.

Weaknesses

The original charge carried with it an obligation to identify weaknesses in the research literature. But in a positive sense, weaknesses can be viewed as opportunities for improvement, and it is in this spirit that the following observations are presented. General weakness will be discussed first, followed by discussions of specific topic areas.

General Notes

As noted in previous syntheses (Dyrenfurth and Householder 1979; Streichler 1966), selection and use of research design remains a persistent problem. Although the number of studies precluded detailed analysis of experimental designs, it was evident in some cases that findings did not warrant the conclusions. Some studies were excluded from this paper because they used faulty research designs. In one doctoral study of teaching methods, for example, the control group and the experimental group were given the same treatment (a lecture and demonstration). The experimental group was then subjected to additional content via computer-assisted instruction (CAI) and both groups were given a knowledge test. As might be expected, the experimental group, which had received additional instruction, scored higher than the control group. It was then wrongly concluded that CAI was a useful instructional tool to increase student knowledge.

Some experimental studies either focused on a single, somewhat trivial variable, or they included so many extraneous variables that the results were inconclusive. Doctoral dissertation abstracts, for example, often included so many uncontrolled variables that it was difficult to determine how the data could have warranted so many conclusions and recommendations. A related weakness was noted in the size of the population samples. Granted, many of the studies focused on local or state concerns in which the population size was restrictive by its nature, but in many cases the sample population could have been enlarged so as to strengthen the findings of the study.

Another weakness was noted in the way abstracts were written, especially in doctoral dissertations. Some studies that otherwise sounded promising could not be included in this synthesis paper because their findings were not communicated clearly enough to determine if the study was significant. As micromedia and electronic data bases are becoming more predominant than papercopy records, abstracts serve as the first line of communication between the original investigator and other researchers wishing to find what has been done in any particular research topic. If abstracts do not clearly indicate the nature of the population, the treatment, the findings, and the conclusions, there may be a tendency for readers to pass over what might be a significant addition to the knowledge base.

It was evident that the survey technique is a frequently used research method in the technology education profession. Assuredly, surveys can be practical means of obtaining certain types of information, especially quantitative measures of attitudes and opinions. However, surveys have serious shortcomings. The population selected for a Delphi survey, for example, will generally determine the results of the study. Overdependence on the Delphi and other survey methods could limit development of the research base.

Human Resources

Much of the descriptive research in this category resulted from the Survey Data phase of the Standards Project, and information is now available regarding the gender and racial balance among students and teachers. Data were also provided to show the numbers of students with special needs enrolled in industrial arts/technology education programs. Several guidelines for establishing equity and for adapting to special needs students were also established. However, there was very little research to determine what adjustments are being made in practice or how effective they might be. Nor was there much research to determine what knowledge and skills are needed, not only in industry, but in society in general.

Learning Process Variables

The number of studies related to special needs students, learning styles, personality variables, and creativity signaled a growing concern for issues in this category. However, the number and quality of studies about the effect of organizational patterns was disappointing. Overall, it must be concluded that the profession is gaining very little knowledge about the learning process in the context of technology education.

Instructional Media, Materials, and Methods

The best that can be said of research in this category is that there has been some research related to instructional methods such as directive versus indirective teaching, although many of the findings were inconclusive. Other than studies of computer use, there was almost no research about the effect of instructional media or materials.

Student Personnel and Guidance

Studies to determine career maturity seemed to be designed to find evidence that industrial arts/technology education courses improve student career choices. In general, findings were inconclusive. Although there were a few studies of student characteristics, this topic, too, was largely unexplored.

Facilities

In contrast to need, especially as the profession alters its course toward technology content and new teaching methods, this category was one of the weakest of all. Lab planning was represented by only one study about the nature of existing laboratories (based on the Standards Project's survey data) and by a set of guidelines for modifying laboratories to meet the needs of handicapped learners. A few studies related to laboratory safety and mobile facilities added to a meager total. There were no studies of the effects of table-top training equipment for computing, robotics, solar energy, pneumatics, or electronics. Nor was there any research on the effect of using existing laboratories, many of which were designed to teach industrial processes, not concepts and principles of technical systems. It would seem that more research on facilities is needed if new curriculum content is to be implemented in the schools and universities.

Evaluation

There were some studies of school and university program effectiveness and others that assessed the capabilities of teachers. Research on evaluation of student learning, however, was not in evidence. It must be concluded that the profession is simply not exploring how best to determine student achievement of instructional goals.

Professional Concerns

It was encouraging to see research activity devoted to the practice of research itself. This finding correlates with the conclusion offered at the beginning of this chapter—that there seemed to be an overall increase in quantity and quality of research, compared to the previous decade. In addition, there was research activity on the topic of professional leadership, which is sorely needed if the field of study is to make progress in the years ahead. On the other hand, there was no research related to professional associations, their characteristics, or their effect on those whom they serve. This finding raises the question of to what degree the field of study is, in fact, a profession as measured against established fields such as science education and engineering education.

Strengths

Despite the weaknesses noted here, the research reviewed in this paper illustrated some significant strengths. In general, there was an obvious increase in research activity, especially in certain topic categories. A large degree of credit must go to the various professional associations and their journals, monographs, and yearbooks, which provided investigators with outlets for dissemination of their research findings. Though it was not quantified, the breadth of research was impressive, as was the number of investigators involved in research. With few exceptions, no single researcher or group of researchers dominated the research scene in the 6 years reviewed in this paper. This expanding research base was noted by Dyrenfurth and Householder in their research synthesis published in 1979. It appears that research activity in technology education has finally come of age.

History, Philosophy, and Objectives

Clearly, this category was one of the strongest areas of research. Studies of the profession's historical roots strengthened the sense of progression in the field of study, and the Jackson's Mill curriculum theory document and subsequent studies added much to the knowledge base of philosophical foundations. Studies related to goals and objectives, although plentiful, left something to be desired. Results were widely mixed and sometimes in conflict, depending upon which population was sampled. Overall, however, the profession can be proud of its research accomplishments in this area.

Status Studies

In addition to providing a large amount of national data, the Standards Project also served to encourage a number of status studies at the regional and state levels. Although not encouraging in substance (the national Survey Data showed little change in curriculum or facilities in 15 years), the findings provided a firm knowledge base from which program revisions can be judged.

Curriculum

This category of research might be classified as both a strength and a weakness. Program content received a large amount of attention, as did the area of curriculum development and implementation. On the other hand, there was very little research focusing on the translation of program objectives and content into instructional units or activities.

Needs and Recommendations

Much has already been said in this paper about the need for improved research methods, especially related to research designs. More than a few of the doctoral dissertations reviewed for this paper were found to be of questionable quality, and that is alarming. Today s doctoral graduates will be the researchers and research advisors of tomorrow; they will need to be well grounded in the fundamentals of research theory and practice. Research advisors must take great care in coaching their students not only to develop valid research designs, but also to focus on topics of significance to the field of study. Improvements are also needed in the way research reports are communicated in print. Even the best research designs and significant findings can be lost if reported in a quagmire of stilted jargon. After expending a great deal of intellectual and physical energy on the research itself, researchers should make a concerted effort to report results in the clearest manner possible.

The value of research lies in its application, and practitioners and other investigators need ready access to the literature. We are in the age of electronic communication, and we must make use of the technology. Many teachers (and students) now have computer equipment capable of downloading research data to their classrooms, offices, and homes. Efforts should be made to ensure that research results are made available on existing data bases, or new storage/retrieval data bases should be established. During the course of research for this paper, it was noted that several significant pieces of research did not appear in the data banks. Either the documents were not entered or they were given descriptors other than the keywords used for the search. In any case, investigators are encouraged to ensure that their research is abstracted in a way that will lend itself to retrieval by others.

Part of the information access problem may be caused by the ambiguous terms used by researchers. Does a study on "industrial education" refer to industrial arts, technology education, technical education, or industrial studies? If a research abstract indicates that the study has implications for vocational education, it may also have implications for technology education and should be coded to assist researchers in both fields of study. Is a study on "graphic communication technology" related to one on "computer-assisted drafting"? It would be no surprise if those who determine keyword descriptors might be confused. A few institutions are apparently trying to solve this problem by including suggested keywords as a part of the title when the abstract is submitted to a data base. If this were to become a common practice, it might help, but a better solution would be for the profession to form a consensus on terminology in the same way that agreement was reached on the curriculum foundation for technology education.

Related to this suggestion, there is a need for a comprehensive research agenda in the profession. The 36th yearbook of the Council for Technology Teacher Educators (Israel and Wright 1987) could serve as a point of departure toward this goal. Much of the research cited in this study, though potentially useful, was fragmented. There seemed to be no common direction nor set of recognized priorities for investigation. It could be that as members of the profession become more comfortable with the new philosophical foundation and content structure for technology education, a consensus for research will evolve. However, there is a need for direction now. Unless the profession can show progress in its knowledge base of theory and practice, it could become vulnerable to other political and economic priorities.

The profession also needs more classroom research. Many teachers report that the exigencies of daily schedules leave little time for research. This attitude, unfortunately, belies an assumption that research is something done outside the school. Perhaps the mystique of formal research should be removed and teachers shown how to carry out brief, uncomplicated studies directly related to their day-to-day concerns. Supervisors and administrators could have a significant impact on the profession by encouraging teachers to conduct research. Likewise, teacher educators could invite teachers to carry out research in their classrooms as part of graduate courses. As a result, the numerous curriculum revision projects recently begun at state and local levels could generate some extremely important findings for the profession.

In addition to these general needs and recommendations, there are a number of specific topic areas in need of research attention. With the profession undergoing massive changes in curriculum structure and philosophy, research that was adequate yesterday may be obsolete today. The primary question is "What research is of most worth?" The answer, of course, is difficult to determine. Although the topics named here are somewhat arbitrary, perhaps they will serve to stimulate further action.

Status Studies

The Industrial Arts Standards Project of 1978-80, with its survey data, provided the profession with much-needed information. However, a new curriculum direction could result in sweeping changes within a few short years. Planning should begin now to conduct another national status study of the same magnitude before the end of the present decade. Improvements are also needed in the reporting of federal and state data regarding numbers of students, programs, and means of fiscal support. In addition, more studies are needed to document industrial/technical education on the international scene in order to put U.S. program efforts in perspective and to uncover promising practices used in other countries.

Curriculum

New curriculum guides and textbooks are being generated at a quickening pace, but technology education teachers need to know what teaching units and learning activities to employ. There is an immediate need for research, both developmental and descriptive, on teaching methods and materials to implement the new programs. Despite the attitudes expressed by respondents to one study cited herein, more of the same will not be sufficient. The problem facing teachers now is not what content is to be learned, but how students are to learn it. Electronic media, for example, might help solve some of the problems facing teachers in small schools and rural areas where facilities and curricular offerings are inadequate.

Learning Process Variables

Closely related to this concern is the need for more studies of alternative organizational patterns, use of educational technology, and methods to improve problem-solving abilities. Research, some of it cited in this paper, clearly indicates that creatively and academically gifted students are not being challenged by existing programs of industrial education. We need to know what causes the situation and what can be done about it.

Facilities

The topic area of facilities has gone far too long without attention. National data show that existing laboratories are predominantly unit shops with outdated industrial production equipment purchased during the post-war years. As new curricula are introduced, teachers will need guidance to select new equipment and suggestions for modifying existing facilities. Research should begin immediately to determine what a technology education laboratory should/could be and what steps might be most effective in moving toward that goal. Research on mobile or shared facilities was more prevalent a decade ago, and perhaps those findings could spur new investigations using recent developments.

Endnote

This synthesis of research in technology education has found an impressive amount of effort expended by members of the profession during a relatively short period of time. There has been substantial progress in some areas of research and slippage in others. It is imperative, however, that researchers at all levels recognize the importance of redoubling their efforts to continue building the knowledge base, lest the profession regress toward mediocrity.

The scope of studies cited in this synthesis paper also suggests that research in technology education may have developed to the point that more frequent papers on specific research areas are needed. Research on any one of the topics or subtopics in this paper should be reviewed and analyzed on a regular basis in order to disseminate the findings and to stimulate further investigation.

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