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Students' attitudes and perceptions toward technology

by

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A dissertation submitted to the graduate faculty

in partial fulfillment of the requirements for the degree of

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Major: Industrial Education and Technology

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Iowa State University

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For the Major Department

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For the Graduate College

DEDICATION

To

my father and mother

Joong-Ho Kim

and

Jong-Nam Park

and

my husband

Yun-Ho Shinn

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABSTRACT

This study was conducted to synthesize previous studies and provide educators and administrators an overall picture of the students' attitudes towards and concepts of technology research that has been done so far. By integrating research-based data and identifying recommendations regarding which areas of research need to be studied in greater detail, this meta-analysis could lead to the enhancement of K-12 and college technology education programs.

The characteristics of students' perceptions towards technology as they progress through school were investigated. To this end, a meta-analytic approach with three specific objectives was conducted to: (1) integrate the similarities and differences of previous studies using quantitative and qualitative research methods as appropriate; (2) investigate by grade level, the characteristics of students' perceptions of technology from elementary through university levels; and (3) identify key issues for future studies of students' perceptions of technology.

Six attitude sub-scales (interest, curriculum, gender, career, difficulty, and consequence) and four concept sub-scales (technology and society, technology and science, technology and skills, and technology and pillars) were investigated from the pioneer study conducted on students' perceptions of technology, titled "Pupils Attitude Towards Technology (PATT)." The findings indicated that gender was the most explanatory factor and also the most frequently used variable for studies on students' attitudes toward technology. Boys rated higher than girls on the interest, consequences, curriculum and career scales, while girls viewed technology as an activity for both boys and girls alike.

Because many studies provided data that were difficult to integrate with current research on technology education, it was recommended that more studies should be conducted using multiple regression analysis to identify explanatory variables for students' attitudes toward technology. Many studies compared different groups without the use of statistical measures such as the t or F test. The use of more appropriate statistical methods and careful interpretation and reporting of results are recommended. Those studies wherein the primary author did not report all numerical data needed to conduct statistical analysis should be republished. This would enable other researchers to conduct additional meta-analyses by integrating the data from previous studies.

CHAPTER I. INTRODUCTION

Background

> Americans live in an electromechanical, digital, computational, chemical, biomedical society. Humans use technology to provide society with new capabilities and new opportunities. Technology makes obsolete certain ways of life and certain values. Technology in today's society is centralized, specialized, autocratic, threatening and intimidating. (Kozak & Robb, 1991, p. 31)

People may well agree that we live in a technological society even while they actually do not know the meaning of technology and its extent. The term 'technology' has been used for a long time and is familiar to everybody. Pytlik, Lauda, and Johnson (1985) defined technology as "a study of the technical means undertaken in all cultures, which involves the systematic application of organized knowledge and tangibles for the extension of human faculties that are restricted as a result of the evolutionary process" (p. 7). According to this definition, technology has existed for a long time. However, most people generally prefer to call the present a 'technological society' because the role of technology is much more pronounced and critical to society.

Today, for example, it seems evident that some technological literacy is required of all people who live in our society. The project titled 'Technology for All Americans' was initiated to "offer those who are interested in technology education as an essential core subject a clear vision for what it means to be technologically prepared, how this preparation can be achieved at a national level, and why it is important for our nation" (Satchwell & Dugger, 1996, p. 6).

People can, and perhaps should, become technologically literate through formal schooling. While many people think technology is significant in a society, "only in the past decade has technology education gained national consideration" (Satchwell & Dugger, 1996, p. 6). The purpose of technology education shows why such efforts are important. The main purpose of technology education is "to prepare students to understand and participate in a technological society through experience with technological methods, resources, and knowledge" (Zuga, 1994, p. 1). It is anticipated that if students accomplish the goal of technology education successfully, they will readily participate in, and contribute to, our technological society.

A positive attitude toward technology may also affect such behavior. If so, how could we develop such attitudes? Information regarding students' needs and interests toward technology education could be used to improve students' perceptions toward technology and technology education. "Individual perceptions are largely dependent on a person's background, the amount of study and reflection about technology, and personal experiences with technology" (DeVore, 1980, p. 216).

Beginning with the Dutch study (Raat & De Vries, 1986) on students' perception toward technology in 1984, increasing numbers of studies have been done to see how students perceive technology. De Vries (1992) stated that "research into pupils' concept of and attitude towards technology is only worth its effort when it helps educators and policy makers in their decisions about determining the why, what, and how of technology education" (p. 246).

Statement of Problem

We live in a highly technological world. Compared to the past, however, technology today is developing much more rapidly and diversely. For instance, the travel time from coast to coast across the lower 48 states took 8 minutes by space shuttle in 1981 while it took 5 hours by a Boeing 747 airplane in 1975 and 11 days by train in 1870 (Starkweather, 1992).

As society moves toward ever more advanced stages, the impact of technology on society becomes increasingly significant. If a person does not prepare for a technological society, he/she risks becoming isolated from the society. Thus, the concept of technological literacy has been accentuated. Wiens and Wiens (1996), however, pointed out that our current technological society has a problem. According to these researchers, "our use of and dependence on technology is pervasive and yet our understanding of technology in society is elementary" (p. 3). For example, when people think about technology, some may refer to products of technology such as the computer, television, video, and so on and others may have the misconception that technology is mainly comprised of the computer and the areas like engineering, science, and instructional technology.

Perhaps some of the causes of this problem could be attributed to the lack of pervasive technology education. Even though there are numerous examples of authors promoting technology education, the literature does not document an attitude shift in actuality.

Technology education teacher preparation programs have declined due to lack of student enrollment (Kozak & Robb, 1991). Documenting this, Hatch and Jones (1991) pointed out that the enrollment rate in technology teacher education programs has decreased since the 1980s when compared to the period between 1960s and 1970s. Evans (1992) supported these findings. The problems in technology teacher education programs as identified by Evans (1992) are:

> (a) that a number of institutions which provide teacher education in our field has been declining for more than a decade, and that the rate of decline has

> increased sharply in the past year; (b) that the number of teacher educators in our field has declined even more than the number of institutions; (c) that the number of persons completing our teacher education courses or programs have declined even more rapidly than the number of teacher educators; (d) that the numbers of our programs and teachers in secondary schools have also been decreasing, and that the demand for new teachers is very low – perhaps lower than it has been for more than 50 years; and (e) that the average age of our teachers is at an all time high. (p. 8)

Other researchers have also documented further problems of technology education in secondary education in terms of students' perceptions. Silverman and Pritchard (1996) found that middle school girls are reluctant to take more technology education in high school because of two major factors, such as traditional stereotypes about male-female occupations and the lack of economic realities and the world of work.

Furthermore, McCarthy and Moss (1994) found that some students possess only vague concepts of technology. For example, some students recognize technology as being similar to science subjects. Others perceive the benefits of technology, but have "narrow concepts or misconceptions of what comprises technology" (Boser, Palmer, & Daugherty, 1998, p. 17). A discrepancy, or gap, between professionals' and learners' perceptions regarding technology may exist. Thus, it is reasonable to suggest there is a need to determine the extent of this gap to bring about a consensus in the way technology is perceived by professionals and learners. A consensus may result in the development of a clear concept of technology that is acknowledged by educational arenas as well as the world of work. This could lead to the resurgence of K-12 and college technology education programs that professionals and learners clearly perceive as meeting the needs of society.

In conclusion, the literature suggests that even though students do not have appropriate understandings, concepts, or perceptions regarding technology they agree they could not live a single day without technology. Moreover, the numbers of students and institutions participating in technology education programs in the United States appear to be decreasing as society is moving toward a more advanced technology environment. Why is this so? Why are students and parents not pressuring schools to offer more technology education? Perhaps it begins with students' attitudes toward technology. This study sought to address the perception and attitudes of students toward technology. It generated relevant information leading to a better understanding of the issues involved.

Purpose and Objectives of the Study

The purpose of this study was to investigate the characteristics of students' perception towards technology as they progress through school. To this end, a meta-analytic approach with three specific objectives was employed to:

1. integrate the similarities and differences of previous studies using quantitative and qualitative research methods as appropriate;
2. investigate by grade level, the characteristics of students' perceptions of technology from elementary through university levels; and
3. identify key issues for future studies of students' perceptions of technology.

Significance of the Study

Students' perceptions of a course may be directly related to their involvement patterns as well as their potential success in the course. For example, according to McCarthy and Moss (1994), a student's attitude is an important factor in selecting a subject. Studies on students' perceptions of technology and technology education have helped technology teachers and professionals to review what has been done and should be done in their field. These components are required for effective teaching of technology (Bame, Dugger, De Vries, & McBee, 1993).

According to Bensen (1992), each school level has a different program goal. The preschool/elementary school level focuses on technology awareness. Middle/junior high school students are usually offered a technology orientation program while high school students have more exposure to technology through exploration and utilization.

Most studies of students' perceptions toward technology or technology education have shown what the students' perceptions are at a particular grade level. For example, some studies have been done on students' perceptions of technology at the elementary school level (De Klerk Wolters, 1989a; Dunlap, 1990; Rennie & Jarvis, 1995; Rennie & Treagust, 1989), and at the middle school level (Bame & Dugger, 1992; Bame et al., 1993; Boser et al., 1998; Jeffrey, 1993; McCarthy & Moss, 1994). Householder and Bolin (1992), Silverman, and Pritchard (1996), Jones, Womble, and Searcy (1996), and Zoller and Donn (1991) conducted similar studies at the high school level, while De Vries (1991) focused on the postsecondary school level.

Since 1980, many studies, including the above literature reviews, have looked at students' perceptions regarding technology. However, none have been integrative or synthesizing to document how students' perceptions evolve from the elementary school level through college. In addition, only a few cross-national comparisons of students' perceptions toward technology have been conducted.

The current study was conducted for two principal reasons. First, the synthesis of previous studies may give educators and administrators an overall picture of the work that has been done so far in this area. Second, the findings of this research study may be useful in providing research-based data and recommendations regarding which areas of research need to be studied in greater detail.

Limitations of the Study

The following limitations apply to the study being reported:

1. Differing conditions have existed in the various countries where the source studies have been conducted. These include such variables as subject, methodologies available, and research facilities. For example, up-to-date literature and computer analysis software packages may not be available in some developing countries.
2. Incomplete reporting: The researcher may not have had access to complete reports, including methodologies and statistics from primary sources. Nor were these all reported in the publications reviewed.
3. Limited contact with the primary author: Necessary communication with primary authors was difficult if not impossible due to communication challenges.
4. Differences in English language comprehension and interpretation across geographical boundaries, on both the part of the original reporting researcher and the author of this study.

Definitions of Terms

The following definitions were used for the purpose of this study:

Attitude: A learned predisposition to respond in a consistently favorable or unfavorable manner with respect to a given object (Fishbein &Ajzen, 1975, p. 6).

Opinions: A person's judgement about the likelihood of events or relationship (Oskamp, 1977, p. 19). It is used interchangeably with belief and is formed by an analysis of perception.

Perception: An awareness of a given object depending on insight and intuition gained through a student's senses, experience, and knowledge. Some studies have used the concepts of perception and attitude interchangeably. In this study the meaning of perception is regarded as a cognitive component of attitude.

Technology: 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 environment (Wright & Lauda, 1993, p. 3).

Delimitations of the Study

This study was subject to the following delimitations.

1. This study only selected research reports that were conducted using subjects from K-12 or college levels.
2. Only research reported in the period from 1980 to 1999 was selected.
3. Only research reports that could be accessed were selected.

Summary

The background and problem of this study were presented in this first chapter. From these, the purpose and three objectives of the study were evolved and listed. The significance of the study followed and was justified in two aspects: (a) providing an overall picture of the studies in the area, and (b) providing research-based data and recommendations for practice. In addition, terms related to this meta-analysis were defined and the study's limitations and delimitations were stated.

CHAPTER II. REVIEW OF LITERATURE

The purpose of this study was to investigate the perceptions of students regarding technology. This chapter's review of relevant literature provides a theoretical basis and rationale for the study. It is organized into the following subsections: (1) Literature Review Strategy, (2) Related Terminology, (3) Students' Perceptions and Attitudes toward Technology, (4) Measurement of Perceptions and Attitudes, (5) Methodological Considerations, (6) Meta-analytic Procedures, and (7) Summary.

Literature Review Strategy

A literature review strategy is included to communicate important methodological approaches and decision involved in finding and collecting information central to this study. The following four steps were adopted to locate literature related to this dissertation topic.

1. Defining the research objectives.

   The research objectives were defined as specifically as possible. These enabled the researcher to identify the relevant descriptors for further searching.

2. Selecting the databases to be searched.

   The primary databases searched included Educational Resources Informational Center (ERIC), *Dissertation Abstracts Ondisc*, the ISU Parks Library Catalog, and *Psychological Abstracts (PsychLit)*. The decision for selecting these databases was based on their accessibility and their relevances (e.g., that they encompassed education and attitude in their scope) to the topic.

   ERIC is one of the most commonly used databases in education. It provides abstracts of articles published in more than 700 educational journals and thousands of reports since 1966. The main topics covered are "adult and vocational education; teacher education; reading and communication skills; disabled and gifted children; tests, measurements, and evaluation; and higher education" (Iowa State University Library, 1999a).

Dissertation Abstracts Ondisc provides abstracts and information on dissertations published or unpublished primarily in the United States and some other selected countries. It covers a period from 1860 to the present. The Parks Library Catalog at Iowa State University was also utilized in this study. It provides access to more than 1,114,600 items including books, serials, and other materials. *PsycLIT* includes citations and abstracts from psychology-related articles, books, and book chapters published since 1887. The main fields of study included "psychology, sociology, anthropology, education, pharmacology, physiology, linguistics, eating disorders, forensic psychology, and related subjects" (Iowa State University Library, 1999b).

3. Formulating Search Terms.

Search terms are words or phrases used to locate primary sources. Each database may have different search terms. To ensure the selection of appropriate terms, the Thesaurus was referenced. The Thesaurus contains special terms used to index records. It, in general, provides scope note for a term, more general terms, more specific terms, and related terms. They were available for ERIC and PsycLIT searches. The descriptors used for a search were: technology, perception, attitude, opinion, student, learner, pupil, measurement, test, meta-analysis, integration, synthesis, qualitative analysis or study, and quantitative analysis or study. Other operating functions used for retrieval were

Boolean operators (e.g., 'and,' 'or', and 'not') and truncation (e.g., '*').

4. Searching and locating the references.

The references were identified and located from the computer search. In addition the most frequently cited references (e.g., journals) were manually searched to identify related literatures that were not found in computer search. Each major accessible source was scanned to see if it included further appropriate articles.

5. Further searching.

Additionally the researcher consulted with Drs. De Vries, Dyrenfurth, and Householder to identify additional documents.

Related Terminology

Several related terms were used to establish a concept of technology. The related terms reviewed were: technology, perception, and attitude.

Technology

Although the term 'technology' is used frequently, no consensus existed on its definition. Some people confuse technology with computers, instructional technology, and science (Custer, 1992). In terms of values some believe that technology is inferior to science. Hansen and Froelich (1994) pointed out that the "philosophical bias against practical endeavour has undoubtedly been a major reason for the view that science is superior to technology and that technology is just applied science" (p. 194).

Lowe (1995) described that technology originated from "the Greek 'tekhnologia' which means the systematic treatment of an art or craft (techne-is an art or skill; logia-is science or study)" (p. 6). To yield a clearer understanding of the nature of technology, the definition and characteristics of technology provided by different author was reviewed. Definitions reviewed included the following:

Technology is:

...a study of the technical means undertaken in all cultures (a universal), which involves the systematic application of organized knowledge (synthesis) and tangibles (tools and material) for the extension of human facilities that are restricted as a result of the evolutionary process. (Pytlik, Lauda, & Johnson, 1985, p. 7)

...the process of creating, utilizing, and discarding of adaptive means-including tools, materials, process, energy, and information-and relating these individual elements and collective systems to individuals, society, and the environment. (Kozak & Robb, 1991, p. 29)

...a body of knowledge and the application of resources using a systematic approach to produce outcomes in response to human needs and wants. (Savage, 1991, p. 21)

...the structured application of scientific principles and practical knowledge to physical entities and systems. (Lowe, 1995, p. 6)

The study of the creation and utilization of adaptive means, including tools, machines, materials, techniques, and technical systems and the relation of the behavior of these elements and systems to human beings, society, and the civilization process. (DeVore, 1980, p. xi)

The human activity that purposefully address the satisfaction of human wants or needs via the use of physical means that are extension of human capabilities. (Dyrenfurth, 1991, p. 152)

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)

The above sample indicates that the concept of technology could be described by adopting such words as process, knowledge, application, or means. Among the definitions introduced above, Wright and Lauda (1993) seem to include all four words. Thus, it is not easy to delimit the extent of the term "technology" from any set of definitions because definitions are inherently condensed and diverse.

To flesh out the meaning of the term, it is useful, therefore, to also look at the characteristics of technology. Pytlik et al. (1985) identified ten characteristics of technology. These are: universal, knowledge based and application of knowledge, accumulative, fundamental to humanity, fundamental to survival, alters culture and society, future oriented, observable, harmonious relationship between human life and nature, and extension of the human faculties. Satchwell and Dugger (1996) cited four characteristics of technology previously identified by Johnson, Foster, and Satchwell (1989): applied knowledge, application based, extension of human capability, and existence in social and physical domains.

In Europe, De Vries (1986, p.33) pointed out that technology has the following five characteristics:

1. Essential feature of mankind, with three consequences: existence for both man and women; relationship between one's view and technology; experience of historical development.
2. Three pillars of technology: matter, energy, and information
3. Interrelationship between technology and natural sciences in terms of methodology, and technical and scientific knowledge.
4. Most important skills: designing, practical-technical skills (producing), and handling technical products (using)
5. Mutual influence between technology and society; that is, technology affects all

aspects of society, namely, economy, labor, social relations.

DeVore (1980) identified four constants, which are related to specific categories of investigation about technology:

> (1) that technology is an intellectual endeavor, a creation of the human mind, based on knowledge and procedures which are cumulative; (2) that there is a direct interrelationship between the nature and character of technology and society; (3) that there is a direct and positive relationship between technology and the evolution of human kind; and (4) that the control of tools, machines, techniques, and technical systems for the enhancement of human beings will require the study of the behavior of technological, social, and ideological systems and their interrelationship. (p. 220)

DeVore also pointed out that each of constants described above corresponds to an epistemological, sociological, anthropological, and phenomenological viewpoint, respectively.

Frey (1989) discussed four metaphysical/epistemological characteristics of technology using Mitcham's (1978, 1980) typology. In Mitcham's classification, the word 'technology' as currently used, "has both a narrow and a broad meaning, corresponding to the way it is used by engineers and by the social scientists" (Sinclair & Tilston, 1982, p. 88). Four characteristics are object, process, knowledge, and volition (Frey, 1989). First, technology is any object intentionally produced by humans "to extend practical human possibilities, to adapt the environment to meet human need, or to adapt human capability to the environment" (p. 25). Second, technology as process refers to "the action of making and using technology objects" (p. 25). There are three types of process: a material object transforming process, a design process, and decision-ruled process. The third characteristic is technology as knowledge. Three features of technological knowledge are explained in terms of its basis in praxis, its aims and purpose, and its levels of complexity. Fourth, technology is characterized as volition, which is the deepest compared to the other characteristics, and links together all of the other characteristics.

Through the review of the above definitions and characteristics of technology, this researcher would define operationally technology as an application of knowledge and skills to the designing, producing, and using of objects and practices to meet human needs or to enhance human ability.

Attitude and perception

The term attitude is used in our daily life. Like the definitions of technology, the definition of attitude is diverse according to each researcher's points of view. A literature review based on Allport (1935) defined attitude comprehensively as "a mental and neural 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" (p. 810). Objects include events, concepts, condition, issues, and individuals.

In general, it is known that there are three components of attitude (Oskamp, 1977; Triandis, 1971). The first component is cognition, which refers to ideas, beliefs, and perceptual responses about an attitude object. The second component is affect, which is related to a person's feelings and emotions about an object while the third is behavior, which is the tendency to take action.

There is a close relationship among these three components. According to Triandis (1971), "the more pleasant the events, and the more frequently they occur in the presence of the category, the greater is the amount of affect that becomes attached to the category" (p. 3). This interrelationship, however, may not be consistent. A description of an example is given by Triandis (1971): "A person who has just been in an automobile accident may have a negative component (feels 'bad' when he thinks about cars), but he may realize that he cannot get around in his town without using cars and, therefore, has a positive behavioral component, is predisposed to use them" (p. 4). Fishbein and Ajzen (1975) named three components of attitude as belief, attitude, and behavioral intention but that it was difficult to differentiate among these consistently. They defined attitude as "a learned predisposition to respond in a consistently favorable or unfavorable manner toward an attitude object" (p. 6).

Based on the literature review, the researcher would define attitude as a person's positive, negative, or otherwise affective response to an object or concept. Therefore, there are no correct or incorrect answers on attitude questionnaires. In contrast, a person's cognitive response to question is based on his/her knowledge and, for factual ones, could be wrong or correct. Attitudes are related to beliefs, opinions, perceptions, and concepts.

Students' Perceptions and Attitudes toward Technology

The initial thrust of studies on students' perceptions toward technology or technology education may be found in a Dutch study begun in 1984, conducted by Raat and De Vries (1985), the Pupil's Attitudes Toward Technology (PATT). Since the PATT study, researchers have been encouraged to study students' attitudes toward technology. A long series of conferences promoted this as did the establishment of a foundation. The following literature review focused on shedding more light on understanding the PATT and the research work that has been accomplished so far.

PATT

As described previously, PATT stands for Pupil's Attitudes toward Technology. The PATT evolved into an international research project facilitated by Raat and De Vries (among others) at Eindhoven University of Technology in the Netherlands. The purpose of the initiative was to "integrate what pupils think of technology and to use the results of this research for the development of the new subject technology in primary and secondary school education" (De Klerk Wolters, 1989b, p. 291). The significance of the PATT studies as described by De Klerk Wolters (1989b) is: "it permits to confront pupils' views of others, e.g., experts; it gives clues for curriculum developments; it gives information about students' needs and students' interests; and it permits curriculum development that is more student centered than subject centered" (p.291).

Conferences

The PATT was begun in 1984 and has been extended to more than 20 countries since 1987 (Bame et al., 1993). Raat (1992) describes that "one of the aims of PATT is to being people together to offer opportunities for exchange of ideas and information on technology education" (p. 59).

To meet the stated goal, nine PATT conferences were held annually or biannually between 1986 and 1999. The objectives of the conferences were to: (1) bring together experiences in PATT research; (2) discuss developments in technology from an international perspective; and (3) discuss the relevance of PATT studies for development efforts (De Vries, 1992, p. 246). Each conference had a main theme related to technology education and sub-themes helped organize these conferences. A summary of the conferences has been provided by Mottier, Raat, and De Vries. (1991), Raat (1992), and De Vries (1992). This dissertation provides references to the more recent conference proceedings

- PATT-1. Eindhoven, The Netherlands, 1986. It produced new studies with the development of the instruments for international use. Twelve countries, namely Australia, Belgium, Canada, Hungary, Kenya, Nigeria, Poland, Sweden, U.K., and USA, participated in the pilot studies. The conference produced information on improving research instruments for further studies.

• PATT-2, Eindhoven, The Netherlands, 1987. The results of new pilot studies conducted in twelve countries were presented. Three issues discussed were PATT-research, related research, and curriculum development.

• PATT-3, Eindhoven, The Netherlands, 1988. A special issue concerning basic principles of school technology was discussed. There were four sub-themes: (1) frameworks for school technology; (2) PATT-research, related research, and its relevance; (3) how to make technology interesting for girls; and (4) education of teachers for technology education.

• PATT-4, Eindhoven, The Netherlands, 1989. The hosting institute changed from Eindhoven University to the Pedagogical Technological College. The main theme discussed was teacher education for technology education. Five sub-themes were: frameworks for technology teacher education, PATT research, women in technology teacher education, and teacher education for primary school technology.

• PATT Conference, Nairobi, Kenya, 1990. The main theme was curriculum and socio-cultural issues in appropriate technology. The participants were from Africa (Kenya, Botswana, and Zimbabwe), Europe, and the USA.

• PATT Conference, Zielona Gora, Poland, 1990. The main theme was technology and school with five sub-themes: technological education of society; training of technology teachers; PATT-research; the relationship between technology teaching and sciences; and technology teaching and environmental protection. The participants were from eastern and western Europe, China, Canada, and the USA.

- PATT-5, Eindhoven, The Netherlands, 1991. The main issue, technology and industry, was discussed with five sub-themes: (1) technology education, industry, and the labor market; (2) research in technology education and industry; (3) technology education and attracting women for technological professions in industry; (4) technology teacher education and industry; and (5) primary school technology and industry.

- ITEA-PATT International Conference, Reston, Virginia, USA, 1992. The main theme was Technology education: A global perspective. ITEA stands for International Technology Education Association.

- PATT-6, Breukelen, The Netherlands, 1993. The main theme discussed was technology education and the environment with four sub-themes: environmental issues in primary and secondary education; pupils' attitudes towards technology and the environment; gender aspects of environmental issues in technology education; and environmental issues in the education of technology teachers.

- PATT-7, Breukelen, The Netherlands, 1995. Its main theme was teaching technology for entrepreneurship and employment dealing with values, attitudes, and skills; primary education (5-12 year olds); lower secondary education (12-15 year olds); higher secondary (15-18 year olds) and tertiary education.

- PATT-8, Scheveningen, The Netherlands, 1997. Its main theme was assessing technology education, which was divided into general concepts, national experiences, attitudes, and methods and instruments.

• PATT-9, Indianapolis, Indiana, USA, 1999. It was organized in cooperation with the ITEA in the USA. The main theme guiding the conference was impacts of technology education.

Instruments

Five instruments were developed for use in PATT studies (De Klerk Wolters, 1989b, pp. 292-297). The first instrument is an attitude questionnaire designed to measure attitude toward technology. Items include both affective and behavioral components of attitude mentioned in the preceding section. There are six Likert-type scales, each indicating one dimension, with five alternatives ranging from strongly agree to strongly disagree. It has been validated though pilot studies. Six sub-scales are:

1. Interest: comprised of 10 items asking how well students participate in or are willing to participate in technological activities outside school.
2. Role pattern: comprised of 9 items asking how students think that technology is appropriate for both boys and girls as a study or career.
3. Consequences: comprised of 13 items asking questions on what students think about the effects of technology on the society.
4. Difficulty: comprised of 9 items exploring students' perceptions regarding difficulty of technology as a school subject or a profession.
5. Curriculum: comprised of 9 items asking how students feel about technology as a school subject.
6. Career: comprised of 8 items asking if students would be pleased to have a job in a technology area in the future.

The second instrument is a concept questionnaire designed to measure students' concepts of technology. This represents a cognitive component of attitude. Items were developed based on five characteristics of technology identified by De Vries (1986). This instrument has a true and false format. The first scale, named technology and society, is related to the first and fifth characteristics. It is composed of 10 items regarding technology control by humans and its influence on society. The second scale, named technology and science, consists of 6 items and is used to assess the difference between technology and science. The third scale, named technology and skill, includes 7 items and was used for evaluation of the relationship between technology and certain skills. The fourth scale, named technology and pillars, has 5 items and was used for measuring knowledge of three pillars of technology.

The third instrument consists of essays, drawings, and open-ended questionnaires. It is designed to yield more information regarding the concept of and attitudes toward technology. Each questionnaire was given to a different age group. Drawings are utilized for the age group of 10 to 12, essays for 13 to 15, and an open-ended questionnaire for 16 to 18. Each version has an identical assignment: What do you think technology is?

The fourth instrument is the Technology Attitude Scale (TAS). It is a short version of instruments 1 and 2, developed by De Klerk Wolters (1988) and presented at the PATT-3 Conference.

The fifth instrument is a teacher attitude questionnaire aimed at measuring teachers' attitudes toward technology. It uses a pool of statements developed from interviews with teachers from which 74 items were selected for the study. It has been used in Finland, Poland,

and the Netherlands.

In overview, the development of the PATT instruments involved an examination of the frequency distribution of items and the correlation matrix. These were used to remove bad items. In addition, studies reviewed by the researcher employed the following analysis methods. Reliability was tested by calculating item-total correlations and Cronbach's alpha. Factor analysis was used to test construct validity.

Other related studies

Many studies related to students' perceptions toward technology were derived from the PATT study although the instruments may have been adapted. For example, in the PATT-USA study, a modified version of PATT tailored for use in the United States, was developed by Bame et al. (1993). Furthermore, PATT-USA was also adapted by Dunlap (1990) for third- and fourth-grade students. The TAS-USA version was adapted and validated by Jeffrey (1993).

Some studies have used self-developed instruments. For example, Householder and Bolin (1992) developed the Secondary Students' Attitude Toward Technology (SSATT) instrument to meet the requirements of the TEC-LAB project by modifying selected items from previous studies and adding additional items. Their instrument was comprised of a 10-point scale, ranging from "strongly disagree" to "strongly agree." It has been used by several researchers such as Shafiee (1994) and McHaney (1998). There are many other self-developed instruments, several of which are presented and discussed in the Findings and Results section of this dissertation.

Measurement of Perceptions and Attitudes

The review of measurement of perception will be done by looking at the measurement of attitudes, since perception is considered as one component of attitude. Rennie and Jarvis (1995) investigated the methods for measuring students' perceptions of technology. There are several methods, such as: questionnaires generally using a Likert-type attitude scale; open-ended questions to gather the respondents' perspectives; drawing for young children; lists of words to probe respondents' understanding; and interviews to obtain detailed information.

Oskamp (1977) declared that attitude could be studied using five different approaches: description, measurement, polls, theories, and experiments. The description approach is used to investigate the attitudes of a single group and is less concerned with sophisticated quantification, while the measurement approach deals with the attitudes of two or more groups and is highly concerned with sophisticated quantification. Polls are done to investigate attitudes on important social issues of large groups. A theoretical approach is used for describing the basic nature of attitudes regardless of their importance. Last, the experimental approach is used for factor identification or to test attitude theories.

The scaling methods mainly employed to assess attitudes are the Guttman, Thurstone, Likert, and semantic differential scales. These methods possess the following characteristics (Fishbein & Ajzen, 1975; Oskamp, 1977).

Thurstone's equal-appearing interval scale

Thurstone's method is based on the assumption that each item has its own degree of favorableness or unfavorableness toward the attitude objects. The equal-appearing interval scaling is one of Thurstone's two methods of paired comparisons, whereas the equally-appearing interval is used most widely.

The scaling procedures for the equally-appearing interval are described as follows:

1. Collect a large pool of items
2. Give the items to judges from a population to indicate their favorableness toward the attitude object disregarding their attitude toward the topic. Each item has eleven equally spaced categories from unfavorable to favorable, including neutral
3. Compute a scale value, i.e., mean or median, for each item
4. Determine and items eliminate producing high levels of disagreement as determined by the interquatile range or standard deviation among judges
5. Select about 20 items so that they are spread more or less evenly along the attitude continuum
6. Administer the final scale chosen to a sample of respondents without any indication of scale values and let the respondents indicate their agreement with each item on the questionnaire.

There are two drawbacks with this method according to Oskamp (1977). First, if many judges have extreme views on the topic, their opinion will affect the scale values of the items. Secondly, it is "time consuming and tedious to apply" (p. 29).

Likert's method of summated ratings

The Likert scale is characterized by its simplicity in construction and relatively high scale reliability compared to Thurstone's method. This scale is used to measure "the extent of the respondent's agreement with each item, rather than simply obtaining a 'yes-no' response" (Oskamp, 1977, p. 29). As indicated in the name summated ratings, "a respondent's attitude score is determined by adding his ratings for all of the items" (Oskamp, 1977, p. 29).

The general procedures to construct the scale are described as follows:

1. Collect a pool of monotone items, i.e., items having the characteristics that the more favorable the individual's attitude toward the attitude object, the higher his expected score for the item (Shaw & Wright, 1967, p. 24).
2. Eliminate ambiguous items through investigation.
3. Give the remaining items to a sample of the target population with a five-point scale ranging from 'strongly agree' to 'strongly disagree.' For favorable items, 'strongly agree' is scored 5 and 'strongly disagree' is scored 1. It is applied reversely for unfavorable items. A central value of 3 is assigned to a 'neutral' or 'undecided' response.
4. Calculate attribute scores to determine whether an item should be retained. The most discriminating items are selected for the final scale. A criterion to do this is to either compare highly-correlated items with the total score or to compare the means and variances of the upper and lower 25 percent of the distribution of total scores. The reason for eliminating uncorrelated items can be found in this method's assumption that "all of the items are measuring the same underlying attitude" (Oskamp, 1977, p. 30).
5. Give the final items, measured on a 5-point scale, to the sample and then compute the score as the sum of individual item scores.

Oskamp (1977) pointed out that, if a researcher does not follow the procedure to select the most discriminating items, the Likert method loses its strength of item analysis.

Guttman's scalogram analysis

Guttman's method refers to a perfect cumulative scale where the items are ordered along their difficulty levels. With this idea, Guttman developed a scale to measure attitudes.

The procedures to construct a scale are as follows (Oskamp, 1977):

1. Collect a pool of items;
2. Give to a large group of respondents with a "yes-no" or "agree-disagree" format;
3. Rank the items from high to low frequency of agreement on them. The item yielded the lowest frequency is considered the most favorable item.
4. Compute all responses' score by their frequencies of endorsement; and
5. Rank the subjects according to their total scores to investigate their response pattern.
6. Remove the items which resulted in many inconsistent responses (e.g., A respondent agreed on the favorable item and then disagreed on the less favorable item.)
7. Give final short scale to respondents.

A Guttman scale assumes that a set of items is unidimensional, i.e., measures a single characteristic on a cumulative scale. For this reason, Guttman scales tend to "be quite short (perhaps 4-10 items) and restricted to a narrow topic" (Oskamp, 1977, p. 32). A number of errors or inconsistent response items obtained through these procedures indicate a deviation from unidimensionality. This response error should be less than 10% to meet the criterion of unidimensionality (Oskamp, 1997). To determine whether the scale is acceptable or not, a coefficient R is calculated. R is called the coefficient of reproducibility and is formulated as:

$$R = 1 - \frac{\text{Total Number of errors}}{\text{Total number of responses}}$$

Another useful coefficient is minimal marginal reproducibility (MMR):

$$\text{MMR} = \frac{\text{Number of responses in modal categories}}{\text{Total number of responses}}$$

Fishbein and Ajzen (1975) elucidated that the Guttman scale has an advantage only when R greatly exceeds MMR as well as when R is greater than or equal to .85 (p. 67).

Osgood's semantic differential technique

Osgood's method is called the "semantic differential technique" because it "attempts to measure the connotative meaning of the concept or object being rated; that is, its implied meaning or differential connotations to the respondents" (Oskamp, 1977, p. 34). Osgood, Suci, and Tannenbaum (1957) explained the major dimensions of connotative meaning by applying factor analysis to a large set of scales. Through this procedure, they arrive at three major dimensions, namely (1) evaluative (i.e., good-bad, beautiful-ugly, sweet-sour, etc.); (2) potency (i.e., large-small, strong-weak, heavy-light, etc.), and (3) activity (i.e., fast-slow, active-passive, hot-cold, etc.). Among the three dimensions, evaluative is considered an affective dimension while potency and activity are cognitive dimensions. That is, "once a set of evaluative scales has been identified, it can be used to measure attitudes toward a large number of concepts" (Fishbein & Ajzen, 1975, p. 76).

The general procedure to use a semantic differential scale is as follows (Osgood et al., 1957; Fishbein, & Ajzen, 1975):

1. Choose concepts that are being judged by subjects. To obtain good judgement from subjects, a researcher should consider that the concepts being used show individual differences, have a single meaning for the individual, and be familiar to all respondents.
2. Select about three scales for each dimension that yielded high loadings on the

dimension as a result of other researcher's study. Each semantic scale has seven points with a pair of polar adjectives (i.e., hot-cold) at the end of each scale. No opinion statements are included.

3. Administer the scale to subjects.
4. Score the most positive one as '+3' and the least positive one as '-3' and then use sum or mean scale value for each dimension as an index.

Summary of perception and attitude measurement

No specific method is the best for every measurement, and the best method to apply depends on the nature of the research conducted. Oppenheim (1966) states that

> If we wish to study attitude-patterning or explore theories of attitudes, then probably the Likert procedure will be the most relevant. If we wish to study attitude change, or the hierarchical structure of an attitude, then Guttman's method might be preferable. If we are studying group differences, then we'll probably elect to use the Thurstone procedure, ... (p. 123)

Methodological Considerations

To construct an effective scale, researchers need to consider reliability, validity, equality of units, uni-dimensionality, a zero point, and reproducibility. Among these qualitative attributes, the most important things to be considered are the reliability and validity of the measurements. Reliability and validity refer to measurement error. In general, an obtained score is composed of a true score (t) and error (e). The error component is divided into a variable error (e_v) and constant error (e_c). An observed score (x_i) is expressed by the following formula:

$$x_i = t_i + e_v + e_c$$

From the formula e_v is related to reliability and e_c is related to validity.

Reliability

Reliability refers to the consistency of scores on the same instrument when scores are measured over time. The lower the reliability of an instrument, the less useful it is. Thus, reliability is one of the main concerns in measurement. Fishbein and Ajzen (1975) argued that reliability is not a major problem in attitude measurement when instruments are employed properly because reliabilities of standard attitude scales are generally high. In general, three ways of measuring the reliability of an attitude scale are test-retest methods, equivalent form methods, and split-half methods (Shaw & Wright, 1967).

The test-retest method is an estimate of the reliability between two scores on the same test administered to the same group within a certain time interval. The equivalent forms method is used to estimate the relationship between two scores on two different but equivalent (parallel or alternate) forms of an instrument administered to the same group at the same time. The split-half method estimates the relationship between two sets of scores obtained by separating a test into two halves (e.g., odd items vs. even items).

Reliability is a necessary but not a sufficient condition for validity. In other words, a measure that has validity also will have reliability but the reverse is not necessarily true.

Validity

Validity refers to "the degree to which the scale measures what it is supposed to measure" (Shaw & Wright, 1967, pp. 17-18). The three main procedures for estimating validity are: content validity, criterion validity, and construct validity.

Content validity refers to the appropriateness of the content and format of the instrument (Fraenkel & Wallen, 1996). Two judgments are required to be made to determine if an instrument has content validity. First, it is done by evaluating if the items of an instrument are an appropriate sample of the domain of content to be assessed. Second, the format of an instrument is evaluated by investigating characteristics such as "the clarity of printing, size of type, adequacy of work space (if needed), appropriateness of language, clarity of directions, and so on" (p. 155). "In practice, the evaluation of content validity is usually a subjective, judgmental procedure" (Shaw & Wright, 1967, p. 18). To obtain this validity, a researcher asks expert judges to examine the test items.

Criterion validity is obtained by showing how adequately a test score can estimate or predict the performance on a second or criterion test intended to measure the same variables. There are two types of criterion validity based on the time when the criterion measure is obtained. If an administration of an instrument and the gathering of criterion data have been conducted at nearly the same time, it is related to concurrent validity and if there is a time interval between two measurements, it is considered as predictive validity.

Construct validity, which is the broadest and the most complex type of validity, refers to the degree to which an instrument measures an intended hypothetical psychological construct or nonobservable trait. In an attitude study, it is estimated by determining "the relationship between the attitude score and other aspects of the personality" (Shaw & Wright, 1967, p. 19).

There are two techniques to show the evidence of construct validity in attitude study (Shaw & Wright, 1967, pp. 19-20): namely, the known groups approach and the correlation matrices approach. The known-groups approach evaluates the relationships between the attitude scores and the known-groups based on hypothesis. The correlation matrices approach shows that "correlations among scores for a given attitude measured by different scales should be higher than correlations among attitude measured by different scales" (p. 19). Finally, Shaw and Wright (1967) pointed out that internal consistency and test-retest reliability could be used as evidence of construct validity in some cases.

Meta-analytic Procedures

Compared to the existence of meta-analytic methods, the use of the term meta-analysis has a short history. In 1976, it was first used by Gene V. Glass. Meta-analysis is defined as "a set of quantitative techniques that permit synthesizing results of many types of research, including opinion surveys, correlational studies, experimental and quasi-experimental studies, and regression analyses probing casual models" (Cook et al., 1992, p. 4).

The procedures of meta-analysis are the same as these for primary research even though there is no fixed sequence of stages. Cooper (1984) suggested five stages to conduct an integrative research. Those are problem formulation, data collection, data evaluation, analysis and interpretation, and public presentation. The characteristics of each stage are described in terms of the research question asked, the primary function of the review, procedural differences, and sources of invalidity. Detailed descriptions are given in Table 1. In the problem-formulating stage, the research synthesist should be aware of the boundaries of research synthesis. Research synthesis could be done for three categories of studies: cause and effect, generalization, and theory development.

One of the major methodological considerations is insuring validity. According to

Table 1. The process of integrative research

Stage Characteristics	Stage of Research				
	Problem Formulation	Data Collection	Data evaluation	Analysis and Interpretation	Public Presentation
Research Question Asked	What evidence should be included in the review ?	What procedures should be used to find relevant evidence?	What retrieved evidence should be included in the review?	What procedures should be used to make inferences about the literature as a whole	What information should be included in the review report?
Primary Function in Review	Constructing definitions that distinguish relevant from irrelevant studies	Determining which sources of potentially relevant studies to examine	Applying criteria to separate "valid" from "invalid" studies.	Synthesizing valid retrieved studies.	Applying editorial criteria to separate important from unimportant information.
Procedural Differences That Create Variation in Review Conclusions	1. Differences in included operational definitions 2. Differences in operational detail.	Differences in the research contained in sources of information	1. Differences in quality criteria. 2. Differences in the influence of non-quality criteria.	Differences in rules of inference.	Differences in guidelines for editorial judgement
Sources of Potential Invalidity in Review Conclusions	1. Narrow concepts might make review conclusions less definitive and robust. 2. Superficial operational detail might obscure interacting variables.	1. Accessed studies might be qualitatively different from the target population of studies. 2. People samples in accessible studies might be different from target population of people	1. Non-quality factors might cause improper weighting of study information. 2. Omissions in study reports might make conclusions unreliable	1. Rules for distinguishing patterns from noise might be inappropriate. 2. Review-based evidence might be used to infer causality	1. Omission of review procedures might make conclusions irreproducible. 2. Omission of review findings and study procedures might make conclusions obsolete.

Source: Cooper (1982), cited in Cooper (1984), p. 13.

Cooper (1984), threats to validity can occur in three ways: (1) the use of any evaluative criteria other than methodological quality; (2) incomplete data reporting by primary researchers; and (3) unreliable coding of research results. In addition, Cooper (1984) suggested what can be done to protect validity:

1. Reviewers should make every effort to insure that *only* conceptual judgements influence the decision to include or exclude studies from a review.
2. If studies are to be weighted differently, the weighting scheme should be explicit and justifiable. Personal involvement in a study is not a legitimate criteria for giving it added weight.
3. The approach used to categorize study methods should exhaust as many design moderators as possible. The reviewer should detail each design distinction that was related to study results and tell the outcome of the analysis.
4. More than one study coder should be employed and intercoder agreement should be quantified and reported. Also the coding sheets should be filled out by coders who are blind to the results of the study.
5. The reviewer should state explicitly what conventions were used when incomplete or erroneous research were encountered. (pp. 77-78)

Before analyzing the data, three assumptions need to be mentioned to insure the validity of a synthesized conclusion (Cooper, 1984). First, the individual comparisons test the same conceptual hypothesis. Second, the individual comparisons are independent from one to another. Third, the assumptions by the primary researcher for the comparison are valid. Under these assumptions, researchers combine the probabilities of independent studies. Depending on the data availability, different techniques for combining independent findings can be employed.

The simplest method is the vote counting method which is based on the directional results of comparisons or the frequency of statistically significant findings. Cooper (1998) introduced several methods of vote counting (pp. 116-120):

1. Vote count of significant findings. Findings are classified into three categories,

namely statistically significant findings in the expected direction (positive), statistically significant findings in the unexpected direction (negative), and statistically insignificant findings. It is considered that the category which has the highest frequency of findings, indicates the target population's direction of the relationship. It is intuitive approach so that it is recommended that "at least 34% of findings be positive and statistically significant before the expected result is declared a winner" (p.117).

2. Comparing the frequency of statistically significantly positive findings versus the frequency of significantly negative ones. This technique is based on the assumption that the frequency of significant positive and negative findings are equal. The drawback of this technique, i.e., when a researcher considers only statistically significant findings, is the possibility of losing information on many non-significant findings and consequently the statistical power of this technique is low.
3. Comparing the number of positive and negative findings regardless of their statistical significance. The basic assumption of this technique is the same as technique number two described above. The direction of cumulative findings is determined by the result of sign test. The formula to compute z score is as follows (p.118).

$$Z_{vc} = \frac{N_p\text{-}1/2 \times N}{1/2 \times \sqrt{N})}$$

Where N_p: the number of positive findings
N: the total number of findings

The P level is obtained using the z value. Although this technique includes the direction of all findings, there are still some disadvantages because it does not consider the sample size and magnitude of each finding. Moreover, a practical problem with this technique occurs when the primary researcher does not report the direction of his/her findings, especially for statistically non-significant results.

4. Estimation of confidence interval for the population using vote counting. Hedges and Olkin (1980) introduced this method. This technique considers not only the direction of study but also the sample size of each finding. Confidence interval of population is computed using the method of maximum likelihood. It, however, can not be employed if all results are in same direction because "there is not a unique value of p" where P indicates "the proportion of positive or significant positive results for the k studies" (Bushman, 1994, p.211 & p.196). In that case, a Bayes estimate (Chew, 1971) are referred.

The method of adding Z scores is simple and more applicable than the vote counting method. Sometimes, adding Z scores may underestimate the results if no information is available for statistically insignificant data. In that case, the calculation of fail-safe N helps a reviewer know how many additional null-summing comparisons are needed to raise the combined probability. The formula for fail-safe N is given by Cooper (1998, p. 123):

$$N_{FS,.05} = (\Sigma Z_i / 1.645)^2 - N$$

where, $N_{FS,.05}$ is the number of additional null-summing findings needed to raise the combined probability to just above $p < .05$, and 1.645 is the standard normal deviate associated with $p < .05$ (one-tailed)

Combining probabilities from each study allows the researcher to draw an integrative result, which can show whether or not a null hypothesis is true. It is not enough to interpret the p-values when a null hypothesis is rejected.

The calculation of effect size is also important. There are two indices, d and r, for effect size. Index d refers to Cohen's statistic d. Index d either is estimated by dividing group differences in mean scores by the pooled standard deviation or is derived from selected statistics (e.g., t values or F values). Index r refers to the Pearson product-moment correlation coefficient, which can be calculated from either the t value or χ^2 value and is transformable into a d value.

Another way to do the meta-analysis is to use moderator variables to evaluate hypotheses that were not tested in the primary studies. There are two types of moderator variables: low-inference and high-inference (Hall et al., 1994). The low-inference variables can be obtained from the primary study directly while the high-inference variables involve the inference of coders. The implication is that a synthesist should consider the validity of research when he/she employs the high-inference variables. One suggestion to improve validity for research synthesis using high-inference coding is "to keep raters unaware of a study's results and to evaluate interrater reliability" (Hall et al., 1994, p. 26).

Summary

The literature review provided an understanding of related terminology and measurement of perceptions and attitudes. It also gave an overview of studies on students' perceptions and attitudes toward technology.

The review of literature revealed that there was no unique term for technology, but its characteristics were explained with relation to knowledge, human, society, objects, and skills.

In the literature, perception was described as cognition which were one of three attitudes' components, namely cognition, affect, and behavior.

A glance of studies on students' perceptions toward technology revealed that PATT project drove the movement on this topic and contributed to activating the research. PATT studies were highlighted under the subheading "students' perceptions toward technology."

The literature suggested that the researcher could chose the scale depending on the nature of the research. The scales mainly used in attitude measurements were Thurstone's, Likert's, Guttman's, and Osgood's methods. The reviews provided methodological considerations to construct an effective scale.

The last part of the review of literature was assigned to the concept, procedure, and methods of meta-analysis. The literature accentuated the importance of validity and data availability in meta-analysis.

CHAPTER III. METHODS AND PROCEDURES

This chapter describes the methods and procedures employed for the study. It is organized into six subsections namely; (1) Research Design and Procedures, (2) Population or Target Studies, (3) Coding Method, (4) Analysis, (5) Reliability and Validity, and (6) Summary.

Research Design and Procedures

The overall design and procedures of this study are summarized in Figure 1. These procedures involved thirteen steps.

1. Set eligibility criteria for accessible studies. A detailed description of this step is given in the population and target studies subsection of this chapter.
2. Identify and retrieve eligible studies. A detailed description of this step is given in the population and target studies subsection of this chapter.
3. Develop a coding sheet to classify each study by considering variables, formats, analyses, and the like. It is provided in the coding method subsection of this chapter.
4. Conduct pilot test of coding. A detailed description of this step is given in the coding method of this chapter.
5. Validate coding. Validation methods are discussed in the reliability and validity subsection of this chapter.
6. Code the balance of the studies. Data were coded on the computerized coding sheet for later use. These data in summarized form are provided in Appendix B.
7. Develop variables map. Those are provided in Figures 6 and 7 in Chapter IV.

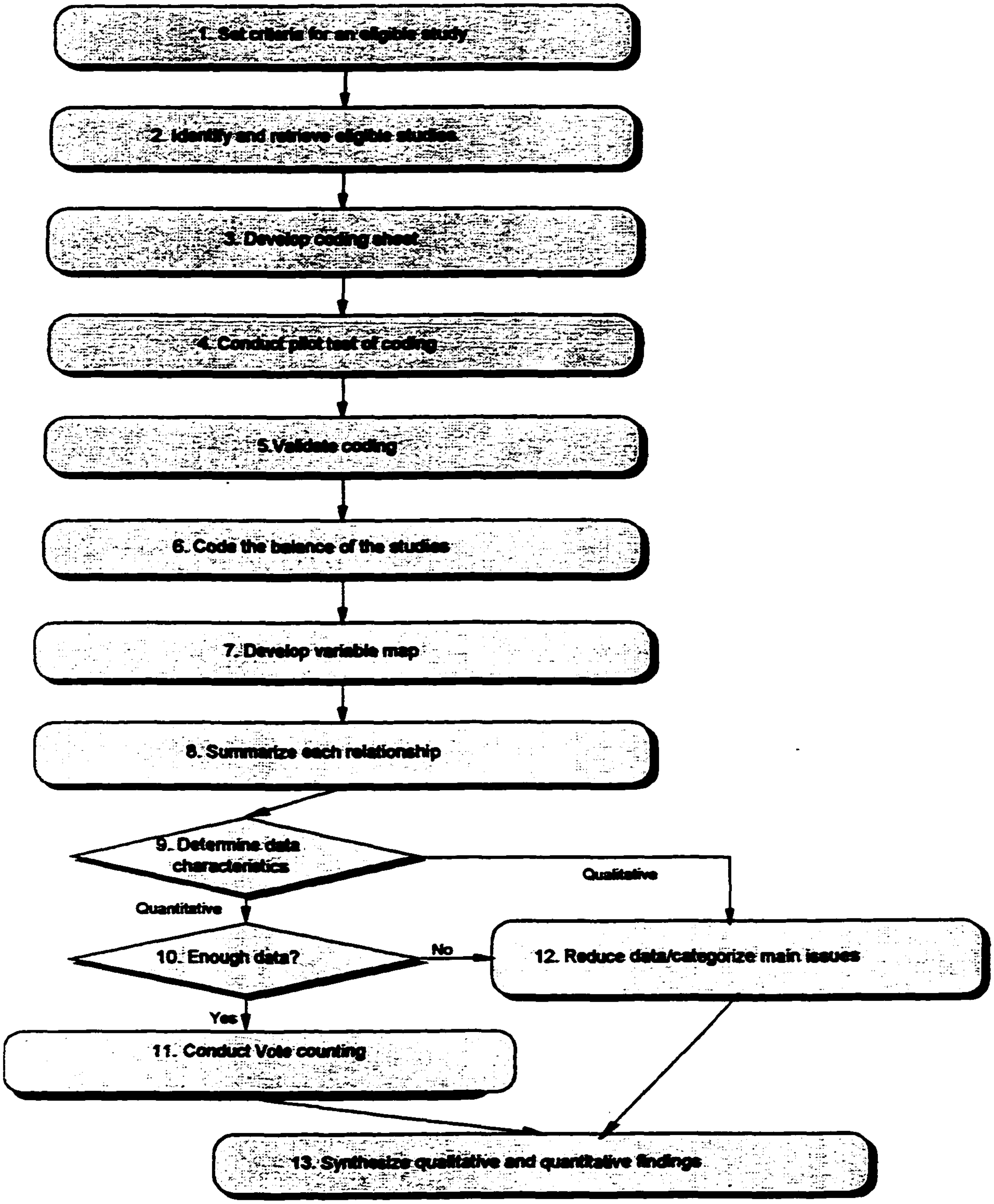


Figure 1. Flowchart of the research procedures

8. Summarize each relationship among variables by showing the relationship on the variable maps and annotating them. This information is provided in Chapter IV.
9. Determine each study' data characteristics and classify them as quantitative or qualitative.
10. Enough data? For studies reporting quantitative data, decide whether each study's report supplied sufficient data for quantitative meta-analysis.
11. Conduct vote-counting for quantitative studies that reported sufficient data. A detailed description of the method is given in analysis subsection of this chapter and the results of vote-counting are provided in Chapter IV.
12. Purely qualitative studies and studies with inappropriate or incomplete quantitative data for meta-analysis were analyzed qualitatively to reduce data by categorizing their main issues. The results are provided in Chapter IV.
13. Synthesize qualitative and quantitative findings. The results are given in Chapter IV.

Population and Target Studies

The major purpose of this study was to integrate a worldwide series of studies related to students' perceptions toward technology. These studies have been conducted for a variety of reasons, including, but not limited to, identify the changes that have occurred in the students experiencing technology education. To achieve the researcher's primary purpose, all previous studies on student perceptions of technology located through multifaceted search were used as target studies.

The search keywords included technology, technology education, perception, attitude, believe, opinion, students, and pupil. All studies identified by the researcher were subjected to these selections to determine the eligibility of the studies for inclusion:

1. The subjects were students in grades K-12 or college students as described in Chapter I. Studies of preschool, graduate, or post-graduate students as well as professional studies were excluded.
2. The study was related to perceptions or attitudes toward technology or technology education.
3. The publication dates of the study was fell within the target period of time. To be included the selected study should have been published or reported between these dates namely, between 1980 and 1999.

Most of the documents were retrieved from the ISU Parks Library Catalog, ERIC, *Dissertation Abstracts*, and *PsychLit* databases. Others were obtained from relevant journals, reference lists of sources in the cited literature, and through direct contact with experts in the field. The conference proceedings of Pupils' Attitudes Toward Technology (PATT) were also utilized to identify further studies.

Coding Method

Data coding involved reading the identified studies and extracting relevant information. The coding system and form were developed and pilot-tested using selected studies by the researcher. There were some needs to add or delete variables, or change the format because unexpected happenings occurred during the pilot test. After scrutinizing the draft through the pilot test, a revision of the draft followed.

The researcher entered different content representative of each study. Data were entered into the database management program, Microsoft Access (n.d.), for further analysis.

The major aspects of each study that were coded on the coding forms were:

1. Identification Number: Assigned by a researcher to unequally identify the article
2. Study Characteristics
   A. Author(s): The name(s) of author(s) involved in the study.
   B. Study source (with following classification):
      a. Journal article
      b. Book or chapter
      c. Thesis or dissertation
      d. Technical Report
      e. Conference Paper
      f. Unpublished manuscript
   C. Date: Publication or presentation date
   D. Professional affiliation: Authors' professional affiliation with the following classification:
      a. Academic
      b. Government agency
      c. Research firm
3. Subjects' Characteristics:
   A. Age: Subjects' age
   B. Gender proportion: Gender proportion in the sample
   C. Grade: Subjects' grade level on school
   D. Population: The population from which the sample was drawn
   E. Sample size
4. School Characteristics:
   A. Location: School's location (i.e., urban, suburban, or rural area)
   B. Level: Schools' level (i.e., elementary, junior high, senior high, or college)

C. Country: Country where the study has conducted

5. Method and Analysis:

A. Design: Research design

B. Sampling method: Sampling method used in the study

C. Instrument: Instrument used in the study with its name

D. Instrument sub-scales: Instruments' sub-scales or components for which analysis was done

E. Independent variables: Independent variables used

F. Dependent variables: Dependent variables used

G. Analysis: Data analysis method

6. Results/Findings/Conclusions/Recommendations:

A. Findings/Results: Findings/results described by author(s)

B. Conclusions: Conclusions drawn from findings/results in the study

C. Recommendations: The recommendations given by author(s)

Analysis

Analysis was conducted using both quantitative and qualitative procedures. Qualitative analysis was employed for studies reporting data that cannot be quantified or that provided insufficient information to be analyzed quantitatively. In qualitative analysis, data were reduced, assembled, and then categorized by issues. Three types of analysis were employed: frequency analysis, topical descriptive/narrative characterization, and relationship analysis.

Quantitative analysis depends heavily on data availability. Most studies, regardless of the significance of their studies, did not report enough numerical information such as standard deviation, some statistical values (F, t, χ^2, or p). Available data were, mainly, the number of students and mean value of each group. Moreover, additional problems were encountered. Most studies with non-significant findings did not report their direction of findings. Other studies simply used percentages or frequencies to compare group differences without conducting any statistical tests.

Given these conditions, the vote counting method was selected to generate the series of findings for all conditions presented in the research studies selected for review and analysis. Among the four different vote-counting methods described in the literature review, the third method, 'comparing positive and negative findings regardless of their statistical significance,' was employed although combining method four with method three would have been more valuable because most studies for each scale had a similar direction. However, there was a limitation to employ this counting method. The confidence interval estimates for a population could be obtained using a computer program but the available program could not run without information on effect sizes. Therefore, only method three was used to integrate the findings.

Reliability and Validity

An extensive literature search was done to improve the reliability and validity. The target studies were identified through several different sources.

The data were coded on pre-developed coding sheets from which the findings of the study were drawn. Sample study codings were validated by experts in the field (see Appendix A). Each expert was sent a formal letter describing the purpose of coding evaluation as well as the direction of evaluating. Accompanying this was a set of coding validation sheets. Each validator received coded sheets for two studies, with a total of 24 classifications in all from the data in the coding sheets. The ensuring inter-validator and researcher agreement rate was 100 percent. The validators also provided constructive comments to improve the validity of the coding sheets. The coding validation sheets and the letter sent to each validator appear in Appendix B.

Summary

This chapter detailed the methods and procedures adopted to conduct the study. The overall research design and procedures of this study were described in thirteen steps. The criterion for selected target studies and data coding method were established systematically to improve the validation of the study. Data were analyzed qualitatively and quantitatively. Frequency analysis, descriptive/narrative characterization, and relation analysis were employed for qualitative analysis, whereas vote-counting method was utilized for quantitative analysis. Two approaches were used to improve reliability and validity, namely an extensive literature search and the validation of the coding sheets.

CHAPTER IV. FINDINGS AND RESULTS

This chapter presents the findings and results of the qualitative and quantitative analysis of the data. The chapter is organized using the following subheadings: (1) General Characteristics of Previous Studies, (2) Description of the Subjects, (3) Variables, (4) Methodologies used, (5) Students' Attitudes toward and Concepts of Technology, and (6) Summary. The methodologies used reports on research designs, sampling methods, and instruments employed. The students' attitudes and concepts section included findings on variables and relationships for both attitudes toward and concepts of technology.

General Characteristics of Previous Studies

This section describes six general characteristics of students' perceptions and attitudes toward technology as documented by the seventy-eight studies identified for inclusion in this research study. These six general characteristics are: the study source, publication date, first author's professional affiliation, study country, level of schools included, and sample size.

Study sources were classified into the following categories: journal, book/chapter, dissertation/thesis, technical report, and conference paper. Table 2 shows the number of

Table 2. Sources of previous studies

	Study Source				
Classification	Journal	Conference Paper	Dissertation	Report	*Total*
Number of studies	19	52	6	1	*78*
Percentage (%)	24.3	66.7	7.7	1.3	*100*

related studies classified by their study source. Fifty-two (66.7%) of the 78 studies (see Appendix C) were retrieved from conference proceedings. All were published in the various PATT conference proceedings except for two studies. Nineteen (24.3%) of the studies were located in journals. The most frequently used journal was *Research in Science and Technological Education* (6). The other related journals were: *European Journal of Science Education* (1), *International Journal of Science Education* (1), *International Journal of Technology and Design Education* (4), *Journal of Technology Education* (2), *Journal of Technology Studies* (1), *Research in Education* (1), *Research in Science Education* (2), and *The Technology Teacher*(1). Six (7.6%) dissertations were included in the study. Eight studies were published in two or more outlets apparently using the same studies in different sources. Each occurrence was considered a separate source.

The current study limited its investigation to the period of time since 1980 because the literature review indicated that most of the studies had been conducted since that date. As shown in Figure 2, many of the studies on students' perceptions and attitudes toward

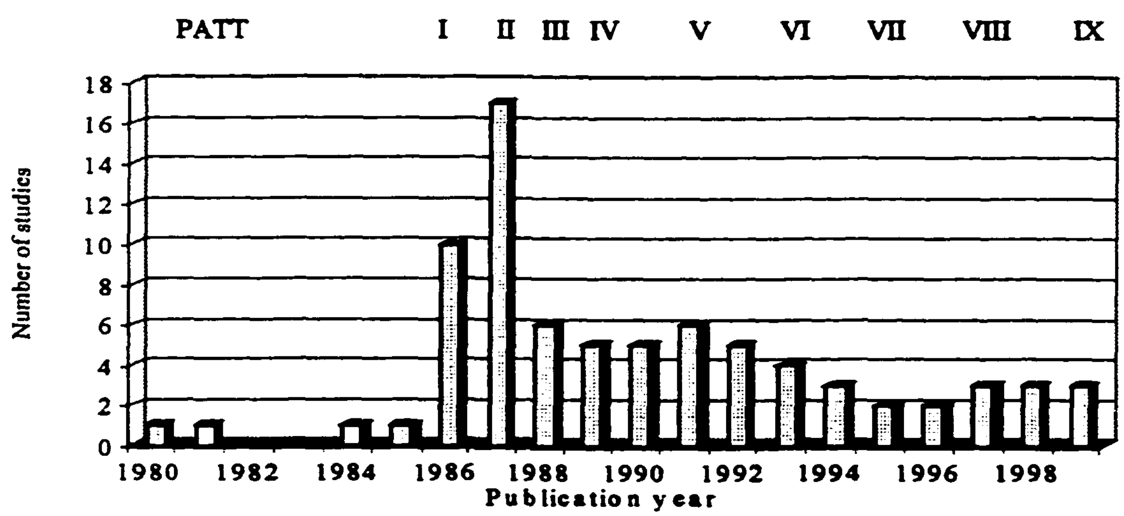


Figure 2. The number of students' attitude studies in technology by publication year

technology were conducted between 1986 and 1991, with its mode occurring in 1987. The number on the top of the figure displays the series of PATT conferences with relation to its date held. It appeared that the PATT study triggered the subsequent studies. After 1991, less than four studies could be found each year.

The first author's professional affiliations were classified using the following studies could be found each year. Duplicated studies were included in the analysis of publication year because some studies were published in different years. categories: academic (school and university), government agency, and research firm. Fifty-six (84.8%) of the 66 authors' professional affiliation were academic. All except one, who was from secondary school, were involved in universities. Seven of the sixty-six primary authors' professional affiliations were not identified and three did not indicate clearly. Authors of duplicated studies were counted only once.

In the literature review, it was mentioned that PATT studies have been conducted in more than twenty countries. The studies identified for this meta-analytic study derived from work conducted in twenty-seven different countries. These were summarized by geographical areas and economies (see Table 3). Over half (37) studies involved in Europe. Eleven studies came from Africa and 22 reported on North American country studies. In addition, each participative country from Asia and Oceania was identified. There were no studies identified from South America. Four studies were conducted in two different countries but were counted once for each country.

According to economic status classified by International Monetary Fund (1999), the studied countries were divided into developing/transitional and advanced economies. Both categories had a similar number of countries. Twelve were from actual developing and

Table 3. Summary of study countries by geographical area and economy

Continent	Countries	Economies	Number of studies	Sub-total
Africa	Botswana	Developing	2	11
	Kenya	Developing	2	
	Lesotho	Developing	1	
	Nigeria	Developing	4	
	South Africa	Developing	1	
	Zambia	Developing	1	
Asia	India	Developing	3	5
	China (Hong Kong)	Advanced	2	
Europe	Belgium	Advanced	1	37 (2)
	Denmark	Advanced	1	
	Finland	Advanced	1	
	France	Advanced	1	
	Germany	Advanced	1	
	Hungary	Developing	2	
	Italy	Advanced	1	
	New Zealand	Advanced	1	
	Poland	Developing	8	
	Portugal	Advanced	1	
	Sweden	Advanced	1	
	The Netherlands	Advanced	8 (2)*	
	Turkey	Developing	1	
	United Kingdom	Advanced	9	
North America	Canada	Advanced	2	22 (9)
	Mexico	Developing	1	
	USA	Advanced	18 (9)	
	Trinidad and Tobago	Developing	1	
Oceania	Australia	Advanced	7 (1)	7 (1)
Total	*27*	*A (15), D (12)*	*82 (12)*	

* The number inside parenthesis indicates the number of studies in the total which have been reported in multiple documents. 'A' and 'D' stand for advanced and developing countries, respectively. Four studies were conducted in two different countries.

transitional countries, while 15 were from advanced countries. The number of studies from each category was quite different in proportion. Nearly two-thirds of the studies were conducted in economically advanced countries.

The levels of schools studies were elementary, junior high, senior high, and university. There was, however, no consistent categorization of these levels across the countries involved. For example, some elementary schools can have a span of 5 to 8 years, while in others, 6th, 7th, and 8th grades can be classified into elementary or secondary level depending on the school system.

Given this situation, it was difficult to analyze the data concerning the school levels in the school systems of the different countries. To operationalize the analysis, the school level of the subjects were based on the following criteria:

1. If the subjects' ages were below 13, their level was considered as elementary.
2. If the subjects' ages were 13 to 18 and they were in primary or secondary school, the subjects were considered to be in the secondary level.
3. If the subjects' age included students both above and below 13 or 18, they were counted once for each classification. For example, if subject ages were 12-16 in a study, the assigned school level of subjects was both elementary and secondary.
4. If the subjects' ages were not reported in the study, the subject's grade was used to make a decision. Subjects in seventh grade and above were regarded as secondary level.

This classification approach yielded school level finding grouped as shown in Figure 3. The number on the top of each bar displays the number of studies in each classification and one with shadow in each bar shows the number of studies shared with other classifications (e.g., elementary and secondary levels). The number without shadow in each bar indicates the number of studies unshared with other classifications. Fifty-two (68.4%) studies out of 76 dealt with the secondary level while 21 (27.6%) referred to the elementary level. Fifteen studies were shared with both elementary and secondary levels. Only a few

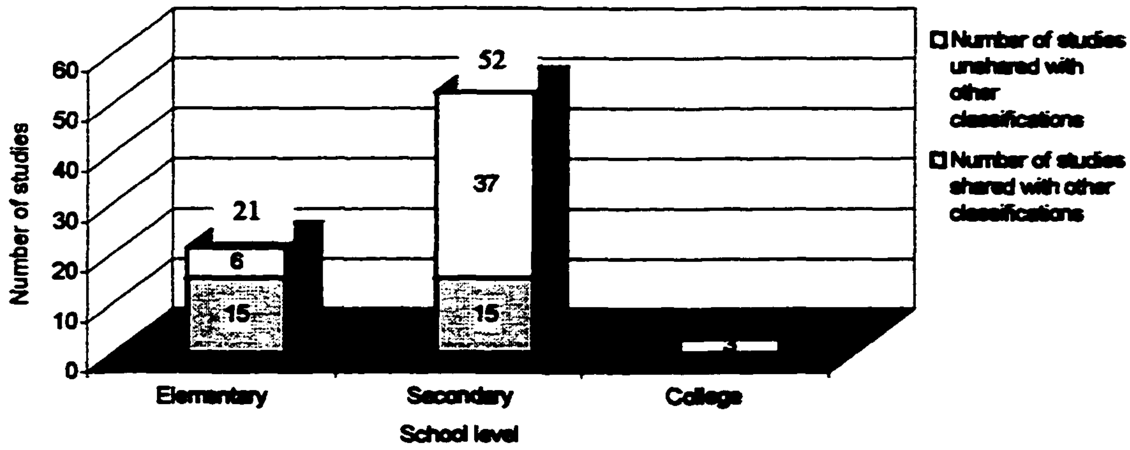


Figure 3. School type in previous studies

studies (3.9%) were related to college level. Five studies were excluded from the analysis of school type due to the lack of adequate information on the data.

Sample sizes were categorized eight groups. The multi-reported studies mentioned earlier were each counted as one study. Figure 4 shows the number of studies focused using sample size. The most frequently used sample size was up to 200. Samples up to 400, 501 to 1000, and 1001 to 2000 followed in decreasing frequency. The least frequently used sample

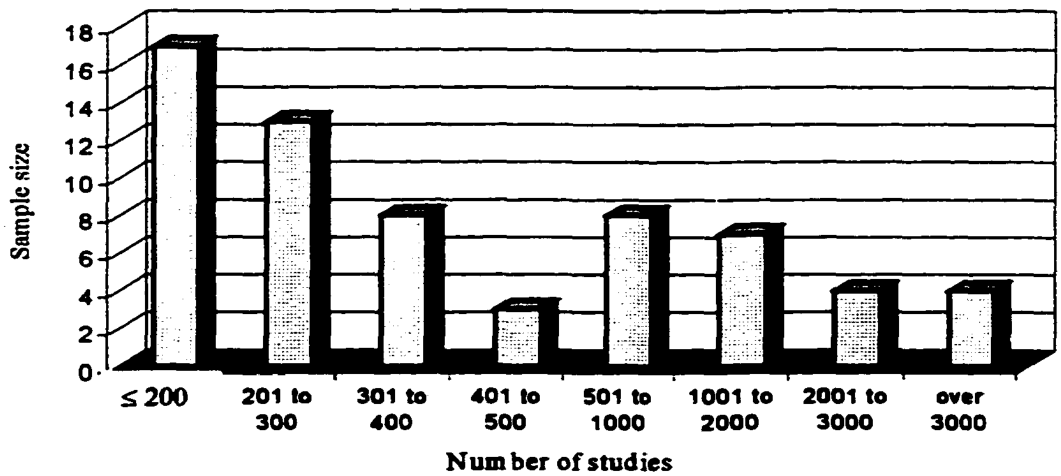


Figure 4. Number of studies by sample size

sizes were 401 to 500 and over 2000.

Description of the Subjects

This section presents the description of the subjects included in the identified studies. The age and grade level distributions of the subjects were analyzed according to five different age groups, namely: 8 to 10, 11 to 13, 14 to 16, 17 to 19, and over 19 years old. The counting method for these groups was similar to the one adopted for the analysis of school level. If the reported range of age spanned several age groups, it was counted once for each group. Table 4 displays the age distribution of the subjects as grouped into the five age groups. The most frequently used age groups were the 11 to 13 and the 14 to 16 year groups. Only few (8) studies have been conducted in the age groups 8 to 10 and over 19 year-olds.

Paralleling the school level information, the data on the subjects' grade levels were difficult to analyze. Although some researchers reported grade levels, ascertaining grade

Table 4. Age distribution of the subjects

Age Group	Number of studies	Number of studies shared with other age groups							Unshared studies
		a & b	b & c	c & d	d & e	b, c, & d	a, b, c, & d	b, c, d, & e	
8 – 10 (a)	3	2	-	-	-	-	1	-	0
11 – 13 (b)	39	2	21	-	-	1	1	1	13
14 – 16 (c)	35	-	21	4	-	1	1	1	7
17 – 19 (d)	11	-	-	4	3	1	1	1	1
Over 19 (e)	5	-	-	-	3	-	-	1	1
Sub-total		2	21	4	3	1	1	1	
		33							22
Total		55							

Note: Eleven studies did not report the age of subjects.

levels was necessary to relate the level to school system. An example of this was 'second form of general secondary school' which could be interpreted as eighth or tenth grade depending on the school systems of that country.

Only the studies, in which the subjects' grades were readily identifiable, were utilized for the level analysis. A total of 29 out of 66 studies were identifiable, sixteen studies reported ambiguous information, and twenty-one did not report the grade level at all. Figure 5 displays the number of studies included in the certain grading system for the research. The most frequently studied grades studied were the seventh and eighth grades, while the least frequently used were the third and fifth.

Variables Used for the Study

The researcher' analysis also focused on the kinds of variables used for the studies regarding students' perceptions of technology. Both dependent and independent variables were categorized. The dependent variables found were either one or a combination of the

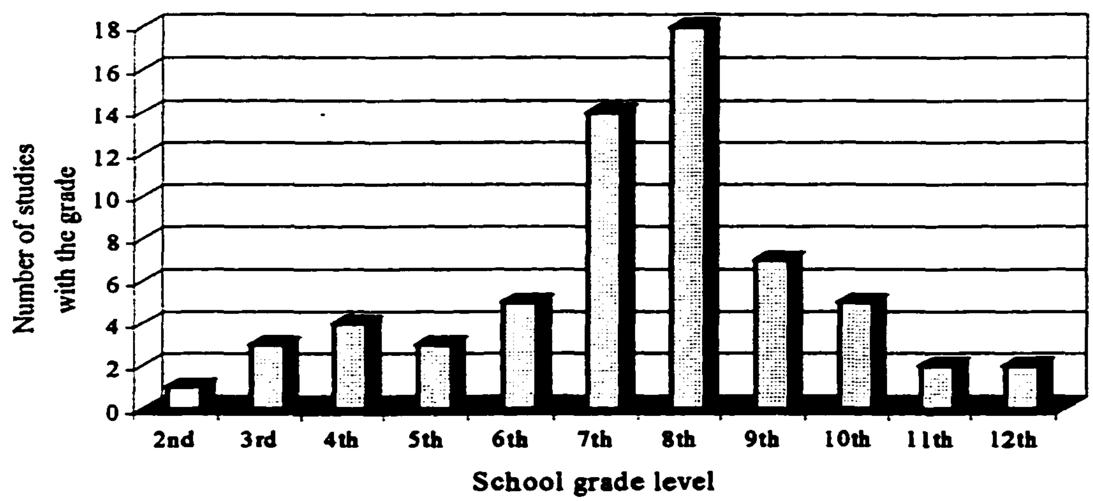


Figure 5. Subjects' grade used in the studies

following: students' attitudes toward technology, students' concept of technology, and students' perceptions of technology. Table 5 shows the classification of independent variables and their frequency. Most studies (77 %) dealt with students' concept alone or its combination with students' attitudes toward technology.

The independent variables reported were classified using four categories: student attributes, school environment, home environment, and country. Table 6 details the categorical classification, the individual variables, and the frequency of usage in the studies identified, including examples for some of the variables. Student attributes, school environment, and home environment categories were composed of 13, 7, and 13 variables respectively. One variable, country, that did not fall into the above categories was classified in the other category.

Methodologies Used

A description of the research design, sampling methods, instruments, validity and reliability of instruments, and analysis method used in the studies is presented in this section.

Table 5. Independent variables used in the studies

Variable	Frequency
Students' attitudes toward technology (A)	7
Students' concept of technology (B)	28
Students' perceptions of technology (C)	7
A + B	23
A + C	1
Total	*66*

Table 6. **Dependent variables used in the studies**

Category	Variable	Frequency	Example*
Student attributes	Age	11	
	Concept of technology	3	Meaning of technology to students
	Course taking	10	Taking or not taking technology course
	Current interest in technology education	1	High or low
	Educational profile	4	Mathematical-physical or humanistic profile
	Educational or professional background	1	
	Ethnicity	1	Maori or non-Maori, Eurpean
	Gender	44	Male or female
	Grade level	6	
	Inclination towards emancipation	1	
	Professional aspiration (ambition)	5	Future technical or non-technical career
	Self-assessment	1	
	Self-concept	2	Evaluation of students' concept of technology by themselves
	Students' academic ability	3	Lower, average, or above
School Environment	Instructional approach	1	Industrial arts, integrated, modular, or problem solving
	Locality	3	State
	School choice	1	Subject selected by school
	School experience	4	Like school or not, exposed to special program (e.g., mission 21) or not
	School type	11	Private or government; co-educational or single sex; technical or non-technical; categorical or multilateral; elementary or secondary
	Teacher attitude	1	Attitude of the classroom teacher towards technology
	Teacher attribute	1	
	Urbanization	8	Rural, urban, or boarding
Home environment	Existence of workshop at home	2	Yes or no
	Family members' having a talent for technology	1	Yes or no
	Friends	1	Technical or non-technical toys/play
	Influence of parents on motivation for school	1	Amount of influence (self reported)
	Parents' (fathers' or/and mothers') profession	14	Technical or non-technical
	Parents' level of education	1	Highest education earned
	Presence of personal computer	3	Yes or no
	Siblings' profession	1	Technical or non-technical brothers and /or sisters
	Situation of the family	1	Brothers, sisters, being the oldest child, etc
	Socio-economics status	2	Low or high; low, medium, or medium-high to high income
	Support and encouragement from friends, parents' and teacher	1	High to low
	Technical toys	5	The existence in childhood; amount; play or not
	Technological environment at home	3	
	The extent to which technical tasks	1	Chores experienced at home
Others	Country	1	

* Not all studies reported information on examples of variables.

Research design

Table 7 provides a summary of the research design used in the study. A Classification by Frankel and Wallen (1996) was modified for the analysis of this study. Fifty-four (81.8%) of the 66 studies were descriptive surveys, four were experimental, and the rest were causal-comparative, case studies, or developmental study.

Table 7. Summary of research design

Research design		Number of studies	Sub-total
Developmental		1	1
Survey	Pilot test	10	54
	Cross-sectional	43	
	Longitudinal	1	
Experimental	Ex post facto	1	4
	Quasi-experimental, non-equivalent groups, post-test only	1	
	Static group pre-post test	1	
	Pre-post test	1	
Causal-comparative		1	1
Case study		6	6
Total		*66*	*66*

Sampling methods

Both random and non-random sampling methods were used to draw samples for the identified studies. The random methods employed included cluster, simple, and stratified while the non-random methods included convenience, purposive, and stratified approaches. Table 8 shows the distribution for the sampling methods that were identified for 35 of the studies. Twenty-eight out of the 35 studies selected their subjects using non-random sampling methods while seven chose random sampling methods. Convenience sampling was

Table 8. Sampling methods for the studies

Sampling method		Number of studies	Sub-total
Random sampling	Cluster	1	7
	Simple	3	
	Stratified	3	
Non-random sampling	Convenience	16	28
	Purposive	4	
	Stratified	8	
Total		*35*	*35*

the most frequently used method. Notably, 31 studies did not report their sampling methods.

Instruments, scales, and sub-scales

An instrument is a device a researcher uses to collect data. The types of instruments, scales, and sub-scales used in the identified studies are depicted in Table 9. Six instruments reported were: the Pupils Attitudes Toward Technology (PATT), the Students' Attitudes Toward Technology (SATT), the Secondary Students Attitude Toward Technology (SSATT), the Technology Attitude Questionnaire (TAQ), the Technology Picture Questionnaire (TPQ), and the Technology Attitude Scale (TAS). The PATT instrument consisted of three scales such as attitude or affective-behavior, concept, and essay scales. Most attitude and concept scales, in turn, were comprised of 6 and 4 sub-scales, respectively.

The SATT is a modified version of PATT-USA. The SSATT was developed to measure high school students' attitudes toward technology by modifying previous instruments and by adding some more items to the meet the study's purpose. The instrument was composed of 65 items using 10 point scales. On that scale, 1 indicated 'strongly

Table 9. Identified instruments, scales and sub-scales

Instrument	Scale	Sub-scales
PATT	• Attitude scale	Interest Career Consequence Curriculum Difficulty Gender role
	• Concept scale	Technology and Society Technology and Science Technology and Skills Technology and Pillars
SSATT including revised version	• Original version: This attitude scale's items were modified from those in instruments developed by Raat & De Vries (1985), Fife-Schaw et al. (1987), and Bame & Dugger (1990) and were supplemented with additional items. • Thomson & Householder's (1994) version: Attitudes toward science, mathematics, and technology; computer application; perceptions of aspects of technology; and the students' future plans • Shafiee's (1994) version: Attitude toward technology, interest in technology; benefits of technology; application of technology; effects of technology; respondents' comfort level with using computers	No sub-scales
SATT	• Attitude scale (17 items from PATT-USA)	No sub-scales
TAQ	• Employ; future; social; career; school; satisfaction; and pollution	No sub-scales
TPQ	Not specified	
TAS	Same as PATT	

disagree' and 10 was for 'strongly agree.' Developers of the instruments claimed the advantage of the scale is "the tendency of respondents to use all points on the scale, with the result that the range of mean responses is maximized" (Thomson & Householder, 1994, p. 3). It was revised by others to conduct the studies using different subjects. The TAQ had 7 multiple item scale. Each item was rated using a 4 point responses which omitted a neutral option. 5 represented 'strongly agree,' and 1 'strongly disagree.' The TAS is a shorter version of PATT that was developed for classroom teachers. Therefore, the scales and sub-scales of the TAS were equivalent in content and format to those of the PATT instrument.

Table 10 displays the use of the instruments with their scales. The most frequently

Table 10. Instrument use and related scales

Instrument		Attitude scales	Concepts' scales	Essays	Not specified
A list of objects		-	-	-	1
Drawings		-	-	-	3
Essays		-	-	-	5
Interview		-	-	-	3
Modified SSATT and modified PATT-USA		-	-	-	1
Open ended questionnaire		-	-	-	4
PATT	Modified or translated version	12	8	4	2
	Original version	-	-	-	12
	Survey version	15	15	5	-
Picture quiz		-	-	-	1
SATT		-	-	-	1
Self developed questionnaire		-	-	-	8
SSATT including modified version		-	-	-	2
TAQ including modified version		-	-	-	2
TAS including translated into other language		1	1	-	-
TPQ		-	-	-	1

used instrument was a modified or translated PATT. The pilot test utilized the original version of PATT while 24 subsequent studies used the revised version. Seven studies reported self-developed instruments, most of which were used only once by the original researcher. In addition to structured written questionnaires, alternative data collecting methods were adopted to determine the validity of the responses. These alternative methods included essays (e.g., De Klerk Wolters, 1989b; Kapiyo, 1987; Oleniacz, Szydlowski, & Dudziak, 1988; Rennie, 1987), interview (e.g., De Klerk Wolters, 1989a, 1989b; McCarthy & Moss, 1994), drawings (e.g., De Klerk Wolters, 1989a, 1989b), open-ended questions. (e.g., De Klerk Wolters, 1989b), and picture quizzes (e.g., Rennie, 1995). In addition Table 11 displays the source of studies which included the instruments utilized by the researchers.

Table 11. The studies that included their instruments used in the study

Instrument	Source of study
PATT (Questionnaire about Technology, 78 items) with essays	Parker & Rennie (1986)
PATT (Questionnaire for Pupils about Technology, 78 items)	Raat & De Vries (1985)
PATT attitude (60 items) and concept (28 items)	Raat, J. H. et al. (1987)
PATT-USA (modified version, 36 items)	Shafiee (1994)
SSATT (65 items)	Householder & Bolin (1992, 1993)
SSATT (modified version, 24 items)	McHaney (1998)
SSATT (modified version, 32 items)	Shafiee (1994)
Student Attitudes Toward Technology (SATT)	Dunlap (1990)
Survey about Technology	Moore (1987)
TAS	De Klerk Wolters (1988)
TAS (modified version)	Jeffrey (1993)
Technology Picture Quiz (TPQ)	Rennie & Jarvis (1995)
Technology Questionnaire (TQ)	Rennie & Jarvis (1995)
Technology Survey	Thomson & Householder (1994)
TPQ (example, used in the pilot test)	Moore (1987)

Reliability and validity of instruments

Reliability of the instrument was variously calculated using Cronbach's alpha, Guttman analysis, and KR-20. Cronbach's alpha values were frequently calculated for both attitude and concept scales while Guttman analysis and KR-20 values were calculated for the concept scales only. Twenty-eight studies reported reliability values for their instruments and thirty-eight did not reported the values. Fourteen of 28 studies calculated reliability for an instrument used only once or twice but computed reliability for their self-developed instrument. However, it was difficult to compare the reliability of those instruments. Therefore, summary of the reliability values was focused only on PATT instruments, especially attitude and concept scales. The reliability values for 14 studies are shown in Table 12. To determine whether the reliability values obtained were acceptable, the criteria for a minimum α value used was .60. If the obtained alpha value was greater than .60, an instrument or scale was considered as reliable. In the attitude scale, all sub-scales, except the difficulty sub-scale, yielded acceptable values for reliability. Only three of the difficulty sub-scale studies gave an acceptable value, in which case the minimum α value of .60 was applied.

Inconsistent reliability values were obtained for the concept scale. In order to improve the reliability of this scale, De Klerk Wolters employed the use of the Mokken analysis. De Vries (1990) argued that "De Klerk Wolters tried to establish reliability of these items by Mokken analysis. Results of this analysis are somewhat better, but still problematic. Homogeneity is not the best way of looking for reliability in this case. Probably test-retest could give better results" (p. 35).

Some researchers also reported content, construct, and predictive validities. Typically

Table 12. Reliability of the PATT instrument scales

	Attitude Scale							Concept Scale				
Studies	Interest	Role pattern	Consequences	Difficulty	Curriculum	Career	Overall	Technology and society	Technology and science	Technology and skills	Technology and pillars	Overall
1	.73	.71	.25	.22	.74	.80	.81	.72	.61	.48	.47	.83
2	.79	.78	.62	-	.75	.84	-	-	-	-	-	-
3	.76	.77	.65	.56	-	-	.84	-	-	-	-	-
4	.65	.75	.68	.62	.71	.83	-	-	-	-	-	-
5	.73	.78	.64	.52	.70	.80	-	-	-	-	-	-
6	.75	.79	.64	.52	-	-	.85	.66	.66	.55	.44	.82
7	.79	.71	.72	.41	.67	-	-	.41	.51	.54	.26	-
8	.61	.50	.67	.47	.52	.64	-	-	-	-	-	-
9	-	-	-	-	-	-	.28	-	-	-	-	-
10	.71	.66	.58	.45	.56	.66	.84	.20	-.06	.20	.23	.44
11	.78	.70	.59	.60	.80	.80	-	.25	-	.33	-	-
12	-	-	-	.76	-	-	.84	-	-	.45	-	.89
13	-	-	-	-	-	-	.58	-	-	-	-	.56
14	-	-	-	-	-	-	.81	-	-	-	-	.77

content validity was ascertained when the researcher developed or modified an instrument. Most of the measurement of validation of content was judged by a panel of experts for use of parameters such as appropriateness of language, clarity, brevity, and item analysis.

To determine construct validity, mainly factor or principal components analysis was applied. In factor analysis, the minimum loading criterion for the inclusion of an item in a factor varied from .10 to .30. In addition, Shafiee (1994) validated the construct of the instrument by investigating the difference between known-groups and a correlation of similar measures of the same constructs with minimum acceptable level (r = .70).

Table 13 presents the first four factors identified from 18 PATT studies. It appears that the four most common factors among the studies were interest in technology, role pattern, difficulty in technology, and consequence of technology. Their total percentages of variance varied with the range from 13.7 % to 86.1 %. Factors such as career and curriculum were not identified as separate factors in most studies. Bame and Dugger (1989) reported that interest, curriculum, and career scales were combined into interest scale because factor analysis revealed that those were in one category.

A factor analysis was conducted for the first version of the PATT instrument, which did not have separate scales for attitude and concept measurements. The results revealed that the factors related to the concept scale were not readily evident. Several authors subsequently conducted factor analysis studies for the concept scale. Claeys (1987) identified four factors: technology and science, technology and society, practical skills, and technology and machines/computers. This author argued that technology and pillars did not exist as separate factors. Bame and Dugger (1989) expressed doubts about the validity of the concept scale. They reported that "the students [12-14 years old] cannot distinguish any of the four concept scales" (p. 314). This authors also reported, "Almost all negatively worded statements in the attitude scales loaded onto one factor, even when the number of factors were increased or decreased" (p. 315).

Burns (1992) identified three concept factors: people and society, problem-solving of technical process, and science and change. The results of this particular study also questioned the validity of concept scales by stating that "the view of technology which underpins these scales, including the restrictions of products to artefacts and the exclusion of human input from 'pillars' and the identification of problems and needs from 'human activity and

Table 13. **Factors identified in studies using the PATT or revised PATT instruments**

Factors identified \ Studies	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Interest in technology	1 (44.7)	1 (47.2)	1 (40.2)	1 (23.4)	1 (NR)	1 (NR)	1 (17)		1 (13.3)	1 (16.9)	2 (7.3)	1 (30.5)	1 (21.1)	1 (18.1)	1 (20.4)		1 (NR)	1 (21.5)
Role pattern	2 (21.3)	2 (19.3)	2 (33.8)		4 (NR)	2 (NR)	2 (8)		2 (8.1)	3 (7.1)		3 (8.3)	2 (13.7)		2 (8.0)		2 (NR)	2 (7.2)
Difficulty in technology	4 (8.8)	4 (8.6)	4 (11.5)			3 (NR)				4 (5.8)	3 (6.4)		3 (7.4)				4 (NR)	3 (6.8)
Consequences of technology	3 (10.2)	3 (11.0)				4 (NR)											3 (NR)	4 (5.7)
Importance of technology			3 (14.5)				4 (7)	2 (11.2)	3 (5.8)							2 (10)		
Diversity in technology				2 (8.2)	2 (NR)		3 (7)											
Positive consequences and importance of technology				3 (6.9)	3 (NR)							4 (7.5)		3 (7.0)				
Knowledge of technology								4 (5.3)		2 (10.8)	4 (5.6)			4 (5.6)				
Distance from technology								1 (13.0)	4 (5.6)									
Scope of technology												2 (14.2)	4 (6.0)					
Involvement in technology														2 (10.4)	3 (7.4)			
Universality																1 (30)		
No name											1 (12)							
Manual dexterity								3 (7.1)										
Limited view on technology															4 (5.9)			
Gender and knowledge about technology				4 (4.7)														
Total % of variance *	85.0	86.1	85.5	23.4	-	-	25	-	21.4	29.8	13.7	38.8	42.2	18.1	28.4	-	-	41.2

Note: The number inside parenthesis indicates the percentage of variance explained by the factor and NR stands for 'not reported.' * It is the total percentage of variance explained by the factors within the highlighted area.

society,' also constrains them" (p. 75).

Other studies also adopted the use of the factor analysis. In his study, Shafiee (1994) identified nine factors within the 32 items of the modified SSATT instrument. He assigned a name to each of the factors and classified them into as affective, cognitive, or behavioral attitude construct for all respondents and gender. The first five factors were: benefits of technology (cognitive), technology as a tool for work and study (behavior), positive influences of technology (affective), negative influences of technology (affective), and video games are bad (cognitive). The results for male respondents were: benefits of technology (cognitive), technology as a tool for work and study (behavior), positive influences of technology (affective), video games are bad (cognitive), and negative influences of technology (affective). The female subjects responded to: benefits of technology (cognitive), the contradiction of technology (affective), technology as a tool for work and study (behavior), positive influences of technology (affective), and video games are bad (cognitive).

In addition, McHaney (1998) reported on two factors using 13 items from SSATT. The factors were personal affect for technology and computers on the work and the future, and the importance of technology and computer.

Data analysis method

The analytical method used in the primary studies is discussed in this section. Repeated discussion of validity and reliability was considered unnecessary in this section because it has been addressed. Instead, the analytic methods employed for various instruments, such as drawings, essays, interview, picture quiz, and questionnaires are highlighted.

Drawings (De Klerk Wolters, 1989a; Moore, 1987; Rennie & Jarvis, 1995) were analyzed descriptively by different coders. The strategy espoused was to investigate the evidence of pre-determined classification or categorize the elements of drawings into certain groups. Inter-rater agreement rate was measured by Kappa coefficient. After adjusting the items with disagreement responses, the frequency and percentage values of each classification were computed. Similarly, the same method was employed in computing the frequency of selected picture quizzes.

Essays (Balogun, 1988; Oleniacz, Szydlowski, & Dudziak, 1988; Rennie, 1987) were analyzed by counting key words (catch words) and grouping them into categories. Categorization of the responses was based on either the identified dimensions (e.g., interest, gender, career, curriculum, etc.) or students' responses. Frequency and/or percentage of each category were computed by using the Ethnography program or by counting group phrases and similar content label categories. The same process was applied to the interviews that were conducted.

Carefully designed questionnaires were used to generate comparative information on the instruments. The methods could vary depending on the purpose of analysis such as comparing groups and retrieving relationship among variables. The analytical methods employed for questionnaire data are described in detail in Table 14.

Students' Attitudes and Concepts of Technology

This section of chapter IV presents the analysis of the identified studies with respect to their reports of students' attitudes and concepts of technology. Two subsections are used

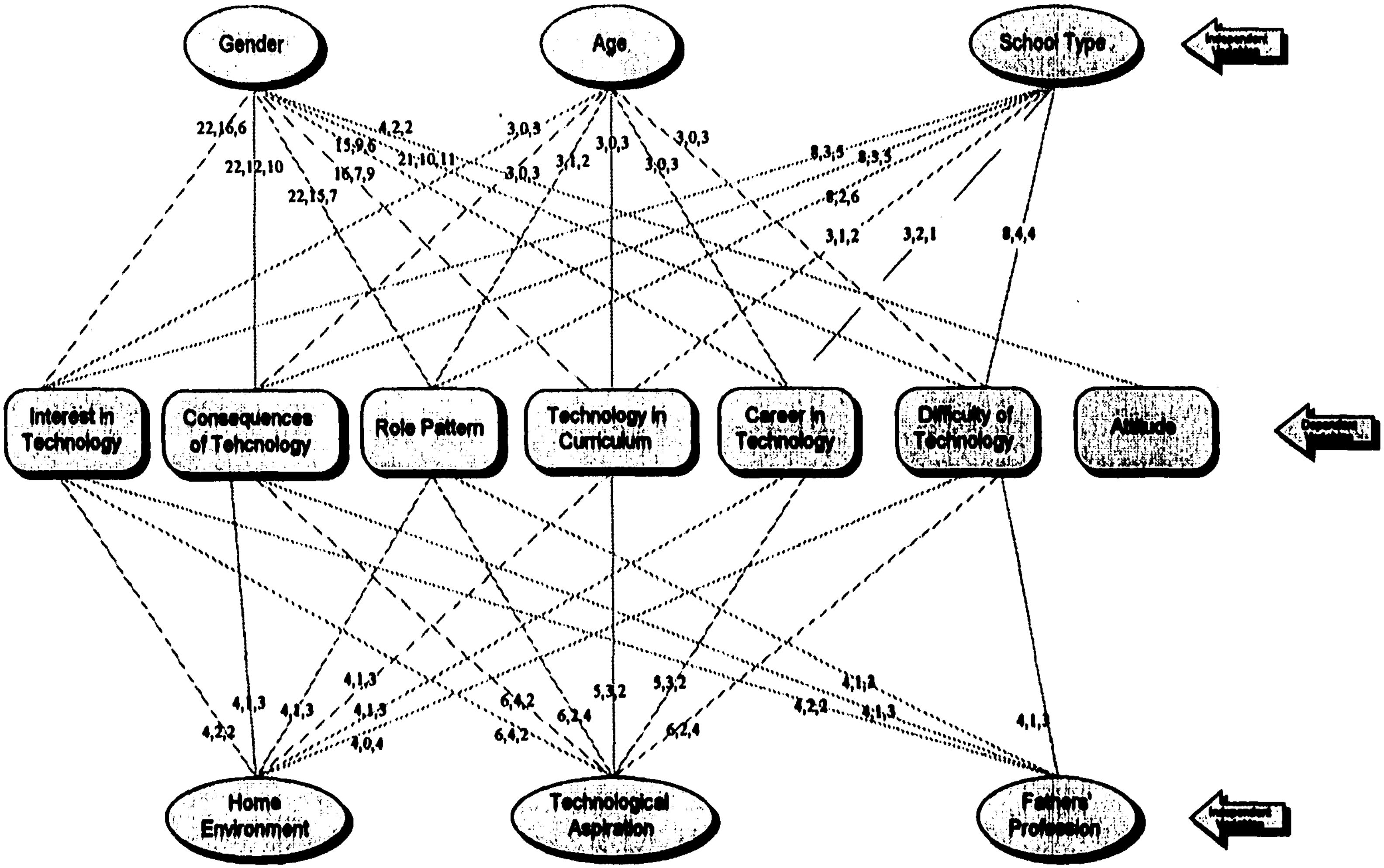
Table 14. Analysis of the questionnaires

Classification	Comparing two or more groups	Relationship among variables within one group
Descriptive statistics	• Frequency • Mean of each scale • Standard deviation of each scale • Effect size	• Correlation coefficient (between item scales; between attitude and concept scales-Pearson correlation), Spearman correlation, Kendall correlation coefficient • Partial correlation • Path analysis
Inferential statistics	• One or two sided t-test (sub-scale scores with dichotomous data), • One-way ANOVA (sub-scale score with sub-groups based on selected variables) • ANCOVA (using a result as the covariate and the rest results as the dependent variables) • Confidence interval • Tukey post-hoc test	• Multiple regression • Dunnett T3 post hoc multiple comparisons for non-dichotomous variables

to present the researchers' findings, namely: (1) Variables and their relationships; and (2) Similarities and differences among previous studies.

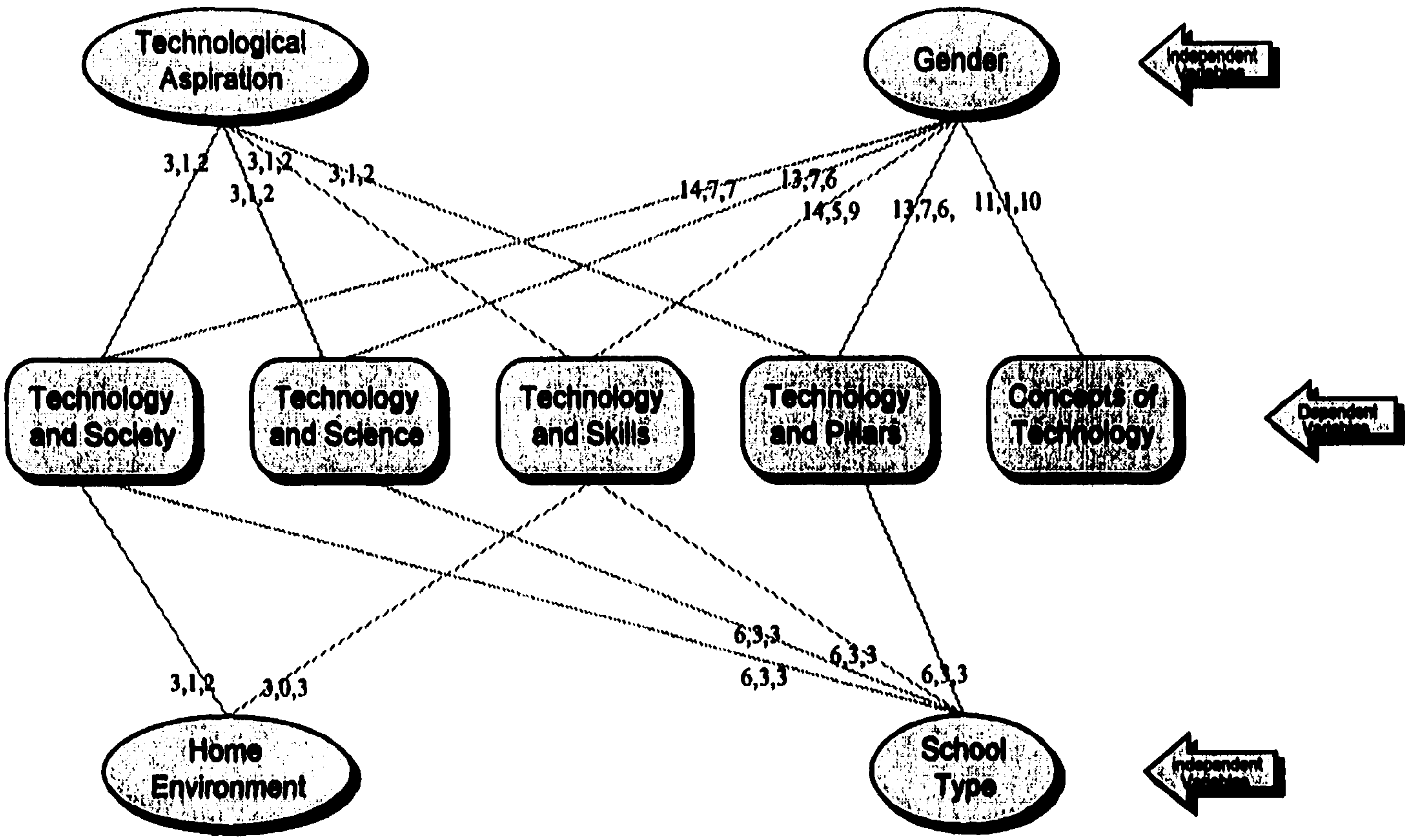
Variables and their relationships

A variable map was developed to generate a holistic picture of the relationships among the reported variables (see Figures 6 and 7). This map was also used to focuses the researchers' detailed analysis. All relationships that were investigated three or more times are included in each map. Dependent variables are located in the center of the map and represent sub-scales of attitude and concept scales in the PATT studies. These were treated as individual variable because they were not combined into a single dependent variable for a single attitude or concept construct in the factor analysis. Studies that did not use PATT instruments were not included in these maps but their variables were identified in Table 5.



Note: The first number on each relationship line indicates the number of studies (at least 3) in which the relationship between these variables has been investigated. The second reports the number of studies in which the relationship has been shown to be significant, and the third number reports the number of studies in which the relationship has been found not significant or has not been reported.

Figure 6. Variable map pertaining to attitude scales



Note: The first number on each relationship line indicates the number of studies (at least 3) in which the relationship between these variables has been investigated. The second reports the number of studies in which the relationship has been shown to be significant, and the third number reports the number of studies in which the relationship has been found not significant or has not been reported.

Figure 7. Variable map pertaining concept scales

Independent variables are located around the dependent variables on each map. The numbers inserted on each relationship line refer to the number of studies included (e.g., 22 in the gender and interest relation), the number of significant studies (e.g., 15 in the gender and interest relation), and the number of studies with results that were non-significant, unreported, or with no t-test results (e.g., 7 in the gender and interest relation).

A detailed description of the research results on each variable follow. As seen on the maps, the independent variables are gender, school type, technological aspiration, home environment, fathers' profession, and age. The results on attitudinal difference of technology on a specific variable are presented first, followed by the concepts of technology. In the end of each section, comparisons of country and age group on a given variable are conducted depending on data availability.

Gender and attitudes toward technology

Gender was the most frequently studied variable on both attitude and concept scales. Attitudinal gender differences were studied focus to 22 studies depending on the dependent variables. The result of each study is displayed in Table 15, which lists the studies dealing with interest of technology based on gender differences. Other tables describing the study results for the dependent variables shown on the map are presented in Appendix D. These tables offer useful information on author(s), publication years, and numerical results of the studies as well as a short description of the research results. The direction of result in the table displays which group showed more positive attitude in a given scale. Coenen-van den Bergh (1987) reported three research results from different countries in one paper and De Klerk Wolters (1989b) produced four different study results with different age groups, and

Table 15. **Studies dealing with gender differences on interest in technology**

Author (year)	N		Mean		SD		*F* or *t*	P	Direction of effect
	Boys	Girls	Boys	Girls	Boys	Girls	value	value	
Bame et al. (1993)	6256	4013	2.5	3.0	-	-	-	-	B
Coenen-van den Bergh (1987)	1427	1042	2.3	3.0	-	-	-	-	B
	112	122	2.3	2.7	-	-	-	-	B
	79	73	2.3	2.7	-	-	-	-	B
Boser et al. (1998)	152	127	2.1	2.5	-	-	-	.001	B
Claeys (1987)	193	97	2.3	2.7	-	-	-	-	B
Grodzka-Borowska et al. (1988)	288	137	-	-	-	-	-	-	B
De Klerk Wolters (1989b)	1021	1029	2.3	3.0	-	-	-	-	B
	1365	982	2.3	3.0	-	-	-	-	B
	697	560	2.4	3.1	-	-	-	-	B
	655	526	2.4	3.2	-	-	-	-	B
Martins (1991)	249	290	24.1	18.4	-	-	-7.35 (t)	-	B
Moore (1987)	171		3.6	3.1	-	-	-	.000	B
Szydlowski et al. (1987)	113	149	2.4	2.7	-	-	-	-	B
Volk et al. (1999)	1882	1477	2.45	2.74	-	-	-	-	B
De Vries (1991)	66	16	1.9	2.5	-	-	-3.94 (t)	.01	B
Balogun (1988)	244	236	37.9	37.8	5.24	5.63	.17 (t)	.86	B
Burns (1992)	749	720	-	-	-	-	-	-	B
De Klerk Wolters (1988)	2428		-	-	-	-	-	-	B
De Klerk Wolters (1989a)	1160	1153	-	-	-	-	-	-	B
Natali (1987)	285	281	-	-	-	-	-	-	B
Rajput (1987)	273	227	-	-	-	-	-	-	NR (marginal difference)

Note: NR indicates 'not reported'; highlighted studies showed statistically significant results.

counted each age group as one.

Twenty-two studies were conducted on gender's effect on interest in technology. Sixteen studies reported significant results while six studies had no significant results or did not conduct t-tests. All studies reported their direction of results agreed that boys were more interested than girls in technology.

Twenty-two studies were related to gender and role patterns in technology. Fifteen studies revealed that their relationship is significant, while seven studies either showed no significant results or did not report the research results. Unlike the studies between gender and interest in technology, all of the studies which showed the direction of the results agreed unanimously that girls viewed technology as an activity for both boys and girls alike while boys felt that technology was more appropriate for their gender.

The relationship between gender and difficulty of technology was investigated in twenty-one studies. Seven out of ten significant studies indicated that girls viewed technology as less difficult than boys did while three studies revealed opposite results. Only four of eleven non-significant studies reported their results.

On the relation to gender and perceived consequences of technology, more than half (12) of the 22 relevant studies contained significant studies and the other portion (10) either were non-significant or were lacking t-tests to determine significance. Eleven out of twelve significant studies revealed that boys viewed the consequences of technology more positively than did girls.

Sixteen studies on the relationship of gender to technology as curriculum were conducted. The results from seven studies were significant while nine were not. All the significant studies and part of the non-significant studies revealed that boys had a more positive view than girls in their perception of technology as a major component of curriculum.

Fifteen studies looked into the relationship between gender and career in technology. Nine were significant while six were not. All of the studies that reported the direction of results revealed that boys viewed technology as a future career more positively than did girls.

There were four studies that looked into gender differences on attitudes toward technology. Two dimensions of the term "attitude" were used: (1) attitude as a combination of career and curriculum scales; and (2) overall attitude scale. Half (2) of the studies reported significant results, but with contradiction in the direction of their results.

As shown in Table 15, most of the studies did not supply enough information to calculate the effect size or p value. Therefore, the vote-counting method was utilized to integrate the results of the previous studies. Using Cooper's (1998) formula, the Z values for all of the findings, including those with the significant results, were computed based on the direction of study results. Thus, the studies that did not have directional reports were excluded from the analysis.

Table 16 shows the results of the vote-counting computation. Data were analyzed using both total identified studies and only significant studies. Z indicates the standard normal deviate for the findings and p is a probability (two-tailed) corresponding to Z. Studies that showed boys as the direction of effect were considered positive while studies that depicted girls were considered negative. Utilizing the same method as above, vote counting was adopted to obtain the cumulative results of the studies where there were more than three studies. The studies with no directional reports were excluded from the analysis.

Based on an analysis of Table 16, most researchers agreed that boys showed more

Table 16. Number of studies dealing with students' attitudinal differences on gender and their findings

Dependent variables	Total directional findings				Significant findings			
	N				N			
	Boys	Girls	Z	P	Boys	Girls	Z	P
Interest	21	0	4.26	.0000	16	0	3.87	<.0002
Consequences	17	2	3.44	<.0006	11	1	2.71	.0068
Role pattern	0	19	-4.36	.0000	0	15	3.74	<.0004
Curriculum	11	0	3.32	<.0006	7	0	2.65	.0080
Career	12	0	3.46	<.0006	8	0	2.83	.0046
Difficulty	5	9	-0.83	.4066	3	7	-1.26	.2076

Note: Z indicates the standard normal deviate for the overall series of findings. N indicates the number of studies showing the directional results in each classification.

positive responses than girls on four attitude scales: interest, consequences, role pattern, curriculum, and career scales. These findings were supported by the p values from vote-counting. The primary authors agreed unanimously that girls rated technology as being an activity for both girls and boys to a greater extent than did boys. One possible reason for this result could be attributed to the boys' stereotypical perception of technology as a 'masculine' subject (Rajput, 1990). The difficulty scale revealed that girls considered technology less difficult. However, the differences between both genders indicated no significance according to the p values.

Nash (1984) studied the importance of interest in choosing technology subject. According to his study, students responded to select technology subject in relation to their interests and enjoyment if they had the freedom to make a choice. Studies conducted by Claeys (1987), Szydlowski (1988), De Klerk Wolters (1989b), and Connen-van den Bergh (1987) agreed that interest was the most explanatory factor to which attitudinal differences on gender were attributed.

The low scores obtained for girls on the attitude scales could be explained by their response pattern giving more 'neutral' and 'don't know' responses for the items than did boys (De Klerk Wolters, 1989b; Rennie, 1987). The reasons for the girls' responses were attributed to a lack of opinion and awareness of technology, unclear understandings of the questions, as well as seeing genuinely undecided (Burns, 1992; Parker & Rennie, 1986; Rennie, 1987; Riis, 1986; Warren, 1986). Perhaps addressing this concern, Bame et al. (1989) suggested that eliminating the neutral responses would result in enhancing systematic variance.

The researcher noted that the selected studies spanned a nineteen-year period. Given this an analysis was conducted to see whether recently reported studies reflected different findings than the early studies. The results of this analysis are presented in Table 17. There have been no attitudinal changes on five sub-scales from early to recent studies. The results did not show any directional shifts over times. Only the difficulty scale had inconsistent

Table 17. Analysis of early and recent study findings on students' attitudinal differences toward technology

Variables	Total directional findings				Significant findings			
	Pre 1988		Post 1992		Pre 1988		Post 1992	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
Interest	8	0	4	0	4	0	3	0
Consequences	7	0	3	1	5	1	2	0
Role pattern	0	8	0	4	0	7	0	3
Curriculum	5	0	2	0	3	0	1	0
Career	6	0	2	0	4	0	1	0
Difficulty	1	4	2	2	1	3	2	1

Note: Numbers indicate the number of studies showing the directional results in each classification results in terms of their direction.

Based on the significant findings, the effect of age on attitudinal gender difference was further analyzed. Classification of the age group was the same as the method adopted in the description of subject age. If the range of age belonged to several groups, it was counted once for each group. No statistical method was utilized because the number of studies conducted for many groups was too small. Table 18 shows the number of studies in each age group with relation to attitudinal gender differences toward technology. Although the number of studies in each group varies, there seemed to be no attitudinal change with age on five scales: interest, role pattern, consequences, curriculum, and career. The synthesis of difficulty scale revealed that a majority study found that girls considered technology less difficult in two age groups, 11 to 13 and 14 to 16. Other age groups did not have a large enough number of studies to draw a conclusion.

This conclusion is partially supported by other studies, which investigated the effect of age on attitudes toward technology. Most studies revealed no significant age differences

Table 18. Comparison of age group on students' attitudinal differences toward technology

Variables	Age group										Number of studies
	8-10		11-13		14-16		17-19		Over 19		
	B	G	B	G	B	G	B	G	B	G	
Interest	1	0	10	0	13	0	4	0	2	0	14 (12)
Consequences	1	0	8	0	9	1	2	0	-	-	11 (10)
Role pattern	0	1	0	11	0	13	0	3	0	1	14 (13)
Curriculum	1	0	5	0	5	0	2	0	1	-	6 (6)
Career	1	0	5	0	6	0	2	0	1	0	7 (6)
Difficulty	1	0	3	6	2	7	0	2	0	1	10 (10)

Note: The number in the parentheses indicates the number of studies assigned into different groups. The numbers in each B or G column indicate the number of studies showed the directional results into each classification.

although older age groups revealed a more critical and differentiated attitude (De Klerk Wolters, 1988). Only Martins (1991) reported significant results dealing with age differences on role pattern of technology. According to Martins, 13- to 14 year old students were more positive than the age groups 15 to 16 and 17 to 20 year olds.

The study countries were investigated in terms of their economies. As shown in Table 19, most significant findings were obtained from developed countries. There were no significant studies on curriculum and difficulty in developing countries, although one-third of the studies were conducted in developing countries. Studies from both advanced and developing countries agreed on the direction of effect of the studies on interest, role pattern, and career. However, it is noted that one study (Szydlowski & Dudziak, 1987) from a developing country had a result contrasting to that of advanced countries.

Gender and concepts of technology

As shown in the concept variable map, conceptual gender differences on all four dependent variables were studied more than three times. Five tables describe the study results

Table 19. The effect of economy on attitudinal gender differences on technology

Variables	Economy			
	Advanced		Developing	
	Boys	Girls	Boys	Girls
Interest	14	0	2	0
Consequences	11	0	0	1
Role pattern	0	13	0	2
Curriculum	7	0	0	0
Career	7	0	1	0
Difficulty	3	7	0	0

Note: The numbers in each B or G column indicate the number of studies showed the directional results into each classification.

for dependent variables (see D1.2 in Appendix D).

There were fourteen studies relating to gender differences pertaining to concepts of technology and society. One-half of them showed significant results while the other half revealed insignificant or unreported results. All studies that reported their direction of results except one (De Vries, 1991) reported that boys had a better concept of technology and society than did girls. In addition, only De Vries' study had adult subjects.

Thirteen studies dealt with gender difference on the concept of technology and science. Seven having significant findings reported that boys showed more informed concepts of technology and science when compared to girls. However, two of the six non-significant or no t-test studies did not agree with these findings.

With relation to gender difference on technology and skills, five of fourteen studies were significant with same direction of study results, namely a better concept by boys. Two studies had contradicting results but their findings were not significant.

Of thirteen studies, eleven that had directional results on gender difference of technology and pillars, revealed a consistent directional results. namely that boys had better concepts of technology and pillars than girls did. Seven out of thirteen studies were significant and the other six were not.

Eleven studies dealt with gender difference on overall concept of technology. Only one study had significant results while the ten others were either insignificant or had unreported significance. Based on mean values without considering their number of subjects, as a whole boys scored higher on the concept scales than did girls.

Table 20 displays the results integrated by using the vote-counting method. As shown in the table, the most interesting findings were obtained for differences between the results

Table 20. Number of study results dealing with students' conceptual difference on gender and findings

Dependent variables	Total directional findings				Significant findings			
	N		Z	P	N		Z	P
	Boys	Girls			Boys	Girls		
T. & society	11	1	2.89	.004	7	0	2.65	.008
T. & science	9	2	2.11	.035	7	0	2.65	.008
T. & skills	9	2	2.11	.035	5	0	2.25	.025
T & pillars	11	0	3.32	<.001	7	0	2.65	.008

Note: Z indicates the standard normal deviate for the overall series of findings. The numbers in each B or G column indicate the number of studies showed the directional results into each classification.

from total directional findings and significant findings. According to the results from significant findings, boys had better concepts on all four scales. Meanwhile, the results from total directional findings reveal that there were some studies which yielded at least directional indication that girls had better concepts of technology with relation to technology and science and technology and skills.

Also as documented in Table 21, there have been no changes on four conceptual scales with relation to different study years. Although no studies reported significant findings

Table 21. Analysis of early and recent study findings on students' conceptual differences toward technology

Variables	Total directional findings				Significant findings			
	Pre 1988		Post 1992		Pre 1988		Post 1992	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
T. & society	5	0	1	0	3	0	0	0
T. & science	4	1	1	0	3	0	0	0
T. & skills	3	1	1	0	2	0	0	0
T & pillars	5	0	1	0	3	0	0	0

Note: Numbers indicate the number of studies showing the directional results in each classification for post 1992 and most studies were conducted in pre 1988, the directional results were not different.

The descriptions provided by primary authors added more information on gender differences toward technology. Although boys revealed a better concept of technology on four variables, they rated significantly better than girls for the scale regarding technology as a human activity in society (Claeys, 1987; Connen-van den Bergh, 1987). De Klerk Wolters (1989b) indicated that these gender differences on concept of technology were formed at the early age of 10 and seemed to be held continuously regardless of gaining age.

Based on the significant findings, the effect of age on conceptual gender difference was analyzed. Classification of the age group and counting method were identical that used and explained in the preceding attitudinal analysis. No significant studies showed that girls revealed better concepts of technology. As shown in Table 22, most studies were conducted with subjects in the age groups of 11 to 13 and 14 to 16. In the same vein, studies with these age groups have been shown most frequently in the significant studies. The results of the

Table 22. Number of studies comparing age group on students' attitudinal differences toward technology and findings

Variables	Age group								Number of studies
	11-13		14-16		17-19		Over 19		
	B	G	B	G	B	G	B	G	
Technology & society	4	0	6	0	3	0	1	0	6 (6)
Technology & science	4	0	6	0	3	0	1	0	6 (6)
Technology & skills	3	0	4	0	2	0	1	0	4 (4)
Technology & pillars	4	0	6	0	3	0	1	0	6 (6)

Note: The numbers in each B or G column indicate the number of studies showing the directional results in each classification.

studies were consistent with these for different age groups.

In terms of study countries, the studies that obtained significant results were only from advanced countries. The resulting trend is similar to the simple gender differences in the concept of technology mentioned previously.

School type and attitude

The six attitudinal sub-scales were studied three or more times in relation to the school type variable. Four of them: interest, role pattern, consequences, and difficulty, were found more frequently (8 times) in the literature. Classifications of school type adopted for the study were lower education schools and higher education schools or schools with technical training and schools with non-technical training. It is noted that all of these studies except one were from the Netherlands.

Eight studies dealt with students' interest in technology depending on their school type. Three studies showed significant results, reporting that students from schools with higher education or technical training revealed more interest in technology compared to students without such training. However, a similar study with higher and lower education (e.g., junior versus senior high school) on age groups 10 to 12 and 13 to 15 showed no significant results.

Eight studies dealt with the influence of school type on role pattern of technology. Two had significant results showing that students from non-technical training schools had more positive attitudes on role pattern of technology than did students from technical training schools. Six of the eight studies showed non-significant or unclear direction.

Four of eight studies regarding school type difference on attitude regarding the difficulty of technology reported their significance. Although two of the studies focused on different age groups, 13 to 15 and 16 to 18 year-olds, similar results were obtained. Students from non-technical training schools considered technology less difficult than those with a technical background. However, the results of studies with higher and lower education schools were not consistent with the different age groups.

Eight studies focused on the relationship between school type and consequences of technology. Two significant studies out of three showed that students from technical training schools viewed the consequences of technology more positively regardless of their age group than did students with no technical training. One study with higher and lower level schools in the age group 16 to 18 revealed significant results on direction of higher education while the study with age groups 10 to 12 and 13 to 15 indicated that there were no significant differences in consequences of technology across school types. Finally, three studies dealing with school type influences on curriculum and career yielded no clear direction in their results.

School type and concept

The four conceptual sub-scales showed consistent results in terms of the number of total studies, the number of significant studies, and others. A total of six studies were found for each sub-scale. Three of them gave significant results and the other three either had no t-test results or no reported results. When considering only significant results, students from higher education and technical training schools rated higher on all four conceptual sub-scales. All studies were from advanced countries and they involved the age group of 13 to 18 year-olds.

Technological aspiration and attitude

The influence of technological aspiration on interest in and consequences of technology showed similar results. Four out of the six studies revealed significant results while two did not report or conduct t-tests. Regardless of their significance, the results showed that students with technological aspirations considered technology more interesting and having better consequences compared to the students without technological aspiration.

The influence of technological aspiration on role pattern and difficulty sub-scales appeared to be similar. Each relationship was investigated by six studies with two significant results, two insignificant results and two other studies which did not conduct t-test. Except for the two non-significant studies with results, the other studies revealed that students with technological aspiration viewed technology for both genders more positively and considered technology less difficult than students without technological aspiration did.

In addition, the influence of technological aspiration on curriculum and career had similar results although their means showed only slight differences. Three out of the five studies reported significant results while t-tests were not conducted for the other two studies. All of them agreed that students with technological aspirations viewed curriculum and careers of technology more positively than students with lower technology aspirations.

Technological aspirations and concept

As shown in D3.2 in Appendix D, the effect of technological aspirations on subjects' concept of technology had similar results on each of the four sub-scales. Out of three studies, one had significant findings while two did not report t-tests. The three studies indicated that the students with technological aspiration had better concepts of the field on all four sub-scales, namely technology and society, technology and science, technology and skills, and technology and pillars than students without technology aspirations.

Home environment and attitude

Four studies, which examined the effect of home environment on attitude formation on each sub-scale, were located. The four studies were all conducted in the Netherlands on subjects with the age groups of 10 to 12 and 16 to 18.

Two studies dealing with the influence of home environment on interest in technology yielded significant results while two other studies reported no t-test results. It appeared that technological home environment had a positive influence on interest in technology according to four studies.

Studies dealing with the effect of home environment on the role pattern of technology yielded one significant result, one insignificant result, and two directional studies albeit without t-tests. All studies except one with an insignificant result reported that students from technological home environments viewed technology as an activity for both genders to a greater extent than did students from non-technical home environments.

There were two insignificant studies and two directional studies with no t-tests that focused on the influence of the home environment on difficulty of technology. All of them agreed that students from a technical home environment viewed technology less difficult than did students without such a background.

The influence of a technical home environment on the three sub-scales (consequence, curriculum, and career scales) revealed a similar pattern. Out of four studies, one had significant results and another had insignificant results, while two produced directional studies with no t-tests. Based on the findings, it appeared that students from a technical home environment viewed the consequences of, curriculum on, and careers in technology more positively than did students from non-technical homes.

Home environment and concept

In three studies dealing with the relationship of the home environment on the concept of technology two sub-scales were located. The sub-scales were technology and society and technology and skills. One of the three studies did not report any results. One of the remaining two studies produced significant results for the influence of technical home environment on the concept of a technical home environment on the concept of technology and society. The other study had no t-test results but it indicated a definite direction. With regards to the sub-scale technology and skills, one study yielded insignificant results while another indicated a direction but had no t-test results. From the findings of the studies with both sub-scales, it appeared that students with a technical home environment had better concepts of technology and society and technology and skills than students without a technical home background.

Fathers' profession and attitude

There were four studies that examined the relationship between subjects' father's profession and their attitude on four sub-scales. Each sub-scale had one or two significant studies. The directional and the significant studies revealed that students whose fathers possessed technology-oriented professions exhibited more interest in technology and viewed consequences of technology more positively than did students with fathers who did not have technology-oriented careers. The remaining study indicated no directional results.

The results of the studies regarding the influence of fathers' profession on role pattern of technology, difficulty of technology, and consequences of technology showed a similar tendency. Significant results were obtained in one study, insignificant results in another, one produced directional results, and the last reported no results at all. The directional study showed that fathers' profession affected students' attitude on three sub-scales but the others revealed that the direction of results was not clear.

Age and attitude

Three studies dealt with the influence of age on attitude and role pattern of technology. Only the role-pattern study showed significant results. Two of the three studies regarding interest in and role pattern of technology reported that younger students showed more positive attitudes than older students. For the others, only one study revealed a clear direction for younger students while the remaining studies were not clear.

Of the variables described in the previous section (see Table 5), only the variables included with the delimitation of this study were examined. Thus, only those studies that were examined three or more times were analyzed in this study.

Similarities and dissimilarities

The similarities and dissimilarities among the study findings are discussed as follows.

Similarities among studies

1. Gender was the most explanatory factor for both students' attitude and concept of technology.
2. Boys showed more interest in technology than did girls.

3. Girls had non-stereotypical views on technology as an activity associated with both genders.
4. Boys viewed the consequences of technology more positively than did girls.
5. Boys considered careers in technology more positively than did girls.
6. Boys viewed technology in the school curriculum more positively.
7. Gender influences by age groups on students' attitudinal differences toward technology appeared to reveal similar patterns on the five sub-scales used in the study, namely interest, consequences, role pattern, curriculum, and career.
8. There were more studies on attitudes toward technology conducted with subjects in the 11 to 16 age group than with any other age groups.
9. Studies from advanced countries produced more significant findings on students' attitudes toward technology than did studies conducted in developing countries.
10. All studies with significant results agreed that boys had better concepts of technology on all four sub-scales such as technology and society, technology and science, technology and skills, and technology and pillars.
11. Most of the studies on students' concept of technology utilized subjects within the age group of 11 to 16.
12. All the studies that produced significant results on concept of technology were conducted in advanced countries.
13. Subjects who attended technical training school exhibited a higher level of interest in technology and a more positive attitude to its consequences than students without such background.
14. Students from non-technical training schools rated higher on scales of role pattern and

technology difficulty than did students from technical schools.

15. All significant studies regarding the influence of school type on students' concept of technology revealed that students from technical training or higher education schools had better concept of technology on all four sub-scales than students with no such training.
16. It appeared that students' technological aspiration had a positive influence on their attitudes toward technology and its concepts or vice versa.
17. It appeared that students' technical home environment played a positive role on their attitudes toward and concepts of technology.
18. Most studies revealed that age was not a significant factor on students' attitudes toward technology.
19. It appeared that there is no overall pattern of changes in boys' and girls' attitudes toward, and conception of, technology during the 1980-99 period investigated in this analysis.

Dissimilarities among studies

1. There were considerable discrepancies in the findings relating to the influence of gender on the difficulty of technology scale.
2. Only one study (Szydlowski & Dudziak, 1987) revealed that girls viewed consequences of technology more positively than boys when compared to other advanced countries.
3. Gender influences on students' attitudinal differences toward technology varied with different age groups.

4. There were differences in the findings of on the influence of higher or lower education (junior versus senior high school) on students' attitudes toward technology.
5. There were disagreements on the influence of fathers' profession on students' attitudes toward technology.

Summary

This chapter provided the findings and results of the study. The results were obtained mainly from qualitative and some quantitative analyses. Eighteen similarities were highlighted by the analysis as were five dissimilarities. Chapter 5 presents a summary of the findings, results of the study, and implications for future research.

CHAPTER V. SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

The preceding chapters presented of the Introduction, Review of Literature, Methodology, and Study Findings and Results. This current chapter summarizes the findings, draws conclusions based on the research findings, and makes recommendations for further study.

Summary

The findings are summarized as follows. For continuity, the same subheadings are used as in the previous chapter: General characteristics of previous studies, Description of the subjects, Variables, Methodology, Students' attitudes and concepts of technology.

General characteristics of previous studies

The sources of data for the study were ranked according to their frequency as follows: conference papers, journals, and dissertations. Over 60 percent of the study sources came from to conference papers, especially those of the PATT conferences. It appears that the PATT project played a key role in generating researcher interest in these topics. Over 80 percent of the first authors' professional affiliation was academic.

Studies on students' perceptions and attitudes toward technology were published mainly between 1986 and 1987, when the PATT conferences were initiated. Although 27 countries were involved in this study, the majority came from Europe and North America. Only few of the studies were conducted in Africa and Asia. In terms of the source countries' economies, the ratio of developing to advanced countries was about 1:1.

The type of schools used in the studies was investigated. About seventy percent of the studies dealt with the secondary level of schooling. About twenty eight percent dealt with the elementary levels and only a few studies were conducted at the college level. The most frequently used sample sizes were up to 200 and between 201 and 300, while the least frequently used sample sizes were 401 to 500 and over 3000.

Description of the subjects

The age and grade of the subjects were used for the descriptive component of the study. The most frequently used subjects' age groups were 11 to 13 and 14 to 16, while the least frequently used age groups were age 8 to 10 and over 19 year-olds. With regard to grade distribution, the most frequently used grade level was seventh and eighth grades, while the least frequently used were the second, eleventh, and twelfth.

Variables

The main independent variables were student attributes, school environment, and home environment. Student attributes included age, concept of technology, course taking, interest in technology, educational profile, gender, grade level, and so on. School environment involved instructional approach; locality; school choice, experience and type; teacher attitude; and urbanization. Home environment factors included presence of workshop, computer, toys, parents' or sibling's profession, parents' level of education, and socio-economic status.

Methodology

The methodology described the research design, sampling methods, instruments, and their validity and reliability. Over eighty percent of the studies utilized the descriptive survey design while only a relatively few studies employed experimental and case study approaches.

Eighty percent of the studies employed non-random sampling methods. The primary instruments utilized to measure students' attitudes toward and concept of technology were PATT, SATT, SSATT, TAQ, TAS, and TPQ. Among these, two scales of the PATT instrument were the most frequently used.

Some studies conducted reliability and validity tests on the instruments. Based on the reliability tests on the PATT instruments, all sub-scales except the difficulty sub-scale were acceptable at minimum alpha values of .60. On the contrary, the reliability of the concept scales was inconsistent and ambiguous.

Validity tests were included in some studies. Content was validated by a panel of experts for parameters such as appropriateness of language, clarity, brevity, and item analysis. The construct validity of the instrumentation was validated mainly by factor or principal component analysis. The minimum loading criteria used for the inclusion of an item in a factor varied from .10 to .30. The four most common factors of the PATT attitude instrument were: interest in technology, role pattern, difficulty in technology, and consequences of technology. It was observed that career and curriculum were not identified as separate factors. Factor analysis of the PATT concept instrument, however, did not yield four sub-scales as envisioned by its authors.

Shafiee's (1994) factor analysis showed interesting findings. Shafiee classified factors into cognitive, behavioral, and attitude constructs for different genders. According to his results, the first factor for both genders was cognitive while the second factor differed. The second factor for boys was behavior whereas that for girls was affective. This may explain the difference in formation of attitude between boys and girls.

Drawings were analyzed descriptively by different coders and the frequency and percentage of each classification were calculated. The analysis methods adopted for essays were counting keywords and grouping them into categories. The frequency and/or percentage of each category were computed. The same procedure was used for the interview results.

Any analysis of questionnaires depends on the study purpose, such as comparing groups and relationship among variables. To compare two or more groups, descriptive statistics often used were frequency, mean, and standard deviation. The inferential statistics used were t-test, ANOVA, ANCOVA, confidence interval, and Tukey post-hoc test. To investigate the relationship among variables within one group, the descriptive statistics included were Pearson correlation coefficients and path analysis, while inferential statistics were adopted for multiple regression and multiple comparisons.

Students' attitudes and concepts of technology

In Chapter IV the researcher examined the variables and their relationships pertaining students' attitudes and concepts of technology. Then similarities and differences among previous studies were drawn. The following sections now present the summary of those.

Variables and their relations

A variable map was generated to depict a holistic picture of the relationships among variables and to narrow down the scope of the study. The most frequently used variables for studying students' attitudes toward technology were: gender, technological aspiration, home environment, school type, fathers' profession and age, while gender, technological aspiration, home environment, and school type were used for students' concepts of technology. These independent variables were connected to related dependent variables to indicate the number of studies conducted on their relationships. The influence of variables on students' attitudes toward, and concepts of, technology was further analyzed where there was sufficient data to see patterns when considering age group (grade level), economic level, and study year.

1. *Gender*: The findings indicated that gender was the most explanatory and the most frequently used variable for studies on students' attitudes toward technology. The study findings indicated that boys rated higher than girls on the interest, consequences, curriculum, and career scales, while girls viewed technology as an activity for both boys and girls alike. Only the difficulty sub-scale did not show an agreement among researchers, in that girls considered technology less difficult.

Comparison among age groups on students' attitudinal differences toward technology revealed that there seemed to be no attitudinal change with age. Most studies dealt with secondary-level students, and the results were uni-directional on all sub-scales except for difficulty. Most significant studies on influence of attitude measurement on technology were from economically advanced countries. It was also noted that there were no observable changes in the study findings over the different years encompassed by this analysis.

Based on the significant studies, it appeared that boys possessed better concepts of technology on all four sub-scales. As for the age and country comparison, the trend was similar to the attitude results; that is, the boys' attitudes on interest, curriculum, career, and consequences were better. However, the results were uni-directional on all sub-scales except for difficulty. No patterns in these findings were observed across different study years.

2. *School Type*: Attending a technical training school seemed to have a positive effect on interest, consequences, and students' concept of technology, while it did not affect students' attitude on role pattern and difficulty of technology. Higher or lower school levels

seemed not to affect students' attitude toward technology, but a higher school level appeared to influence students' concepts of technology in a positive manner.

3. *Technological Aspirations*: The findings indicated that technological aspirations played a positive role on forming positive attitudes for the six attitudinal and four conceptual sub-scales employed in the study.

4. *Home Environment*: It appeared that technical home environment encouraged the forming of positive attitudes towards technology on the six attitudinal and four conceptual sub-scales.

5. *Father's Profession*: Although two significant studies reported findings pertaining to the influence of fathers' profession on students' attitudes toward technology, their direction of effect was not clear on the four attitudinal sub-scales of interest, role pattern, difficulty, and consequences. It was not possible to say conclusively that fathers' profession had an influence on students' attitudes toward technology because of the inconsistent direction and inadequate information.

6. *Age*: Overall, younger students showed a better attitude toward technology, with insignificant gender differences on the six attitudinal sub-scales.

Similarities and differences among studies

The similarities among studies are summarized as follows. Gender was the most explanatory factor for both boys and girls. Boys showed more positive views on the attitudinal scales of interest, consequences, career, and curriculum than did girls, while girls had a non-stereotypical view of technology as an activity for boys and girls to a greater extent than the boys.

In addition, all significant results from advanced countries revealed that boys had better concepts of technology on the four sub-scales: technology and society, technology and science, technology and skills, and technology and pillars.

The findings imply that school type, students' technological aspiration, and technical home environment played positive roles in students' attitudes toward technology and its concepts, while age had no significant impact on students' attitudes toward technology.

Studies on attitudes toward and concepts of technology were conducted mostly with subjects in the 11 to 16 age groups. These studies produced the most significant findings in developed countries.

There were disagreements on the influence of gender on difficulty of technology, an effect of higher or lower education, and of fathers' profession on students' attitudes toward technology as well as the influence of gender with different age groups on attitudinal differences. Other dissimilarities found were that only Polish girls revealed more positive attitudes on the consequences of technology than boys.

Conclusions and Discussion

The following conclusions were drawn based on the findings of the study:

1. All but a few of the PATT scales possessed acceptable reliabilities. The difficulty and concept scales had questionable reliabilities. These conclusions are based on correlation coefficient values. If the value were greater than a certain level such as .60, it was considered that the given scale was acceptable. That means the results of the scale would be stable with repeated measurements. Unreliable results of scale measurements are attributed to some factors, such as group heterogeneity and lack of time limits and test length (Crocker &

Algina, 1986).

2. The attitude scales of the PATT instruments appeared to be valid except for career and curriculum scales, while concept scales did not show any distinguishable characteristics. This conclusion is based on construct validity from factor analysis. Validity of an instrument needs to be considered seriously because it justifies whether the inferences made by researchers are defendable. The factors affecting the validity of attitude scales are basically question wording and response sets (Oskamp, 1977). Examples of question wording are: rapport, format, order, vocabulary, clarity, biased questions, and incomplete specifications. The response sets include: carelessness of respondents, social desirability, extremity of response, and acquiescence (yea-saying).

3. It appeared that boys and girls differ in attitude formation styles. Most studies reported that boys had more positive attitudes toward and better concepts of technology based on t-test results, mean values, or percentage rates of different response groups. This may be true; however, more cautious conclusions need to be made because one study reported that some differences did exist between boys and girls in developing their attitudes.

4. Multiple measurements using different instruments seemed to improve the validity of study instruments. Some studies showed that the results from questionnaires are different from that of other instruments such as essays or drawings. Therefore, conclusions based on analyses of findings that include input from such instruments may be more valid. It is noted that conclusions need to be made with caution due to problems with supplemental methods, in that their reliability and validity are not established even though they are considered to be useful. However, "multiple measurements through different methods can add greatly to the depth and richness of our understanding of attitude patterns and variations"

(Oskamp, 1977, p. 41).

5. Gender seemed to be the most accountable factor for the differences observed in attitudes and concepts of technology. Gender was the most frequently used variable among researchers. In addition, multiple regression analysis showed gender was the variable that explained the highest variance among students' attitudes toward technology.

6. PATT instrument seemed to be discriminatory for economically developed countries, rather than developing countries. Most significant studies for attitudinal or conceptual difference were conducted in advanced countries. In terms of availability and effectiveness of the PATT instruments, developed countries seemed to have an advantage over and above developing countries.

Recommendations for Further Studies

The following recommendations were made based on the findings and conclusions of the study.

1. Studies on students' attitudes toward and concepts of technology need to be extended to other geographical areas in Africa and Asia. More elementary and college level students should be used as subjects.

2. The design and development of more accurate instruments are necessary to study gender influence on subjects' attitudes toward technology.

3. Attitudes or concepts should be measured using a combination of several different methods such as questionnaires, interviews, drawings, and essays.

4. More studies should be conducted using multiple regression analysis to identify explanatory variables for students' attitudes toward technology.

5. The use of more appropriate statistical methods and careful interpretation and through reporting of results are recommended. Many studies compared different groups without the use of statistical measures such as the t or F test.

6. Those studies wherein the primary author did not report all numerical data needed to conduct statistical analysis should be republished. This would enable other researchers to conduct a meta-analysis by integrating the data from previous studies.

7. It is recommended to conduct more studies using path analysis although two studies (De Klerk Wolteres, 1989; Kananoja; 1992) employed that method. Path analysis enables researchers to draw causal connection among correlated variables

8. The percentage of variance explained by the factors should be considered to determine whether the construct of the instrument is valid.

9. More longitudinal studies should be conducted to ascertain whether attitudinal or conceptual changes occur over time, particularly since the presence of technology is so obviously increasing in all societies.

Implications for Practitioners

The significance of this study was to give educators and researchers an overall picture of the studies of attitude to, and concept of technology work to date, and to provide research-based data and recommendations. Some implications for practitioners as a result of this study were:

1. Educators related to technology education should invest attention to improving students' attitudes toward and concepts of technology because this study's findings showed that no clear improvements have been made during the studied period.

2. Technology education should begin as early as the elementary school level because study results showed that attitudes have already formed at an early age and that they do not change much later.

3. The various study results, particularly those dealing with student concepts of technology, could be used for curriculum development for school based technology education initiatives.

Extending this study's implication to Korean technology education, in which the researcher was involved before this dissertation, yielded the following:

1. Studies on students' attitudes toward and concepts of technology in Korea should be initiated because no study from Korea was found during literature review although such work has been conducted in 27 countries around the world.

2. Teacher education should consider how to help students develop their attitudes toward technology and enhance their concepts of technology because the literature revealed that students' attitudes may affect their willingness to participation in technology education and technological society.

APPENDIX A: LIST OF VALIDATORS

List of Validators

Dr. Allen Bame
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APPENDIX B: REQUEST LETTER FOR VALIDATION AND VALIDATION SHEETS

Request Letter

October 7, 1999

Dr. Daniel Householder
Professor and Chair
Department of Industrial Education & Technology
116 Industrial Education II
Iowa State University
Ames, IA 50011

Dear Dr. Householder:

Thank you from both me and Dr. Dyrenfurth for accepting to help my doctoral research by serving as a validator. Enclosed are copies of the two articles with evaluation sheets. Also enclosed are four pages that show my coding of these articles. The overall purpose is to insure that my codings accurately reflect what was reported in the articles.

As I mentioned in my e-mail, the purpose of this request is to validate my data coding. Descriptions of each field are given in the left-hand column of the coding validation sheets. Please note these when you check my coding results. If you have any corrections and/or recommendation for improvement of my codings, I will be glad to have them. Some abbreviations are used to decrease the number of pages. For example, 'NR' stands for not reported and 't.' means technology.

Your efforts will be very helpful to me. If you have any suggestions on my data coding, please do not hesitate to write on the paper. I will appreciate your efforts. You may keep the copies of articles but please return the coding validation sheets to me. If possible, I would like to have them back within a week but we know you are busy.

Thank you in advance for your assistance. If you have any questions regarding this please contact me at either jskim@iastate.edu or (515)294-6243.

Best regards,

Ji-Suk Kim

cc: M. Dyrenfurth, Advisor

Coding Evaluation Sheets

INSTRUCTIONS: Please check (√) the column (appropriate or inappropriate) to indicate your assessment of my coding. If you think the coding was not appropriate, please indicate correction needed in the rightmost column and use post-it notes or the back space for additional space/comment if needed.

ID: Identification number assigned by a researcher to identify the articles				4
Classification	Coding Results	Appropriate	Inappropriate	Correction/ Recommendation
Stu-Author(s): The name(s) of author(s) involved in the study	Boser, Palmer, & Daugherty			
Stu-Source: Study source with following classification: Journal (JO), book/chapter (BO), dissertation/thesis (DT), technical report (TR), conference paper (CP), unpublished manuscript (UM)	JO (JTE)			
Stu-Date: Publication date	1998			
Stu-Prof Affil: Authors' professional affiliations with the following classification: academic (AC), government agency (GA), program agency (PA), and research firm (RF)	AC (Illinois State U., Illinois State U., & Granby High School in Norfolk, VA)			
Population: The population from which the sample was drawn	Middle school students who enrolled in TE program in central Illinois or Chicago metropolitan area			
Sub-Age: Subjects' age	12 to 14			
Sub-sample: The sample size	155 students who enrolled in TE program from 4 schools (pre: 155, post:127)			
Sub-GenProp: The gender proportion in the sample	Pre:86(b), 68(g), post: 66(b), 59(g)			
Sub-Grade: Subjects' grade level on school	7th			
Sub-sampling method: Sampling method used in the study	Purposive sampling			
Sch-Loc: School's location (i.e., urban, suburban, or rural area)	Central Illinois or Chicago metropolitan area			
Sch-Level: School's level (i.e., elementary, junior high, senior high, or college)	Middle School			
Sch-Country: Country where the study have conducted	IL, USA			
Design: Research design	Experimental design: the static group pre-test & Post-test (9week interval)			
Instru-type: Instrument used in the study with its name	PATT-USA			
Instru-Subscales: Instrument's sub-scales or components for which analysis was done	• short written description of t. • demographic data & info. on students' technological climate at home (11items) • attitude scales (57 items): general interest, attitude, t. as an activity for boys and girls, consequences, and difficulty • concept scale (31 items)			

Ind-vars: Independent variables used	Instructional approach (industrial arts, integrated, modular, and problem solving), gender, before/after trt			
Dep-vars: Dependent variables used	Attitude & concept of t.			
Analysis: Data analysis method	• Factor analysis(attitude items) • Guttman analysis(concept items) • Cronbach's Alpha (combined attitude and concept items) • t-test and MANOVA			
Findings/Results : Findings/results described by author(s) (as detailed as possible)	• Reliability: The instrument has acceptable reliability. • *Sig.* Differences between pretest and posttest: integrated approach (more negative attitude toward consequences on the posttest), modular (more negative attitude of t. and narrower and less accurate concept on posttest), and problem solving (decreased difficulty of t. on posttest) • *Sig.* Gender differences: general interest (Females viewed t. as less interesting and more difficult subject than did males but more females perceived t. to be an activity for boys and girls • *Sig.* Gender diff. In different instructional approach: industrial arts (More females responded t. is more difficult.), modular (Females had better concept of t. and rated higher on the scale, t. as activity for boys and girls)			
Conclusions : Conclusions drawn from findings/results in the study (as detailed as possible)	• The nine-week instructional period in TE does not significantly changed students' interest in T. but decreased students' belief in difficulty of T. • *Sig.* Gender differences on 3 of 5 attitude sub-scales are independent of instructional approach. • Students have narrow concepts or misconcepts of what comprises T. on both the pre-and posttest. • No positive conceptual change over the nine-week TE program • No clear direction of instructional approach influence on attitude change			
Recommendations : The Recommendations given by author(s)	• Need an effort to develop curr. Mat'ls and activities that meet the interest and technological needs of girls too			
My meta-analysis treatment : Analysis method (i.e., qualitative(Qual) or quantitative (Quan)) that I will use to synthesize my research findings	Qual and Quan			
Note: Additional notes which will be help a researcher understand the study	• problem solving method: excluded from analysis of gender diff. • Included info. on n, mean, & p value			

ID: Identification number assigned by a researcher to identify the articles				5
Classification	Coding Results	Appro-priate	Inappro-priate	Correction/ Recommendation
Stu-Author(s): The name(s) of author(s) involved in the study	Bame, Dugger, Jr., de Vries, & McBee			
Stu-Source: Study source with following classification: Journal (JO), book/chapter (BO), dissertation/thesis (DT), technical report (TR), conference paper (CP), unpublished manuscript (UM)	JO (JTS)			
Stu-Date: Publication date	1993			
Stu-Prof Affil: Authors' professional affiliations with the following classification: academic (AC), government agency (GA), program agency (PA), and research firm (RF)	AC (Virginia Polytechnic Institution and State U.(VPI&SU), VPI&SU, Eindhoven U. of T., & visiting professor of Educational research of Virginia Tech.			
Population: The population from which the sample was drawn	Middle school students from 7states			
Sub-Age: Subjects' age	12 to 16 or older, mainly 13 to 15 (over 67%)			
Sub-sample: The sample size	10,349 students from 128 schools			
Sub-GenProp: The gender proportion in the sample	60.9% b (6256), 39.1% g (4013) based on 10269			
Sub-Grade: Subjects' grade level on school	6, 7, 8th, and 9th or higher (over half)			
Sub-sampling method: Sampling method used in the study	Convenience sampling			
Sch-Loc: School's location (i.e., urban, suburban, or rural area)	NR			
Sch-Level: School's level (i.e., elementary, junior high, senior high, or college)	Middle School			
Sch-Country: Country where the study have conducted	VA, NJ, WI, OH, OK, FL, & UT, USA			
Design: Research design	Descriptive survey design			
Instru-type: Instrument used in the study with its name	PATT-USA			
Instru-Subscales: Instrument's sub-scales or components for which analysis was done	• Short description: what the student thinks technology is • Demographic data (11 *items*): gender, age, grade, technological climate in the home, interest in technological profession • Attitude toward t.(58 five-point Likert items): general interest in t., negative attitude, gender differences, t. is difficult, & consequences of t. • Concept of t. (31 items): Knowledge about t.			
ind-vars: Independent variables used	• demographic characteristics (gender, age, grade level) • technological climate in the home (fathers' job, mothers' job, technical toy, workshop, & personal computer)			

	• interest in technological profession (technological aspiration, siblings in technological profession) • IA/TE course taking			
Dep-vars: Dependent variables used	Attitude & concept of t.			
Analysis: Data analysis method	• Frequency analysis (demographic data) • One-way ANOVA analysis (6 sub scale scores with subgroups based on grade, father's job, and mother's job) • t-test (6 sub scale scores with dichotomous demographic data) • χ^2 analysis (relationship between gender and general student characteristics as well as the home environment)			
Findings/Results: Findings/results described by author(s) (as detailed as possible)	• Technological climate in the home: More than half responded on three items; father's job very much or much to do with t., presence of t. toys at home, & taking IA/TE • Sig. Relationship between the gender and all demographic characteristics (alpha<.01) • Sig. Gender difference on all attitude subscales and concept scale: Boys rated more positively on all scales except difficulty and t. as being an activity for both boys and girls scales. • Sig grade level difference on 4 attitude subscales and concept scale: more interest, more difficulty, more positive consequences, & more knowledge as being higher grader, no direct relnship on gender diff. • Sig. Effect of father's job on 4 attitude subscales and concept scale (interest, attitude, gender difference, consequences, & knowledge): students who have fathers in technological profession rated higher in general interest and better attitude but no linear relnship on gender difference. • Sig. Effect of mother's job on 5 subscales of 6: general interest (direct relnship), attitude and consequences (mother's jobs had anything to do with t.- more positive), gender diff. (not clear direction), knowledge (nonlinear effect) • Sig. Positive effect of the existence of technical toys in the home on all attitude scales and concept • Workshop(not so sig.), having tech. Toys (more general int., greater positive view on the consequences of tech., & better general attitude), • Personal comp.: sig. Positive effect on general int., attitude, & consequences • Technological aspiration: sig. On general int. positive attitude, better consequences, and greater knowledge • taking or having taken IA/TE: sig. Difference on all attitude scales as well as the concept scales (positive effect except gender diff.) • international comparisons: similarities (1. Positive influence of parents' technological; profession on the attitude, 2. The concepts of students become better with increasing age) and dissimilarities (1. Students in US are rather strongly aware of the importance of t. 2. Rather low score on concept items compared to other industrialized countries)			
Conclusions: Conclusions drawn from findings/results in the study (as detailed as possible)	Although students are well aware of the importance of t. & are interested in it, their concept of t. is not very broad.			

Recommendations: The Recommendations given by author(s)	NR			
My meta-analysis treatment: Analysis method (i.e., qualitative(Qual) or quantitative (Quan)) that I will use to synthesize my research findings	Qual			
Note: Additional notes which will be help a researcher understand the study	• 1(positive)-5(negative) • same study with Berne & Dugger (1992) • Interest, curr., & career have been combined into two scales, positive and negative attitudes • did not report sd & probabilities for t and F values			

ID: Identification number assigned by a researcher to identify the articles				14
Classification	Coding Results	Appro-priate	Inappro-priate	Correction/ Recommendation
Stu-Author(s): The name(s) of author(s) involved in the study	de Vries			
Stu-Source: Study source with following classification: Journal (JO), book/chapter (BO), dissertation/thesis (DT), technical report (TR), conference paper (CP), unpublished manuscript (UM)	JO (RISTE)			
Stu-Date: Publication date	1991			
Stu-Prof Affil: Authors' professional affiliations with the following classification: academic (AC), government agency (GA), program agency (PA), and research firm (RF)	AC (Pedagogical Technological College, The Netherlands)			
Population: The population from which the sample was drawn	Students in T. teacher training programmes in the Netherlands (about 350)			
Sub-Age: Subjects' age	under 30 to over 40			
Sub-sample: The sample size	89 technology teacher training students			
Sub-GenProp: The gender proportion in the sample	66 b, 16 g, 7 NR			
Sub-Grade: Subjects' grade level on school	NR			
Sub-sampling method: Sampling method used in the study	Convenience sampling			
Sch-Loc: School's location (i.e., urban, suburban, or rural area)	NR			
Sch-Level: School's level (i.e., elementary, junior high, senior high, or college)	University?			
Sch-Country: Country where the study have conducted	Eindhoven, Groningen, & Zwolle, Netherland			
Design: Research design	Descriptive survey design			
Instru-type: Instrument used in the study with its name	Adapted version of PATT			
Instru-Subscales: Instrument's sub-scales or components for which analysis was done	• Demographic data (sex, age, edu. & prof. background) • Description of t. & A list of 34 objects (5 pt scale) • Concept scale(t. as a human activity:SOC, t. as SCIence, t. as PROCess, pillars of t.: MEI, 34 items, 3 pt scale) • Attitude scale(INTerest, role of GENder, importance and CONsequence, DIFficulty, & CURRiculum, 37 items, 5 pt scale)			

Ind-vars: Independent variable used	Gender			
Dep-vars: Dependent variables used	Attitude & Concept of t.			
Analysis: Data analysis method	• Descriptive analysis: counting key words and grouping them into categories • Mean • Cronbach's coefficient for each scale • Factor analysis • Two tailed t-test, & multiple regression			
Findings/Results: Findings/results described by author(s) (as detailed as possible)	• No sig. Gender diff. On concept scales at 1% or 5% level • Factor analysis on the list of objects: Five factors (technology with biological mat'ls, appliances in and around the home, mechanical objects, high t. equip., & electrical items) accounts for more 65 % of variance. • Regarded high t. as more technological than low t. • The most frequently wrong answered items: the importance of the role of machines in t. and the historical dimension of t. • Matter was seen as more essential than energy & info. • SCI: the highest scale score • Sig. Gender difference on INT (males, more interest) • No sig. Gender Difference on GEN (t. as a field for both gender), CON (generally agree on imp. Of t. consequences), DIF(fairly accessible), CUR(view t. as a part of school curr) • Multiple regression: students with a better concept in general have a more positive attitude • Homogeneity: INT(.79), GEN(.71), CON(.72), DIF(.41), CUR(.67), SOC(.41), SCI(.51), PROC(.54), MEI(.26)			
Conclusions: Conclusions drawn from findings/results in the study (as detailed as possible)	• Attitude: positive but not uncritical • students have fairly broad concept of t. with some biases (more towards new than toward old t., more towards mechanical and electrical than towards bio-related objects, weakly related with science, focused on matter than on energy and info., focused on individual human needs than on societal effects)			
Recommendations: The Recommendations given by author(s)	NR			
My meta-analysis treatment: Analysis method (i.e., qualitative(Qual) or quantitative (Quan)) that I will use to synthesize my research findings	Qual & Quan			
Note: Additional notes which will be help a researcher understand the study	• Conducted survey before taking a course • In 1989, six teacher training institutes started an initial teacher training program for TE in the Netherlands • t. introduced as a school subject in lower secondary edu. In 1992.			

APPENDIX C: LITERATURES USED FOR ANALYSIS

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APPENDIX D: VARIABLES AND STUDY RESULTS

D1.1: Gender and Attitude

D1.1.1: Studies dealing with gender differences on interest in technology

Author (year)	N		Mean		Sd		F or t value	P value	Direction of Effect	Subject age	Country
	Boys	Girls	Boys	Girls	Boys	Girls					
Bame et al. (1993)	6256	4013	2.5	3.0	-	-	-	-	B	12-16	USA
Conen-van den Bergh (1987)	79	73	2.3	2.7	-	-	-	-	B	-	Denmark
Conen-van den Bergh (1987)	1427	1042	2.3	3.0	-	-	-	-	B	13-14	The Netherlands
Conen-van den Bergh (1987)	112	122	2.3	2.7	-	-	-	-	B	13-14	France
Boser et al. (1998)	152	127	2.1	2.5	-	-	-	.001	B	12-14	USA
Claeys (1987)	93	97	2.3	2.7	-	-	-	-	B	13-14	Belgium
Grodzka-Borowska et al. (1988)	288	137	-	-	-	-	-	-	B	16-17	Poland
De Klerk Wolters (1989b)	1021	1029	2.3	3.0					B	10-12	The Netherlands
	1365	982	2.3	3.0	-	-	-	-	B	13-15	
	697	560	2.4	3.1	-	-	-	-	B	16-18 (sec. Genera	
	655	526	2.4	3.2	-	-	-	-	B	16-18 (senior voc.)	
Martins (1991)	249	290	24.1	18.4	-	-	-7.35 (t)	-	B	13-20	Portugal
Moore (1987)	171-		3.6	3.1	-	-	-	.000	B	11-16	UK
Szydlowski et al. (1987)	113	149	2.4	2.7	-	-	-	-	B	14-15	Poland
Volk et al. (1999)	1882	1477	2.45	2.74					B	12-16	Hong Kong
De Vries (1991)	66	16	1.9	2.5	-	-	-3.94 (t)	.01	B	Under 30 to over 40	The Netherlands
Balogun (1988)	244	236	37.9	37.8	5.24	5.63	.17 (t)	.86	B	12-14	Nigeria
Burns (1992)	749	720	-	-	-	-	-	-	B	13	New Zealand
De Klerk Wolters (1988)	2428		-	-	-	-	-	-	B	16-18	The Netherlands
De Klerk Wolters (1989a)	1160	1153	-	-	-	-	-	-	B	10-12	The Netherlands
Natali (1987)	285	281	-	-	-	-	-	-	B	13-14	Italy
Rajput (1987)	273	227	-	-	-	-	-	-	NR (marginal difference)	Under 14+	India

Note: Studies in the highlighted area showed statistically significant results.

D1.1.2: Studies relating to gender differences on role pattern in technology

Author (year)	n		Mean		Sd		F or t value	P value	Direction of Effect	Subject age	Country
	boys	girls	Boys	Girls	boys	Girls					
Balogun (1988)	244	236	29.0	32.4	5.48	6.58	5.91(t)	.00	G	12-14	Nigeria
Bame et al. (1993)	6256	4013	2.3	1.7	-	-	-	-	G	12-16	USA
Conen-van den Bergh (1987)	1427	1042	2.5	2.2	-	-	-	-	G	13-14	The Netherlands
Conen-van den Bergh (1987)	112	122	2.3	1.8	-	-	-	-	G	13-14	France
Conen-van den Bergh (1987)	79	73	2.4	1.8	-	-	-	-	G	-	Denmark
Boser et al. (1998)	152	127	2.1	1.6	-	-	-	.001	G	12-14	USA
Claeys (1987)	93	97	2.8	2.2	-	-	-	-	G	13-14	Belgium
De Klerk Wolters (1989b)	1021	1029	2.0	1.6					G	10-12	The Netherlands
	1365	982	2.5	2.2	-	-	-	-	G	13-15	
	697	560	2.1	1.9	-	-	-	-	G	16-18 (sec. general)	
	655	526	2.5	2.0	-	-	-	-	G	16-18 (sen. voc.)	
Martins (1991)	249	290	23.3	16.2	-	-	11.82 (t)	-	G	13-20	Portugal
Moore (1987)	171		3.4	4.0	-	-	-	.000	G	11-16	UK
Szydlowski et al. (1987)	113	149	3.0	2.8	-	-	-	-	G	14-15	Poland
Volk et al. (1999)	1882	1477	2.6	2.5					G	12-16	Hong Kong
Burns (1992)	749	720	-	-	-	-	-	-	G	13	New Zealand
Grodzka-Borowska et al. (1988)	288	137	-	-	-	-	-	-	NR	16-17	Poland
De Klerk Wolters (1988)	2428		-	-	-	-	-	-	G	16-18	The Netherlands
De Klerk Wolters (1989a)	1160	1153	-	-	-	-	-	-	G	10-12	The Netherlands
Natali (1987)	285	281	-	-	-	-	-	-	NR (similar)	13-14	Italy
Rajput (1987)	273	227	-	-	-	-	-	-	NR (marginal difference)	Under 14+	India
De Vries (1991)	66	16	1.8	1.7	-	-	-	-	G	Under 30 to	The Netherlands

Note: Studies in the highlighted area showed statistically significant results.

D1.1.3: Studies dealing with gender differences on difficulty of technology

Author (year)	N		mean		sd		F or t value	P value	Direction of Effect	Subject age	Country
	boys	girls	Boys	girls	boys	girls					
Bame et al. (1993)	6256	4012	3.3	3.6	-	-	-	-	G	12-16	USA
Conen-van den Bergh (1987)	1427	1042	2.3	2.2	-	-	-	-	G	13-14	The Netherlands
Conen-van den Bergh (1987)	112	122	2.7	2.6	-	-	-	-	G	13-14	France
Boser et al. (1998)	152	127	3.5	3.7	-	-	-	.014	B	12-14	USA
Claeys (1987)	93	97	2.8	2.4	-	-	-	-	G	13-14	Belgium
De Klerk Wolters (1989b)	1021	1029	2.3	2.4	-	-	-	-	B	10-12	The Netherlands
	1365	982	2.3	2.1	-	-	-	-	G	13-15	
	655	526	2.8	2.3	-	-	-	-	G	16-18 (sen. voc.)	
Martins (1991)	249	290	26.1	24.5	-	-	3.12(t)	-	G	13-20	Portugal
Volk et al. (1999)	1882	1477	2.7	2.8					B	12-16	Hong Kong
Balogun (1988)	244	236	26.91	26.93	4.84	5.14	0.05(t)	.96	G	12-14	Nigeria
Conen-van den Bergh (1987)	79	73	2.8	2.8	-	-	-	-	NR	-	Denmark
Burns (1992)	749	720	-	-	-	-	-	-	G	13	New Zealand
Grodzka-Borowska et al. (1988)	288	137	-	-	-	-	-	-	NR	16-17	Poland
De Klerk Wolters (1988)	2428		-	-	-	-	-	-	B	16-18	The Netherlands
De Klerk Wolters (1989a)	1160	1153	-	-	-	-	-	-	B	10-12	The Netherlands
De Klerk Wolters (1989b)	697	560	2.9	2.9	-	-	-	-	NR	16-18 (sec.	The Netherlands
Natali (1987)	285	281	-	-	-	-	-	-	NR (overall results)	13-14	Italy
Rajput (1987)	273	227	-	-	-	-	-	-	NR (marginal difference)	Under 14+	India
Szydlowski et al. (1987)	113	149	3.0	3.0	-	-	-	-	NR	14-15	Poland
De Vries (1991)	66	16	2.7	2.6	-	-	-	-	NR	Under 30 to over 40	The Netherlands

Note: Studies in the highlighted area showed statistically significant results

D1.1.4: Studies dealing with gender differences on consequences of technology

Author (year)	N		Mean		Sd		F or t value	P value	Direction of Effect	Subject age	Country
	boys	girls	Boys	Girls	boys	girls					
Bame et al. (1993)	6256	4012	2.0	2.1	-	-	-	-	B	12-16	USA
Conen-van den Bergh (1987)	1427	1042	2.3	2.6	-	-	-	-	B	13-14	The Netherlands
Conen-van den Bergh (1987)	112	122	2.5	2.6	-	-	-	-	B	13-14	France
Conen-van den Bergh (1987)	79	73	2.5	2.7	-	-	-	-	B	-	Denmark
Claeys (1987)	93	97	2.3	2.5	-	-	-	-	B	13-14	Belgium
De Klerk Wolters (1989b)	1021	1029	2.3	2.4	-	-	-	-	B	10-12	The Netherlands
	1365	982	2.2	2.6	-	-	-	-	B	13-15	
	697	560	2.2	2.5	-	-	-	-	B	16-18 (sec. general)	
	655	526	2.3	2.7	-	-	-	-	B	16-18 (sen. voc.)	
Moore (1987)	171		3.6	3.4	-	-	-	.000	B	11-16	UK
Szydlowski et al. (1987)	113	149	2.3	2.1	-	-	-	-	G	14-15	Poland
Volk et al. (1999)	1882	1477	2.36	2.44					B	12-16	Hong Kong
Balogun (1988)	244	236	39.33	39.28	4.68	5.61	.12 (t)	.92	B	12-14	Nigeria
Boser et al. (1998)	152	127	2.2	2.1	-	-	-	.899	G	12-14	USA
Burns (1992)	749	720	-	-	-	-	-	-	B	13	New Zealand
Grodzka-Borowska et al. (1988)	288	137	-	-	-	-	-	-	NR	16-17	Poland
De Klerk Wolters (1988)	2428		-	-	-	-	-	-	B	16-18	The Netherlands
De Klerk Wolters (1989a)	1160	1153	-	-	-	-	-	-	B	10-12	The Netherlands
Martins (1991)	249	290	23.7	24.3	-	-	-1.56 (t)	-	B	13-20	Portugal
Natali (1987)	285	281	-	-	-	-	-	-	NR	13-14	Italy
Rajput (1987)	273	227	-	-	-	-	-	-	NR (marginal difference)	Under 14+	India
De Vries (1991)	66	16	2.0	2.3	-	-	-	-	B	Under 30 to over 40	The Netherlands

Note: Studies in the highlighted area showed statistically significant results.

D1.1.5: Studies dealing with gender differences on curriculum in technology

Author (year)	N		Mean		sd		F or t value	P value	Direction of Effect	Subject age	Country
	boys	girls	Boys	Girls	boys	girls					
Conen-van den Bergh (1987)	112	122	2.6	2.9	-	-	-	-	B	13-14	France
Conen-van den Bergh (1987)	79	73	2.6	2.8	-	-	-	-	B	-	Denmark
De Klerk Wolters (1989b)	1021	1029	2.1	2.6	-	-	-	-	B	10-12	The Netherlands
	697	560	2.9	3.1	-	-	-	-	B	16-18 (sec. general)	
Martins (1991)	249	290	21.3	24.7	-	-	6.21(t)	-	B	13-20	Portugal
Moore (1987)	171		3.6	3.3	-	-	-	.005	B	11-16	UK
Volk et al. (1999)	1882	1477	2.56	2.72					B	12-16	Hong Kong
Balogun (1988)	244	236	38.6	37.7	5.08	5.68	1.64(t)	.10	B	12-14	Nigeria
Burns (1992)	749	720	-	-	-	-	-	-	B	13	New Zealand
Grodzka-Borowska et al. (1988)	288	137	-	-	-	-	-	-	NR	16-17	Poland
De Klerk Wolters (1988)	2428		-	-	-	-	-	-	B	16-18	The Netherlands
De Klerk Wolters (1989a)	1160	1153	-	-	-	-	-	-	B	10-12	The Netherlands
Natali (1987)	285	281	-	-	-	-	-	-	NR	13-14	Italy
Rajput (1987)	273	227	-	-	-	-	-	-	NR (marginal difference)	Under 14+	India
Szydlowski et al. (1987)	113	149	2.8	2.8	-	-	-	-	No difference	14-15	Poland
De Vries (1991)	66	16	1.8	1.8	-	-	-	-	No difference	Under 30 to over 40	The Netherlands

Note: Studies in the highlighted area showed statistically significant results.

D1.1.6: Studies relating to gender differences on careers in technology

Author (year)	n		mean		sd		F or t value	P value	Direction of Effect	Subject age	Country
	boys	girls	Boys	girls	boys	girls					
Conen-van den Bergh (1987)	112	122	2.7	3.1	-	-	-	-	B	13-14	France
Conen-van den Bergh (1987)	79	73	2.5	2.8	-	-	-	-	B	-	Denmark
Grodzka-Borowska et al. (1988)	288	137	-	-	-	-	-	-	NR	16-17	Poland
De Klerk Wolters (1989b)	1021	1029	2.0	2.6	-	-	-	-	B	10-12	The Netherlands
	697	560	2.4	3.1	-	-	-	-	B	16-18 (sec. general)	
Martins (1991)	249	290	23.9	27.9	-	-	-7.44(t)	-	B	13-20	Portugal
Moore (1987)	171		3.4	2.8	-	-	-	.000	B	11-16	UK
Szydlowski et al. (1987)	113	149	2.8	3.1	-	-	-	-	B	14-15	Poland
Volk et al. (1999)	1882	1477	2.55	2.74					B	12-16	Hong Kong
Balogun (1988)	244	236	36.0	35.5	4.8	5.4	1.03(t)	.30	B	12-14	Nigeria
Burns (1992)	749	720	-	-	-	-	-	-	B	13	New Zealand
De Klerk Wolters (1988)	2428		-	-	-	-	-	-	B	16-18	The Netherlands
De Klerk Wolters (1989a)	1160	1153	-	-	-	-	-	-	B	10-12	The Netherlands
Natali (1987)	285	281	-	-	-	-	-	-	NR	13-14	Italy
Rajput (1987)	273	227	-	-	-	-	-	-	NR (marginal difference)	Under 14+	India

Note: Studies in the highlighted area showed statistically significant results.

D1.1.7: Studies dealing with gender differences on attitudes toward technology

Author (year)	n		mean		Sd		F or t value	P value	Direction of Effect	Subject age	Country
	boys	girls	Boys	girls	boys	girls					
Bame et al. (1993)*	6254	4011	3.4	3.3	-	-	-	.000	B	12-16	USA
Dunalp (1990)							44.12 (F)	.000	G	NR	USA
Boser et al. (1998)*	152	127	2.7	2.6	-	-	-	.192	-	12-14	USA
Prime (1991)	250	223	2.95	2.97	-	-	-0.47 (t)	-	-	13-16+	Trinidad and Tobago

Note: In the studies which have the symbol, '*', attitudes' score was computed from combined sub-scales of career and curriculum. In the rest of above studies, attitudes' score were based on overall attitude scale. Studies in the highlighted area showed statistically significant results.

D1.2: Gender and Concepts

D1.2.1: Studies dealing with gender differences on technology and society

Author (year)	N		mean		Sd		F or t value	P value	Direction of Effect	Subject age	Country
	boys	girls	boys	girls	boys	Girls					
Conen-van den Bergh (1987)	1427	1042	.50	.36	-	-	-	-	B	13-14	The Netherlands
Conen-van den Bergh (1987)	112	122	.49	.42	-	-	-	-	B	13-14	France
Conen-van den Bergh (1987)	79	73	.46	.40	-	-	-	-	B	NR	Denmark
De Klerk Wolters (1989b)	1365	982	.50	.36	-	-	-	-	B	13-15	The Netherlands
	697	560	.62	.52	-	-	-	-	B	16-18 (sec. general)	
	655	526	.62	.49	-	-	-	-	B	16-18 (sen. voc.)	
Martins (1991)	249	290	5.8	5.1	-	-	4.63(t)	-	B	13-20	Portugal
Burns (1992)	749	720	-	-	-	-	-	-	B	13	New Zealand
Claeys (1987)	93	97	.48	.40	-	-	-	-	-	13-14	Belgium
Dudziak, et al (1987)	61	91	.66	.61	-	-	-	-	B	14-15	Poland
De Klerk Wolters (1988)	2428		-	-	-	-	-	-	B	16-18	The Netherlands
De Klerk Wolters (1989a)	1160	1153	-	-	-	-	-	-	B	10-12	The Netherlands
Natali (1987)	285		281	.34 (B+G)	-	-	-	-	NR	13-14	Italy
De Vries (1991)	66	16	.71	.74	-	-	-	-	G	Under 30 to	The Netherlands

Note: Studies in the highlighted area showed statistically significant results.

D1.2.2: **Studies relating to gender differences on technology and science**

Author (year)	N		mean		sd		F or t value	P value	Direction of Effect	Subject age	Country
	Boys	girls	Boys	girls	boys	girls					
Conen-van den Bergh (1987)	1427	1042	.48	.33	-	-	-	-	B	13-14	The Netherlands
Conen-van den Bergh (1987)	112	122	.39	.34	-	-	-	-	B	13-14	France
Conen-van den Bergh (1987)	79	73	.46	.43					B	NR	Denmark
De Klerk Wolters (1989b)	1365	982	.48	.33	-	-	-	-	B	13-15	The Netherlands
	697	560	.75	.71	-	-	-	-	B	16-18 (sec.	
	655	526	.65	.49	-	-	-	-	B	16-18 (sen. voc.)	
Martins (1991)	249	290	5.6	4.9	-	-	3.17(t)	-	B	13-20	Portugal
Burns (1992)	749	720	-	-	-	-	-	-	B	13	New Zealand
Claeys (1987)	93	97	.34	.32	-	-	-	-	-	13-14	Belgium
Dudziak, et al (1987)	61	91	.60	.69	-	-	-	-	G	14-15	Poland
De Klerk Wolters (1988)	2428	-	-	-	-	-	-	-	B	16-18	The Netherlands
Natali (1987)	285	281	.36 (B+G)	-	-	-	-	-	NR	13-14	Italy
De Vries (1991)	66	16	.80	.84	-	-	-	-	G	Under 30 to	The Netherlands

Note: Studies in the highlighted area showed statistically significant results.

D1.2.3: Studies focusing on gender differences on technology and skills

Author (year)	N		mean		sd		F or t value	P value	Direction of Effect	Subject age	Country
	Boys	girls	Boys	girls	boys	girls					
Conen-van den Bergh (1987)	1427	1042	.75	.65	-	-	-	-	B	13-14	The Netherlands
Conen-van den Bergh (1987)	79	73	.76	.73					B	NR	Denmark
De Klerk Wolters (1989b)	1365	982	.72	.65	-	-			B	13-15	The Netherlands
	655	526	.76	.71					B	16-18 (sec. voc.)	
Martins (1991)	249	290	6.5	5.5	-	-	5.21(t)	-	B	13-20	Portugal
Conen-van den Bergh (1987)	112	122	.59	.59	-	-	-	-	-	13-14	France
Burns (1992)	749	720	-	-	-	-	-	-	B	13	New Zealand
Claeys (1987)	93	97	.80	.88	-	-	-	-	-	13-14	Belgium
Dudziak, et al (1987)	61	91	.60	.68	-	-	-	-	G	14-15	Poland
De Klerk Wolters (1988)	2428		-	-	-	-	-	-	B	16-18	The Netherlands
De Klerk Wolters (1989b)	697	560	.75	.71	-	-	-	-	B	16-18 (sec. general)	The Netherlands
De Klerk Wolters (1989a)	1160	1153	.72	.71					B	10-12	The Netherlands
Natali (1987)	285	281	.47 (B+G)		-	-	-	-	-	13-14	Italy
De Vries (1991)	66	16	.77	.81	-	-	-	-	G	Under 30 to over 40	The Netherlands

Note: Studies in the highlighted area showed statistically significant results.

D1.2.4: Studies dealing with gender differences on technology and pillars

Author (year)	N		mean		sd		F or t value	P value	Direction of Effect	Subject age	Country
	boys	girls	Boys	girls	boys	girls					
Conen-van den Bergh (1987)	1427	1042	.57	.45	-	-	-	-	B	13-14	The Netherlands
Conen-van den Bergh (1987)	112	122	.60	.49	-	-	-	-	B	13-14	France
Conen-van den Bergh (1987)	79	73	.46	.35					B	NR	Denmark
De Klerk Wolters (1989b)	1365	982	.57	.45	-	-	-	-	B	13-15	The Netherlands
	697	560	.90	.63	-	-	-	-	B	16-18 (sec.	
	655	526	.72	.56	-	-	-	-	B	16-18 (sen. voc.)	
Martins (1991)	249	290	6.0	4.9	-	-	5.63(t)	-	B	13-20	Portugal
Burns (1992)	749	720	-	-	-	-	-	-	B	13	New Zealand
Claeys (1987)	93	97	.49	.42	-	-	-	-	-	13-14	Belgium
Dudziak, et al (1987)	61	91	.61	.55	-	-	-	-	B	14-15	Poland
De Klerk Wolters (1988)	2428		-	-	-	-	-	-	B	16-18	The Netherlands
Natali (1987)	285	281	.55 (B+G)		-	-	-	-	NR	13-14	Italy
De Vries (1991)	66	16	.72	.67	-	-	-	-	B	Under 30 to	The Netherlands

Note: Studies in the highlighted area showed statistically significant results.

D1.2.5: **Studies dealing with gender differences on concept of technology**

Author (year)	N		mean		sd		F or t value	P value	Direction of Effect	Subject age	Country
	boys	girls	Boys	girls	boys	girls					
Bame et al. (1993)	6082	3905	15.5	14.7	-	-	-	-	B	12-16	USA
Balogun (1987)*	103	200	.47 (B+G)		-	-	-	-	-	12-14	Nigeria
Boser et al. (1998)	152	127	.56	.56	-	-	-	.969	-	12-14	USA
Claeys (1987)*	93	97	.53	.51	-	-	-	-	-	13-14	Belgium
Dudziak, et al (1987)*	61	91	.62	.63	-	-	-	-	-	14-15	Poland
Natali (1987)*	285	281	.43 (B+G)		-	-	-	-	-	13-14	Italy
Ogar (1987)*	321 (B+G)		.58 (B+G)		-	-	-	-	-	13-15	Poland
Rajput (1987)*	273	227	16.3 (.60)	14.6 (.61)	4.6	6.2	-	-	G	Under 14+	India
Conen-van den Bergh (1987)	1427	1042	.57	.45	-	-	-	-	B	13-14	The Netherlands
Conen-van den Bergh (1987)*	112	122	.51	.46	-	-	-	-	B	13-14	France
Conen-van den Bergh (1987)	79	73	.54	.48	-	-	-	-	B	-	Denmark

Note: Numerical information on studies with symbol, '*', was obtained from R. Coenen-van den Bergh (1987, p.39). Studies in the highlighted area showed statistically significant results.

D2.1: School Type and Attitude

D2.1.1: Studies relating to school type differences on interest of technology

Author (year)	N		mean		Sd		F value	P value	Direction of effect	Subject age	Country
	A	B	A	B	A	B					
De Klerk Wolters (1989b)	516 (L)	741 (H)	2.9 (L)	2.5 (H)	-	-	-	-	H	16-18	The Netherlands
	339 (TT)	772 (NTT)	2.2 (TT)	3.1 (NTT)	-	-	-	-	TT		
	1194 (TT)	1031 (NTT)	2.3 (TT)	3.0 (NTT)	-	-	-	-	TT	13-15	
Connen-van den Bergh (1987)	-	-	-	-	-	-	-	-	NR	13-14	The Netherlands
Claeys (1987)	-	-	-	-	-	-	-	-	No t-test. Hardly any difference between 3 VSE and & 3 TSE but difference between 3 GSE and 3 VSE and 3 GSE and 3 TSE have same difference as between boys and girls.	13-14	Belgium
De Klerk Wolters (1988)	-	-	-	-	-	-	-	-	No t-test. Pupils from senior technical training and pre-university schools showed the most favorable score and more positive interest.	16-18	The Netherlands
De Klerk Wolters (1989b)	662 (L)	900 (H)	2.6 (L)	2.7 (H)	-	-	-	-	L	10-12	The Netherlands
	1512 (L)	360 (H)	2.8 (L)	2.8 (H)	-	-	-	-	-	13-15	

Note: L indicates 'lower education' and H does 'higher education.' TT stands for 'Technical Training' and NTT stands for 'Non-Technical Training.' VSE indicates 'Vocational Secondary Education', TSE does 'Technical Secondary Education,' and GSE does 'General Secondary Education.' Studies in the highlighted area showed statistically significant results.

D2.1.2: Studies dealing with school type differences on role pattern of technology

Author (year)	N		mean		Sd		F value	P value	Direction of effect	Subject age	Country
	A	B	A	B	A	B					
De Klerk Wolters (1989b)	1194 (TT)	1031 (NTT)	2.5 (TT)	2.2 (NTT)	-	-	-	-	NTT	13-15	The Netherlands
	339 (TT)	772 (NTT)	2.5 (TT)	2.2 (NTT)	-	-	-	-	NTT	16-18	
Connen-van den Bergh (1987)	-	-	-	-	-	-	-	-	NR	13-14	No result reported.
Claeys (1987)	-	-	-	-	-	-	-	-	No t-test. (same as interest)	13-14	Belgium
De Klerk Wolters (1988)	-	-	-	-	-	-	-	-	No t-test. (same as interest)	16-18	The Netherlands
De Klerk Wolters (1989b)	662 (L)	900 (H)	1.8 (L)	1.7 (H)	-	-	-	-	H	10-12	The Netherlands
	1512 (L)	360 (H)	2.1 (L)	2.0 (H)	-	-	-	-	H	13-15	
	516 (L)	741 (H)	2.2 (L)	2.2 (H)	-	-	-	-		16-18	

Note: Studies in the highlighted area showed statistically significant results.

D2.1.3: Studies dealing with school type differences on difficulty of technology

Author (year)	N		mean		Sd		F value	P value	Direction of effect	Subject age	Country
	A	B	A	B	A	B					
De Klerk Wolters (1989b)	1512 (L)	360 (H)	2.4 (L)	2.2 (H)	-	-	-	-	H	13-15	The Netherlands
	516 (L)	741 (H)	2.8 (L)	3.0 (H)	-	-	-	-	L	16-18	
	1194 (TT)	1031 (NTT)	2.3 (TT)	2.2 (NTT)	-	-	-	-	NTT	13-15	
	339 (TT)	772 (NTT)	2.8 (TT)	2.6 (NTT)	-	-	-	-	NTT	16-18	
Connen-van den Bergh (1987)	-	-	-	-	-	-	-	-	NR	13-14	The Netherlands
Claeys (1987)	-	-	-	-	-	-	-	-	No t-test. (same as interest)	13-14	Belgium
De Klerk Wolters (1988)	-	-	-	-	-	-	-	-	No t-test. (same as interest)	16-18	The Netherlands
De Klerk Wolters (1989b)	662 (L)	900 (H)	2.4 (L)	2.4 (H)	-	-	-	-	-	10-12	The Netherlands

Note: Studies in the highlighted area showed statistically significant results.

D2.1.4: Studies relating to school type differences on consequences of technology

Author (year)	N		mean		Sd		F value	P value	Direction of effect	Subject age	Country
	A	B	A	B	A	B					
De Klerk Wolters (1989b)	1194 (TT)	1031 (NTT)	2.2 (TT)	2.6 (NTT)	-	-	-	-	TT	13-15	The Netherlands
	339 (TT)	772 (NTT)	2.2 (TT)	2.6 (NTT)	-	-	-	-	TT	16-18	
	516 (L)	741 (H)	2.9 (L)	2.5 (H)	-	-	-	-	H	16-18	
Connen-van den Bergh (1987)	-	-	-	-	-	-	-	-	NR	13-14	The Netherlands
Claeys (1987)	-	-	-	-	-	-	-	-	No t-test. (same as interest)	13-14	Belgium
De Klerk Wolters (1988)	-	-	-	-	-	-	-	-	No t-test. (same as interest)	-	The Netherlands
De Klerk Wolters (1989b)	662 (L)	900 (H)	2.3 (L)	2.3 (H)	-	-	-	-	-	10-12	The Netherlands
	1512 (L)	360 (H)	2.1 (L)	2.2 (H)	-	-	-	-	L	13-15	

Note: Studies in the highlighted area showed statistically significant results.

D2.1.5: Studies focusing on school type differences on curriculum of technology

Author (year)	N		mean		Sd		F value	P value	Direction of effect	Subject age	Country
	A	B	A	B	A	B					
De Klerk Wolters (1989b)	516 (L)	741 (H)	3.2 (L)	2.9 (H)	-	-	-	-	H	16-18	The Netherlands
De Klerk Wolters (1988)	-	-	-	-	-	-	-	-	No t-test. (same as interest)	16-18	The Netherlands
De Klerk Wolters (1989b)	662 (L)	900 (H)	2.4 (L)	2.4 (H)	-	-	-	-	-	10-12	The Netherlands

Note: Studies in the highlighted area showed statistically significant results.

D2.1.6: Studies dealing with school type differences on career in technology

Author (year)	N		mean		Sd		F value	P value	Direction of effect	Subject age	Country
	A	B	A	B	A	B					
De Klerk Wolters (1989b)	662 (L)	900 (H)	2.7 (L)	2.9 (H)	-	-	-	-	L	10-12	The Netherlands
	516 (L)	741 (H)	3.0 (L)	2.5 (H)	-	-	-	-	H	16-18	
De Klerk Wolters (1988)	-	-	-	-	-	-	-	-	No t-test. (same as interest)	16-18	The Netherlands

Note: Studies in the highlighted area showed statistically significant results.

D2.2: School Type and Concept

D2.2.1: Studies dealing with school type differences on concept of technology and society

Author (year)	N		mean		Sd		F value	P value	Direction of effect	Subject age	Country
	A	B	A	B	A	B					
De Klerk Wolters (1989b)	516 (L)	741 (H)	.53 (L)	.61 (H)	-	-	-	-	H	16-18	The Netherlands
	1194 (TT)	1031 (NTT)	.50 (TT)	.37 (NTT)	-	-	-	-	TT	13-15	
	339 (TT)	772 (NTT)	.64 (TT)	.52 (NTT)	-	-	-	-	TT	16-18	
Connen-van den Bergh (1987)	-	-	-	-	-	-	-	-	NR	13-14	The Netherlands
Claeys (1987)	-	-	-	-	-	-	-	-	NR	13-14	Belgium
De Klerk Wolters (1988)	-	-	-	-	-	-	-	-	No t-test	16-18	The Netherlands

Note: Studies in the highlighted area showed statistically significant results.

D2.2.2: Studies dealing with school type differences on concept of technology and science

Author (year)	N		mean		Sd		F value	P value	Direction of effect	Subject age	Country
	A	B	A	B	A	B					
De Klerk Wolters (1989b)	516 (L)	741 (H)	.67 (L)	.77 (H)	-	-	-	-	H	16-18	The Netherlands
	1194 (TT)	1031 (NTT)	.49 (TT)	.34 (NTT)	-	-	-	-	TT	13-15	
	339 (TT)	772 (NTT)	.65 (TT)	.58 (NTT)	-	-	-	-	TT	16-18	
Connen-van den Bergh (1987)	-	-	-	-	-	-	-	-	NR	13-14	The Netherlands
Claeys (1987)	-	-	-	-	-	-	-	-	NR	13-14	Belgium
De Klerk Wolters (1988)	-	-	-	-	-	-	-	-	No t-test	16-18	The Netherlands

Note: Studies in the highlighted area showed statistically significant results.

D2.2.3: Studies relating to school type differences on concept of technology and skills

Author (year)	N		mean		Sd		F value	P value	Direction of effect	Subject age	Country
	A	B	A	B	A	B					
De Klerk Wolters (1989b)	516 (L)	741 (H)	.70 (L)	.72 (H)	-	-	-	-	H	16-18	The Netherlands
	1194 (TT)	1031 (NTT)	.72 (TT)	.66 (NTT)	-	-	-	-	TT	13-15	
	339 (TT)	772 (NTT)	.78 (TT)	.71 (NTT)	-	-	-	-	TT	16-18	
Conne-van den Bergh (1987)	-	-	-	-	-	-	-	-	NR	13-14	The Netherlands
Claeys (1987)	-	-	-	-	-	-	-	-	NR	13-14	Belgium
De Klerk Wolters (1988)	-	-	-	-	-	-	-	-	No t-test	16-18	The Netherlands

Note: Studies in the highlighted area showed statistically significant results.

D2.2.4: Studies focusing on school type differences on concept of technology and pillars

Author (year)	N		mean		Sd		F value	P value	Direction of effect	Subject age	Country
	A	B	A	B	A	B					
De Klerk Wolters (1989b)	516 (L)	741 (H)	.63 (L)	.69 (H)	-	-	-	-	H	16-18	The Netherlands
	1194 (TT)	1031 (NTT)	.58 (TT)	.46 (NTT)	-	-	-	-	TT	13-15	
	339 (TT)	772 (NTT)	.73 (TT)	.60 (NTT)	-	-	-	-	TT	16-18	
Claeys (1987)	-	-	-	-	-	-	-	-	NR	13-14	Belgium
De Klerk Wolters (1988)	-	-	-	-	-	-	-	-	No t-test	16-18	The Netherlands
Conen-van den Bergh (1987)	-	-	-	-	-	-	-	-	NR	13-14	The Netherlands

Note: Studies in the highlighted area showed statistically significant results.

D3.1: Technological Aspiration and attitude

D3.1.1: Studies dealing with technological aspirations differences on interest of technology

Author (year)	N		mean		Sd		F or t value	P value	Direction of effect	Subject age	Country
	TA	NTA	TA	NTA	TA	NTA					
De Klerk Wolters (1989b)	259	482	1.8	3.2	-	-	-	-	TA	10-12	The Netherlands
	340	430	2.1	3.2	-	-	-	-	TA	16-18	
Bame et al (1993)	4984	5107	2.3	3.1	-	-	-	-	TA	12-16	USA
Volk & Ming (1999)	1945	1458	2.4	2.8	-	-	-	-	TA	12-16	Hong Kong
De Klerk Wolters (1988)	-	-	-	-	-	-	-	-	TA (no t-test)	16-18	The Netherlands
De Klerk Wolters (1989b)	-	-	-	-	-	-	-	-	TA (no t-test)	10-12	The Netherlands

Note: TA stands for students with technological aspiration or ambition and NTA stands for students without technological aspiration. Studies in the highlighted area showed statistically significant results.

D3.1.2: Studies relating to technological aspirations differences on role pattern of technology

Author (year)	N		mean		Sd		F or t value	P value	Direction of effect	Subject age	Country
	TA	NTA	TA	NTA	TA	NTA					
De Klerk Wolters (1989b)	259	482	2.0	1.7	-	-	-	-	TA	10-12	The Netherlands
Volk & Ming (1999)	1945	1458	2.4	2.8					TA	12-16	Hong Kong
Bame et al. (1993)	4984	5107	2.0	2.0	-	-	-	-	-	12-16	USA
De Klerk Wolters (1988)	-	-	-	-	-	-	-	-	TA (no t-test)	16-18	The Netherlands
De Klerk Wolters (1989b)	-	-	-	-	-	-	-	-	TA (no t-test)	10-12	The Netherlands
De Klerk Wolters (1989b)	340	430	2.2	2.2	-	-	-	-	-	16-18	The Netherlands

Note: Studies in the highlighted area showed statistically significant results.

D3.1.3: Studies dealing with technological aspirations differences on difficulty of technology

Author (year)	N		Mean		Sd		F or t value	P value	Direction of effect	Subject age	Country
	TA	NTA	TA	NTA	TA	NTA					
De Klerk Wolters (1989b)	259	482	2.2	2.4	-	-	-	-	TA	10-12	The Netherlands
Volk & Ming (1999)	1945	1458	2.7	2.8					TA	12-16	Hong Kong
Bame et al. (1993)	4984	5107	3.4	3.5	-	-	-	-	TA	12-16	USA
De Klerk Wolters (1988)	-	-	-	-	-	-	-	-	TA (no t-test)	16-18	The Netherlands
De Klerk Wolters (1989b)	-	-	-	-	-	-	-	-	TA (no t-test)	10-12	The Netherlands
De Klerk Wolters (1989b)	340	430	2.9	2.9	-	-	-	-	-	16-18	The Netherlands

Note: Studies in the highlighted area showed statistically significant results.

D3.1.4: Studies focusing on technological aspirations differences on consequences of technology

Author (year)	N		mean		Sd		F or t value	P value	Direction of effect	Subject age	Country
	TA	NTA	TA	NTA	TA	NTA					
De Klerk Wolters (1989b)	259	482	2.1	2.4	-	-	-	-	TA	10-12	The Netherlands
	340	430	2.2	2.5	-	-	-	-	TA	16-18	
Bame et al. (1993)	4984	5107	1.9	2.2	-	-	-	-	TA	12-16	USA
Volk & Ming (1999)	1945	1458	2.3	2.5					TA	12-16	Hong Kong
De Klerk Wolters (1988)	-	-	-	-	-	-	-	-	TA (no t-test)	16-18	The Netherlands
De Klerk Wolters (1989b)	-	-	-	-	-	-	-	-	TA (no t-test)	10-12	The Netherlands

Note: Studies in the highlighted area showed statistically significant results.

D3.1.5: **Studies dealing with technological aspiration differences on curriculum of technology**

Author (year)	N		mean		Sd		F or t value	P value	Direction of effect	Subject age	Country
	TA	NTA	TA	NTA	TA	NTA					
De Klerk Wolters (1989b)	259	482	1.5	3.1	-	-	-	-	TA	10-12	The Netherlands
	340	430	2.6	3.5	-	-	-	-	TA	16-18	
Volk & Ming (1999)	1945	1458	2.5	2.8					TA	12-16	Hong Kong
De Klerk Wolters (1988)	-	-	-	-	-	-	-	-	TA (no t-test)	16-18	The Netherlands
De Klerk Wolters (1989b)	-	-	-	-	-	-	-	-	TA (no t-test)	10-12	The Netherlands

Note: Studies in the highlighted area showed statistically significant results.

D3.1.6: **Studies dealing with technological aspiration differences on career in technology**

Author (year)	N		mean		Sd		F or t value	P value	Direction of effect	Subject age	Country
	TA	NTA	TA	NTA	TA	NTA					
De Klerk Wolters (1989b)	259	482	1.5	3.6	-	-	-	-	TA	10-12	The Netherlands
	340	430	1.8	3.4	-	-	-	-	TA	16-18	
Volk & Ming (1999)	1945	1458	2.4	3.0					TA	12-16	Hong Kong
De Klerk Wolters (1988)	-	-	-	-	-	-	-	-	TA (no t-test)	16-18	The Netherlands
De Klerk Wolters (1989b)	-	-	-	-	-	-	-	-	TA (no t-test)	10-12	The Netherlands

Note: Studies in the highlighted area showed statistically significant results.

D3.2: Technological Aspiration and Concept

D3.2.1: Studies dealing with technological aspiration on the concept of technology and society

Author (year)	N		mean		Sd		F or t value	P value	Direction of effect	Subject age	Country
	TA	NTA	TA	NTA	TA	NTA					
De Klerk Wolters (1989b)	340	430	.66	.50	-	-	-	-	TA	16-18	The Netherlands
De Klerk Wolters (1988)	-	-	-	-	-	-	-	-	TA (no t-test)	16-18	The Netherlands
De Klerk Wolters (1989b)	-	-	-	-	-	-	-	-	TA (no t-test)	10-12	The Netherlands

Note: Studies in the highlighted area showed statistically significant results.

D3.2.2: Studies relating to technological aspiration on the concept of technology and science

Author (year)	N		mean		Sd		F or t value	P value	Direction of effect	Subject age	Country
	TA	NTA	TA	NTA	TA	NTA					
De Klerk Wolters (1989b)	340	430	.80	.67	-	-	-	-	TA	16-18	The Netherlands
De Klerk Wolters (1988)	-	-	-	-	-	-	-	-	TA (no t-test)	16-18	The Netherlands
De Klerk Wolters (1989b)	-	-	-	-	-	-	-	-	TA (no t-test)	10-12	The Netherlands

Note: Studies in the highlighted area showed statistically significant results.

D3.2.3: Studies dealing with technological aspiration on the concept of technology and skills

Author (year)	N		mean		Sd		F or t value	P value	Direction of effect	Subject age	Country
	TA	NTA	TA	NTA	TA	NTA					
De Klerk Wolters (1989b)	340	430	.75	.62	-	-	-	-	TA	16-18	The Netherlands
De Klerk Wolters (1988)	-	-	-	-	-	-	-	-	TA (no t-test)	16-18	The Netherlands
De Klerk Wolters (1989b)	-	-	-	-	-	-	-	-	TA (no t-test)	10-12	The Netherlands

Note: Studies in the highlighted area showed statistically significant results.

D3.2.4: Studies dealing with technological aspiration on the concept of technology and pillars

Author (year)	N		mean		Sd		F or t value	P value	Direction of effect	Subject age	Country
	TA	NTA	TA	NTA	TA	NTA					
De Klerk Wolters (1989b)	340	430	.72	.62	-	-	-	-	TA	16-18	The Netherlands
De Klerk Wolters (1988)	-	-	-	-	-	-	-	-	TA (no t-test)	16-18	The Netherlands
De Klerk Wolters (1989b)	-	-	-	-	-	-	-	-	TA (no t-test)	10-12	The Netherlands

Note: Studies in the highlighted area showed statistically significant results.

D4.1: Home Environment and Attitude

D4.1.1: Studies dealing with home environment effect on interest of technology

Author (year)	N		mean		Sd		F value	P value	Direction of effect	Subject age	Country
	TH	NTH	TH	NTH	TH	NTH					
De Klerk Wolters (1989b)	204	1182	2.4	2.7	-	-	-	-	TH	10-12	The Netherlands
	83	176	2.3	2.9	-	-	-	-	TH	16-18	
De Klerk Wolters (1988)	-	-	-	-	-	-	-	-	TH (no t-test)	16-18	The Netherlands
De Klerk Wolters (1989a)	-	-	-	-	-	-	-	-	TH (no t-test)	10-12	The Netherlands

Note: TH stands for students with technical home environment and NTH stands for students without technical home environment. Studies in the highlighted area showed statistically significant results.

D4.1.2: Studies focusing on home environment effect on role pattern of technology

Author (year)	N		Mean		Sd		F value	P value	Direction of effect	Subject age	Country
	TH	NTH	TH	NTH	TH	NTH					
De Klerk Wolters (1989b)	83	176	2.1	2.3	-	-	-	-	TH	16-18	The Netherlands
De Klerk Wolters (1988)	-	-	-	-	-	-	-	-	TH (no t-test)	16-18	The Netherlands
De Klerk Wolters (1989a)	-	-	-	-	-	-	-	-	TH (no t-test)	10-12	The Netherlands
De Klerk Wolters (1989b)	204	1182	1.7	1.7	-	-	-	-	-	10-12	The Netherlands

Note: Studies in the highlighted area showed statistically significant results.

D4.1.3: Studies dealing with home environment effect on difficulty of technology

Author (year)	N		Mean		Sd		F value	P value	Direction of effect	Subject age	Country
	TH	NTH	TH	NTH	TH	NTH					
De Klerk Wolters (1988)	-	-	-	-	-	-	-	-	TH (no t-test)	16-18	The Netherlands
De Klerk Wolters (1989a)	-	-	-	-	-	-	-	-	TH (no t-test)	10-12	The Netherlands
De Klerk Wolters (1989b)	204	1182	2.3	2.4	-	-	-	-	TH	10-12	The Netherlands
	83	176	2.8	2.9	-	-	-	-	TH	16-18	

D4.1.4: Studies relating to home environment effect on consequences of technology

Author (year)	N		Mean		Sd		F value	P value	Direction of effect	Subject age	Country
	TH	NTH	TH	NTH	TH	NTH					
De Klerk Wolters (1989b)	83	176	2.2	2.5	-	-	-	-	TH	16-18	The Netherlands
De Klerk Wolters (1988)	-	-	-	-	-	-	-	-	TH (no t-test)	16-18	The Netherlands
De Klerk Wolters (1989a)	-	-	-	-	-	-	-	-	TH (no t-test)	10-12	The Netherlands
De Klerk Wolters (1989b)	204	1182	2.3	2.4	-	-	-	-	TH	10-12	The Netherlands

Note: Studies in the highlighted area showed statistically significant results.

D4.1.5: Studies dealing with home environment effect on curriculum of technology

Author (year)	N		Mean		Sd		F value	P value	Direction of effect	Subject age	Country
	TH	NTH	TH	NTH	TH	NTH					
De Klerk Wolters (1989b)	204	1182	2.2	2.5	-	-	-	-	TH	10-12	The Netherlands
De Klerk Wolters (1988)	-	-	-	-	-	-	-	-	TH (no t-test)	16-18	The Netherlands
De Klerk Wolters (1989a)	-	-	-	-	-	-	-	-	TH (no t-test)	10-12	The Netherlands
De Klerk Wolters (1989b)	83	176	2.7	3.1	-	-	-	-	TH	16-18	The Netherlands

Note: Studies in the highlighted area showed statistically significant results.

D4.1.6: Studies dealing with home environment effect on career in technology

Author (year)	N		Mean		Sd		F value	P value	Direction of effect	Subject age	Country
	TH	NTH	TH	NTH	TH	NTH					
De Klerk Wolters (1989b)	83	176	2.1	2.8	-	-	-	-	TH	16-18	The Netherlands
De Klerk Wolters (1988)	-	-	-	-	-	-	-	-	TH (no t-test)	16-18	The Netherlands
De Klerk Wolters (1989a)	-	-	-	-	-	-	-	-	TH (no t-test)	10-12	The Netherlands
De Klerk Wolters (1989b)	204	1182	2.7	2.8	-	-	-	-	TH	10-12	The Netherlands

Note: Studies in the highlighted area showed statistically significant results.

D4.2: Home Environment and Concept

D4.2.1: Studies dealing with home environment effect on the concept of technology and society

Author (year)	N		mean		Sd		F value	P value	Direction of effect	Subject age	Country
	TH	NTH	TH	NTH	TH	NTH					
De Klerk Wolters (1989b)	83	176	.67	.57	-	-	-	-	TH	16-18	The Netherlands
De Klerk Wolters (1988)	-	-	-	-	-	-	-	-	TH (no t-test)	16-18	The Netherlands
De Klerk Wolters (1989a)	-	-	-	-	-	-	-	-	NR	10-12	The Netherlands

Note: Studies in the highlighted area showed statistically significant results.

D4.2.2: Studies relating to home environment effect on the concept of technology and science

Author (year)	N		mean		Sd		F value	P value	Direction of effect	Subject age	Country
	TH	NTH	TH	NTH	TH	NTH					
De Klerk Wolters (1988)	-	-	-	-	-	-	-	-	TH (no t-test)	16-18	The Netherlands
De Klerk Wolters (1989b)	83	176	.78	.72	-	-	-	-	TH	16-18	The Netherlands

D4.2.3: Studies dealing with home environment effect on the concept of technology and skills

Author (year)	N		mean		Sd		F value	P value	Direction of effect	Subject age	Country
	TH	NTH	TH	NTH	TH	NTH					
De Klerk Wolters (1988)	-	-	-	-	-	-	-	-	TH (no t-test)	16-18	The Netherlands
De Klerk Wolters (1989a)	-	-	-	-	-	-	-	-	NR	10-12	The Netherlands
De Klerk Wolters (1989b)	83	176	.74	.69	-	-	-	-	TH	16-18	The Netherlands

D4.2.4: Studies focusing on home environment effect on the concept of technology and pillars

Author (year)	N		mean		Sd		F value	P value	Direction of effect	Subject age	Country
	TH	NTH	TH	NTH	TH	NTH					
De Klerk-Wolters (1989b)	83	176	73	62	-	-	-	-	TH	16-18	The Netherlands
De Klerk Wolters (1988)	-	-	-	-	-	-	-	-	TH (no t-test)	16-18	The Netherlands

Note: Studies in the highlighted area showed statistically significant results.

D5.1: Father's Profession and Attitude

D5.1.1: Studies dealing with the influence of father's profession on interest in technology

Author (year)	N		mean	sd	F or t value	P value	Direction of Effect	Subject age	Country
Bame et al. (1993)	Vm	5679	2.5	-	-	-	Pupils' interest in technology was more positive as their fathers' professions were more technology oriented.	12-16	USA
	M	3252	2.6	-					
	L	2674	2.8	-					
	N	1339	2.9	-					
Balogun (1988)	Us	2	42.5	4.95	2.46 (F)	.03	Unclear direction	12-14	Nigeria
	Ss	6	38.5	7.99					
	S	35	37.43	3.42					
	Sp	75	37.59	5.66					
	Pm	46	40.20	4.97					
	Pmr	1	37.00	0.00					
Claeys (1987)	-		-	-	-	-	TP	13-14	Denmark
Grodzka-Borowska et al.	-		-	-	-	-	NR	16-17	Poland

Note: The abbreviations used above are as followings: Vm (very much related to technological profession), M(much related to technological profession), L(little related to technological profession), N (not related to technological profession), Us(unskilled profession), Ss (semi-skilled profession), S (skilled profession), Sp (semi-professional and small business), Pm (professional managerial), Pmr (professional and managerial in responsibilities), TP (fathers in technological profession), and NR (not reported). Studies in the highlighted area showed statistically significant results.

D5.1.2: Studies dealing with the influence of father's profession on role pattern of technology

Author (year)	N		mean	sd	F or t value	P value	Direction of Effect	Subject age	Country
Bame et al. (1993)	Vm	5679	2.06	-	-	-	No linear direction	12-16	USA
	M	3252	2.02	-					
	L	2674	2.03	-					
	N	1339	2.11	-					
Balogun (1988)	Us	2	34.0	2.83	.43 (F)	.99	Unclear	12-14	Nigeria
	Ss	6	27.8	5.35					
	S	35	30.9	5.06					
	Sp	75	29.8	6.85					
	Pm	46	30.7	7.12					
	Pmr	1	33.0	0.00					
Claeys (1987)	-		-	-	-	-	TP	13-14	Denmark
Grodzka-Borowska et al. (1988)	-		-	-	-	-	NR	16-17	Poland

Note: Studies in the highlighted area showed statistically significant results.

D5.1.3: Studies dealing with the influence of father's profession on difficulty of technology

Author (year)	N		mean	sd	F or t value	P value	Direction of Effect	Subject age	Country
Balogun (1988)	Ss	6	31.0	6.29	3.14 (F)	.01	Unclear direction	12-14	Nigeria
	S	35	25.0	3.88					
	Sp	75	25.0	5.19					
	Pm	46	26.6	4.05					
	Pmr	1	21.0	0.00					
Bame et al. (1993)	Vm	5679	3.46	-	-	-	No linear direction	12-16	USA
	M	3252	3.44	-	-	-			
	L	2674	3.41	-	-	-			
	N	1339	3.47	-					
Claeys (1987)	-		-	-	-	-	TP	13-14	Denmark
Grodzka-Borowska et al. (1988)	-		-	-	-	-	NR	16-17	Poland

Note: Studies in the highlighted area showed statistically significant results.

D5.1.4: Studies dealing with the influence of father's profession on consequences of technology

Author (year)	N		mean	sd	F or t value	P value	Direction of Effect	Subject age	Country
Bame et al. (1993)	Vm	5679	2.0	-	-	-	Pupils with fathers in technological profession had more positive attitude on consequences of technology	12-16	USA
	M	3252	2.0	-					
	L	2674	2.1	-					
	N	1339	2.3	-					
Balogun (1988)	Us	2	35.5	0.71	.51 (F)	.99	TP	12-14	Nigeria
	Ss	6	39.5	6.92					
	S	35	41.4	4.70					
	Sp	75	39.4	6.24					
	Pm	46	40.7	5.16					
	Pmr	1	41.0	0.00					
Claeys (1987)	-		-	-	-	-	TP	13-14	Denmark
Grodzka-Borowska et al. (1988)	-		-	-	-	-	NR	16-17	Poland

Note: Studies in the highlighted area showed statistically significant results.

D6.1: Age and Attitude

D6.1.1: Studies dealing with the influence of age on interest in technology

Author (year)	N		Mean	sd	F or t value	P value	Direction of Effect	Subject age	Country
Balogun (1988)	12 yr	56	38.9	5.53	.81 (F)	.99	Younger students	12-14	Nigeria
	13yr	192	38.0	5.40					
	14 yr	189	34.5	5.35					
De Klerk Wolters (1988)	-	-	-	-	-	-	Younger students	16-18	The Netherlands
Martins (1991)	13 – 14 yrs	258	26.4	-	-	-	-	13 - 20	Portugal
	15 – 16 yrs	202	26.4	-					
	17 – 20 yrs	79	26.2	-					

D6.1.2: Studies dealing with the influence of age on role pattern of technology

Author (year)	N		mean	sd	F or t value	P value	Direction of Effect	Subject age	Country
Martins (1991)	13 – 14 yrs	258	18.4				13 – 14 yrs old	13 - 20	Portugal
	15 – 16 yrs	202	20.6						
	17 – 20 yrs	79	20.1						
Balogun (1988)	12 yr	56	31.1	6.05	.20 (F)	.99	Younger students	12-14	Nigeria
	13yr	192	30.4	6.12					
	14 yr	189	30.9	6.49					
De Klerk Wolters (1988)	-	-	-	-	-	-	Younger students	16-18	The Netherlands

Note: Studies in the highlighted area showed statistically significant results.

D6.1.3: Studies relating to the influence of age on difficulty of technology

Author (year)	N		mean	sd	F or t value	P value	Direction of Effect	Subject age	Country
Balogun (1988)	12 yr	56	27.3	4.68	.39 (F)	.99	-	12-14	Nigeria
	13yr	192	27.4	5.02					
	14 yr	189	26.5	5.00					
De Klerk Wolters (1988)	-	-	-	-	-	-	Younger students	16-18	The Netherlands
Martins (1991)	13 – 14 yrs	258	25.1	-	-	-	-	13 - 20	Portugal
	15 – 16 yrs	202	25.2	-					
	17 – 20 yrs	79	26.0	-					

D6.1.4: Studies dealing with the influence of age on consequences of technology

Author (year)	N		mean	sd	F or t value	P value	Direction of Effect	Subject age	Country
Balogun (1988)	12 yr	56	40.3	5.37	2.37 (F)	.10	-	12-14	Nigeria
	13yr	192	38.6	5.09					
	14 yr	189	39.3	5.10					
De Klerk Wolters (1988)	-	-	-	-	-	-	Younger students	16-18	The Netherlands
Martins (1991)	13 – 14 yrs	258	24.1	-	-	-	-	13 - 20	Portugal
	15 – 16 yrs	202	23.9	-					
	17 – 20 yrs	79	24.2	-					

D6.1.5: Studies focusing on the influence of age on curriculum of technology

Author (year)	N		mean	sd	F or t value	P value	Direction of Effect	Subject age	Country
Balogun (1988)	12 yr	56	39.1	5.38	.20 (F)	.99	-	12-14	Nigeria
	13yr	192	38.0	5.47					
	14 yr	189	37.9	5.33					
De Klerk Wolters (1988)	-	-	-	-	-	-	Younger students	16-18	The Netherlands
Martins (1991)	13 – 14 yrs	258	22.9	-	-	-	-	13 - 20	Portugal
	15 – 16 yrs	202	23.1	-					
	17 – 20 yrs	79	24.1	-					

D6.1.6: Studies dealing with the influence of age on career in technology

Author (year)	N		mean	sd	F or t value	P value	Direction of Effect	Subject age	Country
Balogun (1988)	12 yr	56	35.8	5.32	1.29 (F)	.28	-	12-14	Nigeria
	13yr	192	35.3	4.82					
	14 yr	189	35.8	5.33					
De Klerk Wolters (1988)	-	-	-	-	-	-	Younger students	16-18	The Netherlands
Martins (1991)	13 – 14 yrs	258	26.1	-	-	-	-	13 - 20	Portugal
	15 – 16 yrs	202	26.2	-					
	17 – 20 yrs	79	24.1	-					

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