ADAPTATION AND VALIDATION OF A TECHNOLOGY ATTITUDE SCALE FOR USE BY AMERICAN TEACHERS AT THE MIDDLE SCHOOL LEVEL

by

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(ABSTRACT)

The purpose of this study was to adapt and validate the Technology Attitude Scale (TAS) for use by American teachers at the middle school level. The study provided an instrument for American middle school teachers to determine students' attitudes toward technology and concepts of technology.

The Technology Attitude Scale (TAS), an adaptation of a Dutch instrument consisting of three sections, was used to collect descriptive information. The first section of the instrument obtained demographic information about the respondents including: (1) age (2) grade level (3) gender (4) school location (rural, urban) (5) respondents involvement with technology education.

The second section obtained information about students' attitudes toward technology. There were 26 items divided over 6 subscales, (interest, role pattern, consequences, difficulty, curriculum, and career). Students responded by using a five choice Likert-type scale with 3 to 5 items per subscale.

The third section obtained information about the students'

concept of technology, measuring cognitive or knowledge aspects based on 5 generally accepted characteristics of the concept technology. There were 28 items divided over 4 subscales, (technology and society, technology and science, technology and skills, and technology and pillars).

Content validity was determined through a Panel of Experts consisting of five individuals with expertise in middle school education.

The study population included five middle schools in Virginia. It consisted of a Pilot Study (*N* = 48) and a Large Group Administration (*N* =185). Statistical analysis included reliability measures using Cronbach's homogeneity coefficient alpha (Attitude Scales) and Kuder-Richardson 20 (Concept Scales) with attention to demographic information. Both the Attitude Scales (overall correlation .81) and the Concept Scales (overall correlation .83) met the minimum criterion (.60).

The Technology Attitude Scale (TAS) has been adapted and validated for use by American teachers at the middle school level.

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CHAPTER I. INTRODUCTION

> Throughout the history of civilization, the social fabric of humans and their enterprises has been interwoven with the thread of technology. Accordingly, young adults need to be familiar with technology and its dynamics, pervasiveness, and relationships to the society in which they will live and work. (Johnson, 1989, p. 1)

The importance of understanding technology by the citizens of the U.S.A. has been recognized by business, government and education leaders. Major reports espousing solutions to problems facing public schools during the eighties mention the importance of studying and understanding technology. Boyer (1983) in High School includes the study of technology as a part of the core curriculum for students. "We recommend that all students study technology: the history of man's use of tools, how science and technology have been joined, and the ethical and social issues technology has raised" (p. 110). In a document published by the International Technology Education Association Boyer (1985) states, "The issue . . . is the changing of our society, driven by a technology revolution that is as fully important as the industrial revolution over 100 years ago" (p. 6).

The Education Commission of the States published a report in June of 1983, Action for Excellence, which stated that schools must upgrade the definition of basic skills, and recognize the importance of technology (p. 9). In the report Educating Americans for the 21st

Century. The National Science Board on Precollege Education in Mathematics, Science and Technology (1983) lists as a priority not only reading, writing, and arithmetic, but also communication and higher problem-solving skills and scientific and technological literacy (p. 45). The message of each report varies, but a singular theme, the importance of technology, manifests itself often enough to focus attention on this important aspect of society. These references to the importance of technology by leaders in this country and the prevalence of a multitude of technological influences on the lives of our citizens leaves little doubt that the study of technology in our schools should be given consideration.

The study of technology is not exclusively an American phenomenon. Leaders in several countries are investigating means to include the subject of technology in their schools. In England, Design and Technology is mandated as part of the national curriculum and according to Atkinson (1990) technology is one of the 10 subjects all children must study at school (p. 11). Nigeria is making gradual but steady progress toward integrating technology education in the schools (Akubue, 1992). Interest is growing and programs are developing in India, Australia, Canada, African countries, and in Eastern and Western Europe (Raat, 1991, p. 20). Because technology has become so wide-ranging and acquired such an important position in the cultures of most countries in the world, it is essential that the study of technology be undertaken with international cooperation. It can be most useful for the development of the subject world-wide that experiences and results of research and curriculum development are exchanged.

During the mid-1980's, researchers in the Netherlands introduced efforts to include the study of technology in the curriculum of the schools. A large-scale research project was put forth to determine what pupils' beliefs were about technology. The result was an instrument known as the Pupils' Attitude Toward Technology (PATT), the use of which soon spread to other countries (Raat, de Klerk Wolters, and de Vries, 1987, p. 14). Another instrument, the Technology Attitude Scale (TAS), was generated in 1987 and was evaluated and revised by R. Coenen-van den Bergh in 1988 and 1989 (de Klerk Wolters, 1989a, p. 9). The TAS instrument, like the PATT instrument, is a questionnaire that provides information on what pupils think of technology. The TAS is specifically designed for use by the classroom teacher to determine student attitudes toward technology and concepts of technology (de Klerk Wolters, 1989a, p. 102).

This study examined the validity of the TAS instrument with selected middle school students in the State of Virginia.

Need for the Study

Technology as a school subject in general education teaches students to better understand the technological world around them and contributes to the development of a more positive attitude towards technology (de Klerk Wolters, 1989a, p. 3). The fact that pupils have different opinions of technology has already become evident from various research studies including Shrigley & Koballa (1984), Koballa & Crawley (1985), Todd (1986), Raat, de Klerk Wolters & de Vries (1987), de Vries (1987b), de Klerk Wolters (1989a), Bame & Dugger (1989), and Dunlap (1990). For a teacher it is important to know if the pupils in class have ideas of technology that are different from the perceptions of the teacher. The teacher may assume that students understand that the term technology encompasses many aspects of the technical world, when in actuality students associate the term with machines, computers or even the equipment used to present lessons to a class. The term technology is used in a myriad of ways. It is advantageous for instructional purposes that before teaching about technology, the teacher understand the students' understanding and perceptions of technology. Incorrect beliefs can be corrected, correct knowledge and understanding can be reinforced. Curriculum preparation is based on student needs instead of some notion the teacher has of what is correct or needed. When student attitudes toward technology and concepts of technology are known, a teacher can better plan and adapt lessons that address this subject.

Statement of the Problem

The purpose of this study was to adapt and validate the Technology Attitude Scale, originally developed in the Netherlands, for use by American teachers at the middle school level.

Significance of the Study

This study was significant because it provided an instrument for American middle school teachers to determine students' attitudes toward technology and concepts of technology. No instrument for determining attitudes towards and concepts of technology at the middle school existed. A research instrument must be developed with the intention of adhering to the highest possible accepted research standards to ensure that the best available data for the study may be obtained by the user.

Teachers should be able to ascertain what students think about technology, which enables adjustments in curriculum to reflect differences in perception between student and teacher. Because curriculum so obviously involves both students and teachers, it should be built collaboratively between them.

Another important aspect of the study was the autonomy it provides for the teacher in the use of the Technology Attitude Scale. The TAS is administered, scored and interpreted by the teacher, eliminating reliance upon out of school expertise for these services, thus directing valuable time to the task at hand, teaching. The teacher will be better able to plan curriculum and put into action a system of beliefs that highlight both action and reflection in learning and teaching.

Limitations of the Study

The following limitations were identified in this study:

1. The sample was selected from 5 middle schools and 231 students.
2. Of the 231 students, 136 were administered the Technology Attitude Scale by technology teachers who volunteered to do so.
3. Of the 231 students, 95 were administered the Technology Attitude Scale by selected teachers from subject areas other than technology chosen by the technology teachers.
4. This study included only seventh, eight and ninth grade students.
5. The instrument used in this study was intended for use with groups of students rather than with individual students. Individual scores were not calculated.
6. Only information regarding students' attitudes toward and concepts of technology was obtained as part of this study.

Delimitations of the Study

1. The study was delimited to five middle schools and 10 teachers in the Commonwealth of Virginia.
2. The study was delimited to experts selected from the field of education for the purpose of reviewing the instrument for appropriate language, clarity, and brevity.

Assumption of the Study

One assumption was formulated for the study. It was assumed that the translation of the original TAS from Dutch to English was done in such a manner that the meaning of the instrument is the same in English as in the original Dutch language.

Definition of Terms

The following definitions were used for this study:

1. Attitudes - "a mental and neutral state of readiness, organized through experience, exerting a directive or dynamic influence upon the individual's response to all objects and situations to which it is related" (Allport, 1936, cited in Greenwald, Brock & Ostrom, 1968, p. 362).

2. Concept - "an idea of something formed by mentally combining all its characteristics or particulars; a construct" (Webster's Encyclopedic Unabridged Dictionary of the English Language, 1989, p. 304).

3. PATT - Pupils' Attitude Towards Technology
   a) an instrument which investigates what pupils think of technology and uses the results for the development of the subject of technology in primary and secondary

education.

b) PATT Foundation - a formal international organization founded in 1990 to enable a more flexible and efficient organization for the study of technology.

c) PATT Conferences - a series of international conferences which began in March, 1986 with the aim of bringing people together to offer opportunities for exchange of ideas and information (Raat, 1991, p. 21).

4. TAS - Technology Attitude Scale: an instrument derived from the large scale PATT study for use by individual classroom teachers to ascertain student attitudes and concepts towards technology.

5. Technology - ". . . is a body of knowledge and actions, used by people, to apply resources in designing, producing, and using products, structures and systems to extend the human potential for controlling and modifying the natural and human -made (modified) environment" (Wright & Lauda, 1993, p. 3).

6. Technology Education - the school discipline for the study of ". . . a body of knowledge and actions, used by people, to apply resources in designing, producing, and using products, structures and systems to extend the human potential for controlling and modifying the natural and human-made (modified) environment" (Wright & Lauda, 1993, p. 3).

Summary

The importance of the study of technology has been recognized not only in the USA but world-wide as well. Researchers in the Netherlands initiated in the mid-1980s a large-scale study to determine what pupils' attitudes and concepts were regarding technology. The Pupils' Attitude Towards Technology (PATT) instrument was a result of this research effort that soon spread to several other countries. Another instrument, the Technology Attitude Scale (TAS), was developed in 1987 from the large-scale PATT research. It was designed specifically for use by classroom teachers so that they might independently determine student attitudes towards technology and concepts of technology.

When student attitudes towards technology and concepts of technology are known, the teacher can better plan and adapt curriculum to the teaching task. The purpose of this study was to adapt and validate the Technology Attitude Scale, originally developed in the Netherlands, for use by American teachers at the middle school level.

CHAPTER II. REVIEW OF LITERATURE

Introduction

As a means of contemplating the essence of the study of childrens' thoughts towards technology, a review of literature relative to the aspects concerned with adapting and validating an existing attitude instrument designed to obtain information about students' attitudes towards and concept of technology was carried out. de Klerk Wolters (1989a) indicates that "education in technology can contribute to the development of a more positive attitude towards technology" (p. 3). Several countries have introduced the study of technology as a school subject, and although there is no tradition to guide its development, the demand continues for inclusion in both primary and secondary education.

The review of literature includes a look at technology and technological literacy, both of which are interrelated and difficult to precisely define. Technology education in the middle school is reviewed with a look at developmental periods, characteristics of growth and development between childhood and adolescence, and national reports that support a vigorous middle school movement.

The development, definition and the tripartite view of attitudes are reviewed followed by an examination of concepts. The attitude and concept constructs are the foundation and introduction to a review of Pupils' Attitude Towards Technology (PATT) research and organization. An analysis of attitude and concept measurement as components of statistical methodology complete the final section of the review of literature.

What is Technology?

> The story of technology is a story of man's attempts to control his environment - in terms of materials, from stone to bronze, from bronze to iron, and iron to steel; in terms of energy, from human muscle power to animal, to wind and water, to steam and oil, to rockets and nuclear power; and in terms of machines, from hand tools, to mass production lines, to computer - controlled factories (Kranzberg, 1977, p. 4).

The significance and function of technology lies in its use by human beings and what it does. People have always attempted to adapt materials, energy and machines to solve the problems of the environment in which they live. From the furs of animals to sophisticated synthetic fabrics, from stone clubs to alloyed steel hammers, humans have endeavored to adapt materials in order to live more comfortably in their environment. From the wood of the forests to the complex products of petroleum, from water powered mills to the electrically driven motors of industry, humankind has strived to harness the forces of natural energy for beneficial purposes. Human powered machines were replaced by animal driven machines which were later replaced by fossil fueled machines in an attempt to accomplish tasks more efficiently. The technology has always been the result of humans attempting to solve problems that deal with their environment, frequently through social endeavors.

Technology is a common thread of our social structure. It is present in all aspects of society.

> Technology and society work a complex weave of effects on each other. Man's scientific knowledge and technological capabilities have expanded like a giant fabric woven by a million hands working without design (Pascarella, 1979, p. 3).

Technology is often thought of as something mechanical, yet all technical processes and products are the result of the human creative imagination and human skills. Technology is of humanistic interest, not only because it is a product of the human mind, but also because it affects the course of human and societal development. Technological development is a complex human activity integrating many factors which may interact at the same time. Historian Lewis Mumford insisted "technology is both a shaper of, and is shaped by values" (Blake, 1983, p. 126). Most studies involving technology recognize a close tie with society, although disagreements may arise over which influences the other. Some would argue that technology drives society while others insist society dictates the development of technology. In many instances a blend of both arguments is probably closer to reality, but most agree that technology is closely allied to the culture in which it exists.

The term technology has been defined in many ways, from the most simple to rather complex statements. The context of the definition and who offers it may influence the meaning. Application of knowledge is a theme frequently used in the definition of technology. Dr. Lewis M. Branscomb, Vice President and Chief Scientist of IBM Corporation, stated: "Technology is what people do with what they know" (Pascarella, 1979, p. 5). Popenoe described technology as "a special kind of knowledge which is directed toward practical application in the physical and social world" (Pytlik, Lauda & Johnson, 1978, p. 5).

Technology is defined using the theme of application as well: "A process undertaken in all cultures (a universal) which involves the systematic application of organized knowledge (synthesis) and tangibles (tools and materials) for the extension of human faculties that are restricted as a result of the evolutionary process" (Pytlik, et al. 1978, p. 6); "Technology is a body of knowledge and the systematic application of resources to produce outcomes in response to human needs and wants" (Savage & Sterry, 1990, p. 7); "Technology . . . the use of our knowledge, tools, and skills to solve practical problems and extend human capabilities" (Todd, McCrory & Todd, 1985, p. 3).

An additional theme encompasses the concepts of controlling and changing our environment or the world around us. Spier, Hughes, Lenski, and Lenski include in their definitions of technology the concepts of control and change: "Technology embraces the means by which man controls or modifies his natural environment" (Spier, 1968, p. 131). "Technology is the effort to organize the world for problem solving so that goods and services can be invented, developed, produced, and used" (Hughes, 1989, p. 6). Lenski and Lenski (1974) defined technology as "the information, techniques, and tools with which people utilize the material resources of their environment to satisfy their various needs and desires" (p. 498). Later (1982) Lenski and Lenski's definition was modified to "cultural information about the utilization of the material resources of the environment to satisfy human needs and desires" (p. 448). James Young, General Electric Company's Vice President of Technical Resources, followed the theme of control and change as well, stating: "Technology is all the techniques, knowledge, lore, methods, and tools that have helped society survive and improve its life" (Pascarella, 1979, p. 5).

Wright and Lauda's recent definition (1993) of technology synthesizes and extends both of the themes application of knowledge and controlling and changing the environment.

> . . . technology is a body of knowledge and actions, used by people, to apply resources in designing, producing, and using products, structures and systems to extend the human potential for controlling and modifying the natural and human-made (modified) environment. (p. 3)

While these definitions illustrate variations in defining technology, they do contain elements which appear to be universal with the term. One of these elements is expressed as "knowing," "information," and "knowledge," which, as Pytlik's definition mentions, refers to synthesis. In a sense, we are speaking of "basics" in education, and are identifying the knowledge and understanding of technology as basic (National Science Board Commission, 1983, p. 73).

The number of definitions for technology are extensive. One researcher, Mark de Vries (1987a), foregoes an attempt to define the term, opting instead to formulate five characteristics on the basis of literature studies and consultation of experts.

1. technology is a feature of human activities and three consequences of this are:
   a. there is a relation between a person's view of humankind and the world, and this person's view of technology,
   b. technology belongs to both males and females, and
   c. technology, like other aspects of humankind, passes through a historical development;
2. matter, energy, and information are the basis or foundation of technology. de Vries refers to matter, energy and information as the "pillars" of technology;
3. there is a mutual influence between technology and science which concerns both the methodology of technology and science and technological and scientific knowledge;
4. the three most important skills in technology are designing, making, and using; and
5. there is continuous interaction between technology and society.

These characteristics include most of the themes included in many of the definitions of technology. The use of characteristics as a means to describe technology provides a flexibility that allows for acceptance of components of technology rather than parameters that might limit them. The term technology is an elusive concept defined in many ways. It is essentially a result of human creativity and skills based on a synthesis of knowledge.

A sociocultural understanding of the applications and limitations of technology is perhaps at least as important as an understanding of its technical structure and operation. . . . How technology is applied depends on what society thinks it is, what its limitations are perceived to be, what is its role in society, and how that role is assessed. These then should become issues addressed in a program which attempts to educate to technological literacy. (Gilberti, 1986, p. 22).

Technological Literacy

The term technology can be elusive when attempts are made to define it. Likewise, a definition of technological literacy can be elusive. Croft (1989) noted, "Experts cannot agree on a single definition of literacy because the attributes and standards are relative to the context in which literacy is observed" (p. 10). Educators in the discipline of technology education have literacy as a valued goal of their teaching. The International Technology Education Association (ITEA) has identified technological literacy as a major goal in the discipline of technology education (Loepp, 1986, p. 37). This goal was reinforced by the ITEA when attention was focused on a professional improvement plan that targeted technological literacy through leadership, professional development and services (Lauda, 1990, p. 3). Legislation titled "The Technology Literacy Act of 1985" was introduced with the purpose of preparing "future generations for the world that will confront them. . . . Unless we begin to prepare our children, the next generation of Americans will be technologically illiterate and will lose their competitive edge in the international marketplace" (p. 2).

Webster's Encyclopedic Unabridged Dictionary of the English Language defines literacy as: "the quality or state of being literate, esp. the ability to read and write" (1989, p. 836). Dyrenfurth (1991) offers an additional perspective about what it means to be literate:

> Literacy . . . means the ability to read and write, that is, to do something with a language, not merely to recognize that language is composed of words, to identify a letter of the alphabet, or to be aware of the pervasive role of language in society. (p. 139)

The skills of recognition and awareness can be enhanced and enriched by development of skills such as comprehension, application, experimentation and assessment which extend the concept of literacy in any discipline.

A theme of technological literacy is that of action. In the discipline of technology education which has technological literacy as a valued goal, there is a theme of 'doing' technology through such skills as comprehension, application, experimentation, and assessment. In an effort to foster technological literacy, decision making and problem solving skills must be an integral component of technology education. Waks (1991) supports the notion of 'higher' level skills; "*New basic skills* for productive employment would necessarily include evaluation and synthesis skills, critical thinking, problem solving . . . synthesis, application, creativity, and decision-making given incomplete information" (p. 240).

Hersh (1983) points out that "technological literacy is much more than knowing how to operate high-tech devices" (p. 27). He suggests that abilities to comprehend, sort, analyze and synthesize require one to be a good reader and writer with solid language arts instruction. The meaning of literacy in the context of technology is rooted in the language arts namely, reading and writing with an important extension that includes a functional dimension. Rosenberg and Birdzell (1990) support the action theme of what it means to be technologically literate: "Whatever the origins of a technology, the people and institutions using it must be able to understand it, experiment with it and evaluate the economic repercussions of its use" (p. 48). Fleming (1989) extends this theme by noting, "A technologically literate person has the power *and* the freedom to use that power to examine and question the issues of importance in sociotechnology" (p.393).

An additional theme of technological literacy is that of knowledge. Fleming (1989) proposes that "technological knowledge is a unique form of cognition" (p. 395). One of its unique features is that it is in a constant state of flux. Technological knowledge and the concepts of technology must be recognized by educators as ever-changing. "The educational experience must insure that tomorrow's leaders understand the tentative nature of knowledge" (Ost, 1985, p. 695).

Although the nature of knowledge is tentative, the technologically literate individual must have knowledge of the discipline. Householder (1988) challenges educators of the subject: ". . . technological concepts must be identified and a taxonomy of concepts must be developed (p. 33). This notion is supported by Waetjen (1992): "If technology education is a discipline . . . it must have ways of creating knowledge" (p. 26). The National Science Board Commission on Precollege Education in Mathematics, Science and Technology (1983) recognizes that "technological literacy needs to be a part of general literacy and 'numeracy'. In a sense we are speaking of 'basics' in education, and we are identifying the knowledge and understanding of technology as basic" (p. 73). Hayden (1991) mentions that because technology is such a force in our lives, it is only logical that we should be knowledgeable about it. He further states that "this knowledge of technology has been labeled - technological literacy (TL)" (p. 30).

The third theme of technological literacy is that of attitude. The technologically literate individual will approach learning as a life long endeavor. Hersh (1983) supports this theme when stating that "technological literacy is . . . a matter of attitude . . .the technological generation must be able to adapt to constant change. Students must possess the disposition for life-long learning" (p. 27). Ost (1985) notes this importance, stating ". . . an important characteristic of technologic literacy is a positive attitude towards the necessity of continuing education" (p. 691).

Life-long learning as a characteristic of the technologically literate will foster greater involvement in numerous aspects of society.

Technological literacy will encourage greater participation by individuals in shaping public policy, which often involves the

> use of sophisticated technology. It will tend to encourage civic responsibility and overcome voter torpidity, which can arise out of a lack of understanding of new technologies. (National Science Board Commission, 1983, p. 74)

Croft (1989) recognized "the importance of being literate in technology. . . [and]. . . how necessary it is to function as a citizen and make judgments relative to everyday life" (p. 16). Scarborough (1991) reinforces the pervasive theme of attitude in recognizing that "in the U.S., educators are not only concerned about the knowledge and application of technology, but also with the affective and psychological impact of technology which gets into philosophies and attitudes" (p. 78).

Technological literacy is a valued goal of technology educators. Achievement of this goal will promote a more active and knowledgeable citizenry, one that views literacy with an attitude of life-long learning. As Dugger (1988) encourages,

> Our profession is currently in its era of greatest opportunity and challenge. Philosophers, legislators, business and industry leaders, and many others are calling for technological literacy as a basic and fundamental part of education. We must set as our first goal, the development of young minds, both for innovative thinking and technological understanding, who will become the leaders for tomorrow. (p. 6)

Technology Education at the Middle School

The first known middle-level-type school appeared in the 1880's, but what might be known as the junior high school movement really began around 1910. (George, Stevenson, Thomason & Beane, 1992, p. 84). Several factors are recognized for separating out grades 7-9 from the popular K-8 / 9-12 arrangements of that time.

A substantial number of students left school between grades 6 and 8. It was proposed that an earlier exposure to a high school-type curriculum would provide some interaction with classical subjects for students who dropped out of school. There was a belief with increasing support that the 8th grade was too far to extend elementary education. The efficiency movement as part of the larger social environment influenced many educators that the junior high school would provide a better opportunity to distribute students for future education or work. Another factor, though not considered as important as the others, was concerned with developmental differences of students. It was recognized that preadolescents and post-pubescent students ought to be separated because of developmental differences. (George, et al., 1992, p. 84). Finally, the possibility for a separate junior high school as a result of growing needs to relieve classroom space shortage at the secondary school level was a major concern. Toepfer (1992) notes that Hartwell was one of the first to focus on this issue in 1905.

> When the seventh and eighth year pupils are placed under departmental teaching in separate buildings, the first year of the high school will soon be added to their course, making an

> intermediate course of three years. This will relieve the high school and save the immense expense of more high school buildings. The first year of high school is preparatory to selection of the regular courses, and may as well and better be taken with the last two years of the grammar school. (p. 210)

The reasons for establishing junior high schools had mostly to do with either preparing for or assuming some of the functions of the high school. For the most part, the junior high school continued to be a junior version of the high school (George, et al. 1992, p. 84).

Toepher (1992) notes that during the early 1960's another shift ushered in the beginning of the so-called middle school movement. Gatewood (1982) concurs:

> . . . the term "middle school" - long used in Europe and in some American private schools - was revived, given a particular set of educational attributes, and put forward as something new. It caught hold and soon a full-blown movement was under way. (p.3)

Gatewood also credits Alexander with ". . . the most widely-cited, and clearly-stated set of goals ever promulgated for the middle school . . . . " (p. 5). Alexander recommended that an educational program focus on the period of growth and development occurring between childhood and adolescence characterized by:

1. a home base and teacher for every student to provide for continuing guidance and assistance to help the student make the decisions faced almost daily regarding special needs and learning opportunities;

2. a program of learning opportunities offering balanced attention to three major goals of the middle school: (a) personal development of the between-ager, (b) skills for continued learning, and (c) effective use of appropriate knowledge;

3. an instructional system focused on individual progress, with many curricular options and with individualized instruction in appropriate areas;

4. the use of interdisciplinary team arrangements for cooperative planning, instruction, and evaluating; and

5. a wide range of exploratory activities for the socializing, interest-developing, and leisure-enriching purpose of the bridge school.

The Carnegie Council on Adolescent Development (1989) reinforces these characteristics and offers specific recommendations pertaining to the restructuring of education in the middle school in a document entitled, Turning Points: Preparing American Youth for the 21st Century. What significance does this report have for Technology Education? "The world is being rapidly transformed by science and technology . . .[and] work will require much technical competence and a great deal of flexibility" (p. 12). The subject of technology education, although not referred to directly in the report, most certainly provides important principles and concepts in the curriculum of the middle school. The Task Force has specific recommendations pertaining to the restructuring of education in the middle school. Recommendations and their relevance to technology education include the following:

• Creating a community for learning

Size and anonymity in many grade schools creates isolation. It is recommended in the report that large schools be divided into smaller communities with teachers and students divided into teams to foster closer associations. Each student would be assigned an adult advisor that would "ensure that every student is known well by at least one adult" (Carnegie Council, p. 9). Technology education's organizational structure promotes team approaches to instruction which enhance closer association among students and teachers.

• Teaching a core of common knowledge

Productive competent citizens can be the result of child development if instructional programs teach young adolescents to think critically, develop healthful lifestyles, become active citizens and integrate subject matter across disciplines. Technology education emphasizes problem solving as a means of developing critical thinking. Technology education activities readily form a continuum with other subject areas.

• Ensuring success for all students

Tracking students by achievement level was scrutinized throughly in the report. "While tracking is potentially harmful to virtually all young people, it is particularly damaging if a student is placed in a lower track on all subjects based on ability in one major academic area" (Carnegie Council, p. 50). Turning Points suggests two time proven approaches that successfully teach students of differing abilities and rates of learning: cooperative learning and cross-age tutoring. Technology education uniquely contributes to the success for all students by the interaction in small problem solving groups and the opportunities afforded for peer tutoring in these activities.

• Empowering teachers and administrators

The report emphasizes the need for teachers to have "greater authority to make decisions, and responsibility for the consequences of those decisions, regarding the day-to-day educational experiences of their students" (Carnegie Council, p. 54). For example, teachers on teams should "collectively allocate budget and space for the team, choose instructional methods and materials for classroom use, identify and develop interdisciplinary curricular themes, schedule classes, select field experiences including youth service opportunities, and evaluate student performance in light of school-wide objectives" (Carnegie Council, p. 55). Technology education's systems approach which includes studies in production, communication, and transportation provide a variety of choices to identify and develop interdisciplinary curricular themes, field experiences, and opportunities to evaluate student performance.

• Improving academic performance through better health and fitness.

> Because of the direct link between the health of young adolescents and their success in school, the Task Force concludes that middle grade schools must accept a significant responsibility, and be provided sufficient resources, to ensure that needed health services are accessible to young adolescents and that schools become health-promoting environments.

(Carnegie Council, p. 61)

The International Technology Association encourages technology educators to provide wholesome changes in learners which may involve self-evaluation of attitudes towards constructive work and how this work can be utilized for health and recreation.

• Reengaging families in the education of young adolescents.

The report offers a number of ways that the middle grade schools can reengage families, such as: ". . . offering parents meaningful roles in school governance, keeping parents informed and offering families opportunities to support the learning process at home and at school" (Carnegie Council, p. 67). Technology educators and others can offer meaningful parent input by using parent skills and expertise in the learning process, in school governance and by communicating regularly with the parent.

• Connecting schools with communities.

The report strongly states that "A community that sets out to educate all of its young adolescents to become competent, responsible, and productive adults must marshal its resources behind its schools" (Carnegie Council, p. 70). Communities are forming partnerships with middle grade schools. Some examples of school-community cooperation include: "Placing students in youth service, ensuring student access to health and social services, supporting the middle grade education program and expanding career guidance for students" (Carnegie Council, p. 70). Technology education provides excellent opportunities for adolescents to become involved in youth service projects as a result of awareness of social cultural impacts concerned with developing insights into technology.

The Carnegie Council report, Turning Points, reinforces an emerging movement, still relatively unrecognized by policy makers, to build support for and educate young adolescents through new relationships between schools, families, and health and community institutions. The Task Force's specific recommendations pertaining to the restructuring of education in the middle school leave little doubt that technology education can contribute many important principles and concepts to this emerging movement.

Technology education at the middle school level provides experiences for students to develop their innate talents, attitudes, and skills to lead more satisfactory lives in a technological world. Courses at the middle school level are exploratory in nature, designed to promote student investigation and examination of broad content areas such as communication, construction, manufacturing, and transportation. Problem solving and learning for tomorrow's adaptive environment are the cornerstones of the technology education program at this level.

de Klerk Wolters (1989a) suggests that "It may be useful for technology teachers to know what their pupils think of technology and also to be able to evaluate the affective outcomes of their programs." (p. 134). The Technology Attitude Scale (TAS) is designed to gather information about what students think about technology and their concept of it. This information can be significant to the classroom teacher as a means to provide a more effective presentation to students about technology. Kramer (1992) states, "Teachers who work with young adolescents are not surprised by studies suggesting that how students perceive instruction is not always synonymous with what the teacher believes students are learning . . ." (p. 36). The TAS is a means to ascertain the perceptions students have of technology, allowing the teacher to modify the presentation of the topic for a more synonymous understanding between student and teacher.

A generally accepted goal for middle schools is to provide opportunities for students to explore the world around them. Many middle school technology education programs are teaching students what technology is, how it works, and how it affects people's lives. Students in technology programs are learning about tools, materials, and processes while gaining an appreciation for technology's significant social and cultural aspects (McCrory & Bame, 1986, p. 1). Several statements in the technology attitude scale (TAS) elicit responses from students about science and technology relationships. The TAS was developed from the Pupils' Attitudes Towards Technology (PATT) research originally conducted by science professors in the Netherlands. It is interesting that teachers of science felt strongly enough to promote the study of technology for all students and considered the relationships between science and technology of significance.

Science and Technology

Relationship to the Technology Attitude Scale

The purpose of the original PATT research was to gather information about what pupils think about technology and their concepts of it. The original researchers were well aware of the relationship between science and technology and were curious to know how students perceived the roles of these important areas of study. The researchers were especially interested in students' attitudes and concepts towards technology (which included statements about science and technology relationships) as a basis of gathering information for developing curriculum focused on effective teaching about technology. Wright (1993) states, "The challenge for educators is to develop a curriculum that allows students to view technology realistically and consistently" (p. 2).

The Technology Attitude Scale includes several statements that call for students to respond to knowledge of the relationship between science and technology. Students respond to statements such as: I think physics and technology are related; There is a relation between chemistry and technology; To me, technology and science are the same; Elements of science are rarely used in technology; I think technology is often used in science; Biology and technology have nothing in common; and There is a relation between chemistry and technology. Realizing that science and technology each have distinct characteristics is a goal for better understanding this relationship.

The Methodology of Science and Technology

de Klerk Wolters (1989b), a major contributor to PATT research, states, "there is a mutual influence between technology and natural sciences. This influence concerns both the methodology of technology and natural sciences and also the technical and scientific knowledge " (p. 294). The methods of technology have often included trial and error attempts to solve problems. More often than not, the methods of technology have involved direct interaction with activities or materials. Volti (1992) adds, "The basic components of a technological system are not just material artifacts; human skills, organizational patterns, and attitudes are of equal importance (p. 5).

A familiar procedure for acquiring knowledge in science is the scientific method. Various scientific disciplines are alike in their reliance on evidence, the use of hypothesis and theories, the kinds of logic used, and much more (American Association for the Advancement of Science, 1989, p. 29). In the article America is in Danger of getting an F for Science (1993), Carl Sagan states, "Science is not just a body of knowledge, but a way of thinking" (p. 5). Although the "scientific method" is well known to scientists there is no fixed set of steps they always follow. Although scientists differ from one another in what they investigate and how they go about their work, there are certain features of science that give it a distinctive character as a mode of inquiry. Although these features are especially characteristic of professional scientists, every person can utilize them about matters of interest in everyday life (AAAS, p. 26).

Layton (1971) claims that American technology assimilated features and characteristics of science in what he calls ". . .the scientific revolution in technology" (p. 562). During the early part of the 19th century, craftsman, in some cases, departed from the traditional ways of acquiring information and skills of their trade. The master-apprentice method was gradually replaced with educational opportunities at newly established lyceum programs, mechanical institutes and later in the century, manual training schools. A problem of developing skill in the use of tools became apparent in the colleges of mechanical engineering (Anderson, 1926, p. 156). A similar difficulty in the teaching of the sciences had been overcome through the use of the laboratory method of instruction which provided the impetus for educators of engineers to apply "hands on" methods of instruction which were revealed most prominently in the manual arts schools. Over time traditional methods of educating the craftsmen were replaced by additional features borrowed from science.

Another example that technology assimilated features and characteristics of science is provided by Layton (1971) which concerns the oral traditions passed from the master to the apprentice. The new technologist attended college, joined a professional organization and read journals and technical literature fashioned from science (p. 562). In some instances even inventors attempted to apply principles of mechanics to a general set of rules that would apply to all inventions. These amounted to applying scientific methods to technology. Included were the discovery of fundamental principles, making deductions from these principles, and testing the results by experiment (p. 566). Although attempts were made by technologists to apply methods of science to technology, they lacked the expertise to make a significant impact on the technological sciences. This task of applying scientific methods to the technological sciences was relegated to those rare individuals who had interests in both areas.

Scientific contributions to technology required translation by persons referred to as scientist-engineers or engineer-scientists who contributed an important link to channels of communication between the communities of science and technology. Initially the scientist-engineers probably contributed the most to the translation of scientific procedures to technology, but their lack of commitment and precise knowledge of technology curtailed the communication process. The engineer-scientists who had vested interests in technology assumed the role as translators of scientific procedures into technology. The fact that science and technology are different in their basic nature makes the translation of science-based knowledge into technology-based application a difficult and complex process (Volti, 1992, p. 57).

Attempts to communicate the technology-science relationship in recent years have included the term "technoscience." Rushing (1986) uses technoscience to describe technological reasoning and scientific purpose. In her critique of Ronald Reagan's "Star Wars" televised address of March 1983 she states,

> . . . I contend that 'Star Wars" encapsulates technical reasoning within a myth which creates the illusion of both preserving

> science and transcending its transgressions. Reagan accomplishes this by subordinating technical reasoning to the purpose of avoiding nuclear holocaust, and by using *technoscience* [italics added] to rescript history. . . . This leaves science free to continue its traditional purpose of advancing progress. (p.416)

Clearly, Rushing erroneously uses the term technoscience to infer that technology and science are somehow one and the same. Layton's terms scientist-engineer and engineer-scientist seem more appropriate in describing the science-technology relationship.

The History of Science and Technology

The science and technology relationship has been debated often. Although science and technology may seem, in the public mind, to be indistinguishable from one another, in many instances there are definite differences as well as commonalities that have evolved throughout their histories.

It is generally agreed that technology is very old, perhaps as old as mankind (Mayr, 1976, p. 668). Roy (1989) strongly agrees and adds, "Contrary to the obvious fact that technology preceded science (by about 10,000 years) and it is advances in technology which lead to advances in science, scientists, university professors and the public have been taught to believe the opposite" (p. 14). LaPorte and Sanders (1993) contemporary technology educators, remark, "Technological knowledge has existed far longer than scientific knowledge" (p. 17).

In ancient times in the West and in China the man of "science" was the man of knowledge - the philosopher. The task of the philosopher was to educate the elite regarding how to govern properly and how to order society. Cardwell (1972) interjects a difference in opinion when he mentions, "There were no scientists in the ancient world, for science as a social institution did not exist and indeed did not begin to be significant until the seventeenth century" (p. 3). Philosophical speculation was considered an attribute of gentility, while concern with practical matters was seen as a mark of vulgarity. Official, proper science did not concern itself with technology.

Technology had traditionally been in the realm of craftsmen working by rough rules of trial-and-error. In fact, important innovations in textiles, steam engines and metals came about primarily through trial-and-error, rule-of-thumb efforts of craftsmen who, for the most part, were ignorant of contemporary scientific knowledge (Chant, 1989, p. 40).

The European Middle Ages were a time of rapid, significant technological advance. Agricultural practices were improved, and the windmill and water wheel were introduced as power sources. The horse collar evolved into an effective method of applying another source of power in a more efficient manner. Magnificent cathedrals were built in Europe with little reliance or connections to the scientific knowledge of the time. It is believed that the designers and builders of the cathedrals lacked knowledge of multiplication tables (Volti, 1992, p. 56).

Scientific and technological development continued to evolve in separate ways during the following centuries. Kuhn (1969), an historian of science , states, "The sixteenth and seventeenth centuries were the scene of epochal advances in science, yet technological change occurred at a slower rate than it did during the preceding centuries when science had been largely stagnant" (p. 427). Kuhn further speculates " . . .that for the bulk of human history, technology has flourished in societies where science has remained undeveloped, and vice-versa" (p. 428). It may be possible in our era that we have a unique ability to support scientific and technological growth at the same time (Volti, 1992, p. 56).

The Nature of Science and Technology

Science directs its efforts at the discovery of knowledge for its own sake, while technology develops and employs knowledge in order to solve a problem. The discredited assumption is that ". . . science discovers, technology applies" (Jevons, 1976, p. 737). Mitcham (1980) further emphasizes the basic nature of science and technology when he states:

> . . . for example, the ultimate goal of the scientific enterprise is posited as the better understanding of the natural world, or the extension of our knowledge of it; the definitive aim of technology, on the other hand, is the exploitation of the world's natural resources in the interests of the human race, or some portion of it, or more prosaically, "the making or using of artifacts" (p. 285).

Chant (1989) summarizes this discourse on science and technology when he states: "Science, however practical its methods and instruments, is essentially an intellectual, truth-seeking endeavor. Technology, however much it may sometimes rely on scientific understanding of natural processes in order to turn them to human advantages, is an essentially practical, problem-solving enterprise" (p. 42).

An argument concerning the relationship between science and technology revolves around the notion that technology is simply applied science or that scientific knowledge precedes technological applications. It is obvious that some technologies may directly use scientific research while others make little use of this type of information and processes of science. The significance is that there is a difference in the basic nature of science and technology.

Craftsmen of the sixteenth century offer an example of technological application preceding scientific knowledge. Coopers built kegs which seemed to accommodate the optimum volume of beer. A scientist, Johannes Kepler, by employing the calculus of variation, determined the optimum dimensions of beer kegs, ". . . only to discover that these dimensions were already being employed by the coopers who actually built the kegs" (Volti, 1992, p. 58).

A classical example of a technological application that challenged the knowledge and theory of the scientific community concerns the steam engine. The steam injector influenced scientists of the day to reject their popular theory of heat in favor of the first law of thermodynamics. The successful operation of the steam injector provided practical knowledge that the caloric theory of heat must be rejected in favor of another theory. "There have . . . been cases where a technology already in operation defied accepted scientific explanations and stimulated the formulation of new theories" (Volti, 1992, p. 59).

A third example of the notion that technological application precedes scientific knowledge is offered in Project Hindsight, a major eight year study conducted by the Defense Department in the mid-1960s. The purpose of the study was ". . . to assess the importance of basic research for 20 of the nation's most important weapons systems. The study concluded that only a fraction of 1% of the 'events' related to developing the systems could be called basic science" (Staudenmaier, 1989, p. 95).

In reaction to Project Hindsight, another study of the relationship between scientific research and technological application was undertaken. Technology in Retrospect and Critical Events in Science (TRACES) contradicted the previously cited study by determining that a number of recent innovations depended on prior scientific research (Parker, 1978, p. 30). This study took a much longer chronological view of the interaction between science and technology, but even from this perspective researchers pointed out that the sequence of events from scientific discovery to technological application is not linear and ". . . a better understanding needs to be achieved concerning the two-way influence between science and technology" (Layton, 1971, p. 564).

If nothing else, these studies show that the connections between science and technology are not accurately described as the common belief that technology is simply applied science. "By 1972 most historians of science and technology had accepted that technology is knowledge, not merely applied science" (Wise, 1985, p. 236).

The Community of Science and Technology

A commonality shared by science and technology is that each is a separate community influenced by the culture of the society of which they are a part. Bugliarello (1988) offers pertinent tenets that concern the interaction of the science-technology-society interface; Each scientific and technological community is also a social system with goals, values, methods, organization and practices of the scientists and technologists involved; The interactions between the scientific or technological communities and other social systems affect the goals, values, designs, constructions and operations of both the scientific or technological system and the social systems (p. 125). Layton (1976) supports the separate community statement when he states, "Science and engineering are different social organisms; each constitutes a distinctive subculture with its own membership and values, its own rituals and beliefs" (p. 688).

The relationship of science and technology is a dynamic give-and-take interaction. The evolution of the relationship has been from diversity to similarity. Until the seventeenth century, the postures of science and technology were quite distinctive. The industrial revolution probably signified a merging of the methods used in both science and technology. "Technology is not applied science, but rather science and technology are parallel structures in a symbiotic, weakly interacting relationship. . ." (Chant, 1989, p. 47).

The efforts put forth in PATT research emphasize the importance the researchers placed on the science and technology relationship. Science educators recognized the opportunity to incorporate the study of technology into the school curriculum. They further recognized that the study of technology should involve more than a crafts and occupation focus. The researchers were committed to examining pupils' attitudes and concepts of technology by including statements that referenced relationships between science and technology.

Attitude

Historical and Modern Concepts

> Not much more than a hundred years ago, the term 'attitude' was used exclusively with reference to a person's posture. To describe someone as adopting 'a threatening attitude' or 'defiant attitude' was to refer to his physical mien. . . . the word can still be used in this manner, but in recent times 'attitude' increasingly connotes the psychological rather than the physical orientation of a person, his mental state rather than his bodily stance. (Johoda & Warren, 1968, p. 7)

The shift from the physical aspects of attitude to the emotional or the mental aspects was not an easy task. During the last decades of the nineteenth century physiologists studied behavior, an observable phenomenon which was therefore more easily measured. This approach was supported by "Darwinian thought in England and the doing-and-acting emphasis of Deweyan philosophy in America" (Shrigley, 1983, p. 426). Sherrington, a British physiologist, used the attitude concept to study human muscular reflexes. Here again, the physical connotation reigned (Shrigley & Koballa, 1984, p. 112).

Authors point to 1918 as the origin of attitude as a modern concept. Up to this point attitude had been considered more physical than psychological. Thomas and Znaniecki's work, The Polish Peasant in Europe and America, set into motion an era where feelings became worthy of study (Shrigley, Koballa & Simpson, 1988). The 1918 Thomas and Znaniecki study of acculturation of Polish farmers in our urban North gave attitude new prestige as a psychological concept. Their analysis of several hundred letters between old-country and U. S. Poles revealed a change in the lifestyle of Polish immigrants. Attitude was used as a psychological construct to explain this change. "The study brought into focus evaluative quality and social influences, attributes that remain central to the definition six decades later" (Shrigley, et al., 1988, p. 662).

Allport, writing in the Handbook of Social Psychology (1968), emphasizes attitude as a mental concept at this time in history. In fact, Allport claims that attitude was both a mental and physical concept from the beginning, with the former serving the dominant role. The social psychological concept of attitude has been investigated and written about by the above mentioned authors who identify the second decade of this century as the origin of attitude as a modern concept.

Attitude Definition

The term attitude is commonly used in daily life; generally most people have some idea of its meaning, although the meanings of the term often don't coincide. Attitude has been defined in several ways by those who have used it as a means of social psychological research. Definitions of attitude are plentiful (Krech, Crutchfield, and Ballachey, 1962; Smith, Bruner, & White, 1967; Fishbein and Ajzen, 1975; Kerlinger,1984) essentially all indicating that attitudes have three major features: 1) An attitude develops through experience with an object. 2) It predisposes one to act in a predictable manner with respect to an object. 3) An attitude consists of positive or negative evaluations (Palmerino, Langer & McGillis, 1984, p. 179). Fishbein and Ajzen (1975) state, ". . . most investigators would probably agree that attitude can be described as a learned predisposition to respond in a consistently favorable or unfavorable manner toward an attitude object" (p. 6).

In 1928 Louis Thurstone, a noted social psychologist in the study of attitude, defined attitude as "the sum total of a man's inclinations and feelings, prejudice and bias, preconceived notions, ideas, fears, threats, and convictions about any specified topic"

(Mueller, 1986, p. 3). Three years later he stated the definition as simply, "Attitude is the affect for or against a psychological object" (Mueller, p. 3). Thurstone's definition offers a flexible approach and Mueller (1986), in adopting Thurstone's definition, restated it as follows: "*Attitude* is (1) affect for or against, (2) evaluation of, (3) like or dislike of, or (4) positiveness or negativeness toward a psychological object" (p. 3). Fishbein and Ajzen (1975) support these notions when they state, ". . . the major characteristic that distinguishes attitude from other concepts is its evaluative or affective nature" (p. 11). Many researchers feel the evaluative component in the affective domain of attitude is the essence of this construct.

In social psychology it may be helpful to differentiate attitudes from other similar constructs such as opinion, belief, and value. Attitudes have been, and frequently still seem to be, confused with opinions, beliefs, and values.

Opinions are generally more narrow in content than the broad evaluative orientation which we call attitude, and they are primarily cognitive rather than emotion-laden, or as Sherif (1965) stated, "Verbal opinions . . .may or may not reflect an attitude" (p. 20). Cooper and McGaugh (1968) noted that opinions play an important role in the thought process in that they represent cognitive summaries along the way. Ideas and constructs are organized during the constant process of cognitive exploration. Once a summary emerges the individual may appraise it. The extent that ". . . the appraisal is tentative, nonfixed, it is an opinion" (p. 29).

The term "belief" emphasizes some level of acceptance of a proposal regarding the characteristics of an object or event. Fishbein and Ajzen (1975) suggest that beliefs represent the information a person has about the object (p. 12). The object of a belief may be a person, a group of people, an institution, a behavior, a policy, an event, and the applicable attribute may be any object, trait, property, quality, characteristic, outcome, or event. Shaw and Wright (1967) note that a belief links an object to some attribute and may become an attitude when it is accompanied by an affective component which reflects an evaluation (p. 4).

Like attitudes, values involve evaluating. It is generally agreed that values are more abstract, higher-order constructs than are attitudes. Values are more permanent and resistant to change. Values are the most important and central elements in a person's system of attitudes and beliefs. Rokeach (1968) claims that an adult probably has hundreds of attitudes, but only dozens of values (p. 162). Oscamp (1977) describes values as ends rather than means; they are the goals a person strives for and which help to determine many other attitudes and beliefs (p. 13).

Tripartite View of Attitude

In studying attitude it helps to conceptualize attitudes as having three components, a tripartite model described by Oskamp. Those who support the tripartite view of attitude identify the three components as: cognitive, affective and behavioral (Krech et al., 1962, Secord and Backman, 1964).

The cognitive component consists of the beliefs, opinions, values and thoughts which the attitude-holder has about the attitude object. This component can be conceptualized as a person's beliefs about or factual knowledge of, the object or person.

The affective component consists of a person's evaluation of, liking of, or emotional response to some object or person. The affective or emotional component refers to an individual's feelings or emotions toward an attitude object. The affective component is normally considered synonymous with evaluation (like - dislike) of an attitude object.

The behavioral component involves the person's overt behavior directed toward the object or person (Zimbardo & Ebbeson, 1970, p. 20). de Klerk Wolters (1989a) refers to this way of conceptualizing attitude as the three component model and central to the concept of attitude is our like or dislike: the evaluative quality (p. 14). The behavioral component consists of a person's action tendencies (behavioral intentions) toward an attitude object.

The three component model or the tripartite view of the concept of attitude has been supported by the identification of various characteristics relevant to technology. de Vries (1987b) suggests the following characteristics are important to the study of attitudes toward technology: 1) technology is an essential feature of mankind, three consequences of this are; a) there is a relation between one's view of mankind and one's view of technology, b) technology goes with both men/boys and women/girls, and c) technology, as does mankind, undergoes a historical development; 2) matter, energy and information are the "pillars" or base materials of technology; 3) there is a mutual influence between technology and natural sciences; this influence concerns both the methodology of technology and the natural sciences and also the technical and scientific knowledge; 4) the three most important skills in technology are: a) designing, b) producing, and c) using technical products; 5) there is a mutual influence between technology and society (p. 437).

Concept Development

An individual's concept of anything is a product of thought, it is a construct, unique to each individual (Klausmeier & Goodwin, 1966, p. 275). Much of a person's experience is included in concepts, which are expressed in words. An individual's concept of anything is the organized inferences or meaningful associations that the person forms of objects or events that allow the person to classify objects or events as belonging to the same class (p. 250). Bolton (1977) suggests that ". . . a concept may be defined, then as a stable organization in the experience of reality which is achieved through the utilization of rules of relation and to which can be given a name (p. 23).

The concept of technology is based on accepted characteristics of technology. de Vries (1987a) describes the concept technology by pointing out and elaborating five general characteristics. Characteristic features of technology "may predominate early on in concept acquisition but give way to defining features with increasing knowledge and conceptual sophistication" (Keil, 1989, p. 60). Upon examination of the literature it is apparent that the practicality of recognizing several general characteristics of technology through the readings of a multiple of authors is possible. The following characteristics of the concept of technology were recognized by de Vries (1987a),

1) the relation between technology and the human body,
2) the three dimensions of technology: matter, energy, and information,
3) the relation between technology and science,
4) the technical skills: designing, making things, and using technical products, and
5) the relation between technology and society (p. 10).

The concept of technology is defined through these characteristics as opposed to adding another definition of technology. "Most dictionary definitions are not simply lists of defining features. Instead, they frequently - and often only - contain characteristic features" (Keil, 1989, p. 61).

Pupils' Attitudes Toward Technology (PATT)

History of PATT

Pupils' Attitude Towards Technology (PATT) is the name of an international research project. This project is located at the University of Eindhoven and the Pedagocical Technological College in Eindhoven, the Netherlands. The purpose of this project is to investigate what students think of technology and to use this data for the development of the subject technology in primary and secondary education (de Klerk Wolters, 1989b, p. 291).

The PATT research originated from the project Physics and Technology in the department of the teaching of physics, faculty of Technical Physics, Eindhoven University of Technology. Development and evolution of courses on technology as well as finding out what characteristics of technology could be incorporated in the curriculum were the aims of this project.

The Dutch researchers point out that earlier studies had been done in this area of research by Weltner, Liebig, Halbow, Maichle, Reitz and Schoenfeld in 1980, and Nash, Allsop and Woolnough in 1984 (de Vries, 1987b, p. 434, 443-444). In a personal conversation with Falco de Klerk Wolters in 1992, he pointed out that indeed these same researchers had done initial investigations into attitudes towards Physics and Technology (de Klerk Wolters, 1992). Dyrenfurth (1988) expresses appreciation for the efforts of Raat, de Vries and others when he states, ". . . it is to the credit of Jan Raat and Marc de Vries' project groups, and in fact several others of the PATT research group, that they noted the great difference between their intellectual and conceptualized model of technology and the model that young students have in their minds" (p. 207). Similarly Bensen (1991) comments favorably about the Dutch researchers, ". . . the Pupils' Attitude Toward Technology (PATT) Conference holds promise as one of the premier international leadership ventures of the profession" (p. 135).

In 1984/85, research was conducted by Jan Raat and Marc de

Vries with students 13 - 14 years old to determine their attitude toward technology (Ratt, Coenen-van den Bergh, de Klerk Wolters & de Vries, 1988, p. ii). The study seemed to have a potential common interest base for many countries, so it was decided to offer the findings of the research at a number of international conferences and promote the expansion of the research. Because the attitude questionaire proved to have good statistical qualities, a proposal was made at the GASAT conference (Gender and Science and Technology) in London, UK in 1985, and the UNESCO conference (United Nations Educational, Scientific and Cultural Organization) in Bangalore, India also in 1985. Investigators in ten countries joined the research. These countries were Australia, Belgium, Canada, Hungary, Kenya, Nigeria, Poland, Sweden, the UK and the USA. The research in these countries was accomplished with an English translation of the instruments as a basis (Raat et al., 1988, p. 2).

The purpose of the pilot studies was to ascertain the possibility of developing an international instrument. The intent of the pilot studies was not to make comparisons of content between countries, rather to determine the quality of the instrument. All researchers used the same questionaire and all data was analyzed in an identical manner. (Raat, de Klerk Wolters & de Vries, 1987, p. 16). Determination of the items on the attitude questionaire was undertaken through interviews and open-ended questions with students. Some of the aspects of the interviews and open-ended questions that pertain to attitudes toward technology were identified as: 1) generality of the concept of technology, 2) interest in technology, 3) importance of technology, 4) difficulty of technology, 5) role-cast in technology, 6) consequences of technology, 7) creativity in technology, and 8) technical professions and career (Ratt et al., 1987, p. 17).

The International Pupils' Attitude Towards Technology research (PATT research) has as its main aim to do research into pupils' concept of and attitude towards technology (Raat et al., 1988, p. 1). The main arguments that support PATT research in several countries are: it permits pupils' to confront their views with views of others; it gives clues for curriculum development; it gives information about students' needs and students' interests; it permits curriculum development that is more student-centered than subject-centered (de Klerk Wolters, 1989b, p. 291).

In processing the data of the pilot studies, efforts were put forth to determine the validity and the reliability of the instrument.

> With **validity** we mean 'the extent to which the measuring instrument actually measures what has to be measured'. By means of factor analysis it is possible to structure the data and to test whether there is indeed a number of correlating items which, together, form a factor (dimension). Besides, it is then possible to determine the quality of the items. Items that do not cluster are obviously not part of a common factor. So by means of a factor analysis we can confirm the aspects we formulated in advance, in an empirical way. In case this analysis yields explicit factors which describe a dimension in an attitude there is a possibility to go on to scale construction.

> . . . By **reliability** we mean the extent to which a measurement is stable and consistent. For all countries the reliability was checked by means of 'Cronbach's alpha', a widely used coefficient that expresses the internal consistency in a figure. (Raat et al., 1987, p. 18)

It became evident for all counties that four factors accounted for a large part of the variance. These factors are: 1) interest in technology, 2) consequences of technology, 3) gender, and 4) difficulty of technology.

PATT Conferences

Raat (1991) offers a description of the Patt-1 through the PATT 5 conferences. In March 1986 the first international conference, PATT-1 was held in Eindhoven, The Netherlands. There were 25 participants from 11 countries. The content of the conference dealt primarily with presenting and discussing the results of the pilot studies and modification of the PATT-instrument (pp. 16-20).

A new version of the questionaire was published after this conference consisting of a separate part about the pupils' attitude and another part about their concept of technology (Ratt et al., 1988, p. ii).

The international conference PATT-2 was held in Eindhoven in 1987. There were 40 participants from 23 countries. The main emphasis of the program was presentations of PATT research and various topics concerned with the development of technology education, including: the contents of technology education, policy and investments of technology education; and research in the field of technology education (Raat et al., 1988, p. ii).

PATT-3 was held in 1988 once again in Eindhoven. There were 50 participants from 20 countries which addressed the theme "Basic Principles of School Technology." The four subthemes selected were: Frameworks for Technology Education; PATT Research, Related Research and its Relevance; How to Make Education Attractive to Girls; and The Education of Teachers for Technology Education.

PATT-4 (1989) was again held in Eindhoven with 45 participants from 14 countries (de Klerk Wolters, Mottier, Raat, & de Vries, 1989, pp. 485-491). The theme was "Teacher Education for School Technology." It was determined by participants at this conference that future PATT conferences would be held biannually. "This decision allowed to have PATT conferences with a more national and/or regional character in the years in between two international (Eindhoven) PATT conferences" (Raat, 1991, p. 19).

In 1990 two such conferences were held, one in Nairobi, Kenya with the theme "Curriculum and Socio-Cultural Issues in Appropriate Technology" and another in Lagow, Poland with the theme "Technology and School."

A formal PATT foundation was established by the end of 1990 in an effort to enable a more efficient and flexible organization. The chairman of the board is Jan Raat, the treasurer is Ilja Mottier, and Marc de Vries is the secretary (Raat, 1991, p. 20).

PATT-5 (Eindhoven, 1991) had as the main theme "Technology

Education and Industry." There were 49 participants representing 18 countries in attendance (Mottier, Raat, & de Vries, 1991, pp.427-434).

An ITEA (International Technology Education Association) - PATT Conference was held in Reston, Virginia, October 15-18, 1992. The theme was "Technology Education - A Global Perspective." There were 36 participants from 10 countries in attendance (Bame & Dugger, 1992, pp. 353-359).

PATT-6 established "Technology Education and the Environment-Improving our Environment through Technology Education" as the main theme. It was held March 25-30, 1993 in Breukelen, the Netherlands (Raat, 1991, p. 20). There were 52 participants from 15 countries in attendance (Mottier, Raat, & de Vries, 1993, pp. 441-447).

The PATT group has changed its emphasis over the years. Although research in pupils' attitudes about, and concepts of technology remains important to the PATT foundation, it was realized early on that investigations into curriculum, teacher preparation and other interactions with technology would be fruitful diversions. In addition to the worthy efforts of the attitude and concept research of PATT, this international organization has become a catalyst for the blending of world-wide organizations. The IIET (Institute International Pour` Education Technologique), IVETA (International Vocational Education and Training Association, ITEA (International Technology Education Association), GSAT (Girls and Science and Technology), UNESCO (United Nations Educational, Scientific and Cultural Organization) are represented in the PATT conferences. Representatives from all continents have been involved at PATT conferences. From a small group of researchers PATT research has expanded to a true international endeavor which provides a means for contact among common interest groups throughout the world. Jan Ratt (1991), one of the founders, refers to an aim of PATT as bringing ". . . people together to offer opportunities for exchange of ideas and information (p. 21).

Technology Attitude Scale (TAS)

de Klerk Wolters (1989b, p. 292) describes five instruments used in PATT research. One instrument is an attitude questionaire that measures attitude toward technology. A second instrument is a concept questionaire used to measure concepts of technology. A third method that collects additional information about concepts and attitudes towards technology utilizes essays, drawings, and open-ended questionaires. The Technology Attitude Scale (TAS) is a short version of the attitude and concept questionaires. Finally, a teacher attitude questionaire is used to assess teachers attitudes towards technology.

The Technology Attitude Scale (TAS), designed by Falco de Klerk Wolters (Deijsselberg, 1988, p. 506), served as a model for this study. Development of the TAS was generated by an need expressed by classroom teachers who asked this question: "Can we measure . . . the attitude toward technology of our pupils?" (de Klerk Wolters, 1989a. p. 102). The teachers were interested in knowing ". . .their pupils' attitudes and concepts when entering a particular type of education

(=assessment), but also what the effect is of a certain teaching method or didactic approach on the attitude towards technology and the concept of technology (=evaluation)" (p. 102).

de Klerk Wolter's goal was to develop an instrument for teachers to independently determine their students' attitudes towards technology. The TAS can provide information to a teacher about a group of students. It ". . .is not suitable for use at an individual level and certainly not for the assessment of individual pupils" (de Klerk Wolters, 1988b, p. 511).

A short questionaire, with reduced affective attitude scales and complete cognitive attitude scales, was adapted from the PATT instrument. Analysis of data from the Netherlands as well as from other countries was used to determine which statements could be retained in the shortened questionaire without reducing the validity of the instrument. The English translation of the TAS instrument used in this study (Appendix A) appeared in the Report PATT-3 Conference (de Klerk Wolters, 1988b, pp. 533-535).

American Research

Much research has been done about attitudes towards science and until recent years relatively little into attitudes towards technology. In this country Bame and Dugger (1989) Dunlap (1990) and Householder and Bolin (1992) have conducted research associated with technology and have been inspired in various ways by PATT research.

Bame and Dugger (1989) conducted a large scale research study on attitudes toward technology in America. Their research, PATT-USA reported over ten thousand responses from seven states. The data were collected from students aged thirteen to fifteen who were enrolled in technology education/industrial arts classes. The instrument used to measure "Pupils' Attitudes Towards Technology" incorporated a Likert scale for measurement as have previous PATT studies. Because the original PATT instrument was developed and administered in the Netherlands, a language translation (Dutch to English) was necessary for the PATT-USA instrument.

Marc de Vries from the Eindhoven University of Technology spent part of 1988 at Virginia Polytechnic Institute and State University (Virginia Tech) preparing appropriate changes to the instrument. de Vries, through the following procedures, made it possible to conduct research in America using the original PATT instrument:

1. The language of the English translation of the PATT Likert questionnaire was checked for non-American expressions and words. A few minor changes were made.
2. The Likert questionaire was field-tested with a sample of 200 pupils in grade six and seven of five junior high and middle schools in various parts of Virginia; in addition to this 100 other students of the same schools wrote an essay on "What I Think of Technology"; to see whether the instruction for the teachers to administer the instrument functions properly, the researchers visited four of the five schools and watched the

administration of the questionaire. Essays were written afterwards and sent back to Virginia Tech, and

3. The results of this field-testing were analyzed and have lead to modifications of the instrument; The analysis consisted of: a frequency analysis of all measured variables, a factor analysis of the attitude items, a Guttman analysis of the concept items, a reliability analysis of the concept items, t-tests on the attitude and concept scale scores with subgroups based on sex, grade, rural or urban school area, parents' profession, technological climate at home, quality of a definition given by the students in the questionaire (Dunlap, 1990, pp. 38-9).

In the Bame and Dugger research a determined effort was made to follow the original PATT objectives as evidenced by the assistance of Dr. Marc de Vries through a cooperative exchange effort between Eindhoven University of Technology, the Netherlands and Virginia Tech. Findings of their research (Bame & Dugger, 1992 p. 61-63) are:

1. Boys indicated a greater interest in technology than girls.
2. Boys rated technology as having a more consequence than did the girls. It is interesting to note that even though the boys exhibited a more positive attitude toward technology than do the girls, the males also perceive technology as being more difficult.
3. The girls view technology as being an activity for both boys and girls to a greater extent than do the boys.

4. There is a significant difference between boys and girls on their knowledge about technology (i.e. boys appear to be more knowledgeable).
5. The general interest in technology of older students was significantly greater than that of those who were younger.
6. There was no direct relationship between grade level and the view that technology is an activity for boys and girls.
7. The extent that a student's father was reported as having a job dealing with technology was significantly related to the pupils' general interest in technology.
8. Students with fathers who have jobs that deal to some extent with technology had a more positive view on the consequences of technology than did the students whose fathers' jobs had nothing to do with technology.
9. The more technology represented in the fathers jobs corresponded to a greater knowledge about technology.
10. If the mothers' job had anything to do with technology, then their children had a significantly better attitude toward technology than those whose jobs had nothing to do with technology.
11. If the mothers' jobs had "anything" to do with technology, then their children had a significantly better attitude toward technology than those who had "nothing" to do with technology.
12. The technological bent of mothers' professions had a nonlinear effect on children's knowledge about technology.

13. The existence of technical toys in the home had a significantly positive impact on all attitude scales.
14. Having technical toys at home also had a significant effect on the knowledge about technology that students have.
15. Having a technical workshop in the home does not appear to have the effect that having technical toys does.
16. Students who come from homes equipped with technical workshops have more general interest in technology and a greater positive view on the consequences of technology.
17. Having a personal computer in the home had a significant positive effect on their general interest in technology.
18. Students who think they will choose a technological profession were significantly more likely to have a greater general interest in technology, a more positive attitude toward technology, a better view of the consequences of technology, and greater knowledge about technology than those shying away from a technological profession.
19. Taking or having taken Technology Education/Industrial Arts made a significant difference on all attitude scales, as well as the concept scale.
20. Students who took Technology Education/Industrial Arts classes displayed a greater knowledge about technology than did students who had no exposure to the classes.

Dunlap (1990) conducted research comparing attitudes toward technology of elementary grade students in Virginia relative to their exposure to technology. Dunlap's study is the first research in the USA to measure student attitudes before or after experiencing technology education based activities. The study also assessed the effectiveness of Mission 21 in providing students with a more positive attitude toward technology. According to Dunlap, "Mission 21 is a technology education elementary project designed to integrate the study of technology through existing elementary curriculum" (p. 29).

The instrument used in Dunlap's study was a modified version of the PATT-USA scale. The modified instrument was titled "Student Attitudes Toward Technology" (SATT). The research methodology was factorial analysis of variance. The results of the study provided evidence that both boys and girls who participated in the third and fourth grade Mission 21 project did, in fact, have a substantially more positive attitude towards technology than those students who did not (p. 87).

Householder and Bolin (1992) have developed an instrument for assessing Secondary Students' Attitudes Toward Technology (SSATT). The researchers were interested in assessing the outcomes of a project which offered a ". . . technologically-rich environment for senior high students in courses in social studies, literature, geometry, physical science and technology. . . [and this study] . . . was developed to monitor shifts in attitude toward technology and toward the specific school subjects which might be attributed to the activities conducted by the Technology Education Curriculum

Laboratory (TEC-LAB) project" (p. 177).

Householder and Bolin conducted an analysis of instruments developed by Raat and de Vries in 1985, Bame and Dugger in 1990, and Fife-Schow, Breakwell, Lee and Spencer in1987, and concluded that none of these instruments would meet the requirements of the TEC-LAB project. It was decided to create an instrument by adapting some of the items from previous instruments and develop additional items that would fit within the content of the factors identified by the previous researchers.

The resulting SSATT instrument consisted of 65 items that could be ranked by the students on a scale of 1 to 10. This instrument was administered to students (*N* =206) participating in the TEC-LAB project three times from September, 1991 through May, 1992. After each administration, a factor analysis was performed on the resulting data, followed by an analysis of covariance performed on the results of the entire group of students who had participated in the TEC-LAB project or in the comparison classes. Field testing of the SSATT continued through the fall of 1992 to a much larger sample of high school students with the intent of obtaining data to validate the instrument. The researchers expressed the belief that it may be possible to conduct more definitive research into the assessment of the attitudes toward technology and other subjects held by high school students, as well as ". . . the study of changes which occur in those attitudes over time and in differing educational situations" (p. 188).

Statistical Methodology: Attitude Measurement

L. L. Thurstone's most often acknowledged contribution to the modern study of attitudes was his solution to the problem of attitude measurement (Greenwald, Brock & Ostrom, 1968, p. 6). Prior to his contribution in 1929, attitudes were not an important factor in educational research because of difficulties in the measurement of them. "Thurstone's measurement design, a neutral point with five steps to either side, mirrored the like-dislike format of evaluative quality - the historical heartbeat of the attitude concept" (Shrigley, et al., 1988, p. 663). Shortly after Thurstone's work, in 1932 Likert proposed a simpler method of attitude scale construction with reliability at least as high as that of the more difficult-to-construct Thurstone scales (Oskamp, 1977, p. 29). Shrigley (1983) stated, "Likert simplified the process with an item analysis technique which allowed the data of those responding to statements to also serve as measures of validation" (p. 426). Other attitude measurement scales followed, namely Guttman and the Semantic Differential scales.

Literature in the area of educational psychology indicates that the measurement of attitudes has long been a highly controversial area of educational and psychological testing. Perhaps the complexity of measuring attitudes contributes to the controversy of the subject. In discussing the measuring of attitudes, Murphy (1972) stated,

Measuring attitudes and measuring changes in attitude represents a more complex task than measuring the acquisition of factual or cognitive information. There are, however, techniques that are accurate and appropriate for the task. (p. 11)

Murphy's statements imply that the use of attitude scales are used extensively to measure attitudes. These scales are constructed by using statements which are related to the contents of a study. Statements used in a questionaire should be simply stated in the present tense and relevant to the object under consideration. Statements which have been properly developed may be used with the Likert's summated rating scale or any scale designed to measure an attitude. Because a Likert summated rated scale was used in the TAS, it will be examined in more detail.

The Likert technique which uses a continuum for scaling the attitudes of individuals was developed by Rensis Likert with the help of his associate, Gardner Murphy. The use of the Likert technique has been discussed widely. Kerlinger (1973) stated,

> The summated rating scale seems to be the most useful in behavioral research. It is easier to develop and yields about the same results as the more laboriously constructed equal-appearing interval scale. Used with care and knowledge of [their] weaknesses, summated rating scales can be adopted to many needs of behavioral researchers. (p. 49)

In addition to the characteristics mentioned by Kerlinger, the Likert technique provides precise information about the respondent's degree of agreement or disagreement. The design of the Likert scale also permits quick responses by the examinee and rapid scoring by the examiner.

Statistical Methodology:
Concept Measurement

The measurement of the concept 'technology' for the TAS instrument is based on the five characteristics of technology described by de Vries (1987a) previously listed on page 15 in this study.

de Klerk Wolters (1989a) makes a distinction between active and passive knowledge in the area of concept measurement (p. 58). In keeping with this distinction, the characteristics of the concept 'technology' were operationalized at a certain level of abstraction. Concrete knowledge of technology was not sought, rather aspects related to the characteristics of technology were evaluated. Concrete information (active knowledge) of a concept was not asked in a question, but respondents were asked whether they were aware of a relationship between certain concepts or characteristics of technology which would represent passive knowledge.

The Guttman scale has been used in previous PATT research as a method of concept measurement. The Guttman technique presents a model for scaling concept measurement in that, by a single score, the responses to each item or statement can be reproduced. The technique assumes that position on an issue is cumulative in the sense that the individual who agrees with one position will also agree with all less-extreme positions on the topic.

Summary

This chapter was concerned with the review of topics that support and justify the existence of an instrument that measures students' attitudes towards technology and concepts of technology. The Technology Attitude Scale is designed for individual middle school teachers to independently determine their students' attitude towards and concepts of technology. The review of literature examined various topics with the purpose of systematically building support for the successful validation of the TAS for use in the U. S. A.

CHAPTER III. METHODS AND PROCEDURES

The background and need for the study were discussed in Chapter One and the review of literature was presented in Chapter Two. This chapter focuses on the research question, the population and sample, general procedures, the adaptation of the Technology Attitude Scale (TAS), the collection of data and the analysis of data.

The purpose of this study was to adapt and validate the Technology Attitude Scale (TAS), originally developed in the Netherlands, for use by American teachers at the middle school level. The procedures for validation of the TAS in the USA replicated those of Falco de Klerk Wolters, the primary researcher responsible for the development of the TAS instrument in the Netherlands.

Research Question

How can the Technology Attitude Scale (TAS), developed in the Netherlands, be adapted and validated for administration in the U.S.A. by American teachers at the middle school level?

Adaptation of the Instrument

The Technology Attitude Scale (TAS), consisting of three sections, was used to collect information (Appendix D). The first section of the instrument was designed to obtain demographic information about the respondents including: (1) age, (2) grade level,

(3) gender, (4) school location (rural or urban), and (5) respondents involvement with technology education (presently or previously enrolled in a technology education class).

The second section of the instrument (Attitude Scales) was designed to obtain information about students' attitudes toward technology. There were 26 expressions or items divided over 6 subscales. The attitude of the respondents toward technology was measured by means of the 6 subscales consisting of 3 to 5 items. Raat et al. (1987a) state, "It has been concluded, though, that beforehand it must be made clear to pupils that the attitude items are about their personal feelings and that the concept items ask for knowledge (p. 29). de Klerk Wolters (1988b) further clarifies the differences between the attitude scales and the concept scales by stating, " These attitudinal aspects are distinct from the conceptual aspects in that they refer to the affective part of the attitude towards technology" (p. 512).

de Klerk Wolters (1988b) described the subscales of the attitude towards technology section of the instrument as follows:

(1) Interest (5 statements)

This scale indicates the extent to which students are interested in technology outside school.

(2) Role Pattern (4 statements)

In this scale students indicate to what extent they think girls and boys are fit for technology.

(3) Consequences (5 statements)

The consequences scale indicates how important technology is considered to be for the world in general (whether technology means progress).

(4) Difficulty (3 statements)

This scale elicits from the respondent their feelings of difficulty towards technology that they have experienced.

(5) Curriculum (4 statements)

This scale indicates whether students would like more technology at school.

(6) Career (5 statements)

The career scale indicates whether students would like to have job related to technology (pp. 512-513).

Respondents completed the Attitude Scales by specifying to what extent they agreed with each statement by using a five choice Likert scale:

(1) Strongly Agree

(2) Agree

(3) Don't Agree, Don't Disagree

(4) Disagree

(5) Strongly Disagree

The third section of the instrument (Concept Scales) was designed to obtain information about the students' concept of technology. There were 28 items divided over 4 subscales. The conceptual section measured the cognitive or knowledge aspects, based on 5 generally accepted characteristics (de Vries, 1987a) of the concept technology. The characteristic of technology and mankind and the characteristic technology and society were combined to form a single subscale "Technology and society" which accounts for the five characteristics of technology being represented by four subscales

The subscales of the concept of technology (de Klerk Wolters, 1988b) can be described as follows:

(1) Technology and Society (10 statements)

This scale measured to what extent students thought that technology was determined and controlled by humans and influences all aspects of society. A high score indicated agreement with this notion, whereas a low score indicated that the student thought technology was only related to modern products and technology develops independently of society.

(2) Technology and Science (6 statements)

Between technology and science, and the natural sciences in particular, there is a mutual relationship. Natural sciences influence technology, but on the other hand, technology also influences natural sciences. This scale measured the extent respondents understand this mutual relationship.

(3) Technology and Skills (7 statements)

There is a process-side to technology. Of importance is not only the product but also the process to manufacture it. Designing, practical skills and knowing how to operate equipment are technical skills. This scale measured whether students see the relationship between technology and skills. A high score means that students understand this relationship.

(4) <u>Technology and Pillars</u> (5 statements)

This scale uses the word 'pillars' to designate the 'foundation' or 'basis' of technology. Information, matter and energy are the pillars of technology, and each are equally important. If students think that matter, energy and information are the pillars of technology they will score high on this scale (p. 514).

The Concept Scales measure the knowledge and concept of technology at a relatively abstract level. An approach in which facts are not asked for, and right and wrong or don't know answers are scored to the concept questions was deliberately chosen as the means to measure the knowledge and concept of technology. Students responded to the Concept Scales by indicating:

(1) Agree

(2) Disagree

(3) Don't Know

Population and Sample

In education it is not always possible to implement random sampling procedures. According to Fraas (1983) the term used to describe nonrandom samples is "convenience samples." A convenience sample is often drawn for educational purposes by one of the following methods:

1. The students who are in the classroom of the teacher conducting the study constitute the sample.

2. The students in the classes of teachers who volunteer or are selected to participate in the educational program form the sample.

3. Students whose schedules permit them to be included in the study are identified as the sample (p. 104).

Because of legal, time, administrative and other constraints, the above methods of selection are often used to obtain a sample in educational research.

If a nonrandom sample is used, it is essential to determine whether the sample accurately represents the population. As Fraas points out, "A specific procedure can be used to determine if the sample is biased with respect to relevant student characteristics and, therefore, should not be used to represent the population" (p. 104). The procedure requires that an evaluator compare relevant characteristics of students in the sample to those of the students in the population.

In the validation process of the TAS the sample resulted from students of teachers who volunteered to participate in the study. The characteristics of age, grade level and gender proportions of the sample matched closely to the same characteristics of the population. Fraas (1983) states, "The more these student characteristics are similar in both the sample and the population, the greater the chance that a representative sample has been selected" (p. 105).

The target population for this study consisted of middle school students from independent school districts in the Commonwealth of Virginia. According to Fraas (1983), ". . . the target population is the group of students for which the research instrument was designed" (p. 102). The TAS-USA is intended for use by middle school students ages 12-14 in both urban and rural areas.

Ary, Jacobs, and Razavieh (1985) described a form of sampling called stratified sampling which can be used when the population contains a number of subgroups or strata that may vary in the characteristic being studied (p. 142). Ary et al. also suggested that,

> . . . in this kind of sampling one may either take equal numbers from each stratum or select in proportion to the size of the stratum in the population. This latter procedure is known as proportional stratified sampling, the stratum is represented in the sample in exact proportion to its frequency in the total population. (p. 143)

Stratified sampling, according to Ary et al., ensures that each stratum of the population is adequately represented in the sample. Because the study included middle school students from five school districts in the Commonwealth of Virginia, a stratified sample was used designating rural or urban location. Five middle school technology teachers were selected on a volunteer basis. A letter was sent to each of the technology teachers requesting their participation in the study (Appendix E). They were also requested to coordinate the administration of the instrument with an additional teacher from another area of study. Therefore, the technology teacher enlisted the assistance of another subject area teacher (one English teacher and four science teachers) in administering the TAS to middle school boys and girls.

The sample for this study was 231 middle school students from five middle schools in Virginia. The middle schools represented urban and rural school populations in the Commonwealth of Virginia. Appendix I represents a graphic overview of the research sequence.

Panel of Experts

The language of the English translation of the TAS questionnaire was checked for problems that may have occurred in translation from the Dutch language. Five individuals with experience and knowledge of middle school students and middle school curriculum were selected to serve on the Panel of Experts (Appendix B).

A middle school English/social studies teacher was selected because of expertise in middle school language arts. A middle school science teacher was selected because of several years experience in teaching science related subjects. A technology education teacher was selected because of experience in this area. Two university technology teacher educators interested in and experienced with middle schools completed the Panel of Experts.

Panel members examined the instrument for appropriate language and word usage. The researcher, with the consensus of the panel members, made the final decisions for any language or word changes based on the concern of maintaining the essence of the original instrument (Appendix C). The Webster's Dictionary of Synonyms was used as a reference for the modification of words.

TAS Pilot Study: Student Review

In an effort to determine difficulties with the instrument, the Technology Attitude Scale was administered to 48 middle school students. The students selected to complete the TAS were not part of the sample selected for the Large Group Administration, but possessed characteristics similar to students in the large group sample. The students were asked to circle any words they didn't understand and to indicate any difficulties they may have had in completing the instrument. Modifications to the instrument were made with consideration given to the original intent of the questionnaire.

Immediately after administration of the TAS Pilot to the 48 middle school students was completed, preliminary examinations were made. The following sections were evaluated: directions to the classroom teacher for administering the instrument, suggestions from the Panel of Experts regarding appropriate language and word usage, and specific difficulties in understanding statements or words in the instrument experienced by the students. The TAS was modified and the final form of the instrument was administered to 231 students in five middle schools selected for the study.

Instrument Validity

The Panel of Experts was used to establish content validity for the instrument used in the study. Members of the panel were selected because of their experience with middle school children, expertise in technology education or experience in instrument development or curriculum development. The panel was used to:

(1) examine all statements for appropriate language and word usage, and

(2) make suggestions about item terminology which would enhance clarity and brevity.

This procedure is consistent with Ary et al. (1985) description for content validity attainment, "In order to obtain an external evaluation of content validity the test maker should ask a number of experts or other teachers to examine the test content systematically and evaluate its relevancy to the specified universe" (p. 215).

Instrument Reliability

Ary et al. (1985) described the reliability of a measuring instrument as the degree of consistency with which an instrument measured what it is supposed to measure. The Cronbach Alpha procedure was used to obtain the reliability estimate of the internal consistency of the attitude measurement section of the TAS. The Cronbach Alpha estimates reliability and ". . . is used when measures have multiple scored items, such as attitude scales or essay tests"

(p. 235). Mueller (1986) mentions that ". . . tests with items scored along a continuum, such as Likert scale attitude items (scored 1 through 5), require the use of alpha" (p. 61). Mueller further states, "Internal-consistency reliability-estimation procedures are particularly relevant for tests measuring psychological constructs (such as, attitudes, values and personality traits)" (p. 62).

van den Bergh (1987) suggests that an "Alpha-value at least more than .60" (p. 43) indicates a scale has good reliability. An Alpha -value of at least .60 or higher is the target number set as a goal for the acceptance of the TAS for use in Virginia.

The Kuder-Richardson formula 20 (KR 20) procedure was used to obtain the reliability estimate of the internal consistency of the concept measurement section of the TAS. The Kuder-Richardson formula 20 is ". . . probably the best known index of homogeneity . . . and is based on the proportion of correct and incorrect responses to each of the items on a test" (Ary et al., 1985, p. 233). The concept measurement section of the TAS was scored in a dichotomous procedure (Correct=1; Not Correct or Don't Know= 0).

Collection of Data

The instruments for the validation of the TAS were hand delivered by the researcher to the coordinating technology teacher volunteers (Appendix E). The five middle schools, cooperating technology education teachers, other subject area teachers (Appendix G), and students participated on a voluntary basis with assurance of anonymity. The time to complete the TAS was approximately 10 minutes. The researcher assisted with the administration of the instrument in all five schools and returned with the completed instruments for analysis. Individual instruments were hand scored and data entered on opscan sheets for analysis through the Office of Measurement and Research Services at Virginia Polytechnic Institute and State University.

Analysis of Data

Analysis procedures included the calculation of descriptive and frequency statistics of the data resulting from the administration of the instrument. Cronbach's homogeneity coefficient alpha was employed to determine the reliability and internal consistency of the attitude measurement section of the Technology Attitude Scale used in this study. Kuder-Richardson formula 20 was employed to determine the reliability and internal consistency of the concept measurement section of the Technology Attitude Scale. Previous to the analysis procedures, a Panel of Experts examined the statements in section two of the TAS (attitude items) and section three (concept items) and commented on these statements which resulted in a basis of formulation of content validity.

Summary

Chapter Three presented a description of the research question and of the adaptation of the instrument. The population and sample were described. The general procedure of the research was presented with attention to the duties of the Panel of Experts, the administration of the instrument by a group of students with characteristics similar to those of the target population, and the collection of data. This was followed by a discussion of instrument validity, instrument reliability, and analysis of data.

CHAPTER IV. RESULTS OF THE STUDY

The purpose of this study was to adapt and validate the Technology Attitude Scale (TAS), originally developed in the Netherlands, for use by American teachers at the middle school level. Adaptation and validation of the instrument was achieved through a three-fold process. First, content validity was determined through the Panel of Experts. Second, a Pilot Study was conducted in order to determine difficulties with the instrument. Third, a Large Group Administration was conducted to establish instrument reliability.

The Panel of Experts was composed of five individuals who have expert knowledge and extensive experience with middle school students. The study population included five middle schools in Virginia. Comparisons were made based on geographic location, gender, age, grade level and involvement with technology education studies. The Pilot Study (N=48) was conducted with students in one middle school. The Large Group Administration (N=183) was conducted with students in four middle schools.

Reliability of the TAS instrument was determined through statistical treatment of data collected from both the Pilot Study and the Large Group Administration. Statistical analysis of the data was completed through The Office of Measurement and Research Services, Virginia Polytechnic Institute and State University. Reliability of the Attitude Scales was determined using Cronbach's homogeneity coefficient alpha statistical procedure. Reliability of the Concept Scales was determined using Kuder-Richardson formula 20 (KR-20). van den Bergh (1987) suggested that an alpha-value of .60 or more indicates that a scale has good reliability (p. 43). An alpha-value of at least .60 was the criterion value set as a goal for this study.

Findings of the Panel of Experts

A Panel of Experts can facilitate the process of determining content validity. According to Ary et al., (1985),

> Content validity cannot be expressed in terms of a numerical index. Content validation is essentially and of necessity based on judgment, and such judgment must be made separately for each situation. . . . In order to obtain an external evaluation of content validity, the test maker should ask a number of experts or other teachers to examine the test content systematically and evaluate its relevancy to the specified universe. (p. 215)

The five members of the Panel of Experts included a middle school science teacher, a middle school English teacher, a middle school technology education teacher, and two university technology teacher educators. Panel members reviewed the instrument for appropriate language, clarity, and brevity. The written instructions provided to the members were, "Please review the following statements with the thought of how they would be received by middle school students. Certain words, phrases and sentences may seem a bit awkward. Please circle words, phrases or sentences that you think may cause a middle school student problems with completing this instrument. Suggestions or examples would be gratefully accepted."

Following examination of the instrument by the Panel of Experts, the researcher, in conjunction with other committee members, modified several statements. The modifications were carried out with the intent of keeping the essence of the original instrument.

Several suggestions from the Panel of Experts were incorporated in the statements of the original Technology Attitude Scale. Some suggestions concerned the changing of words. For example, the word "clever" was changed to "smart," "dealing with" was changed to "working with," "think up" was changed to "create", and "handle tools" was changed to "work with tools." In some cases sentences were rearranged, i.e., "In everyday life I have a lot to do with technology," was changed to, "In my everyday life, I work with technology a lot." Another example of a rearranged sentence is, "To understand something of technology you have to do a difficult training course," was changed to, "To understand technology you have to study difficult training courses." Each change in the TAS was done with the thought of keeping the intent of each statement as close to the original meaning as possible.

One exception should be noted. Statement number 7 in the attitude section was identified by a majority of the members on the Panel of Experts as possibly confusing to middle school students. Item 7 was originally translated as follows, "The world would be a worse place without technology." A panel member suggested revising the statement to read, "The world would be a better place with technology." This suggestion was adopted and the revision was included in the TAS for the Pilot Study.

Final Version of the Technology Attitude Scale (TAS-USA)

The final version of the TAS used in this study followed the original instructional format with the exception of some word substitutions and the rearrangement of a few statements. With the intent of keeping the original meaning of the instrument intact, a description of the final version follows.

The Technology Attitude Scale (TAS), consisting of three sections, was used to collect information. In the Technology Attitude Scale, the first section of the instrument was designed to obtain demographic information about the respondents including: (1) age, (2) grade level, (3) gender, (4) school location (rural or urban), and (5) respondents involvement with technology education (presently or previously enrolled in a technology education class).

The second section of the instrument (Attitude Scales) was designed to obtain information about students' attitudes toward technology. There were 26 expressions or items divided over 6 subscales. The attitude of the respondents toward technology was measured by means of the 6 subscales consisting of 3 to 5 items.

The final version of the TAS-USA attitude section subscales are the same as described by de Klerk Wolters (1988b).

(1) <u>Interest</u> (5 statements)

This scale indicates the extent to which students are interested in technology outside school.

(2) Role Pattern (4 statements)

In this scale students indicate to what extent they think girls and boys are fit for technology.

(3) Consequences (5 statements)

The consequences scale indicates how important technology is considered to be for the world in general (whether technology means progress).

(4) Difficulty (3 statements)

This scale elicits from the respondent their feelings of difficulty towards technology that they have experienced.

(5) Curriculum (4 statements)

This scale indicates whether students would like more technology at school.

(6) Career (5 statements)

The career scale indicates whether students would like to have job related to technology (pp. 512-513).

Respondents completed the Attitude Scales by specifying to what extent they agreed with each statement by using a five choice Likert scale:

(1) Strongly Agree
(2) Agree
(3) Don't Agree, Don't Disagree
(4) Disagree
(5) Strongly Disagree

The third section of the instrument (Concept Scales) was designed to obtain information about the students' concept of technology. There were 28 items divided over 4 subscales. The conceptual section measured the cognitive or knowledge aspects, based on 5 generally accepted characteristics (de Vries, 1987a) of the concept technology. The characteristic of technology and mankind and the characteristic technology and society were combined to form a single subscale "Technology and society" which accounts for the five characteristics of technology being represented by four subscales

The final version of the TAS-USA concept section subscales are the same as described by (de Klerk Wolters (1988b).

(1) Technology and Society (10 statements)

This scale measured to what extent students thought that technology was determined and controlled by humans and influences all aspects of society. A high score indicated agreement with this notion, whereas a low score indicated that the student thought technology was only related to modern products and technology develops independently of society.

(2) Technology and Science (6 statements)

Between technology and science, and the natural sciences in particular, there is a mutual relationship. Natural sciences influence technology, but on the other hand, technology also influences natural sciences. This scale measured the extent respondents understand this mutual relationship.

(3) <u>Technology and Skills</u> (7 statements)

There is a process-side to technology. Of importance is not only the product but also the process to manufacture it. Designing, practical skills and knowing how to operate equipment are technical skills. This scale measured whether students see the relationship between technology and skills. A high score means that students understand this relationship.

(4) <u>Technology and Pillars</u> (5 statements)

This scale uses the word 'pillars' to designate the 'foundation' or 'basis' of technology. Information, matter and energy are the pillars of technology, and each are equally important. If students think that matter, energy and information are the pillars of technology they will score high on this scale (p. 514).

The Concept Scales measure the knowledge and concept of technology at a relatively abstract level. An approach in which facts are not asked for, and right and wrong or don't know answers are scored to the concept questions was deliberately chosen as the means to measure the knowledge and concept of technology. Students responded to the Concept Scales by indicating:

(1) Agree

(2) Disagree

(3) Don't Know

Findings of the Pilot Study

The Pilot Study was conducted at Andrew Lewis Middle School in Salem, Virginia, an urban community. The 48 participants included 32 boys and 16 girls ranging in age from 13-15 years. All participants were in the eight grade, with only 3 students not involved in a technology education class.

Attitude Scales

The coefficient alpha values for the Pilot Study Attitude Scales are summarized in Table 1.

Table 1

Alpha Values of Pilot Study Attitude Scales

		Correlation to Other Scales
Scale 1	Interest	.79
Scale 2	Role Pattern	.63
Scale 3	Consequences	.30
Scale 4	Difficulty	.35
Scale 5	Curriculum	.63
Scale 6	Career	.83

Four of the six Attitude Scales met the minimum .60 alpha value criterion.

Concept Scales

The reliability estimates for the Pilot Study Concept Scales are summarized in Table II.

Table II

Reliability Estimates of Pilot Study Concept Scales

	Correlation to Other Scales
Technology and Society	.73
Technology and Science	.65
Technology and Skills	.20
Technology and Pillars	.59
Overall	.84

Two of four Concept Scales had correlations over .60. The overall correlation (.84) was an acceptable reliability estimate value.

Examination of the Pilot Study data analysis revealed that the correlation of statement 7, which was modified for the Pilot Study, fell well below the .25 minimum acceptance value. Further investigation brought forth the fact that the revision of statement 7 had changed the original item from a negatively worded sentence to a positively worded one. The researcher made a decision to change item

7 to its original negatively constructed sentence. This decision was based on the intent of keeping the TAS as close to the original meaning as possible and the fact that the low alpha correlations for each aspect of comparison of item 7 was low.

Based on the Pilot Study coefficient alpha values from the Attitude Scales and the reliability estimates from the Concept Scales, a decision was made by the researcher in conjunction with committee members to proceed with the administration of the TAS to a larger sample.

Findings of the Large Group Administration of TAS

The Large Group Administration of the TAS was completed by 116 boys and 67 girls at four middle schools in Virginia. The schools were:

Hidden Valley Middle School	(N=46)	Roanoke	urban
Cave Spring Middle School	(N=50)	Roanoke	urban
Kate Collins Middle School	(N=40)	Waynesboro	rural
Shelburne Middle School	(N=47)	Staunton	rural

The ages of the students ranged from 12 to 15 years in grades 7, 8, and 9. Of 183 students completing the TAS, 135 have had or were in the process of taking a course in technology education. A more detailed description of demographic information is found in Appendix H.

Attitude Scales

The Large Group Administration Attitude Scales coefficient alpha values are summarized in Table III.

Table III

Alpha Values of the Large Group Administration Attitude Scales

		Correlation to Other Scales
Scale 1	Interest	.73
Scale 2	Role Pattern	.71
Scale 3	Consequences	.25
Scale 4	Difficulty	.22
Scale 5	Curriculum	.74
Scale 6	Career	.80
Overall		.81

Four of the six Attitude Scales met the minimum .60 alpha value criterion. In addition, the overall correlation for all scales (.81) met the minimum .60 value indicator.

An item analysis was done to determine inter-item correlations. The item discrimination index was calculated by correlating item scores with total scale scores. According to Ary (1985), "Each item should correlate at least .25 with the total score" (p. 197). Appendix

J lists correlations of all items in the Attitude Section for each of the six scales and indicates summated scale correlations. Appendix K lists correlations of all items in the Concept Section for each of the four subgroups and the summated scale correlations.

Concept Scales

The reliability estimates for the Large Group Administration Concept Scales are summarized in Table IV.

Table IV

Reliability Estimates of the Large Group Administration Concept Scales

	Correlation to Other Scales
Technology and Society	.72
Technology and Science	.61
Technology and Skills	.48
Technology and Pillars	.47
Overall	.83

Two of the four subgroups met the reliability estimate criterion value of .60, and the overall correlation (.83) also met the criterion value.

Based on the Large Group Administration overall correlations of the coefficient alpha values from the Attitude Scales and the reliability estimates (KR-20) from the Concept Scales, it was determined by the researcher in conjunction with committee members that adequate reliability for the TAS instrument was achieved.

Summary

This chapter presented findings from the Panel of Experts, the Pilot Study, and Large Group Administration validation procedures of the Technology Attitude Scale. The primary purpose of this study was to adapt and validate the TAS for use by American teachers at the middle school level. Content validity was established through the utilization of the Panel of Experts. Reliability correlation values for the Attitude Scales were obtained through the statistical application of Cronbach's homogeneity coefficient alpha. An alpha-value of at least .60 was the target number set as a goal for the acceptance of the TAS. The reliability estimates for the Concept Scales were obtained through the statistical application of the Kuder-Richardson formula 20 to obtain internal consistency values. Item analysis in conjunction with both procedures was used to obtain inter-item correlations(Appendix J: Attitude Section; Appendix K: Concept Section). The criterion value of .25 was used as the minimum acceptance level for inter-item correlations.

Through the Pilot Study ($N = 48$) it was found that four of the six Attitude Scales of the TAS instrument had alpha values of .60 or above. The Concept Scales KR-20 overall reliability value was .84. As a result of positive feedback from the Panel of Experts about the TAS and a majority of acceptable reliability values from the Attitude and Concept Scales data, a decision was made to proceed with the administration of the TAS to a larger sample.

Large Group Administration (*N* =183) included students from four middle schools in Virginia. An overall alpha value of large group administration Attitude Scales was .81. The overall reliability estimate of the large group administration Concept Scales was .83.

Content validity of the instrument established through the Panel of Experts, and reliability of the instrument established through statistical treatment of data, determined that the TAS instrument has been adapted and validated for use in the U. S. A. by American teachers at the middle school level.

CHAPTER V.

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Chapter Five is divided into three general sections. First, a summary of the study, including an overview of the problem, a brief description of both the population and the Technology Attitude Scale (TAS) instrument, and a delineation of the general procedures is presented. Second, conclusions of the Panel of Experts, the Pilot Study, and the Large Group Administration are offered. Recommendations for further study are provided in the third section.

Summary of the Study

Problem. The purpose of this study was to adapt and validate the Technology Attitude Scale, originally developed in the Netherlands, for use by American teachers at the middle school level.

Population. The study population included five middle schools in Virginia. Statistical analysis was based on geographic location, gender, age, grade level and involvement with technology education studies. The Pilot Study ($N=48$) was conducted with students in one middle school. The Large Group Administration ($N=183$) was conducted with students in four middle schools.

Instrument. The Technology Attitude Scale (TAS), an adaptation of a Dutch instrument consisting of three sections, was used to collect information. The adaptation of the Dutch instrument maintained consistency with the original design in that the purpose was descriptive, ". . . the instrument is not a test instrument but a descriptive instrument" (Ratt et al., 1987, p. 31).

In the Technology Attitude Scale, the first section of the instrument was designed to obtain demographic information about the respondents including: (1) age (2) grade level (3) gender (4) school location (rural, urban) (5) respondents involvement with technology education (presently or previously enrolled in a technology education class).

The second section of the instrument was designed to obtain information about students' attitudes toward technology. There were 26 items divided over 6 subscales, (interest, role pattern, consequences, difficulty, curriculum, and career), with 3 to 5 items per subscale. Respondents completed the second section of the TAS by specifying to what extent they agreed with each statement by using a five choice Likert-type scale.

The third section of the instrument was designed to obtain information about the students' concept of technology. This conceptual section measured the cognitive or knowledge aspects, based on 5 generally accepted characteristics (de Vries, 1987a) of the concept technology. There were 28 items divided over 4 subscales; technology and society, technology and science, technology and skills, and technology and pillars (pillars are matter, energy, and information). The statements were designed to measure the knowledge and concept of technology at a relatively abstract level, focusing more on knowledge than attitude or feeling (cognitive vs. affective).

The students responded to the statements of the Concept Scales on a three-point Likert Scale: 1-Agree, 2-Disagree, 3-Don't Know. However, because the statistical analysis chosen, the Kuder-Richardson formula 20 (KR-20) , requires a dichotomously scored response, scoring was analysed according to a two point scale: 1-Agree, 0-Disagree, 0-Don't Know. If the student agreed with a characteristic of technology, the statement was scored as 1. If the student disagreed with or did not know about a characteristic of technology, the statement was scored as 0. It is important to note that responses to the Concept Scale statements were not meant to be considered right or wrong. Concern regarding this aspect of the Concept Scale surfaced during the 1987 PATT Conference.

> The use of the scores 0 and 1 caused the impression that there would be a case of right or wrong answers. Naturally this is not the goal of the instrument. However, the quantification of the answers in 0 and 1 cannot be avoided. (Ratt et al., 1987, p. 31)

<u>General Procedures</u>. The procedure followed to validate the TAS consisted of the following:

1. presenting the original translation of the instrument to the Panel of Experts to examine for appropriate language, clarity and brevity,

2. modifying statements on the instrument to reflect input from the Panel of Experts,

3. conducting a Pilot Study to determine if the directions, statements, time to complete the instrument, and analysis of data were conducive to continuing the validation process,

4. modifying the instrument based on experiences from the Pilot Study,

5. selecting four middle school technology education teacher volunteers who were willing to assist in the Large Group Administration of the TAS,

6. enlisting the four technology teacher volunteers to coordinate the Large Group Administration of the TAS with a teacher who did not teach technology education (an English teacher and three science teachers),

7. requesting the four technology teacher volunteers to obtain permission from their building principals to administer the TAS to their classes and to the non-technology education classes,

8. administrating the TAS instrument,

9. completing analysis of the data for reliability through the Office of Measurement and Research Services, Virginia Polytechnic Institute and State University, using Cronbach's homogeneity coefficient alpha statistical procedure on the Attitude Scales, and Kuder-Richardson formula 20 (KR-20) on the Concept Scales, and

10. interpreting the analysis of data as it pertains to validation of the instrument.

Conclusions of the Panel of Experts

The Panel of Experts facilitated the process of establishing content validity of the TAS. The researcher, in conjunction with the Panel of Experts, examined the contents of the TAS instrument. They provided input for decisions to adapt and rearrange statements in the instrument.

It was the judgment of the Panel of Experts that the statements in both the attitude section and the concept section were relevant for the purpose of determining attitudes of technology for middle school students. With assistance, advice and negotiation with the Panel of Experts, it was determined that the revised format of the TAS could be successfully administered.

It is concluded that the Technology Attitude Scale has appropriate content validity.

Conclusions of the Pilot Study

Attitude Scales

In the Pilot Study, four of the six Attitude Scales have alpha values of .60 or above; Interest .79; Role Pattern .63; Curriculum .63; and Career .83. It is concluded that four of the six Attitude Scales on the Pilot Study (Interest, Role Pattern, Curriculum and Career) are acceptably reliable.

In the Pilot Study, two of the four Attitude Scales have alpha values of less that .60; Consequences .30 and Difficulty .35. It is concluded that two of the six Concept Scales on the Pilot Study (Consequences and Difficulty) are not acceptably reliable.

Concept Scales

In the Pilot Study, two of the four Concept Scales have criterion values of .60 or higher; Technology and Society .73; and Technology and Science .65. It is concluded that two of the four Concept Scales of the Pilot Study are acceptably reliable.

In the Pilot Study, two of the four Concept Scales have criterion values of less than .60; Technology and Skills .20; and Technology and Pillars .59. It is concluded that two of the four Concept Scales of the Pilot Study are not acceptably reliable.

In the Pilot Study, the overall reliability estimate of the four Concept Scales is .84. It is concluded that the Pilot Study Concept Scales are acceptably reliable.

Overall Conclusion

It is concluded that the Pilot Study administration of the Technology Attitude Scale (TAS) provided feedback from students and teachers indicating that the instrument was appropriate for reading level, time to complete, and clarity of instruction for the participants.

Conclusions of the Large Group Administration

Attitude Scales

In the Large Group Administration, four of the six Attitude Scales have alpha values of .60 or above; Interest .73; Role Pattern .71; Curriculum .74; and Career .80. It is concluded that four of the six Attitude Scales on the Large Group Administration (Interest, Role Pattern, Curriculum and Career) are acceptably reliable.

In the Large Group Administration, two of the four Attitude Scales have alpha values of less that .60; Consequences .25 and Difficulty .22. It is concluded that two of the six Concept Scales on the Large Group Administration (Consequences and Difficulty) are not acceptably reliable.

In the Large Group Administration, the overall alpha value of the six Attitude Scales is .81. It is concluded that the Large Group Administration Attitude Scales are acceptably reliable.

Concept Scales

In the Large Group Administration, two of the four Concept Scales have criterion values of .60 or higher; Technology and Society .72; and Technology and Science .61. It is concluded that two of the four Concept Scales of the Large Group Administration are acceptably reliable.

In the Large Group Administration, two of the four Concept Scales have criterion values of less that .60; Technology and Skills .48; and Technology and Pillars .47. It is concluded that two of the four Concept Scales of the Large Group Administration are not acceptably reliable.

In the Large Group Administration, the overall reliability estimate of the four Concept Scales is .83. It is concluded that the Large Group Administration Concept Scales are acceptably reliable.

Overall Conclusion

The primary conclusion of this study based on findings reported in Chapter Four is that the Technology Attitude Scale is a valid and reliable instrument overall. The adaptation of the TAS from the original Dutch translation to appropriate language, clarity and brevity for administration to middle school students was accomplished. The content validity as judged by the Panel of Experts, the overall alpha value of .81 for the Attitude Scales, and the overall reliability estimate of .83 for the Concept Scales indicate that the TAS-USA instrument may be used to ascertain the attitudes towards and concepts of technology of middle school students in the U.S.

The Technology Attitude Scale (TAS-USA) is adapted and validated for use by American teachers at the middle school level.

Recommendations

The results of this research suggest additional directions for consideration in future research. The following recommendations are offered.

1. It is recommended that further development of the TAS instrument, (Attitude and Concept Scales) should be done to improve the acceptance level for all scales above .60 reliability. Item intercorrelations for the scales Consequences and Difficulty in the Attitude Section, and Technology and Skills and Technology and Pillars in the Concept Section are below the desired minimum .60 reliabilty. Rewriting the statements for these scales to obtain the minimum reliability level should result in an improved overall instrument.

2. It is recommended that in future research an expanded number of middle schools in Virginia be included. This study was confined to seventh, eighth, and ninth graders in five urban or rural middle schools in the Commonwealth of Virginia. Also, as a basis for comparison purposes of students' attitudes towards technology and concepts of it, it is recommended that future research expand the population of interest to include other states in the U. S. A.

3. It is recommended that future research include the development of an elementary school TAS instrument with adjustment given to

reading level and consideration to the use of pictures as a means of communicating students' attitudes. Dunlap (1990) conducted a study in which he modified the PATT-USA instrument for use at the elementary level. He provided evidence that both boys and girls who participated in the third and fourth grade Mission 21 Project did, in fact, have a substantially more positive attitude towards technology than those students who did not.

4. A TAS instrument that reflects attitudes toward technology of older adolescents at the high school level is recommended. Householder and Bolin (1992) developed an instrument, the Secondary Students' Attitudes Toward Technology (SSATT). They expressed the belief that a study of changes in attitudes over time and in different educational settings may be possible. A TAS instrument directed to the high school student may provide useful information concerning attitudes and concepts for comparison purposes with middle school students' attitudes and other attitude studies.

5. It is recommended that the scoring procedures of the instrument and an instruction manual for the teachers be developed. This instrument should be valuable for use by classroom teachers. The TAS needs to be developed into a useable form including instruments for administration, scoring, and analysis of results.

REFERENCES

Akubue, A. I. (1992). Technology education: From the United States to Nigeria. In E. A. Bame & W. E. Dugger, Jr. (Eds.), Technology education-A global perspective (pp. 133-148). Reston, VA: International Education Technology Association.

Allport, G. (1968). The historical background of modern social psychology. In G. Lindzey & E. Aronson (Eds.), Handbook of social psychology (2nd ed.) (pp. 1-80). Massachusetts: Addison-Wesley.

America is in danger of getting an F in science. (1993, October 5). Roanoke Times and World News. p. 5.

American Association for the Advancement of Science. (1989). Science for all Americans - A project 2061 report on literacy goals in science, mathematics, and technology (Library of Congress No 88-36252). Washington, DC: American Association for the Advancement of Science.

Anderson, L.F. (1926). History of Manual and Industrial School Education. Appleton and Co.

Ary, D., Jacobs, L. C. & Razavieh, A. (1985). Introduction to research in education. (3rd ed.). New York: Holt, Rinehart and Winston.

Atkinson, S. (1990). Design and technology in the United Kingdom. Journal of Technology Education, 2(1), 5-17.

Bame, E. A., & Dugger, W. E., Jr. (1989). Pupils' attitudes towards teachnolgy: PATT-USA. In F. de Klerk Wolters, I. Mottier, J. Raat & M. de Vries (Eds.), Teacher education for school technology - Report PATT-4 conference (pp.309-323). Eindhoven, The Netherlands: University of Technology.

Bame, E. A. & Dugger, W. E., Jr. (Eds.). (1992). Technology education: A global perspective, ITEA-PATT international conference. Reston, VA: International Technology Education Association.

Bensen, M. J. (1991). Educational perspectives on technological literacy. In M. J. Dyrenfurth & M. R. Kozak (Eds.), Technological literacy - 40th yearbook, Council on Technology Teacher Education (pp. 119-137). Peoria, IL: Glencoe Division, Macmillan/McGraw-Hill.

Blake, C. N. (1983). Lewis Mumford: Values over technique. Democracy, Spring, 125-137.

Bolton, N. (1977). Concept formation. New York: Pergamon Press.

Boyer, E. L. (1983). High school: A report on secondary education in America. New York: Harper & Row.

Boyer, E. L. (1985). A perspective on education. Technology education: A perspective on implementation (pp. 3-6). Reston, VA: International Technology Education Association.

Bugliarello, G. (1988). The science-technology-society matrix. Bullitin of Science, Technology and Society, 8, 125-126.

Cardwell, D. S. L. (1972). Technology, science and history. London: Heinemann.

Carnegie Council on Adolescent Development. (1989). Turning points: Preparing American youth for the 21st century (Library of Congress No. 89-15752 CIP). Washington, DC: Carnegie Council of Adolescent Development.

Chant, C. (1989). Science and technology: Problems of interpretation. In C. Chant (Ed.), Science, technology and everyday life 1870 -1950 (pp. 40-58). New York: The Open University.

Cooper, J. B. & McGaugh, J. L. (1968). Attitude and related concepts. In M. Johoda & N. Warren (Eds.), Attitudes - Selected readings (pp. 26-31). Baltimore: Penguin Books.

Croft, V. E. (1989). A national study to determine the characteristics of technological literacy for high school graduates. (Doctoral Dissertation, Virginia Polytechnic Institute and State University, 1989). Dissertation Abstracts International, 51 / 05A.

Deijsselberg, W. (1988). Teacher training and the concept of technology. In J. Raat, R. Coenen-van den Bergh, F. de Klerk Wolters, & M. de Vries, (Eds.), Basic principles of school technology - Report PATT-3 conference vol.2 (pp. 498-508). Eindhoven, The Netherlands: University of Technology.

de Klerk Wolters, F. (1988a). What do adolescents think of technology? In J. Raat, R. Coenen-van den Bergh, F. de Klerk Wolters, & M. de Vries, (Eds.). Basic principles of school technology - Report PATT-3 conference vol.2 (pp. 323-336 Eindhoven, The Netherlands: University of Technology.

de Klerk Wolters, F. (1988b). Directions for use of the TAS in class. In J. Raat, R. Coenen-van den Bergh, F. de Klerk Wolters, & M. de Vries, (Eds.). Basic principles of school technology - Report PATT-3 conference vol.2 (pp. 509-535). Eindhoven, The Netherlands: University of Technology.

de Klerk Wolters, F. (1989a). The attitude of pupils towards technology. Eindhoven, The Netherlands: Eindhoven University of Technology.

de Klerk Wolters, F. (1989b). The PATT-Project: An overview of an international project in technology education. In F. de Klerk Wolters, L. Mottier, J. Raat & M. de Vries (Eds.), Teacher Education for School Technology - Report PATT-4 conference (pp. 290-308). Eindhoven, The Netherlands: University of Technology.

de Klerk Wolters, F., Mottier, I., Raat, J., & de Vries, M. (Eds.). (1989). Teacher education for school technology - Report PATT-4 conference. Eindhoven, The Netherlands: University of Technology.

de Klerk Wolters, F. (1992, December). [Interview with Dr. Falco de Klerk Wolters, Project Manager, Centre for Leisure & Tourism, Christeliijke Hogeschool Noord - The Netherlands].

de Vries, M. J. (1987a). What is technology? The concept 'technology' in secondary education. Unpublished manuscript. Department of Physics and Technology (N&T 87-01). Eindhoven, The Neatherlands: University of Technology.

de Vries, M. J. (1987b). Technology in education: Research and development in the project physics and technology. In R. Coenen-van den bergh (Ed.), Report PATT-conference vol. 2 contributions (pp.432-445). Eindhoven, The Netherlands: University of Technology.

Dugger, W. E., Jr. (1988). Technology - The discipline. The Technology Teacher, 48(1), 3-6.

Dunlap, D. D. (1990). Comparing attitudes toward technology of third and fourth grade students in Virginia relative to their exposure to technology. (Doctoral dissertation). Blacksvurg, VA: Virginia Polytechnic Institute and State University.

Dyrenfurth, M. J. (1988). International comparisons of technology education and technological literacy. In J. Raat, R. Coenen-van den Bergh, F. de Klerk Wolters & M. de Vries (Eds.), Basic principles of school technology - Report PATT-3 conference vol. 1 (pp. 202-208). Eindhoven, The Netherlands: University of Technology.

Dyrenfurth, M. J. (1991). Technological literacy synthesized. In M. J. Dyrenfurth & M. R. Kozak (Eds.), Technological literacy - 40th yearbook, Council on Technology Teacher Education (pp. 138-183). Peoria, IL: Glencoe Division, Macmillan/McGraw-Hill.

Education Commission of the States. (1983). Action for excellence: A comprehensive plan to improve our nation's schools - Task force on education for economic growth. Denver, CO: The Commission

Fishbein, M. & Ajzen, I. (1975). Belief, attitude, intention and behavior: An introduction to theory and research. Reading, MA: Addison-Wesley.

Fleming, R. (1989). Literacy for a technological age. Science Education, 73(4), 391-404.

Fraas, J. W. (1983). Basic concepts in educational research. Maryland: University Press of America.

Gatewood, T. E. (1982). History and philosophy of the middle school. In A. A. Arth & J. H. Lounsbury (Eds.), The middle school primer (pp. 3-5). Laramie, WY: University of Wyoming.

George, P. S., Stevenson, C., Thomason, J. & Beane, J. (1992). The middle school and beyond. Alexandria, VA: Association for Supervision and Curriculum Development.

Gilberti, A. F. (1986). Technological and civic literacy: Symbiotic relationship. In M. Sanders (Ed.), Technology education symposium proceedings - "Technological literacy: An educational mandate" (pp. 20-23). Blacksburg, VA: Virginia Polytechnic Institute & State University.

Greenwald, A. G., Brock, T. C., & Ostrom, T. M. (1968). Psychological foundations of attitudes. New York: Academic Press.

Hayden, M. A. (1991). The development and validation of a test of industrial technological literacy. Journal of Technology Education, 3(1), 30-42,

Hersh, R. (1983). Are American schools turning out technopeasants? Instructor and Teacher, 92(9), pp. 26-29.

Householder, D. L. (1988). Technological literacy in the information age. In A. F. Gilberti (Ed.), Technology education symposium X proceedings - Technology: An international perspective. St. Cloud, MN: St. Cloud State University.

Householder, D. L. & Bolin, B. (1992). The development of an instrument for assessing secondary students' attitudes toward technology. In E. A. Bame & W. E. Dugger, Jr. (Eds.), Technology Education -A Global Perspective: ITEA-PATT International Conference, (pp. 177-188). Reston, VA: International Technology Education Association.

Hughes, T. P. (1989). American genesis. New York: Penguin Books.

Jevons, F. R. (1976). The interaction of science and technology today, or, is science the mother of invention? Technology and Culture, 17(4), 729-742.

Johnson, J. (1989). Technology - Report of the project 2061 phase I technology panal. Washington, DC: American Association for the Advancement of Science.

Johoda, M. & Warren, N. (Eds.). (1968). Attitudes. Baltimore: Penguin Books.

Keil, F. C. (1989). Concepts, kinds, and cognitive development. Cambridge: The MIT Press.

Kerlinger, F. N. (1973). Foundations of behavioral research. New York: Holt, Reinhart and Winston.

Kerlinger, F. N. (1984). Liberalism and conservation. New Jersey: Lawrence Erlbaum Associates

Klausmeier, H. J. & Goodwin, W. (1966) Learning and human abilities. New York: Harper and Row.

Klausmeier, H. J. (1985) Educational psychology (5th ed.). New York: Harper & Row.

Koballa, T. R. Jr. & Crawley, F. E. (1985). The influence of attitude on science teaching and learning. School Science and Mathemetics, 85(3), 222-232.

Krech, D., Crutchfield, R., & Ballachey, E. (1962). Individual in society. New York: McGraw Hill.

Kramer, L. R. (1992). Young adolescents' perceptions of school. In J. L. Irvin, (Ed.). Transforming middle level education (pp. 28-45). Boston: Allyn and Bacon.

Kranzberg, M. (1977). The Social Ecology of Technology. Technology and society. (Stock No. 060-000-00081). Washington, DC: U.S. Goverment Printing Office.

Kuhn, T. S. (1969). Comment on the principle of acceleration. Comparative Studies in History and Society, 11 (4), 423-435.

LaPorte, J. & Sanders, M. (1993). Integrating technology, science and mathematics in the middle school. The Technology Teacher, 52 (6), 17-21.

Lauda, D. P. (1990). Long-range planning for 1990-1995: The professional improvement plan. The Technology Teacher, 49(6), 3-10.

Layton, E. (1971). Mirror-Image Twins: The communities of science and technology in 19th Century America. Technology and Culture, 12(4), 562-580.

Layton, E. (1976). American ideologies of science and engineering. Technology and Culture, 17(4), 688-701.

Lenski, G. & Lenski, J. (1974). Human societies - An introduction to macrosociology (2nd ed.). New York: McGraw-Hill.

Lenski, G. & Lenski, J. (1982). Human societies - An introduction to macrosociology (4th ed.). New York: McGraw-Hill.

Loepp, F. (1986). Technological literacy, An educational challenge. In M. Sanders (Ed.), Technology education symposium proceedings - "Technological literacy: An educational mandate" (pp. 37-40). Blacksburg, VA: Virginia Polytechnic Institute & State University.

Mayr, O. (1976). The science - technology relationship as a historiographic problem. Technology and Culture, 17(4), 663-673.

McCrory, D. L. & Bame, E. A. (1986). Technology education: A new direction for industrial arts at the middle level. Schools in the middle: A report on trends and practices Reston, VA: National Association of Secondary School Principals.

Mitcham, C. (1980). Philosophy of technology. In P. T. Durbin (Ed.), A guide to the culture of science, technology, and medicine (pp. 282-363). New York: Free Press.

Mottier, I., Raat, J., & de Vries, M. (Eds.). (1991). Technology education and industry - PATT-5 conference. Eindhoven, The Netherlands: University of Technology.

Mottier, I., Raat, J., & de Vries, M. (Eds.). (1993). Technology education and the environment - PATT-6 conference. Eindhoven, The Netherlands: University of Technology.

Mueller, D. J. (1986). Measuring social attitudes - A handbook for researchers and practitioners. New York: Teachers College Press.

Murphy, P. (1972). Teaching for Employability. Fargo, ND: North Dakota State University.

National Science Board Commission on Precollege Education in Mathematics, Science and Technology. (1983). Educating Americans for the 21st century. Washington, DC: The National Science Foundation.

Oskamp, S. (1977). Attitudes and opinions. New Jersey: Prentice-Hall.

Ost, D. H. (1985). The nature of technologic literacy. School Science and Mathematics, 85(8), 689-696.

Palmerino, M., Langer, E., & McGillis, D. (1984). Attitudes and attitude change: mindlessness-mindfulness perspective. In J. R. Eiser (Ed.), Attitudinal judgment (pp. 179-195). New York: Springer-Verlag.

Parker, J. E. S. (1978). The economics of innovation: The national and multinational enterprise in technological change (2nd ed.). London: Longman.

Pascarella. P. (1979). Technology - Fire in a dark world. New York: Van Nostrand Reinhold.

Pytlik, E. C., Lauda, D. P., & Johnson, D. L. (1978). Technology, change and society. Worcester, MA: Davis Publications.

Raat, J. H., de Klerk Wolters, F., de Vries, M. (1987). Report PATT conference 1987 vol. 1 proceedings. Eindhoven, The Netherlands: University of Technology.

Raat, J., Coenen-van den Bergh, R., de Klerk Wolters, F., & de Vries, M. (Eds.). (1988). Basic principles of school technology - Report PATT-3 conference vol.1 framework for technology education. Eindhoven, The Netherlands: University of Technology.

Raat, J. H. (1991). PATT, The international technology education forum. In I. Mottier, J. Raat, & M. de Vries (Eds.). Technology Education and Industry - Report PATT-5 conference vol. 2 contributions (pp. 15-22). Eindhoven, The Netherlands: University of Technology.

Rokeach, M. (1968). Beliefs, attitudes, and values. San Francisco: Jossey-Bass Inc.

Rosenberg, N. & Birdzell, L. E. (1990). Science, technology and the western miracle. Scientific American. 263(5), 42-54.

Roy, R. (1989). Natural allies - STS and technology education. The Technology Teacher, 48(4), 13-17.

Rushing, J. H. (1986). Ronald Reagan's "star wars" address: Mythic containment of technical reasoning. Quarterly Journal of Speech, 72, 415-433.

Savage, E. & Sterry, L. (Eds.). (1990). A conceptual framework for technology education. Reston, VA: International Technology Education Association.

Scarborough, J. D. (1991). International perspectives on technological literacy. In M. J. Dyrenfurth & M. R. Kozak (Eds.). Technological literacy: 40th yearbook, council on technology teacher education (pp. 54-79). Peoria, IL: Glencoe Division, Macmillan/McGraw-Hill.

Secord, P. F. & Backman, C. W. (1964). Social Psychology. New York: McGraw Hill.

Shaw, E. & Wright, J. M. (1967). Scales for the measurement of attitudes. New York: McGraw Hill.

Sherif, C. W. (1965). Attitude and attitude change. Westport, CT: Greenwood Press.

Shrigley, R. L. (1983). The attitude concept and science teaching. Science Education, 67(4), 425-442.

Shrigley, R. L. & Koballa, T. R. Jr. (1984). Attitude measurement: Judging the emotional intensity of Likert-type science attitude statements. Journal of Research in Science Teaching, 21(2), 111-118.

Shrigley, R. L., Koballa, T. R. & Simpson, R. D. (1988). Defining attitude for science educators. Journal of Research in Science Teaching, 25(8), 659-678.

Spier, R. F. (1968). Technology and material culture. In J. A. Clifton (Ed.) Introduction to cultural anthropology (pp. 130-159). Boston: Houghton Mifflin Co.

Smith, M., Bruner, J., & White, R. (1967). Opinions and personality. New York: Wiley.

Staudenmaier, J. M., S. J. (1989). Technology's Storytellers. Cambridge, MA: MIT Press.

Technological Literacy Act of 1985 (S. 1823). An overview. Unpublished manuscript.

Todd, R. D., McCrory, D. L., & Todd, K. I. (1985). Understanding and using technology. Worcerter, MA: Davis.

Todd, R. D. (1986). Technological literacy: An international perspective. Technology education symposium proceedings - "Technological literacy: An educational mandate" (pp. 63-69). Blacksburg, VA: Virginia Polytechnic Institute & State University.

Toepfer, C. F. (1992). Middle level school curriculum: Defining the elusive. In J. L. Irvin (Ed.), Transforming middle level education - Perspectives and possibilities (pp. 205-243). Boston: Allyn and Bacon.

van den Bergh, R. (1987). Results of PATT-research in France, Denmark and the Netherlands. In R. Coenen-van den Bergh (Ed.), Report PATT-conference vol. 2 contributions (pp. 41-51). Eindhovern, The Netherlands: University of Technology.

Volti, R. (1992). Society and technological change. New York: St. Martin's Press.

Waetjen, W. B. (1992). Shaping the future of a profession. Critical issues in technology education - Camelback symposium (pp. 25-30). Reston, VA: International Technology Education Association.

Waks, L. J. (1991). The new world of technology in U. S. education. In J. R. de la Mothe (Ed.), Technology in Society (pp. 233-253). New York: Pergamon Press.

Webster's Encyclopedic Unabridged Dictionary of the English Language. (1989). New York: Portland House.

Wise, G. (1985). Science and Technology. Osiris I (second series), 229-246.

Wright, R. T. (1993). Rationale and structures for studying manufacturing. In R. D. Seymour & R. L. Shakelford (Eds.). Manufacturing in technology education (1-18). Glencoe: MacMillan/McGraw Hill.

Wright, T & Lauda, D. (1993). Technology education: A position statement. The Technology Techer, 52(4), 3-5.

Zimbardo, P. & Ebbeson, E. (1970). Influencing attitudes and changing behavior. Massachusetts: Addison-Wesley.

APPENDIX A

TECHNOLOGY ATTITUDE SCALE (TAS) DEVELOPED BY DE KLERK WOLTERS

The Technology Attitude Scale developed by de Klerk Wolters

____ male ______female
Age: _____ years

Part 1 (questions 1-26)

1. If there was a hobby club about technology I would certainly join it.	1	2	3	4	5
2. Boys are able to do practical things better than girls.	1	2	3	4	5
3. The world would be a worse place without technology.	1	2	3	4	5
4. You have to be very clever to study technology.	1	2	3	4	5
5. I would like to learn more about technology at school.	1	2	3	4	5
6. I will probably choose a job in technology.	1	2	3	4	5
7. I like to read technological magazines.	1	2	3	4	5
8. A girl can very well become a car mechanic.	1	2	3	4	5
9. Technology makes everything work better than before.	1	2	3	4	5
10. Technology is not only for bright people.	1	2	3	4	5
11. I would rather not have technology lessons at school.	1	2	3	4	5
12. I do not understand why anyone would want a job in technology.	1	2	3	4	5
13. There should be less TV- and radio-programs about technology.	1	2	3	4	5
14. Boys know more about technology than girls.	1	2	3	4	5
15. Everyone needs technology.	1	2	3	4	5
16. To understand technology you have to do a difficult training course.	1	2	3	4	5
17. There should not be more education about technology.	1	2	3	4	5
18. I would enjoy a job in technology.	1	2	3	4	5
19. I enjoy repairing things at home myself.	1	2	3	4	5
20. A girl can very well have a technical job.	1	2	3	4	5
21. Technology has brought more bad things than good.	1	2	3	4	5
22. I should be able to take technology as a school subject.	1	2	3	4	5
23. Working in technology would be boring and dull.	1	2	3	4	5
24. I am not interested in technology.	1	2	3	4	5

25. Technology is very important in life. 1 2 3 4 5

26. Most jobs in technology are dull. 1 2 3 4 5

Part 2 (questions 1-28)

One can choose from 3 answers: 'agree', 'not agree', 'don't know'.

1. With reference to technology I mostly think of machines. 1 2 3

2. I think physics and technology are related. 1 2 3

3. In technology you can seldom use your imagination. 1 2 3

4. I think technology has little to do with our energy problem. 1 2 3

5. With respect to technology I mostly think of dealing with equipment. 1 2 3

6. To me technology and science are the same. 1 2 3

7. In my opinion technology is not very old. 1 2 3

8. In technology you can think up new things. 1 2 3

9. I think technology is more part of computers than of computer programs. 1 2 3

10. Technology is as old as mankind. 1 2 3

11. Elements of physics are rarely used in technology. 1 2 3

12. You need not be technical to invent a new piece of equipment. 1 2 3

13. Technology has a large influence on people. 1 2 3

14. I think technology is often used in physics. 1 2 3

15. Manual dexterity is part of technology. 1 2 3

16. In everyday life I have a lot to do with technology. 1 2 3

17. In technology there is little opportunity to think up things yourself. 1 2 3

18. Technology is far away from my daily life. 1 2 3

19. Biology and technology have nothing in common. 1 2 3

20. The government can have influence on technology. 1 2 3

21.	I think the transformation of energy is also part of technology.	1	2	3
22.	In technology you handle tools.	1	2	3
23.	Technology is meant make our life more comfortable.	1	2	3
24.	When I think about technology I mainly think of computer programs.	1	2	3
25.	Only technicians are in charge of technology.	1	2	3
26.	There is a relation between chemistry and technology.	1	2	3
27.	In technology there are less opportunities to do things with your hands.	1	2	3
28.	Processing materials is an important part of technology.	1	2	3

APPENDIX B

NAMES OF PANEL OF EXPERTS

Dr. E. Allen Bame
Associate Professor
Technology Education
144 Smyth Hall
Virginia Tech
Blacksburg, VA 24061

Mr. Tom Chester
Andrew Lewis Middle School
616 College Avenue
Salem, VA 24153

Mrs. Carrie Dugger
Christiansburg Middle School
208 College Street
Christiansburg, VA 24073

Mrs. Nyanne Hicks
Blacksburg Middle School
South Main Street
Blacksburg, VA 24060

Dr. Charles A. Pinder
Associate Professor
Technology Education
144 Smyth Hall
Virginia Tech
Blacksburg, VA 24061

APPENDIX C

TECHNOLOGY ATTITUDE SCALE (TAS) MODIFICATIONS

Attitude statements

1. If there was a hobby club about technology I would certainly join it.

    (If there were a technology club at my school, I would join.)

2. Boys are able to do practical things better than girls.
3. The world would be a worse place without technology.
4. You have to be very clever to study technology.

    (You have to be very smart to study technology.)

5. I would like to learn more about technology at school.
6. I will probably choose a job in technology.
7. I like to read technological magazines.
8. A girl can very well become a car mechanic.

    (A girl can become a car mechanic.)

9. Technology makes everything work better than before.
10. Technology is not only for bright people.

    (Technology is **not** for smart people only.)

11. I would rather not have technology lessons at school.

    (I would rather **not** have technology classes in school.)

12. I do not understand why anyone would want a job in technology.
13. There should be less TV- and radio-programs about technology

    (There should be fewer TV and radio-programs about technology.)

14. Boys know more about technology than girls.
15. Everyone needs technology.
16. To understand technology you have to do a difficult training course.

    (To understand technology you have to study difficult training courses.)

17. There should not be more education about technology.

    (There is enough education about technology.)

18. I would enjoy a job in technology.

19. I enjoy repairing things at home myself.
    (I enjoy repairing things at home.)
20. A girl can very well have a technical job.
    (A girl can have a technical job.)
21. Technology has brought more bad things than good.
22. I should be able to take technology as a school subject.
23. Working in technology would be boring and dull.
24. I am not interested in technology.
25. Technology is very important in life.
26. Most jobs in technology are dull.

Concept statements

1. With reference to technology I mostly think of machines.
   (When I think of technology, I mostly think of machines.)
2. I think physics and technology are related.
3. In technology you can seldom use your imagination.
   (In technology you seldom use your imagination.)
4. I think technology has little to do with our energy problem.
5. With respect to technology I mostly think of dealing with equipment.
   (When I think of technology, I mostly think of working with equipment.)
6. To me technology and science are the same.
7. In my opinion technology is not very old.
8. In technology you can think up new things.
   (In technology, you can create new things.)
9. I think technology is more part of computers than of computer programs.
   (I think technology deals more with computers than with computer programs.)
10. Technology is as old as mankind.
11. Elements of physics are rarely used in technology.
    (Elements of science are rarely used in technology.)

12. You need not be technical to invent a new piece of equipment.
13. Technology has a large influence on people.
14. I think technology is often used in physics.
    (I think technology is often used in science.)
15. Manual dexterity is part of technology.
    (Using your hands is part of technology.)
16. In everyday life I have a lot to do with technology.
    (In my everyday life, I work with technology a lot.)
17. In technology there is little opportunity to think up things yourself.
18. Technology is far away from my daily life.
    (Technology has little to do with my daily life.)
19. Biology and technology have nothing in common.
20. The government can have influence on technology.
21. I think the transformation of energy is also part of technology.
    (I think the using of energy is also part of technology.)
22. In technology you handle tools.
    (In technology, you work with tools.)
23. Technology is meant to make our life more comfortable.
    (Technology makes our life more comfortable.)
24. When I think about technology I mainly think of computer programs.
25. Only technicians are in charge of technology.
26. There is a relation between chemistry and technology.
27. In technology there are less opportunities to do things with your hands.
    (In technology there are fewer opportunities to do things with your hands.)
28. Processing materials is an important part of technology.

APPENDIX D

FINAL TECHNOLOGY ATTITUDE SCALE (TAS)

Final TAS

Technology Attitude Scale

We are interested in your opinion on technology. Therefore, we would like you to answer some questions on this subject. There are no right or wrong answers. You are not to be graded on this. Do not take too much time for any one question. You should need about 15 minutes to complete the whole questionnaire. The first four questions are about you. These are followed by statements about technology. Indicate to what extent you agree or disagree with the statements. In the last set of statements you only have to indicate agree, disagree or don't know.

Please circle or write in the information that applies to you

1. Are you a boy or a girl? Boy Girl
2. How old are you? ______ years
3. What grade are you in now ? 6 7 8 9
4. Are you taking or have you taken Technology Education ? Yes No

---

Part 1 (Questions 5-30) Circle the number that corresponds to the extent you agree or disagree with each statement.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
5. If there were a technology club at my school, I would join.	1	2	3	4	5
6. Boys are able to do practical things better than girls.	1	2	3	4	5
7. The world would be a worse place without technology.	1	2	3	4	5
8. You have to be very smart to study technology.	1	2	3	4	5
9. I would like to learn more about technology at school.	1	2	3	4	5
10. I will probably choose a job in technology.	1	2	3	4	5
11. I like to read technological magazines.	1	2	3	4	5
12. A girl can become a car mechanic.	1	2	3	4	5
13. Technology makes everything work better than before.	1	2	3	4	5
14. Technology is **not** for smart people only.	1	2	3	4	5
15. I would rather **not** have technology classes in school.	1	2	3	4	5

16.	I do not understand why anyone would want a job in technology.	1	2	3	4	5
17.	There should be fewer TV and radio-programs about technology.	1	2	3	4	5
18.	Boys know more about technology than girls.	1	2	3	4	5
19.	Everyone needs technology.	1	2	3	4	5
20.	To understand technology you have to study difficult training courses.	1	2	3	4	5
21.	There is enough education about technology.	1	2	3	4	5
22.	I would enjoy a job in technology.	1	2	3	4	5
23.	I enjoy repairing things at home.	1	2	3	4	5
24.	A girl can have a technical job.	1	2	3	4	5
25.	Technology has brought more bad things than good.	1	2	3	4	5
26.	I should be able to take technology as a school subject.	1	2	3	4	5
27.	Working in technology would be boring and dull.	1	2	3	4	5
28.	I am not interested in technology.	1	2	3	4	5
29.	Technology is very important in life.	1	2	3	4	5
30.	Most jobs in technology are dull.	1	2	3	4	5

Part 2 (Questions 31-58) Circle the number that corresponds to 1-Agree, 2-Disagree, or 3-Don't Know.

31.	When I think of technology, I mostly think of machines.	1	2	3
32.	I think physics and technology are related.	1	2	3
33.	In technology you seldom use your imagination.	1	2	3
34.	I think technology has little to do with our energy problems.	1	2	3
35.	When I think of technology, I mostly think of working with equipment.	1	2	3
36.	To me, technology and science are the same.	1	2	3
37.	In my opinion, technology is not very old.	1	2	3

38.	In technology, you can create new things.	1	2	3
39.	I think technology deals more with computers than with computer programs.	1	2	3
40.	Technology is as old as mankind.	1	2	3
41.	Elements of science are rarely used in technology.	1	2	3
42.	You do not need to be technical to invent a new piece of equipment.	1	2	3
43.	Technology has a large influence on people.	1	2	3
44.	I think technology is often used in science.	1	2	3
45.	Using your hands is part of technology.	1	2	3
46.	In my everyday life, I work with technology a lot.	1	2	3
47.	In technology, there is little opportunity to think up things yourself.	1	2	3
48.	Technology has little to do with my daily life.	1	2	3
49.	Biology and technology have nothing in common.	1	2	3
50.	The government can have influence on technology.	1	2	3
51.	I think the using of energy is also part of technology.	1	2	3
52.	In technology, you work with tools.	1	2	3
53.	Technology makes our life more comfortable.	1	2	3
54.	When I think about technology, I mainly think of computer programs.	1	2	3
55.	Only technicians are in charge of technology.	1	2	3
56.	There is a relation between chemistry and technology.	1	2	3
57.	In technology, there are fewer opportunities to do things with your hands.	1	2	3
58.	Processing materials is an important part of technology.	1	2	3

APPENDIX E

LETTER TO TECHNOLOGY TEACHERS

May 11, 1993

Sharon Brusic
Kate Collins Middle School
1625 Ivy Street
Waynesboro, VA 22980

Dear Sharon:

I am conducting a study to adapt and validate a Technology Attitude Scale (TAS) originally developed in the Netherlands, for use by American teachers at the middle school level. The instrument will be valuable because, upon validation, a tool will be available for middle school teachers to independently determine students' attitudes towards technology and concepts of technology. Teachers will be able to determine what students think about technology, enabling adjustments in curriculum which may reflect differences in perception between student and teacher.

We need your help in testing the reliability of the instrument by administering it to your middle school students. The data obtained from your students will be crucial for the validation procedure. The emphasis at this time is on the validation of the items on the instrument rather than focusing on the students. We are not concerned with the scoring procedures of the students, but rather how consistent and how well the instrument measures students' attitudes.

We are on a tight schedule and would like to test the instrument the week of May 17-21, if convenient for you. Ideally we would like to administer the instrument to 2-3 technology education classes and 1-2 non-technology education classes if possible. We would appreciate it if you would arrange to have a non-technology teacher participate in administration of the TAS as well. We will bring all necessary items to administer the TAS, which will take approximately 20-30 minutes of class time. We will call you on May 17 to confirm the day and times convenient for you and for the non-technology teacher.

Thank you for your support in this important research study. Your time and efforts are appreciated.

Sincerely,

E. Allen Bame
Associate Professor
Technology Education

Thomas J. Jeffrey
Graduate Assistant
Technology Education

APPENDIX F

NAMES OF TECHNOLOGY TEACHER PARTICIPANTS

•Mr. Tom Chester
Andrew Lewis Middle School
616 College Avenue
Salem, VA 24135

Dr. Sharon Brusic
Kate Collins Middle School
1625 Ivy Street
Waynesboro, VA 22980

Mr. Bob LaJuett
Shelburne Middle School
300 Grubert Avenue
Staunton, VA 24401

Mr. Bob O'Keefe
Cave Spring Middle School
5202 Brambleton Avenue
Roanoke, VA 24018

Mr. Bob Warren
Hidden Valley Middle School
4902 Hidden Valley School Road SW.
Roanoke, VA 24018

• Pilot Study

APPENDIX G

NAMES OF OTHER TEACHER PARTICIPANTS

•Mrs. Nancy Rutledge
English Teacher
Andrew Lewis Middle School
616 College Avenue
Salem Avenue, VA 24135

Mr. Glenn Anderson
Science Teacher
Kate Collins Middle School
1625 Ivy Street
Waynesboro, VA 22980

Mrs. Nancy Dickerson
Science Teacher
Shelburne Middle School
300 Grubert Avenue
Staunton, VA 24401

Mr. Robert Giles
Science Teacher
Cave Spring Middle School
5202 Brambleton Avenue
Roanoke, VA 24018

Mr. Joe Hafey
Science Teacher
Hidden Valley Middle School
4902 Hidden Valley School Road SW.
Roanoke, VA 24018

• Pilot Study

APPENDIX H DEMOGRAPHICS:

PILOT STUDY AND LARGE GROUP ADMINISTRATION

	Andrew[1] Lewis Middle School	Hidden Valley Middle School	Cave Springs Middle School	Kate Collins Middle School	Shelburne Middle School
N =	48	46	50	40	47

	Pilot Study	Large Group Administration
Urban	48	96
Rural	0	87
Boys	32	116
Girls	16	67
Age 12[2]	0	28
Age 13	14	66
Age 14	29	57
Age 15	5	28
Grade 7	0	71
Grade 8	48	94
Grade 9	0	18
Yes[3]	45	135
No[4]	3	48

[1] Pilot Study

[2] Four students (Large Group Administration) did not list age

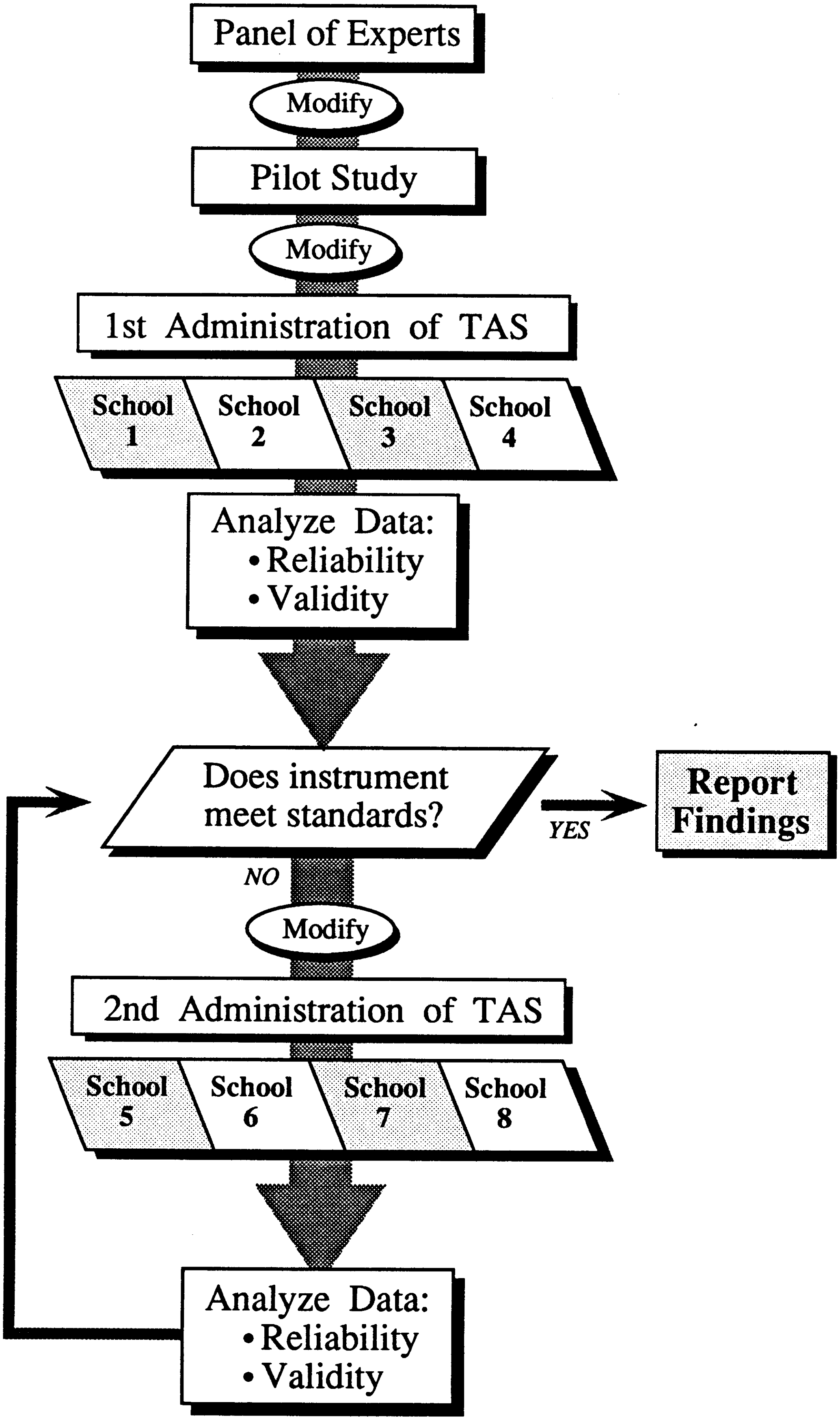
[3] Have taken or are taking a Technology Education class

[4] Have not taken a Technology Education class

APPENDIX I

GRAPHIC OVERVIEW OF RESEARCH SEQUENCE

TAS: USA


Panel of Experts
Modify
Pilot Study
Modify
1st Administration of TAS
School 1
School 2
School 3
School 4
Analyze Data:
• Reliability
• Validity
Does instrument meet standards?
YES
Report Findings
NO
Modify
2nd Administration of TAS
School 5
School 6
School 7
School 8
Analyze Data:
• Reliability
• Validity

APPENDIX J

ITEM INTERCORRELATIONS WITH SCALES: ATTITUDE SECTION

Item Intercorrelations with Scales
Attitude Section

Scales	Item No.	Pos. or Neg. Item	Scale 1 Interest	Scale 2 Role Pattern	Scale 3 Consequences	Scale 4 Difficulty	Scale 5 Curriculum	Scale 6 Career	Summated Scale Correlations
Scale 1	5	+	0.72	-0.03	0.27	0.02	0.59	0.64	0.68
Interest	11	+	0.71	-0.2	0.04	-0.07	0.38	0.52	0.47
	17	-	-0.51	0.14	-0.24	-0.08	-0.27	-0.39	-0.42
	23	+	0.73	-0.05	0.16	-0.04	0.5	0.59	0.6
	28	-	-0.8	0.17	-0.28	0.06	-0.63	-0.63	-0.67
Scale 2	6	-	0.2	-0.76	0.06	-0.07	0.29	0.24	0.03
Role Pattern	12	+	-0.06	0.69	0.23	0.12	0.04	-0.01	0.24
	18	-	0.25	-0.79	0.02	-0.17	0.24	0.18	-0.02
	24	+	0.07	0.65	0.32	0.09	0.13	0.12	0.36
Scale 3	7	+	0.22	-0.06	0.04	-0.08	0.36	0.26	0.24
Consequence	13	+	0.15	0.08	0.65	-0.08	0.24	0.28	0.37
	19	+	0.28	0.08	0.71	0.02	0.39	0.4	0.52
	25	-	-0.18	-0.05	-0.61	-0.09	-0.25	-0.28	-0.39
	29	+	0.4	0.04	0.69	-0.08	0.4	0.44	0.55
Scale 4	8	-	0.25	-0.09	0.17	-0.69	0.21	0.27	0.24
Difficulty	14	+	0.16	0.21	0.19	0.56	0.14	0.25	0.37
	20	-	-0.02	0	0.01	-0.64	-0.08	-0.08	-0.16
Scale 5	9	+	0.73	-0.18	0.38	-0.06	0.8	0.67	0.72
Curriculum	15	-	-0.63	0.13	-0.24	-0.06	-0.82	-0.55	-0.64
	21	-	-0.15	0.02	-0.03	-0.12	-0.53	-0.25	-0.3
	26	+	0.5	-0.12	0.25	-0.03	0.78	0.54	0.58
Scale 6	10	+	0.66	-0.16	0.2	-0.04	0.44	0.8	0.61
Career	16	-	-0.43	-0.03	-0.34	-0.09	-0.49	-0.67	-0.61
	22	+	0.68	-0.14	0.24	-0.03	0.47	0.81	0.65
	27	-	-0.66	0.08	-0.37	-0.08	-0.71	-0.73	-0.64
	30	-	-0.54	0.1	-0.44	-0.08	-0.51	-0.71	-0.66

APPENDIX K

ITEM INTERCORRELATIONS WITH SCALES: CONCEPT SECTION

Item Intercorrelations with Scales
Concept Section

Scales	Item No.	Agree-Disagree	Tech & Society Correlations	Tech & Science Correlations	Tech & Skills Correlations	Tech & Pillars Correlations	Summated Scale Correlations
Tech & Society	33	D	0.59	0.2	0.29	0.4	0.5
	37	D	0.46	0.23	0.1	0.23	0.36
	38	A	0.3	0.09	0.18	0.2	0.26
	40	A	0.54	0.31	0.16	0.3	0.45
	43	A	0.64	0.3	0.43	0.43	0.6
	46	A	0.4	0.32	0.14	0.17	0.36
	47	D	0.58	0.31	0.29	0.37	0.52
	48	D	0.57	0.35	0.31	0.35	0.53
	50	A	0.66	0.38	0.3	0.51	0.62
	53	A	0.59	0.27	0.19	0.35	0.49
Tech & Science	32	A	0.35	0.66	0.23	0.27	0.49
	36	D	0.16	0.39	0.12	0.24	0.29
	41	D	0.43	0.53	0.16	0.37	0.49
	44	A	0.3	0.55	0.27	0.25	0.44
	49	D	0.3	0.67	0.19	0.35	0.48
	56	A	0.34	0.71	0.16	0.23	0.48
Tech & Skills	31	D	0.05	0.11	0.38	-0.01	0.11
	35	D	0.04	0.06	0.44	0.12	0.18
	42	D	0.1	0.09	0.44	0.06	0.2
	45	A	0.35	0.18	0.56	0.2	0.41
	52	A	0.42	0.17	0.5	0.36	0.46
	57	D	0.29	0.19	0.53	0.34	0.41
	58	A	0.37	0.27	0.6	0.35	0.49
Tech & Pillars	34	D	0.37	0.29	0.2	0.63	0.47
	39	D	0.14	0.21	0.12	0.52	0.29
	51	A	0.48	0.33	0.31	0.54	0.53
	54	D	0.32	0.19	0.32	0.56	0.42
	55	D	0.45	0.35	0.22	0.58	0.52

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EDUCATION

DOCTOR OF EDUCATION, 1993
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ASSOCIATE OF ARTS, 1966
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EXPERIENCE

1990-Present	GRADUATE TEACHING ASSISTANT, Technology Education Virginia Polytechnic Institute and State University.
1988-89	GRADUATE ASSISTANT, Technology Education Mankato State University, Mankato, Minnesota.
1977-88	ASSISTANT MANAGER, Standard Lumber Company St. Peter, Minnesota.
1974-77	PART-TIME CONSTRUCTION, Endresen-Dryer Builders Mankato, Minnesota.
1969-77	INDUSTRIAL ARTS INSTRUCTOR, K-12 Program Wilson Campus School, Mankato State University, Mankato, Minnesota.
1965-68	SECOND LIEUTENANT, Minnesota National Guard

1960-63 UNITED STATES ARMY, enlisted man.

AWARDS and HONORS

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MEMBERSHIPS IN PROFESSIONAL ASSOCIATIONS

International Technology Education Association

Council on Technology Teacher Education

Southeastern Technology Education Conference

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PRESENTATIONS

"Validation of a Technology Attitude Scale for use by American Teachers at the Middle School Level" given at the Sixth International Pupils' Attitude Toward Technology (PATT) Conference, Breukelen, The Netherlands, March, 1993.

PUBLICATIONS

"Validation of a Technology Attitude Scale for use by American Teachers at the Middle School Level." In Mottier, Raat & de Vries (Eds.), *Technology Education and the Environment - Proceedings PATT-6 Conference* (pp. 357-364). Eindhoven, The Netherlands: University of Technology.