

AN ABSTRACT OF THE THESIS OF

Anantaporn Disatapundhu Evans for the degree of Doctor of Philosophy in Education
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Title: Development and Administration of a Scale to Measure the Computer Attitude of
Preservice and Inservice Teachers at the Elementary School Level

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The purpose of this study was to: (a) develop a comprehensive plan consisting of a series of logical steps based upon recommendations derived from psychometric, measurement, and research literature and utilize the plan to develop a Likert-type scale to provide valid and reliable measures of the attitude of preservice and inservice elementary school teachers toward computers; (b) administer the developed scale to selected preservice elementary school teachers; and (c) investigate relationships between attitude toward computers and selected teacher variables.

The comprehensive plan consisted of the following steps: (a) develop theory of construction, (b) establish conceptual framework, (c) create item pool, (d) develop trial scale, (e) administer trial scale, (f) conduct item analysis, (g) select items, (h) construct final scale, (i) test for homogeneity, (j) determine reliability, (k) test for unidimensionality, (l) administer final scale, and (m) infer validity. The plan was utilized to develop the Evans Scale for Computer Attitude (ESCA). Validity was inferred utilizing construct-related evidence, which included the manner in which the scale was developed, studies of scale internal structure, prediction and conformation of a general factor, replication of factor structure, relationship of scale scores to nontest variables, relationship of scale scores to similar and dissimilar constructs, comparison of scores

with experimental intervention, comparison of known-group responses. An alpha reliability coefficient was found to be 0.96 on two occasions.

It was concluded that: (a) the ESCA provided valid and reliable measures of the computer attitude of preservice and inservice teachers at the elementary school level, (b) the comprehensive plan was effective for the development of a Likert-type scale for measuring the attitude toward computers of preservice and inservice teachers at the elementary school level, (c) preservice teachers in the Masters of Arts in Teaching Program (MAT) in Elementary Education at Oregon State University as a group had positive attitude toward computers, and (c) computer attitude of elementary MAT preservice teachers was significantly related in a positive direction with computer experience and in a negative direction with age.

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Development and Administration of a Scale to
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Teachers at the Elementary School Level

by

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DEVELOPMENT AND ADMINISTRATION OF A SCALE TO
MEASURE THE COMPUTER ATTITUDE OF PRESERVICE AND INSERVICE
TEACHERS AT THE ELEMENTARY SCHOOL LEVEL

CHAPTER 1
INTRODUCTION

All of the decisions made by individuals are strongly influenced by attitudes. People choose the things they choose largely because of their attitude toward them (Mueller, 1986). Attitude is a major determinant of what people see, hear, think and do. "Without guiding attitudes the individual is confused and baffled" (Allport, 1954, p. 44). Consequently, attitude is of considerable importance to the fields of social psychology and education. Allport stated that attitude "is probably the most distinctive and indispensable concept in contemporary American social psychology" (Allport, 1954, p. 43). He further stated that the term probably occurred more frequently in theoretical and experimental social psychological literature than any other term.

The term "attitude" is a component of nearly every set of educational goals and/or objectives for teachers and students. The ability to evaluate, a central if not the only attribute of the attitude concept, is indispensable to the field of education. Although attitude is an important psychological concept, it is difficult to measure because it is an abstract concept and, as such, cannot be measured directly. To further complicate the problem, attitude has more than one acceptable meaning. According to Fisher (1977), the concept of attitude probably has more definitions than any other concept in social psychology.

Researchers in the fields of social science and education have attempted to measure attitude for nearly a quarter of a century. They have spent a great deal of time and energy in the study of attitude formation and change and of the effects of attitude on

behavior (Mueller, 1986). In recent years, attitude toward computers has been of interest to researchers. A review of the research literature revealed in excess of 60 investigations in which a scale was developed to measure attitude toward computers. A critical review of these investigations (see Chapter 2) revealed that most of the research reports did not specify and use a comprehensive theory of construction in the development and use of a scale. This finding supports a statement by Abdel-Gaid, Trueblood, and Shrigley (1986) that the flaw common in attitude instrumentation was the lack of a systematic plan for establishing the validity of a scale. The critical review revealed that reliability computations were common, but a rationale for validity was rare. A majority of the research which involved the development of a scale to measure attitude toward computers failed to mention the concept of validity in the report. The research reviewed was characterized by the failure to develop and/or report a clear, precise and comprehensive plan, accompanied by a convincing rationale for each step of the plan, for developing a scale to provide valid and reliable measurement.

In a critical review of British research in the field of attitude measurement, Gardner (1975a) stated that some of the research on attitude revealed studies displaying such startling technical deficiencies that one began to wonder whether the procedures for developing and using attitude scales were in fact widely understood. He further identified three fundamental principles to develop and use attitude scales: (a) concepts and procedures should be clearly defined; (b) scores on individual items should not be combined into a total score without some compelling theoretical or practical reasons; and (c) there should be a discernible relationship between experimental treatment and the scale used to measure the outcomes of the treatment. Gardner went on to point out that many of the attitude investigations he reviewed violated one or more of these principles. Rennie and Punch (1991) found that the confusion and inconclusiveness of the attitude research in the area of science can be attributed to a lack of a theoretical framework to direct the investigation. In a review of attitude research, Haladyna, Olsen and

Shaughnessy (1983) identified a number of problems, including (a) an inconsistent definition of attitude, (b) inadequate instrumentation (c) lack of theoretical perspective, and (d) inadequate data analyses.

Attempts to develop scales to measure attitude, particularly computer attitude, have been largely ineffectual. The reason for this situation is no doubt influenced by the inherent difficulty involved in measuring attitude; however, the research reviewed suggests that a large portion of the problem stems from the fact that guidelines and procedures, which are available in the psychometric, measurement, and research literature for developing valid and reliable attitude scales, have been misunderstood or ignored. This research intends to identify and use these guidelines and procedures in the development of an attitude scale. Even though attitude may be difficult to measure, researchers must continue to explore ways of defining and measuring the concept because what it stands for is so important for the fields of social psychology and education (Allport, 1954; Shrigley & Koballa, 1984).

Purpose of the Study

The purposes of this study are threefold. First, a comprehensive plan, which consists of a series of logical steps based on the recommendations derived from psychometric, measurement, and research literature, will be identified for the development of an attitude scale and to utilize the comprehensive plan to develop a Likert-type scale to provide valid and reliable measures of the attitude of preservice and inservice elementary school teachers toward computers. Second, the developed scale will be used to measure the computer attitude of preservice teachers enrolled in the Masters of Arts in Teaching (MAT) Program in Elementary Education at Oregon State University. Third, relationships between attitude toward computers and selected variables associated with preservice teachers enrolled in the MAT Program at Oregon

State University will be investigated. The variables will include grade level, age, computer ownership, computer access, and computer experience.

Theoretical Framework of the Study

The theoretical framework for the study is an argument for the significance of the stated purpose of the study and the feasibility of the approach selected to investigate the stated purpose. The theoretical framework is derived from a critical review of the existing research, psychometric and measurement literature on the development of instruments to measure attitude, with emphasis placed on the research involving the development of instruments to measure attitude toward computers. A summary of the theoretical framework for this study is:

1. A critical analysis of research involving the development of instruments to measure attitude toward computers reveals the need to develop a scale to provide valid and reliable measures of attitude toward computers.

2. Reviews of attitude research in the Encyclopedia of Educational Research and Annual Review of Psychology reveal a resurgence of interest in attitude research (Adams, 1982; Cialdini, Petty, & Cacioppo, 1981; Eagly & Himmelfarb, 1978). Accompanying this renewed interest in attitude research is greater concern being shown for the development of improved instruments to measure attitude.

3. The research on the development of instruments to measure attitude toward computers is characterized by the failure of researchers to identify a theory of construction, that is a comprehensive plan made up of recommended procedures from the existing research and measurement literature, and use the theory of construction to develop an instrument to measure attitude toward computers (Abdel-Gaid et al., 1986; Gardner, 1975a). Thus, a review of the research literature on the development of instruments to measure attitude toward computers reveals a need to identify and use a

theory of construction in the development of a scale to measure attitude toward computers.

4. Attitude is a psychological construct. It is an idealized abstraction and a postulated attribute of people assumed to be reflected by performance on a measurement instrument. An entirely acceptable set of operations is not available for measuring attitude, nor has the content domain of the construct been adequately defined.

Consequently, any attempt to construct an instrument to measure attitude is required to use construct-related evidence to infer validity, that is, the extent to which the instrument provides measures of the construct (American Psychological Association, 1985; Cronbach & Meehl, 1955; Mueller, 1986). In addition, literature on the evolution of validity theory states that all measurement requires construct-related evidence to infer validity because of the growing recognition that all content and criterion-related evidence for validity are subsumed under construct-related evidence (Anastasi, 1986; Messick, 1989; Shepard, 1993).

5. Elementary school teachers are expected to have and use an increasing number of computer competencies in their teaching and learning. Evidence of these expectations is provided by the funding of a project by the Northwest Council for Computer Education and Oregon State University who developed a set of competencies for teacher using educators to be used as guidelines for evaluating preservice and inservice teacher education programs (Niess, 1990). This situation, coupled with the general acceptance of the position that attitude strongly influences all of the decisions a person makes (Mueller, 1986) and the more positive view of social science researchers of the ability of attitude to predict and cause behavior (Cialdini et al., 1981; Eagly & Himmelfarb, 1978), points out the importance of obtaining valid and reliable measures of attitude toward computers of preservice and inservice elementary school teachers to be used in the development and implementation of effective teacher education programs.

6. An investigation of the statistical relationships between attitude toward computers and selected variables was included in a large number of the investigations in which an instrument to measure attitude toward computers was developed. The selected variables most frequently used were sex, computer experience, age, ownership of a computer, grade level, and computer access. Since there is some question about the validity of the attitude measurements, the results of these earlier attempts to related computer attitude to the variables have little meaning. However, further examination of selected variables with better attitude measures should provide insights for future research and practice. A more detailed review of the research and literature supporting the theoretical framework is included in Chapters 2 and 3.

Definition of Terms

The following definitions will be employed in the study. Other terms or phrases used are assumed to be self-explanatory or will be defined within the text of the study.

1. Attitude refers to the intensity of "(1) affect for or against, (2) evaluation of, (3) like or dislike of, or (4) positiveness or negativeness toward a psychological object" (Mueller, 1986, p.3). Mueller points out that this definition is three ways to restate a definition which Thurstone had included in a draft of a paper he published in 1928 but was not included in the final draft. Later Thurstone (1946) stated that he wished he had retained the more limited definition in the final draft of the paper; that is, attitude is "the intensity of positive or negative affect for or against a psychological object" (p.39). He did use the definition in a paper published in 1931 (Thurstone, 1931).

2. Attitudinal object refers to the psychological object in the definition of attitude. "The term psychological object refers to a physical object or it may refer to an idea, a plan of action, form of conduct, an ideal, a moral principle, a slogan or a symbol.

In fact, it may refer to any idea about which the subject may express positive or negative affect" (Thurstone, 1931, p. 262). The attitudinal object in this study is the computer.

3. Homogeneity refers to the characteristic of a scale where all statements in the scale measure a common attribute. A scale has homogeneity when the statements are mutually intercorrelated (Scott, 1960, 1968).

4. Unidimensional refers to the characteristic of a scale where all statements in the scale fall along a single dimension. A scale is unidimensional when it distributes subjects along a dimension which represents the magnitude of the attribute (Green, 1954; Scott, 1968). Green states that "operationally, unidimensionality and homogeneity have essentially the same meaning. Both are defined in terms of the degree of covariation among the items" (p. 339).

5. Computer refers to electronic devices that are capable of receiving information (input) then following the instructions to carry out designated procedures with that information (process), and presenting results (output) (Williams & Williams, 1984).

6. Theory of Construction refers to a clear and precise comprehensive plan, made up of a series of logical steps or procedures based on recommendations derived from a review of psychometric, measurement and attitude research literature, for developing a scale to provide valid and reliable measures of the computer attitude of preservice and inservice teachers at the elementary school level.

7. Conceptual Framework "specifies the meaning of a construct, distinguishes it from other constructs, and indicates how measures of the construct should relate to other variables" (American Psychological Association, 1985, p.10).

8. Preservice elementary school teachers refers to undergraduate and graduate level students who are preparing to teach at the elementary school level, grades K-8.

9. Inservice elementary school teachers refers to teachers who have completed their preservice training and are currently teaching at the elementary school level, grades K-8.

10. Validity refers to "the appropriateness, meaningfulness, and usefulness of the specific inferences made from test scores" (American Psychological Association, 1985, p. 9).

11. Reliability refers to a measure of internal consistency obtained by administering the Cronbach alpha formula and expressed as an alpha coefficient.

12. Scale refers to a series of items whose responses are used to assign respondents to some specific point along a hypothetical dimension, e.g., from a very negative to a very positive attitude toward an attitudinal object.

13. Likert-type scale refers to a scale made up of monotone items, each of which is presented in a multiple-choice format with five response categories. The response categories and points assigned to each are as follows: (a) one point for strongly disagree, (b) two points for disagree, (c) three points for undecided, (d) four points for agree, and (e) five points for strongly agree. A respondent's score on the scale is the sum of his or her scores on the individual items and is assumed to reflect the magnitude the respondent has of the attribute that the scale is supposed to measure (Crano & Brewer, 1973; Likert, 1932; Mueller, 1986).

Assumptions

1. The development and use of a theory of construction is a prerequisite for the development of a scale to provide valid and reliable measures of computer attitude.

2. Since attitudes influence behavior and the expected level of computer competency is increasing for elementary school teachers, valid and reliable measures of teachers' attitude toward computers are needed for use in the development of inservice and preservice teacher education programs.

3. The nature of the existing research on computer attitude suggests the need for the development of a scale to provide valid and reliable measures of computer attitude.

Limitations

The study is limited to preservice and inservice teachers at the elementary school level, grades K-8.

Delimitations

This study is not concerned with value judgments about the attitude of respondents toward computers. No attempt will be made to evaluate individual or groups of preservice teachers, inservice teachers, or schools based on responses to the attitude scale or questionnaire portion of the developed instrument.

Methodology

The methodology utilized in this study will consist of three phases. The phases include (a) an identification of a theory of construction to develop a Likert-type scale to provide a valid and reliable measures of the computer attitude of preservice and inservice teachers at the elementary school level, (b) development of the attitude scale using the identified theory of construction, and (c) administration of the developed scale.

The first phase is to identify a theory of construction for the development of a Likert-type scale to measure attitude toward computers of a specific respondent population. The theory of construction will consist of a comprehensive plan to develop the scale. It will consist of a set of logical steps, each of which consists of one or more procedures, based on recommendations derived from psychometric and measurement literature and a critical review of the existing research on the development of scales to measure attitude toward computers.

The second phase will be to employ the identified theory of construction to develop a Likert-type scale to measure the attitude toward computers of inservice and preservice teachers at the elementary school level. The steps or procedures will include identification of the conceptual framework in which the construct is embedded, generation of an item pool in language employed by the respondents derived from preservice and inservice elementary school teacher descriptions of their feelings about computers, review of each item in the pool by an expert panel, administration of each item in the pool to a sample of respondents, analysis of responses and select items for inclusion in a scale, administration of the scale to a new sample of subjects to gather empirical evidence on the internal structure of the scale and relationship of external structure of the scale to other variables. Validity will be inferred from construct-related evidence. The Cronbach alpha formula will be used to determine reliability.

The third phase involves administering the scale to preservice elementary school teachers enrolled in the MAT Program in Elementary Education at Oregon State University during the 1992 and 1993 academic years. A questionnaire will be attached to the scale to obtain measures of selected preservice teacher variables, including grade level, age, computer ownership, computer access, and computer experience. An examination will be made of the relationships that may exist between the measures of attitude toward computers and selected variables.

Organization of the Remainder of the Study

The remainder of the study is organized in the following manner. Chapter 2 presents a review of the related research, psychometric and measurement literature. Details of the process of developing the instrument for measuring attitude toward computers, procedures for gathering data, and method for analyzing the data are included

in Chapter 3. Chapter 4 reports the results of the study. Chapter 5 presents a summary, conclusions, discussion and suggestions for future practice and research.

CHAPTER 2

REVIEW OF THE LITERATURE

This chapter is organized into four parts. The first is devoted to the concept of attitude. It consists of sections on the history, definitions, importance, and renewed interest in measurement of the concept of attitude. A critical review of research in which an instrument was developed or modified to measure attitude toward computers is presented in the second part. It includes sections on Likert-type scales, semantic differential scales, oral questions, and conclusions. The third part examines research in which relationships between attitude toward computers and selected variables were investigated. Emphasis is placed on the frequency of use of the selected variables. The final part is devoted to a summary of the chapter.

Concept of Attitude

History

Attitude is a concept whose meaning has been evolving since it came into the English language by way of the French in the early part of the 18th century. It came from the Italian term, attitudine, a derivative of aptitudo from medieval Latin which was a derivative of aptus from classical Latin. According to Fleming (1967), in the early part of the 18th century attitude was "a technical term in the arts of design signifying posture, stance, physical disposition of the figure in space" (p. 292). By the middle of the 18th century it changed from its original meaning to "signify any posture of the living body recognizably adapted to a course of action or expressing a mental state" (Fleming, 1967, p. 292). By the end of the 18th century the term had become associated with actors and dancers on the stage. It was used in phrases such as an actor felt his part or his attitudes on the stage. The prevailing sense of attitude in the 18th century was a reflection of the

spontaneous reactions of humans as seen and reproduced by artists. Attitude was not enacted from within; it was not real, regardless of how real-to-life the reproduction may have seemed.

By the middle of the 19th century attitude was occasionally used in phrases which were not associated with the stage or physical expression. Allport (1954) gave credit to Herber Spencer for being the first to refer to attitude as a mental activity in 1862. But, it was not until the latter part of the 19th century that attitude was stripped of its association to the theater as a result of Darwin's use of the term as a bodily expression of strong emotions. In this sense, attitude was real and came from within the organism as an anticipatory response in moments of crisis. This anticipatory response gave the organism a dynamic appearance. It was the beginning of some appropriate physical movement for survival. Darwin felt, however, that man and domesticated animals had been trained so that the actual physical movement associated with strong emotions were vestigial. Actual physical movement had been replaced by communication through a language of gestures and posture (Fleming, 1967).

Sir Charles Sherrington, a contemporary of Darwin, was a physiologist who also emphasized the motor aspects of attitude. He differed from Darwin in that he viewed attitude not as an occasional manifestation of strong emotion but as a steady tonic response that kept organisms at rest between emergencies. It was a state of being ready, which did not preclude disruptions of attitude by an organism responding to situations that arose. When an organism did respond, reflexes were at hand to smooth the transition back to normal, the state of being ready.

In the early part of the 20th century, writers representing two different traditions of English speaking psychologists strengthened the association of attitude with mental activities without diminishing its association with motor activities. Fleming (1967) attributes the dissociation of attitude from its physiological dimension to Thomas and Znaniecki (1918). Their publication, The Polish Peasant in Europe and America,

consisted of five volumes published between 1918 and 1920. Thomas and Znaniecki included a methodological note at the beginning of the publication. Fleming reported,

The methodological note was an effort to build the entire science of social science around the complementary concepts of 'attitude' and 'value.' A value was any phenomenon that elicited a human response; an attitude was the response, itself a favorable or unfavorable disposition 'toward something' in the realm of values. (pp. 325-326)

Koballa (1988) stated that Thomas and Znaniecki were the first to use attitude as a purely psychological concept. It brought into focus the evaluative quality and social influences of attitude.

At the end of the 1930s, The Polish Peasant in Europe and America was selected by the Social Science Research Council as one of the classics in American social science. Fleming (1967) stated that, "The Polish Peasant was the inevitable choice in social psychology and the continuing pertinence of 'attitude' the main point of discussion" (p. 331).

The motor content of attitude was cast out of industrial psychology by Mayo, head of the Department of Industrial Research at Harvard Business School in 1926, as a result of his researches at the Hawthorne plant of General Electric. The improved performance of workers was attributed to changes in mental attitude brought on by the knowledge that the workers were participating in a scientific experiment (Fleming, 1967).

The separation of attitude from physiology resulted in a psychological concept that did not lend itself to measurement. In the intellectual climate in psychology in 1930s, its place as a key concept in social psychology and as a technical term in the vocabulary of science was in peril. Bogardus developed the first formal attitude scale in 1925 (Aiken, 1980). However, Thurstone's status in psychological measurement enabled his work to have greater impact. Fleming (1967) stated that Thurstone saved attitude from being exorcised as a metaphysical ghost by perfecting an indirect technique to

quantify the concept. He published Attitudes Can be Measured in 1928. In 1932, Likert provided the first direct approach for measuring the intensity of attitudes; which was followed by Gallup who advocated the use of small, but representative samples in social research. These developments in the measurement of attitude and sampling techniques in the late 1920s and 1930s brought the measurement of attitudes to the center of modern life (Fleming, 1967).

Although evaluative quality and social influences remained central to the meaning of attitude, efforts have continued to be directed toward further clarification of the concept. An investigation of some of the definitions of the concept of attitude, along with the identification of common features of attitude on which most theorists agree, provide some insight into the current efforts to further clarify the concept of attitude.

Definition of Concept of Attitude

Attitude is an abstract concept with many definitions which differ from one investigator to another. Fisher (1977) stated that concept of attitude probably has more definitions than any other concept in social psychology. It is a term that has many technical definitions, but at the same time it is a term that is used in ordinary speech and intuitively understood. Fleming (1967) reported that although the meaning of the term has changed over time, it has always maintained the characteristic of being oriented toward something else. Although definitions vary, Koballa (1988) reported that most researchers would agree that evaluation is a fundamental aspect of the concept of attitude. Osgood, Suci, and Tannenbaum (1957) went a step further and suggested that the definition of attitude should only reflect evaluative quality. They wrote "attitudes are predispositions to respond, but are distinguished from other such states of readiness in that they predispose toward an evaluative response" (p. 189). Additional definitions follow:

1. "The affect for or against a psychological object" (Thurstone, 1931, p. 261).
2. "The intensity of positive or negative affect for or against a psychological object" (Thurstone, 1946, p. 39).
3. "An attitude is a mental and neural state of readiness, organized through experience, exerting a directive or dynamic influence upon the individual's responses to all objects and situations with which it is related" (Allport, 1954, p. 45).
4. "The intensity of (1) affect for or against, (2) evaluation of, (3) dislike of, or (4) positiveness or negativeness toward a psychological object" (Mueller, 1986, p. 3).
5. "A learned predisposition to respond in a consistently favorable or unfavorable manner toward an attitude object" (Fishbein & Ajzen, 1975, p. 6).
6. "A set of interrelated predispositions to action [beliefs] around an object or situation" (Rokeach, 1969, pp. 404-405).
7. "Learned predispositions to respond positively or negatively to certain objects, situations, institutions, concepts or persons" (Aiken, 1980, p. 2).
8. "An attitude is an idea charged with emotion which predisposes a class of actions to a particular class of social situations" (Triandis, 1971).

The concept of attitude has other common features besides evaluative quality. Allport (1954), in his discussion of the history of attitude, stated that in nearly all cases the term did not appear today with the mental or motor adjective as it did in the past, yet nearly all the definitions implicitly retained both original meanings. Rokeach (1969) identified several additional common features of attitude with which there is general agreement: (a) attitude is some sort of predisposition; (b) the predisposition is more as opposed to less enduring; (c) attitude represents a cluster of two or more interrelated elements; (d) attitudes are learned; and (e) attitudes lead to a preferential response even though the basis for the response is unclear.

Renewed Interest in Measuring Attitude

Numerous education and social science researchers have been concerned with attitude measurement for more than 65 years. Eagly and Himmelfarb (1978) reported that the study of attitude had been the most active area for research in social psychology. However, there had been a decline in interest in attitude research for about a decade largely because of the poor predictability of behaviors from attitudes. Reviews of research on attitude and attitudinal change reveal a renewed interest in the field (Adams, 1982; Cialdini et al., 1981; Eagly & Himmelfarb, 1978). Part of the reason for this renewed interest is the prevailing positive view of using measures of attitude to predict behaviors. The positive view resulted from recent demonstrations that adequate predictability is usually obtained when researchers use methods based on understanding of underlying theoretical and methodological issues. Cialdini et al. reported that prediction of behavior from measures of attitude appeared to be better when the issues had been personally relevant. The consequence of the positive view of the ability to predict behavior from measures of attitude has been and will continue to be greater utilization of attitude measurement and models in applied settings.

Accompanying the renewed interest in attitude research has been more concern directed towards the development of new and improved instruments to measure attitude. Adams (1982) stated, "as in any other field, research on attitudes can be only as effective as the measuring instruments available" (p. 180).

Importance of Concept of Attitude

Allport (1954) stated that agreed upon units of analysis were a characteristic of a firm science. He identified instinct, habit, attitude, and sentiment as being among the most important assumed units of analysis in social psychology. He further stated that,

"this concept [attitude] is probably the most distinctive and indispensable concept in contemporary American social psychology" (p. 43). Shrigley, Koballa, and Simpson (1988) stated that of the four assumed units of analysis identified by Allport, only attitude has survived. The concept of attitude has appeared more frequently in experimental and theoretical literature in social psychology than any other term. Allport reported that work in the areas of public opinion, national character, institutional behavior, and characterization of the mental organization of social man by social psychologists required a concept such as attitude. He stated, "the term itself may not be indispensable, but what it stands for is" (p. 45).

The concept of attitude is equally important to the field of education, because attitude is a major determinant of how humans experience and make sense of their phenomenological world. Allport (1954) stated,

To borrow a phrase from William James, they 'engender meaning upon the world'; They draw lines about, and segregate, an otherwise chaotic environment; they are our method for finding our way about in an ambiguous universe. It is especially when the stimulus is not of great intensity nor closely bound with some reflex or automatic response that attitudes play a decisive role in the determination of meaning and of behavior. (p. 44)

Critical Review of Related Research

The purpose of this part is to provide a critical review of research reports in which an instrument was developed or modified to measure attitude toward computers. It includes 62 research reports which utilized 59 attitude instruments. The critical review is organized into four sections. The first section is devoted to Likert-type attitude scales. It includes 55 research reports involving 53 instruments. The second section focuses on six research reports in which a semantic differential scale was developed to measure attitude toward computers. The third section contains one research report in which an

oral question was used to measure attitude toward computers. The final section presents conclusions drawn from the critical review.

Likert-Type Scales

In 1963, Lee (1970) conducted a nationwide survey to examine beliefs and attitudes that the American public held about electronic computers. He developed 20 belief-attitude items from intensive interviews with samples of the general public and a psychological analysis of computer cartoons. Attitude and belief were not defined. Varimax rotation was used to analyze responses to reveal the structure of attitudes and beliefs about computers as measured by the 20 items. The survey instrument also covered a variety of other topics such as familiarity with computers, various psychosocial attitude scale items, and demographic questions.

Data were collected on a sample of 3000 people 18 years of age and older. Factor analysis using varimax rotation revealed two factors containing the items that had factor loadings of .30 and above. The factors were labeled as follows: (a) beneficial tool of man perspective (7 items) and (b) awesome thinking machine perspective (9 items). The Pearson correlation coefficient between these two factors was -0.02. A Cronbach alpha of 0.77 was reported for Factor 1 and 0.79 for Factor 2. Validity was not discussed in the report.

Lee (1970) was interested in why some individuals viewed the computer as an awesome thinking machine while others viewed it as being beneficial. He examined the demographic data of those individuals who were highest in thinking the computer was an awesome thinking machine and found that those who were most likely to have this view were characterized by low income, low occupation and poor education. He further conducted a multiple regression analysis and found a multiple r of 0.5 for education, alienation, intolerance, and three additional predictors. Dropping out the other variables,

he reported that the psycho-social variables, alienation and intolerance of ambiguity, as a predictor of viewing the computer as an awesome thinking machine had a multiple r of 0.48 and accounted for 23 % of the variance.

The scale developed by Lee (1970) to measure beliefs and attitudes toward electronic computers was utilized totally or in part by a number of researchers, each of which developed computer attitude instruments. These included Coovert and Goldstein (1980), Morrison (1983), and Hui and Pun (1988).

Coovert and Goldstein (1980) modified Lee's scale (1970) as part of a study to determine the relationship between perceived locus of control and attitude toward computers. The modifications included changing the attitude object from electronic brain machine to computer and using only 16 of 20 items. Seven statements in Lee's Factor 1 were categorized as positive statements, and nine statements in Factor 2 were called negative statements. However, Lee had stated that he did not want to call those two factors as positive and negative and provided reasons for not labeling them in that manner. A seven-point numerical value was assigned to the item response categories. No mention was made of the reason to modify Lee's instrument or validity or reliability.

Coovert and Goldstein (1980) conducted two experiments. In the first experiment, 68 undergraduate students were administered the modified scale and a measure of internal-external locus of control. In the second experiment, 65 different undergraduate students were administered the modified instrument and a different measure of locus of control.

In the first experiment, the results showed that internal subjects had significantly more positive attitude toward computers than did the external subjects. Internal subjects had less, but not significantly less, negative attitude toward computers than did the external subjects. In the second experiment, subjects with positive attitude scored significantly higher ($p < .01$) on the internal dimension than did those with negative attitude toward computers. It was reported that even though the difference was not

significant, those with positive attitude toward computers felt that powerful-others were less controlling in their lives than did those with negative attitude toward computers. The same was true for the chance dimension.

Morrison (1983) used 20-item belief-attitude statements from Lee (1970) and seven-point Likert-type response categories to measure the attitude of 412 university students in Australia. The purpose was to determine if the attitude identified by Lee still existed and to investigate the stability of the identified attitude structure. Morrison did not concern himself with instrument reliability or validity. Attitude and attitudinal object were not defined. He did not give any information on how the subjects were chosen. He divided the responses into two equal sets without random assignment. Both sets of data were separately subjected to principal components analysis. One set of data revealed four factors and accounted for 49.2 % of the total variance. Morrison claimed that his study was supported because the major factors extracted in both data sets were similar. He concluded that his findings were not similar to Lee's. In fact, he stated that in view of the time interval, different populations, and sample sizes, it would have been surprising to find similar results.

Hui and Pun (1988) modified the numerical values of the response categories and used Lee's 20 belief-attitude items to examine the attitude toward computers of secondary school principals in Hong Kong. The survey data were factor analyzed and compared with Morrison's (1983). The researchers did not provide any information on validity and reliability, and attitude and attitudinal object were not defined.

The instrument was mailed to 260 secondary school principals in Hong Kong. The data from 138 responses were factor analyzed with four factors accounting for 37.7 % of total variance and bore little similarity to Morrison's (1983). It is interesting that they even expected similar results, since Morrison stated in his report the problem associated with comparisons of different populations from different countries.

Ahl (1976) developed a Likert-type scale consisting of 17 questions to survey public attitude toward computers in society. The response categories ranged from strongly agree to strongly disagree without numerical values being assigned to the response categories. He did not report on how the questions were generated and categorized, nor did he provide any information on validity or reliability. Ahl reported that 843 people in the United States and Germany responded to the survey. No mention was made of how many subjects were surveyed, nor how the subjects were selected. The responses were divided into two groups, over 20 years of age (64 %) and 20 years of age and under (36 %). The four original scales were combined into two scales, strongly or mostly agree and strongly or mostly disagree. The data were analyzed using percentages for each group for each of the two combined scales. In the case of similarly worded questions, comparisons were made with responses to a 1971 American Federation of Information Processing Societies/Time survey. He reported that respondents felt that the computer would improve the quality of life. Young people saw somewhat less improvement from the use of computers than did adults. Most respondents felt they were unable to escape the influence of the computer. Adults saw the computer as suitable for dull, repetitive tasks, while young people saw computers in much broader roles. About one-third of respondents believed the computer was beyond the understanding of the typical person. People in 1976 were found to be more optimistic about the use of computers in most areas than those in the 1971 survey.

The attitude scale developed by Ahl (1976) influenced at least eight other researchers in the development of attitude scales. These included Lichtman (1979), Raub (1981), Smeltzer (1981), Vensel (1981), Ellsworth and Bowman (1982, 1984), McKeehan (1983), Bannon, Marshall and Fluegal (1985), and Lin (1985).

Lichtman (1979) developed a Likert-type attitude instrument by combining six items of his own with the 17 items in scale developed by Ahl (1976) to survey educator's attitude toward computers. The reasons for adding the six additional items or the

methods used in their development were not discussed by the researcher. No mention was made of any attempts to establish validity or reliability. The scale was distributed to 162 teachers and 27 administrators in summer session classes held in college-level education courses. He followed the procedure used by Ahl (1976) in analyzing the data and compared his findings to Ahl's as well as between teachers and administrators. No rationale was provided for making these comparisons. The data revealed that educators seemed less enthusiastic about the computer's role in society than did the general public. Administrators held far more positive attitude toward computers than did teachers. It was concluded that (a) teachers do not feel secure in their relationships with computers especially with respect to mistakes and privacy of data, (b) computers are viewed as being more dehumanizing and isolating than do administrators and other segments of the population, (c) teachers see less improvements in the quality of life as a result of computers than other segments of the population, and (d) although not concerned about their own jobs, teachers are concerned about computers taking away jobs in general.

Raub (1981) developed the Attitude Toward Computers (ATC) questionnaire as part of a study of computer anxiety in college students. It was reported that the ATC was used to measure beliefs and thoughts that contribute to anxiety. A 42-item pool was generated from informal interviews of students and business persons and review of anxiety and attitude research, including Ahl (1976). The items were administered to 118 college students in a pilot test. The responses were factor analyzed and were reported as adding construct validity to the instrument. Twenty-five items loaded on one factor, computer anxiety, and accounted for 36 % of the variance. The 25 items were separated by varimax rotation, identifying three factors: (a) appreciation of computers (11 items), (b) computer usage anxiety (8 items), and (c) computer's negative impact on society (6 items). Attitude was not defined. The items were not subjected to an item analysis nor examined for emotional intensity. A reliability coefficient was not reported.

The ACT questionnaire was administered as a pretest and posttest to 50 college students, 29 in two sections of introduction to COBAL and 21 in general psychology, to determine the impact of computer experience on attitude. It was reported that introductory COBAL significantly decreased ($p < .002$) computer usage anxiety.

Smeltzer (1981) developed a 26 item Likert-type scale, utilizing 17 items from Ahl (1976) and two items from Lichtman (1979), to measure the attitude toward computers of media specialists. The remaining seven items were developed by the researcher. The procedure and criteria used for selecting items, as well as for establishing validity and reliability of the instrument, were not provided. Attitude and attitudinal object were not precisely defined. The survey instrument was mailed to 50 randomly selected active members of a technology education association, and 29 people responded. The responses were analyzed by calculating a percentage for each response category. The computer was seen as playing an important role in education. It was concluded that the attitude of media specialists toward computers were similar if not more positive than the attitude of the general public and other educators.

Vensel (1981) conducted a study to measure attitude of preservice special educators toward computers and to determine whether a demonstration of an educational microcomputer system would have a positive influence on their attitudes. A 20-item Likert-type attitude scale was developed. Although the researcher did not identify specifically the source of the items, a review revealed that 10 items were from Ahl (1976), and five items were from Lichtman (1979). The source of other five items could not be identified. Validity and reliability of the instrument was not mentioned. Attitude and attitudinal object were not defined. The instrument was administered to 23 students in an introductory course in special education. All students completed the pretest, but only 10 completed the posttest. Treatment consisted of a 45 minute computer demonstration. It was concluded that the teachers were not very favorable to computers

in the classroom. The demonstration of the use of a microcomputer caused a significant ($p < .01$) shift in the attitude of preservice teachers.

The purpose of a study by Ellsworth and Bowman (1982) was to determine if the items developed by Ahl (1976) could be used as a meaningful and reliable scale to measure student beliefs about computers. They modified the attitude instrument by combining the 17 items from Ahl's instrument with three items developed by Lichtman (1979). The instrument was administered to 38 junior and senior computer science undergraduate students, who were assumed to be computer literate. Responses of the computer science students were analyzed and used to indicate a positive set of beliefs about computers. Items were chosen for the final instrument using 50 % or more agreement on the response direction for each item as a criterion. Validity was not mentioned in the report. The finalized instrument, Beliefs about Computers, consisted of 17 items, 14 from Ahl and three from Lichtman.

The 17-item instrument was administered to 109 non-computer science undergraduate students in one biology section. The mean score of 59 for the biology group was reported as being significantly lower than the 67.92 mean score of the computer science group. Eighty-two of 109 biology students retook the test one month later and obtained a mean score of 59.83, indicating relative group stability. The test-retest reliability for the instrument was found to be 0.85, while a coefficient alpha of 0.77 was reported for the first testing. It was concluded that Ahl's items plus three items from Lichtman's could be converted into a 17-item scale reflecting positive/negative beliefs about computers.

Ellsworth and Bowman (1984) developed a two-part survey to measure students' attitude toward computers. Part one was the 17-item Beliefs about Computers Questionnaire (Ellsworth & Bowman, 1982), and part two was 12 additional items developed by the researchers to reflect students individual preference for computer use in educational experiences. The researchers reported that the validity and reliability of this

instrument could be found in Ellsworth and Bowman (1982); however, the instrument in this and the previous study were different. In fact, it was reported that the 12 additional items reflected individual student preferences, and a total score could not be obtained.

A non-equivalent control group design was used to determine if microcomputers in large screen demonstration situations would promote more positive attitude toward computers and the use of computers. The modified instrument was administered as a pretest and posttest to 148 students in a control group and 200 students in an experimental group. The subjects were asked questions concerning their previous experience in high school or college courses in which computers were used for instructional purposes or computer programming. The experimental group was made up of undergraduate students in engineering, computer science, chemistry and physics classes. The control group was made up of undergraduate students in general biology. The experimental group was in classes in which microcomputers and large video screens were used occasionally in large group instructional settings. The control group was in classes where microcomputers were not used. Data were analyzed using analysis of covariance and chi square. It was reported that students in the experimental group developed more positive attitude toward computers than did control students who were not exposed to the microcomputers.

McKeehan (1983) developed a 20-item Likert-type scale to assess attitude toward computers in the classroom. Although the source of the items was not identified, some were taken from Ahl (1976) and Smeltzer (1981). The item response categories ranged from strong agreement (1) to strong disagreement (7). Attitude and attitudinal object were defined; however, the researcher was not consistent in referring to the attitudinal object throughout the study. The researcher reported that validity and reliability of the instrument was determined in a pilot study by administering the instrument to teachers from a non-participating building on two occasions. Fourteen teachers responded on one occasion and 12 on the other. Test-retest reliability was reported as 0.76. It was reported

that validity was determined by an item analysis in which the mean of each item was compared to the midpoint on the response scale. Those near the midpoint were reworded because their intent was ambiguous and unclear. Two items were added as a result of questions raised during discussions with respondents. Construct validity was determined by factor analysis, although factors were not identified prior to analysis. Thirteen items loaded on six factors; however, only two factors loaded three or more items.

The instrument was administered to 200 randomly selected teachers from 483 teachers representing all grade levels in Metropolitan Detroit. Subjects reporting computer experience were assigned to an experimental group, and those without computer experience were assigned to the control group. Hoyt's estimate of reliability was reported as 0.79. Teachers in experimental group were reported as having significantly more favorable attitudes toward computers ($p < .05$) than teachers in the control group. Teachers who had computers in their classroom had significantly better attitudes ($p < .05$) than teachers who did not have computers in their classrooms.

Bannon et al. (1985) modified the scale developed by Ahl (1976) as a part of a study to validate cognitive and affective scales for assessing computer attitude among students, teachers, educational administrators, and other educators. The modified scale consisted of 11 items drawn from Ahl and six items developed by the researchers. Nine of the items were categorized as cognitive and eight as affective. No information was provided on how the 11 items were selected, how the six items were developed, or how it was determined that the items were cognitive or affective. The research report did not provide information concerning the validity. The scale was administered to 1811 students and 714 educators. Factor analysis revealed two factors, the first being defined by seven cognitive items with loadings ranging from 0.34 to 0.61. All of these items were judged to be positive attitude statements. The second factor was defined by seven affective items with loadings ranging from 0.30 to 0.67. All of these items were judged to be negative attitude statements. The alpha coefficient reliability of the first and second

factors was reported as 0.920 and 0.896, respectively. Mean scores of 8.02 and 17.06 were reported for the cognitive and affective factors. From these data, it was suggested that the students and educators had positive cognitive attitude and a tendency toward rejection of negative affective attitude.

Lin (1985) used the attitude scales developed by Ahl (1976), Lichtman (1979), and Ellsworth and Bowman (1982) as partial sources for developing a 75-item Likert-type instrument and 57-item shorter version of the instrument to measure computer anxiety. The 75-item instrument was made up of four parts, one of which was reported to have included 20 items to measure attitude toward computers. The coefficient alpha was reported as 0.96 for the 75-item version and 0.95 for the 57-item version. Computer anxiety was defined as a negative attitude or behavior when considering the application or actual use of computers. Several versions of the computer anxiety scale were developed. The first involved the selection of 91 items using anxiety theory and content analysis from a pool of 300 items. Seventy items were rated as appropriate and plausible by 18 faculty members, and five new items were added, resulting in a version containing 75 anxiety and 25 demographic items. The item scale value was reviewed by 49 graduate students and faculty. In a pilot study, 116 responses from students in a programming and an education class were item and factor analyzed. The instrument was field tested, and the responses of 975 high school, community college, and university students were item and factor analyzed. Six factors were identified accounting for 88.2% of variance. The factors did not match the domains of the original anxiety theory or factors identified in the pilot study. The instrument was shortened to 57 items, and the remaining computer attitude items were distributed throughout the six factors. The researcher concluded that the research suggested the use of six dimensions as principal components of a computer anxiety model.

In a study conducted to assess computer literacy among Minnesota junior and senior high school students, Anderson, Klassen, Krohn, and Smith-Cunien (1982)

developed two instruments, one for grade 8 (Form 8) and one for grade 11 (Form 1), to measure five cognitive and one affective dimensions of computer literacy. The affective dimension was defined as attitude and values toward computers. Form 1 contained 30 affective items while Form 8 contained 20 affective items. The study included an investigation of the influence of several block variables, including person, school, and family, on the development of computer literacy. Information was collected on a wide variety of courses, involving computers, from throughout the country. The course materials and other published materials were used to construct a list of objectives reflecting six dimensions of computer literacy, five cognitive and one affective. After several revisions, the objectives were circulated to a national advisory panel of specialists representing professional computer societies, industry, and education. A final revision was made based on the advisory panel's recommendations. Some of the objectives were designated as core objectives, and items were written to represent these core objectives. The researchers stated that content validity was established in a previous study by a sample of 29 high school teachers, who included computer programming in their course involving computers. They indicated whether or not their course included each of the objectives. However, simply verifying that the objectives were included in the courses did not by itself provide evidence of content validity with respect to whether or not the objectives and associated items were representative of the elements in the domain representing attitude toward computers. Attitude and attitudinal object were defined in the research report. The fact that the affective domain was called attitude and values suggested that the researchers did not utilize a clear and precise definition of attitude. Nevertheless, the items representing the core objectives were administered to 1,131 secondary students. Using the information gained in the previous study (or studies), the researchers produced Form 1 of the Minnesota Computer Literacy and Awareness Assessment.

Form 1 was administered to 2,535 students in grade 11, representing 104 randomly selected classrooms. Form 1 was then modified. Some items were added or deleted, and some were rewritten in order to adapt the reading level to the junior high school level. The modified instrument, Form 8, was administered to 3,615 students in grade 8, representing one mathematics classroom selected by the principal in each of 149 randomly selected schools.

The items in the affective domain in Form 1 and 8 were separately item and factor analyzed, but the results of the item analysis were not used to alter items or eliminate them from the factor analysis. This was unfortunate as there were a large number of neutral responses to items on both forms. Sixteen of 30 items on Form 1 had neutral responses ranging from 25 % to 40 % of total responses per item. Six of 20 items on Form 8 had neutral responses ranging from 27 % to 39 % of total responses per item. Items with a high number of neutral responses do not properly discriminate and possibly distort factor analysis. Alpha reliabilities were calculated for the affective scales of both instruments. The alpha reliabilities of the six affective scales in Form 1 were: (a) enjoyment (0.83), (b) anxiety (0.83), (c) efficacy (0.68), (d) sex-typing (0.78), (e) policy concerns (0.64), and (f) educational computer support (0.76). The alpha reliabilities of the affective scales in Form 8 were: (a) enjoyment (0.81), (b) anxiety (0.64), (c) efficacy (0.60), and (d) educational computer support (0.66).

Regression analysis was used to examine the effects of three blocks of variables, person school and family on computer literacy. The following was among the findings reported for the affective domain of computer literacy:

1. For grade 11, affective computer literacy was most influenced by attitude toward mathematics and science, with mathematics being the strongest predictor.
2. For grade 8, aspiration for a computer-related career was the strongest predictor of affective computer literacy.

3. Students that had been exposed to computers were slightly more positive in their attitude toward computers.

4. Students in grade 8 and 11 enjoyed computers and learning about computers, although there was some uncertainty in their feeling as evidenced by the high portion choosing the undecided response. They were not confident in their ability to deal with computers, not found to have anxiety regarding computers, and had positive and supportive attitude toward the use of computers in education.

5. Students in grades 8 and 11 were not found to have anxiety regarding computers.

6. The family had a greater total effect than school on affective computer literacy at both grade levels.

7. For grade 11 students, the effect of person on affective computer literacy was smaller than that of family.

8. For grade 8 students, the effect of person on affective computer literacy was slightly higher than family.

The affective scale developed by Anderson et al. (1982) influenced the development of scales by several researchers. These included Elkins (1985), Smith (1986), and Bluhm and Kishner (1988).

Elkins (1985) developed 20 Likert-type survey items based on the research by Anderson et al. (1982) and literature concerning teachers' fears of uses and misuses of computers to determine attitude of special education personnel toward computers. There was no attempt to determine either validity or reliability. The attitude scale was mailed to 62 special education teachers and teacher aides. Thirty-nine special education teachers and eight teacher aides responded to the survey. The responses for each item were collapsed into two response categories. Data were analyzed and interpreted in percentages for each item. It was reported that the special education personnel indicated an interest in using computers with teachers being more interested than teacher aides.

Teacher aides had less positive attitude toward the use of computers in education than did special education teachers.

Smith (1986) investigated computer attitude of students and teachers, efficacy or confidence, and sex-typing in relation to sex, grade-level, and teacher influence. She used two of the affective scales, efficacy and sex-typing, from Anderson et al. (1982) with a total of 10 items, five items per subscale. She explained that the efficacy scale was chosen because of its relationship to enjoyment, anxiety, and educational computer support. The sex-typing scale was chosen to measure attitude reflected in the documentation of computer access and usage. She reported that content validity had been determined by correlation of objectives related to courses with computer content and test items. Internal consistency, and reliability had been reported as high, with the efficacy scale showing an alpha reliability of 0.68 at grade 11, and 0.60 at grade 8, and with sex-typing scale showing an alpha reliability of 0.74 at grade 11. However, validity and reliability had been determined by Anderson et al. (1982) for grades 8 and 11, while she used them with students and teachers, representing grades 1 through 12. In addition, Anderson et al. (1982) dropped the sex-typing scale from grade 8 and listed five but used only four of the items in the sex-typing scale in grade 11 when establishing reliability of the affective scales.

The instrument was administered to 318 students (179 female, 139 male) and 173 teachers (109 female, 37 male). However, when the numbers of female and male subjects in the teacher group were added, the result was 146 instead of 173. As a result, the number of samples should have been reported as 464 instead of 491. Students questionnaires were administered by the researcher with the procedure varying according to the age level of the students. After the data were collected, combined efficacy score and sex-typing score were created. Two three-way analysis of variance were performed using the combined efficacy scale score and the combined sex-typing score as dependent variables. The three independent variables were grade level, group, and sex. The

following results were reported: (a) elementary students scored significantly higher on efficacy scale than junior high students or high school students, (b) students showed a higher level of confidence than did teachers, and (c) females were significantly higher than males on the scale with higher scores showing attitude that supported beliefs that the sexes had equal competencies and potential for computer careers, while lower scores seemed to show attitude that males were superior to females in computer and science abilities and careers. Using regression analysis, it was found that teacher efficacy scores were significantly and negatively related to student efficacy scores, and teacher scores were significantly and negatively related to student scores.

Bluhm and Kishner (1988) modified Elkin's (1985) computer attitude scale to measure attitude toward computers among school counselors. The modified scale consisted of 20 Likert-type items. Why the instrument was modified and how the items were classified into the new categories were not discussed. There was no information provided on validity and reliability. However, the researchers stated that in the pilot testing of the scale a high correspondence between the initial and subsequent responses was found. If any changes were made in the instrument as a result of the pilot testing, they were not reported. The instrument was mailed to 130 elementary and secondary counselors from five urban and suburban Utah school districts representing 53.8 % of the state's counselors. The strongly agree and agree responses were combined, as were those for strongly disagree and disagree responses. Percentage of responses were calculated for each item. It was concluded that counselor attitude on the three subscales were positive.

Taylor and Parrish (1978) developed a 13-item survey to determine the use of and attitude toward programmed instruction and computers in public school and college music education. The report contained no information on instrument development nor any detail on validity and reliability. It appeared that only one question was used to determine attitude toward computers. The survey was sent to 1180 public school districts

and 233 music departments of colleges and universities. Five hundred and thirty-eight public school districts and 108 music departments returned the survey questions. Data were analyzed using percentages for each of the response categories. It was reported that attitude toward computers was positive, although many respondents were uncertain of their use in music education.

Stevens (1980) developed and used the Computers in Education Survey (CES) to assess knowledge and attitude of K-12 teachers, teacher educators, and student teachers. Attitude and attitudinal object were not defined. Several items were included in tables, but it could not be determined if the tables included all of the items in the instrument. It could not be determined which items were used to assess attitude. No information was presented on scale development, validity, or reliability. Attitude was not defined. The CES was administered to 1,206 randomly selected Nebraska K-12 teachers, all student teachers and staff members of UNL Teachers College. Responses were received from 657 K-12 teachers, 79 teacher educators, and 227 student teachers. Percentages for each scale were computed for each question. It was concluded that the computer anxiety of teachers was higher than that of student teachers or teacher educators. All three groups of subjects agreed that being around computers produced less anxiety than listening to people talk about computers. It was reported that more participants were agreeable than disagreeable to using computers as instructional tools.

Stevens (1982) replicated an earlier study (Stevens, 1980) in order to assess computer knowledge and attitude and to compare the results between the two studies. Responses were received from 714 K-12 teachers, 183 student teachers, and 88 teacher educators. Percentages and a one-way analysis of variance were used to analyze data and compare results of the two studies. The participants in the 1982 study were found to be significantly more knowledgeable about computers ($p < .05$) and computer usage ($p < .01$) than those in the earlier study. There were no significant changes in attitude toward computers.

Woodrow (1987) modified a scale developed by Stevens (1982) and used it to measure and compare educators' attitude and predisposition toward computers. The modified scale consisted of 15 Likert-type items. Eleven items were from Stevens and four were developed by the researcher. No information was provided on validity and reliability. Attitude and attitudinal object were not defined. The scale was administered to 58 teachers, the entire staff of one secondary school, and 89 student teachers. The teachers were selected because they were positively oriented towards the educational use of computers. The school staff adopted and implemented a computer application program that was developed at the school. The student teachers were chosen because they all had positive attitude towards the educational applications of computers as evidenced by their enrollment in an elective computer education course. Percentages for each item were computed. A one-way analysis of variance was used to examine differences between the responses of participants in Stevens' (1982) and Woodrow's study. The results showed that the participants in Woodrow's study had significantly more positive attitude toward computers ($p < .05$) than did the participants in Stevens' study.

Reece and Gable (1982) developed the Attitude Toward Computers, a 30 item Likert-type scale to measure attitude toward computers. Thirty-six item stems were written based upon Triandis' (1971) statement that attitude had three components: cognitive, behavioral, and affective. In an attempt to establish content validity, the 36 item stems were edited and assigned to one of the three attitude components by five judges made up of school psychologists and university professors. However, editing and assigning items to one of three components did not ensure content validity. It was simply a technique to ensure proper categorization of items. Thirty items were selected, 16 negative and 14 positive, 10 representing each of the attitude components. Construct validity was reported as being established by factor analyzing the responses of 172 eighth and 61 seventh grade students. An item analysis was not conducted prior to factor

analysis. At least two of the items in the cognitive component were factual, and factual items do not tend to discriminate among respondents with positive and negative attitudes. The remaining eight may have been factual as well, but this could not be determined because they were not listed in the study. As a result of the factor analysis, 10 items were identified in the first factor and labeled as a measure of general attitudes toward computers. These 10 items included four previously categorized in the behavioral, five in the affective, and one in the cognitive component. The remaining 20 items were distributed across eight other factors without any one factor having enough items load to afford a meaningful and reliable interpretation. The alpha reliability of the 10-item general attitude scale was reported as 0.87.

Offir (1983) used observations, formal and informal interviews, and a questionnaire containing Likert-type items to measure attitude of teachers and students towards the use of computers in the classroom. Information on instrument development, reliability, and validity was not provided. The questionnaire was not available in the research report. Observations consisted of videotape recordings of students studying with computers. The videotapes were analyzed by a panel of judges. However, no information was provided on how the analysis was conducted and whether or not interobserver agreement was established. Attitude and attitudinal object were not defined.

Twelve instructors and 33 students participated in the formal interview. The informal interview involved 12 instructors and 39 students. The observations were made of students in 14 physiology lessons and in six tutorial lessons. The questionnaire was administered to 193 students as a pretest and posttest. Sixty students were in a test group who studied with the aid of a computer, while 133 students in a control group studied without the aid of a computer. Information on assignment to group and data analysis were not provided. It was concluded that instructors had positive attitude toward

computer use in the classroom, but students were not as enthusiastic about using the computer in the classroom.

A questionnaire consisting of 20 Likert-type items was developed by Griswold (1983) to measure estimates of computer awareness. Attitude was not defined. How the items were generated and the validation process were not mentioned. An alpha coefficient was reported as 0.75. The scale was administered to 119 education undergraduate and graduate college students. A composite score (CA) was created by summing the responses to the 20 items. Intercorrelations and multiple regression analyses were used to examine possible relationships between CA and age, sex, scores on a arithmetic quiz, number of mathematics courses taken in college, and scores on an internal-external scale, which measured locus of control. It was reported that CA correlated significantly with locus of control (-0.35), age (0.24), and arithmetic skill (0.30). The locus of control measure was reported to be the best predictor of computer awareness, accounting for 8.3 % of the variance, followed by age (6.6 %), sex (3.9 %), and number of mathematics courses taken in college (4.1 %).

In the second study, Griswold (1985) used the same attitude scale and evaluated the degree to which favorable attitude toward computers was related to college major or student individual differences. It was reported that attitude about computers had been operationalized by the 20-item questionnaire (Griswold, 1983). A composite score (COMP) was created by summing the 20 item ratings. Cronbach alpha was reported as 0.82. The instrument was administered to 207 students majoring in education and 210 majoring in business. In addition, subjects were asked to complete a 10 item arithmetic test, indicate the number of mathematics courses taken in high school and in college, and complete the internal-external scale. After the data were collected, the percent of education and business majors responding positively to each item of the attitude questionnaire was computed. Means, simple correlation and a multiple regression were computed. Business majors were found to respond significantly more favorably than

education majors on 9 of 20 items. Females were reported as having less favorable attitude, being more external, and having less college math than males. Age was found to be the best predictor of attitude, followed by major, locus of control and number of college mathematics courses. Sex and number of high school mathematics courses were found not to be significant predictors of attitudes toward the computers. It was concluded that education majors had less favorable attitude about computers than business majors even after the relationships of selected individual differences were taken into account. According to the researcher, the results suggested that individual differences not controlled in the study accounted for the negative attitude of education majors.

Some of the shortcomings of the scale developed by Griswold (1983, 1985) and method of construction already have been reported. Additionally, the researcher defined attitude and differentiated it from beliefs; however, throughout the two reports, he used attitude interchangeably with other constructs such as computer awareness and opinion. The items in the instrument reflected this failure to be consistent. Also, in the 1985 study, he stated that attitudes about computers were operationalized by what the instrument measured. An operational definition did not ensure validity. He provided no evidence that an attempt was made to establish validity.

Norris and Lumsden (1984) developed three Likert-type attitude statements representing varying degrees of functional distance between computers and educators being surveyed. Validity and reliability of the instrument was not mentioned in the report. Bohrnstedt (1970) pointed out that three item scales were rarely reliable. The instrument was administered to 450 public school educators. Two-tailed t test was used to determine the differences between proportions on each item. Strongly agree and agree were collapsed for purposes of data analysis. Educators were found to be highly positive in their attitude toward educational computing in general. Distance was found to be

operating. Their attitudes were less positive the closer the computer was to their experiential world of practice.

Loyd and Gressard (1984) developed the Computer Attitude Scale (CAS), a 30-item Likert-type scale to measure attitudes toward computers. The instrument was divided into three 10-item subscales by a panel of judges from an original pool of 78 items. Details on item development and criteria for selection were not available. Attitude and attitudinal object were not defined. Item analysis was not conducted prior to factor analysis. The CAS was administered to 155 students in grade 8 through 12. Total scores were calculated by summing the three subscale scores. The coefficient alpha reliabilities of the three subscales and the CAS were found to 0.86, 0.91, 0.91 and 0.95, respectively. A principal component analysis with varimax rotation was performed. The researchers concluded that the scores of the three subscales were stable enough to be used as separate scores, and shared a large amount of common variance. In addition, the total score based on the three subscales represented a general attitude toward computers score.

Loyd and Loyd (1985) conducted a study to obtain factorial validity and reliability of the four subscales of the CAS. Apparently, a usefulness subscale consisting of 10 items was added to the existing three 10 item subscales of the CAS. No information was provided on how the subscale was constructed. Attitude and attitudinal object were not defined. The scale was administered to 114 teachers in grades K to 12. Coefficient alpha reliabilities of the four subscales and the total scale were found to be 0.90, 0.89, 0.89, 0.82, and 0.95, respectively. The principal component analysis with varimax rotation revealed three factors which accounted for 48 % of the total variance. Rather than conclude that the instrument was not factorially valid, the researchers concluded that two of the subscales measured the same trait for this group of teachers, because of the high correlation (0.83) found between computer anxiety and confidence subscales. An analysis of variance for each subscale was performed with computer

experience as an independent variable. It was concluded that attitude toward computers seemed to be related to amount of computer experience.

Gressard and Loyd (1986) replicated their earlier study (Loyd & Gressard, 1984) for the purpose of validating the CAS. The instrument was subjected to two studies. In the first, 192 elementary, middle, and secondary school teachers were administered the instrument. The coefficient alpha reliabilities of the three subscales, and the total scale were found to be 0.89, 0.89, 0.89 and 0.95, respectively. Factor analysis revealed three factors which accounted for 54 % of the total item variance. It was concluded that the findings supported the earlier study.

In the second study, 70 of the 192 teachers who participated in the first study were selected for the purpose of analyzing the results of a preprogram-postprogram administration of the CAS to determine the effectiveness of the scale in reflecting change in computer attitudes as a result of computer instruction and experience. The results of a t test for each of the three subscales with the independent variable being experience showed that teachers were significantly less anxious ($p < .05$), and more confident ($p < .05$) in using computers after the program than before. No significant difference was found for the computer liking subscale. It was concluded that the CAS was sensitive to attitude changes resulting from computer instruction and experience.

Woodrow (1990) developed the Computer Attitude Index Battery (CAIB) by combining subscales and/or items from instruments developed by Loyd and Gressard, (1984), Anderson et al. (1979), and Reece & Gable, (1982). The response categories of the subscales adopted from Loyd and Gressard were changed to match the response categories of the other items adopted from the other two scales. An unconvincing argument was made for validity based on comparisons of results obtained in the study of correlations between the adopted subscales and means, standard deviations, and alpha coefficients of the subscales to results obtained by the researchers, who originally

developed the instruments from which the CAIB was derived. The argument also falsely assumed that validation had been achieved by the original developers of the scales.

The CAIB, demographic questions, and a scale to measure perceptions of locus of control were included in a questionnaire and administered to 115 preservice teachers who were enrolled in an introductory computer literacy course. Responses to the questionnaire resulted in seven locus of control measures and a Computer Attitude Index for each subject. The Computer attitude index was calculated as a weighted sum from the responses CAIB. Data were analyzed by correlation and multiple regression. It was reported that computer attitude did not significantly correlate with gender, age, computer experience, or word processing experience. Externally-oriented preservice teachers were found to be more positive in their attitude toward computers than internally-oriented preservice teachers.

Stone, Kemmerer, and Gueutal (1984) investigated the relationships between belief and attitude toward computer-based information systems and rigidity and self-esteem. The instruments consisted of (a) self-esteem scale, (b) rigidity scale, (c) computer-related belief scale, and (d) computer-related attitude scale. The computer-related belief and attitude scales were apparently developed by the researchers, although this was not clear in the report. The computer-related attitude scale consisted of 10 Likert-type items with seven-point response categories. The computer related belief scale consisted of 21 Likert-type items with similar response categories. Coefficient alpha was reported for the two scales as 0.85 and 0.86, respectively. Instrument development was not discussed. Validity was not mentioned. Attitude and attitudinal object were not defined. Data were collected from 23 subjects in a collective-bargaining agency. Case files had been changed from manual to computerized. It was found that rigidity was negatively correlated to computer-related attitude ($r=-.38, p<.05$) and to computer related belief ($r=-.63, p<.01$), although this was not substantiated with multiple

regression. Self-esteem was not found to be significantly related to computer-related belief or attitude.

Moe (1984) developed a Likert-type scale to examine relationships between a number of variables and attitude of school age students toward computer utilization. The instrument was adapted from two sources: Attitude Toward School, K-12 (Instructional Objective Exchange, 1972) and Conducting Educational Research (Tuckman, 1972). The instrument was reviewed by a panel of three judges for content validity and by three professors for readability, capability to measure what it was designed to measure, and suitability for students in the particular school system. The items were organized into the five subscales, although five items were omitted from any subscale without an accompanying rationale. Attitude and attitudinal object were not defined. Reliability was not mentioned. There was no apparent attempt to pretest the instrument or conduct an item and/or factor analysis. The instrument was completed by 266 students in grades 4, 9, and 11. Analysis of variance and F test were used in analyzing the data. It was reported that there was no significant difference in attitude toward computer utilization by sex and residence status. Students in grade 4 had the highest, while those in grade 11 had the lowest, attitude toward computers.

Holder (1984) measured general attitude toward computers as part of a study to determine how business education teachers felt about computers, how much and what kind of equipment they needed, and what type of training they required. Eight statements were devoted to business education teachers' attitude toward the computer and training needs. It appeared that only two items measured attitude toward computer use in general. No information was provided about the validity and reliability of the questionnaire. The questionnaire was administered to 106 business teachers from randomly selected secondary vocational and business education programs in Nebraska. The responses of the attitude questionnaire were computed using percentages with respect to agree or disagree. Business teachers were reported to have had very positive

attitude about the computer, as well as a desire to learn more about it. The two attitude statements, (a) working with computers would make me feel tense and (b) I enjoy using computers in my class, were compared to the number of years of teaching and the amount of training. Using chi square, the number of years of teaching was not found to be significantly different at the 0.01 level with respect to the enjoyment of using the computer in the classroom. The feeling of tension in using the computer was found to be significantly related to the amount of training received ($p < .01$). A significant relationship ($p < .01$) was found between training and enjoyment using the computer. It was reported that those persons with training were comfortable with the computer and felt confident when using it in the classroom.

Kammire (1984) developed the Computer Attitude Questionnaire (CAQ) to measure attitude toward computers in the workplace. A pilot instrument, the Attitude Toward Computer Questionnaire (ATCQ), consisted of 50 Likert-type items gathered from a literature review, interviews, review of related attitude instruments, and data gathered from two survey questionnaires. The ATCQ was administered to 329 people drawn from intact groups. The results of the statistical analysis of the data were utilized in constructing the Computer Attitude Questionnaire (CAQ). The CAQ included 100 items, each categorized as one of three components of attitude: (a) cognitive, (b) affective, and (c) behavioral. The response categories of the first 89 items ranged from very negative to very positive or very low to very high. The remaining items included a variety of response categories. Attitude was not defined, but it was stated that it was composed of the three components. Attitudinal object was defined. Item-total score correlation and emotional intensity were not determined for the items. The instrument did not contain equal numbers of positive and negative statements randomly distributed throughout the scale to control for acquiescence response set. Further, many of the items appeared to be statements of opinion rather than attitude. Validity was examined using the following procedures: (a) identifying the three components of attitude and a priori

factors and researcher using matrices to determine if items were representative (content validity), (b) identifying a priori factors and exploratory factor analysis (construct validity), (c) submitting pilot instrument to a panel of judges (face validity), and (d) comparing the attitudes of known groups (criterion validity).

The CAQ was administered to 328 subjects selected as intact groups using the procedure for deliberate sampling for heterogeneity. An overall alpha coefficient was reported as 0.86 with subscales ranging from 0.72 to 0.94. Test-retest reliability was found to be 0.91. Factor analysis with varimax rotation revealed 21 factors. Further tests revealed four factors which accounted for 40 % out of the 68 % of the variance accounted for by 21 factors. The factors were (a) impact, feeling and behavioral statements, (b) negative feelings, (c) positive feeling, and (d) behavioral statements. The behavioral factor (four items) was retained, and the items in the other three factors were factor analyzed again, resulting in four new factors. The researcher reported that the series of exploratory factor analysis resulted in five factors made up of 62 items. The manner in which the research was reported made it extremely difficult to identify the factors and associated items. All 100 items were retained, however, in the final instrument. The researcher reported that the exploratory factor analysis revealed that the CAQ had substantial construct validity. Comparisons of subjects' responses by occupation, computer experience, and sex revealed significant differences in all cases as predicted, confirming the test established for the criterion validity of the instrument. Technical people showed more favorable attitude toward computers than non technical; computer users had more favorable attitude toward computers than non-computer users; and men had more favorable attitude toward computers than women.

Foley (1984) used a quasi-experimental research design to determine whether the use of the computer over a period of nine weeks would effect achievement, attitude toward mathematics, attitude toward computers, and class attendance in a general mathematics class. The Foley-Kaylor Adapted Computer Attitude Scale was developed

to measure attitude toward computers. The instrument consisted of 10 positive and 10 negative Likert-type items adapted from the Aiken-Dreger Math Attitude Scale. It was field tested twice, the first on 33 randomly selected teachers and a non random sample of 123 students and the second on 627 high school students from 11 mathematics courses. In the first field test, split-half reliability using teacher scores was reported as 0.96. Reliability using test-retest was determined, but the findings were not reported. Split-half reliability using student scores was reported as 0.98. Students scores in the first field test were used to verify validity. Teachers identified students who had positive and negative attitude toward computers. Students in positive group had a mean of 90.10, while those in the negative group had a mean of 57.82. Based on mean scores, the researcher stated that, assuming the teachers made proper identification, the scale seemed to be valid. The instrument was submitted to a panel of experts who agreed that the instrument should be as valid as similar instruments. It was reported that the results of the second field test were similar to the first. Attitude was not defined, but a definition of the attitudinal object was included in the report. The attitude instrument, along with a math achievement test and attitude toward math test, was administered as pre and posttests to 33 general math students in grades 10 and 11. A non randomized control-group pretest-posttest design was used. The two classes of students were assigned to an experimental (14 students) and a control group (19 students). Treatment consisted of using a personal computer twice a week for nine weeks during the mathematics class. No significant differences were found for attitude toward math, attitude toward personal computer, and attendance.

Yuen (1985) developed an instrument to measure attitude of trade and industrial teachers toward using microcomputers and to examine some factors that influenced the teachers' attitude. A two-part questionnaire was developed. The first measured teacher characteristics. The second consisted of 25 Likert-type items to measure attitude. It was reported that a pilot study was conducted to evaluate, validate, and determine reliability.

Attitude and attitudinal object were not defined. A panel was incorrectly used to determine content validity. Item-total score correlations were calculated. A coefficient alpha was reported as 0.955. Data were collected from 178 trade and industrial teachers who represented 11 randomly selected schools from one state. It was reported that 88 % of the teachers had positive attitude toward computers. Significant positive correlations ($p < .01$) occurred between teacher attitude toward the use of microcomputers in industrial education and microcomputer experience (0.292), microcomputer training (0.219), utilization of microcomputers (0.297), and the availability of microcomputers (0.238).

Yuen (1988) developed another instrument and conducted a second study to determine the availability and use of microcomputers in vocational education and to determine the knowledge, skills, and attitude of vocational teachers toward microcomputers. The second instrument consisted of 41 items, including 20 Likert-type attitude items. The procedure used to determine validity and reliability was exactly the same as in the earlier study. An alpha coefficient was found to be 0.966. Attitude and attitudinal object were not defined. One hundred and twenty-five teachers from 13 randomly selected schools completed the instrument. It was reported that 85 % of the vocational teachers held positive attitude toward microcomputers. Analysis of variance revealed that post-secondary vocational teachers were significantly more positive ($p < .05$) toward using microcomputers than those who taught in secondary vocational schools. Teachers who had microcomputers available of their use at school showed significantly more support ($p < .01$) for their use than teachers who did not have microcomputers available at school. Teachers who received microcomputer training had significantly more positive attitude ($p < .01$) than teachers who did not have training. Teachers in small towns were significantly more supportive ($p < .05$) of using computers than teachers in urban schools.

Wilder, Mackie, and Cooper (1985) conducted two surveys. One was concerned with comparisons of perception of sex-typing and attitude toward computers and video

games between males and females in grades K-12. A second examined differences in attitude toward computers among male and female freshmen from a highly selective coeducational university. An instrument, consisting of 30 items, was developed and used in both studies. Each item was a common object or activity. They were chosen from a list of 50 objects and activities in a pretest on the basis of familiarity to students and representation of a wide range of perceived sex appropriateness. Computers was one of the items. Each item was listed twice with linear response scales, one ranging from male (1) to female (9) and the other ranging from like very much (1) to dislike very much (9). The instruments were not presented in the report. Attitude and attitudinal objects were not defined. Validity and reliability were not mentioned.

In the first survey, the instrument was administered to more than 1,600 students from kindergarten through grade 12 in one school district. The questionnaires were administered individually to kindergarten, first, and some second-grade students by the experimenter. It was found that both sexes and all grade levels perceived the computer as more appropriate to males than did females. Males had more positive attitude toward computers than females, although both sexes reported positive attitude toward computers. Liking of computers decreased over time with females always more negative than males in their attitude toward computers.

In the second survey, the instrument was administered to 334 freshmen in college. It was reported that females saw the computer as slightly more appropriate for females than that of the previous study. Males felt there was no difference in degree of appropriateness. Subjects in this study were found to have more positive attitude toward computers than in the previous study. Although both sexes reported feeling comfortable dealing with computers, females felt significantly less comfortable compared to males ($p < .0001$). Subjects who had high school computer experience were reported to feel significantly more comfortable ($p < .005$) around computers and had significantly more skill ($p < .001$) than the subjects who did not have high school computer experience.

Collis (1985) developed a 24-item Likert-type scale to measure attitude of secondary school students toward computers. A sample of 156 students in grades 8 and 12 responded to a series of open-ended interview questions and sentence completion items. Using this information, a set of 90 statements relating to attitude toward computers, use of computer at home and in school, and stereotypes associated with computer use was identified. Attitude and attitudinal object were not defined. This set of attitude statements was administered in a pilot study to two additional classes of students in grades 8 and 12. The pilot test resulted in an 85-item preliminary instrument. The preliminary instrument was administered to 887 students in grades 8 and 12. Responses were factor analyzed separately for each of the four sex and grade groups. The factor analysis resulted in the retention of 24 attitude toward computer items in the final instrument. An item analysis, including a determination of emotional intensity for each item, was not conducted prior for the factor analysis. The final instrument consisted of these 24 items plus 14 items relating to attitude toward other school subjects and four items relating to experiences with computers.

The final instrument was administered to 1818 students in grades 8 and 12. Factor analysis revealed a dominant first factor relating to attitude toward computers in each of the four sex and grade groups. The factor was labeled as personal interest and enjoyment. Using discriminate function analysis, significant sex differences were found with males being consistently more positive toward computers than females. Significant relationships were found between students' attitude toward computers and their attitude toward mathematics, science, and writing using canonical correlation. Actual correlation were not identified. The relationship between attitude toward computers and computer experience was tested by means of multiple regression. Students who had computer experience were reported as having more positive attitude toward computers than students who did not have computer experience. It was concluded that validity and

reliability were supported by the study, although the reliability coefficient was not in the research report.

Dambrot, Watkins-Malek, Silling, Marshall, and Garver (1985) developed the Computer Attitude Scale (CATT) as part of an investigation to examine possible relationships between computer attitude and a variety of variables. The attitude instrument consisted of 20 Likert-type items, nine positive and 11 negative, which were derived from previous research and observations about peoples' attitude toward computers. However, no information on the previous research and observations were provided in the report. Attitude and attitudinal object were not defined. All items showed a significant item-total score correlation. A coefficient alpha was reported as 0.84. A coefficient alpha of 0.79 was obtained by administering the items to a previous sample of 616 students enrolled in an introductory computer science course. Validity was not discussed in the research report.

The attitude instrument was administered to two groups of volunteers students, 944 from an introductory psychology course and 616 from an introductory computer science course at the university level. Forty-three students in the first group did not complete the instrument, resulting in 901 students, 559 females and 342 males. Five hundred and forty, 198 females and 342 males, of the first group also completed a math anxiety scale three weeks later. All subjects from both groups completed the Computer Aptitude Scale (CAPT), and American College Testing Program Mathematics Test (ACTM) to determine computer and mathematics aptitude. Scholastic achievement was determined by utilizing high school and college GPA. It was reported that females were more negative than males in their attitude toward computers. They were lower on a test for computer aptitude and did not have as much of the prerequisite math experience and aptitude required for computer usage. The sex differences were small but significant. Computer attitude was related to computer aptitude, computer experience, and math

anxiety. However the selected predictors did not explain much of the variance in attitude.

Vermette, Orr, and Hall (1986) developed a 22 Likert-type item survey to measure attitude of elementary school students and teachers toward computers in the classroom. This was an excellent example of an investigation in which an instrument was developed, but the entire report was devoted to analyzing the data resulting from the administration of the instrument. The theoretical construct and attitudinal object were not defined. There was no information on the validity, reliability, source of items, or any aspect of instrument development. The instrument was administered to 116 elementary school students (59 males and 57 females) from grades 3, 4, 5, and 6 and 50 elementary school teachers (13 males and 37 females) from kindergarten through grade 8 plus two resource teachers. There were no details on how subjects were selected. Comparisons were made by means of percentage of response for each item. It was reported that teachers and students seemed to hold positive attitude toward computers, although both groups were negative about the effects of computerization on them personally. Using Chi square, the proportion of students and teachers that responded "agree a lot" were reported to differ significantly on 12 of 22 items. The table presenting the results of the analysis showed significant differences between the groups on 10 of 22 items. It was reported that differences of opinion between the groups were generally not widespread. Significant sex differences in attitude toward computers between students and teachers were not found.

Rafaeli (1986) developed a Likert-type scale to measure employees' attitude toward working with computers. Attitude was not defined; however, a hypothesized model of the relationship of employees' attitude toward working with computers was provided. The initial instrument consisted of 20 brainstormed items which were pretest on 75 white collar employees. The analysis did not include a determination of emotional intensity of the items prior to factor analysis. Factor analysis with varimax rotation

revealed two factors, positive (five items) and negative (four items), and resulted in a final instrument containing nine items. A relatively low alpha coefficient for the two factors was reported as 0.80 and 0.64, respectively.

The nine-item scale was administered to 284 white collar employees from three manufacturing organizations. The researcher reported that factor analysis was used to verify construct validity. The same factors were revealed as those found in the pretest, although the results of the second factor analysis were not presented. Analysis of variance revealed no significant difference in attitude toward working with computers and usage of computers among age, education, and tenure of the employees. Women's attitude were found to be more positive ($p < .01$) with fewer negative attitude than men ($p < .05$). It was concluded that the findings supported the importance of experience in working with computers, job involvement, and organizational commitment as correlates of attitude toward working with computers.

Whitfield and Bishop (1986) developed an instrument which included a measure of attitude toward computer use. Attitude and attitudinal object were not defined. It was inferred from the reported findings that the items were Likert-type. The researchers did not provide a description of the instrument or its development. A reliability coefficient was not reported. They also did not provide any reference to where this information could be obtained. The entire reported was devoted to a description of the sample and findings. It appeared that the researchers did not realize that instrument development was an important aspect of the study. The stated purpose of the study was to determine the attitude toward and awareness of computers of college faculty relative to that of high school seniors. Responses to the questionnaire were received from 249 college faculty and 588 high school seniors. The two groups were compared on (a) use of computer, (b) attitude toward computer use, (c) self-rated computer competency, and (d) non-technical computer literacy. It was reported that college faculty and high school seniors did not

differ significantly on attitude toward computer use, use of computer, and computer competency.

Harmon (1986) developed the Teachers' Attitude Survey, consisting of 27 Likert-type items, to measure teachers' attitude toward the use of microcomputers in business education. It was reported that a panel of experts assured validity by reviewing the instrument and reaching consensus on the content and format. Test-retest reliability was reported as 0.933. The survey was mailed to every business teacher at 200 randomly selected high schools. Two hundred sixty-seven teachers responded to the survey. The survey had not been pilot tested. If any type of item analysis was conducted, it was not reported. Unidimensionality must have been assumed as an overall mean score was reported to be 1.97. Overall attitude of business education teachers toward microcomputers in the classroom was found to be positive.

One study stands out among all the rest. Abdel-Gaid et al. (1986) reviewed the literature and designed a 15-step systematic procedure for constructing Likert-type attitude scales which included logical and psychometric tests for reliability, content and construct validity, and unidimensionality. Then the procedure was used to construct a scale for measuring teachers' attitude toward microcomputers. They began with an attempt to define the attitude object, teachers' attitude toward microcomputers, by identifying and stratifying two factors from the literature. The factors and their substrata follows: " (1) The effective use of microcomputers with (a) students and (b) teachers. (2) The skills of teachers at (a) computer programming and (b) application of computers to learning and teaching (p. 825)."

Seventy trial statements, half negative and half positive, were generated from literature, individual members of the target population's descriptions of feelings about the object, and researcher's experience with the attitude object. The researchers stated that the statements were written in such a way as to capture the shades of meaning associated with the attitude object strata. The 70 trial statements were administered to 281

preservice and inservice elementary teachers. The data generated were subjected to Likert's item analysis. The number of statements was reduced to 23 positive and negative statements by selecting only evaluative statements using the emotional intensity procedure suggested by Shrigley and Koballa (1984). The remaining items were subjected to a check for homogeneity. An alpha coefficient was reported as 0.89. Content validity was tested by means of factor analysis. After checking for factor stability, only 10 of 23 items clustered on two factors, five items for each factor. One factor had been previously identified as microcomputer effectiveness in the definition of the attitude object. The second factor, called computer literacy, was not previously identified.

Construct validity was reported as being accomplished by correlating the scores of 64 subjects on a mathematics attitude scale ($r=.20$) and a reading attitude scale ($r=.02$) with scores on the computer attitude instrument. Further testing of construct validity was accomplished by correlating grade level preference and number of computer courses taken with scores on five statements which factored as computer literacy statements. They assumed that there would be a negligible relationship between grade level preference and each of five items in the computer literacy factor and a stronger relationship between the five items and number of computer courses taken. They reported that four of the five items correlated as predicted. The conclusion was reached that the 23-item scale had a high degree of reliability and validity for testing the attitudes of preservice and inservice teachers toward the use of microcomputers in the classroom.

The research by Abdel-Gaid et al. (1986) deserves recognition, because it was the only investigation which proposed a comprehensive, rationale, precise, and clear theoretical plan to construct a valid and reliable instrument to measure attitude toward microcomputers and then used that plan in the construction of an attitude instrument. It did, however, have several shortcomings. One of the most important steps identified by Mueller (1986), Bohrnstedt (1970), and Gardner (1975a, 1975b) for constructing an

attitude instrument was left out. They did not include a definition of attitude. Not only should attitude have been defined, but its distinctiveness from other psychological constructs such as belief, value, opinion, and interest should have been established (Mueller, 1986). This clearly must have been an oversight as Shrigley et al. dealt with these points in another article in 1988.

A second shortcoming was that the attempt to establish content validity was questionable and not convincing. Attitude was not defined. The attitudinal object was defined, but its meaning was vague. How the boundaries of the attitudinal object were determined and stratified was not clear. They also did not show how the items captured the various meanings of the theoretical construct and attitudinal object domains. And, only five of the 23 items factored as predicted.

A third shortcoming indicated the test for construct validity was weak. A correlation between the microcomputer attitude scale and mathematics attitude scale was only 0.20. Only four of five items in the computer literacy factor correlated as predicted with grade level preference and number of computer science taken. Apparently, additional relationships between the individual items in the computer effectiveness factor and other variables were not investigated.

Delcourt and Lewis (1987) developed the Adults Attitudes Toward Computers (Adult ATC) instrument to measure attitude toward computers. An original instrument was revised and expanded to include a measure of anxiety. The revised instrument was reviewed by teachers and students in the target population. The resultant scale consisted of 21 Likert-type items, six negative and 15 positive. Attitude and attitudinal object were not defined. The source of the items was not identified. Item analysis, including the determination of emotional intensity, was not conducted prior to factor analysis. A section of the report was called content validity, but it contained no data on how content validity was accomplished. The Adult ATC was administered in a pilot study to 103 females and 23 males in an undergraduate education course. The data were subjected to

factor analysis, and three factors were identified which consisted of 15 items and accounted for 71.3 % of variance. They were (a) general interest, (b) usefulness, and (c) anxiety. The final instrument consisted of the three identified factors. An internal consistency for the entire scale was reported as 0.93 with subscale values of 0.87, 0.88, and 0.82, respectively.

Popovich, Hyde, Zakrajsek, and Blumer (1987) developed the Attitudes Toward Computer Usage Scale (ATCUS) to assess how people react to using computers and computer-related mechanisms. The development of the ATCUS involved two studies. The first involved item development, estimates of internal consistency, and test-retest reliability for 40 Likert-type items developed from a literature review and pilot survey. Attitude and attitudinal object were not defined. An estimate of convergent construct validity was obtained by correlating the ATCUS with two attitude questionnaires developed by Zoltan and Chapanis (1982). In addition, the ATCUS was used to investigate the relationship between attitude toward computer usage and gender. The ATCUS and the other two questionnaires were administered to 365 volunteer, undergraduate students enrolled in a general psychology class. The alpha reliability of the ATCUS was reported as 0.88. Two weeks later, the opportunity to retake the test was posted and 44 subjects responded. The responses to the ATCUS were factor analyzed using a principal components factor analysis with varimax rotation. Five factors were identified, which included 20 items, accounting for 37 % of variance. It was concluded that the 40-item ATCUS was a reliable scale with some evidence of convergent validity provided by its significant relationship with Zoltan and Chapanis (1982).

In the second study, the 20-item ATCUS was administered to 351 undergraduate psychology students. The subjects were also asked to give an estimate of how anxious computers and computerized machines made them feel, using a 5-point rating scale with response categories ranging from very anxious to not anxious at all. Five days later, the opportunity to retake the test was posted and, 47 subjects responded. ATCUS scores

were correlated with the other variables, including college computer courses, hours per week on a computer, college mathematics courses, and computer anxiety. A comparison was also made between males and females ATCUS scores. The researchers reported a 0.84 alpha reliability and a test-retest correlation of 0.91. Four factors were identified accounting for 47.7 % of the total variance. Significant sex differences were found with females responding more negatively to computers than males. It was concluded that the ATCUS was a reliable instrument for assessing undergraduate students' reactions to computers.

Brown, Brown, and Baack (1988) used the ATCUS developed by Popovich et al. (1987) to determine the instrument's factor structure for elderly adults and to compare this with the factor structure obtained with college-age students. Four of the questions from the original questionnaire were modified so that the wording would be more appropriate for the older group. The researchers reported that they believed that the changes did not substantially change the meaning of the items. Validity was not considered in the report. The modified instrument was administered to 122 selected senior citizens with an average age of 77 years. A reliability coefficient was not reported. Factor analysis revealed six factors accounting for 62 % of the variance as compared with 47.7 % for the four factors obtained by Popovich et al. (1987). It was reported that the reasons for the differences in the two-factor patterns were not readily apparent. They suggested the need to include adults of all ages when developing a computer attitude instrument.

Baack, Brown and Brown (1991) modified the 20-item Attitude Toward Computer Usage Scale (ATCUS) developed by Popovich et al. (1987) in order to compare attitude toward computers between older adults and young adults. The researchers did not concern themselves with validity or reliability. However, they mentioned that when the instrument was first developed to measure college students' attitude toward computers, it had an internal consistency coefficient of 0.84. The

instrument was administered to 235 young adults and 184 older adults. The average age of young adults was 22.4 years, and the older adults was 73.6 years. They concluded that the young adults revealed more positive attitude toward computers and computer applications than did the older adults.

Norales (1987) developed a 21-item Likert-type questionnaire to determine postsecondary students' attitude toward computers. Information was not provided on how the items were developed nor on validity and reliability. A review of the instrument revealed that the researcher did not have a clear and precise definition of attitude in mind while constructing the items. The attitude instrument was administered to 109 freshman and sophomore students enrolled in an introductory course on information systems at the university level. Responses to the strongly agree and agree categories were combined as were responses to the strongly disagree and disagree categories. A rationale for combining the response categories was not provided. The researcher reported that the data were analyzed by calculating the percentage of students in agreement with items. It was concluded that male and female students had positive attitude toward computers.

Bear, Richards, and Lancaster (1987) developed a Likert-type scale to measure the computer attitudes of students in grades 4 through 12. The initial scale, Bath County Attitude Survey (BCCAS), contained 38 Likert-type items. The theoretical construct and attitudinal object were not defined, and no mention was made as to how the items were generated. The 38-item instrument was administered in a pilot study to 392 students in grades 4 through 12. The students were divided into two groups as follows: (a) grades 4 through 6 and (b) grades 7 through 12. The responses for the two groups were factor analyzed separately. Data from the factor analysis were not presented. It was reported that the instrument was judged to be unidimensional because of the high proportion of total variance accounted for on the first unrotated component for both groups (37.4 % and 30.5 %) and failure to generate an interpretable pattern on the various rotated solutions. A revised scale was constructed consisting of 26 of the 38 items with the

highest corrected item-total correlations. The alpha reliability of the revised instrument was reported as 0.94.

The revised BCCAS was administered to 551 students, 276 boys and 175 girls, in grades 4 through 12. All students completed a survey of computer experience and usage, educational and career plans, and favorite school subjects. A measure of attitude toward school subjects was administered to the elementary school students. These measures and the predicted direction of the relationship to the attitude toward computers scores were provided as a means of validating the BCCAS. One-way analysis of variance revealed that elementary school students scored significantly higher on the BCCAS than the secondary school students. But there was no significant difference in grade level effect within each group. The results of the investigations of relationships between attitude scores on BCCAS and computer experience and usage, educational and career planning, and choice of favorite subjects, and attitude toward school subjects were as predicted. It was concluded that the results of the investigation supported the validity of the BCCAS.

The item-total score correlations and interitem correlation provided evidence that the items were related, but they cannot be attributed to a measurement of attitude toward computers without a definition of attitude and attitudinal object and some rationale to show how the items represented these domains. In addition, according to recommended procedures for attitude instrument development, the item analysis, including an examination of the clustering of the data and low response at the midpoint of the Likert response categories for each item, should have been conducted prior to factor analysis (Shrigley & Koballa, 1984). It was interesting that Bear et al. (1987) predicted and found a positive relationship between attitude toward computers and attitude toward reading as evidence for instrument validity, while Abdel-Gaid et al. (1986) predicted and found a negligible relationship between the same variables as evidence for construct validity.

Koslowsky and Hoffman (1988) developed the Computer Attitude Scale (CAS) and tested its validity by predicting computer usage. The CAS consisted of 34 Likert-type cognitive items which were based upon concepts and individual items from previous research. The items were administered to 50 subjects in a pilot study, resulting in slight modifications, but the number and meaning of items remained the same. Item analysis, including a determination of emotional intensity, was not conducted. Attitude and attitudinal object were not defined. The instrument was administered to 162 first-year undergraduate students who were taking their first computer course. Factor analysis revealed the following two factors: (a) the computer as a controlling device and (b) the computer as a challenging machine. The first factor consisted of eight items and accounted for 17 % of the total variance. Coefficient alpha was reported as 0.77. The second factor consisted of five items and accounted for 9 % of the total variance. Coefficient alpha was found to be 0.82. Three computer usage measures were calculated for each subject over a 12-week semester. Correlations were used to analyze the attitudinal and computer usage data. It was concluded that computer attitude as measured in the study was at best moderate predictor of actual usage.

Morris (1988) developed the Computer Orientation Scale (COS), consisting of eight Likert-type items, to examine the relationships between attitude toward computers and age, education, sex, and household income. Validity was not mentioned in the report. The theoretical construct and attitudinal object were not defined. The source of the items was not identified. Morris surveyed 380 people who were chosen by a computer program which randomly selected telephone numbers. Total scores were used to select two groups, one scoring in the upper and one in the lower 25 %. The results of a t test revealed a significant difference in score between the groups on each item. It was reported that a Spearman-Brown coefficient of 0.733 and a standardized item alpha of 0.728 indicated that the items functioned as a Likert attitude scale. The four independent variables were correlated with COS scores. The correlation between attitude and sex

(.08) was weak and not significant. As a result of regression analysis, it was reported that household income had no effect on attitude. Age and education showed direct effects on the attitude scores, with education being more likely to determine attitude toward computers than was age by itself.

Siann, Macleod, Glissov and Durndell (1990) conducted an investigation of the attitude toward computers between boys and girls before and after a focused Logo programming experience. A 10-item Likert-type scale was developed and administered to 114 primary school children, representing four schools, as a pre and posttest measure of attitude toward computers. The researchers stated that the scale had been pilot tested with children of the same age, but validity and reliability were not mentioned in the report. Additional data were gathered through interviews, children's performance on a set of cognitive tests, and observation and evaluation of performance and interactions on a standard task. Analysis of observations revealed that 9-year-old boys tend to physically crowd girls out when they work at the computer in mixed sex dyads. Measures of general attitude toward computers was positive for both sexes before and after the computing experience. Boys on the pretest measures appeared more confident and showed more interest in computing than girls. Following the computer experience, gender differences in attitudes toward computers diminished except for the general tendency that the anxiety level of girls relative to boys increased.

Semantic Differential Scales

Six investigations were identified in which a semantic differential scale (SD) was used to measure attitude toward computers. These included Zoltan and Chapanis (1982); Ingersoll, Smith, and Elliott (1983); Williams, Coulombe, and Lievrout (1983); Menis (1984); Harvey and Wilson (1985); and Kahn (1985).

The SD was developed by Osgood, et al. (1957) while studying the nature of meaning. A SD instrument consists of presenting a concept along with several pairs of opposite adjectives. The adjectives in each pair are generally separated by a seven-point scale. The subject responds by relating the concept to each pair of adjectives and rating the intensity of the concept on the response scale. In instrument development, the data are subjected to factor analysis to identify dimensions of meaning. It was reported that they consistently found three dimensions of meaning when the data were subjected to factor analysis. The dimensions were evaluation, potency and activity. Later, the researchers stated that it seemed reasonable to identify attitude with the evaluative dimension.

A number of general criteria for developing an SD to measure attitude were identified in The Measurement of Meaning by Osgood et al. (1957). Most of these criteria were for the development of any attitude instrument. However, the two important criteria in developing SD are: (a) high loadings on the evaluative factor and negligible loadings on the other factors and (b) adjectives which are relevant to the concept under consideration.

Zoltan and Chapanis (1982) developed a questionnaire to investigate the attitude of certified public accountants (CPAs), lawyer, pharmacists and physicians toward computers. The questionnaire consisted of (a) background information, (b) general attitudes, and (c) general statements. General attitudes consisted of 41 pairs of adjectives on a SD format. The items were selected from an adjective checklist or from previously published articles. General statements contained 23 Likert-type items to elicit the respondent's beliefs about and reactions toward computers. The questionnaire was mailed to 1937 subjects, and 521 subjects responded. The SD and Likert-type items were collectively factor analyzed using a principal component analysis on the correlation matrix for all 64 items. Six factors were identified which accounted for 36.5 % of the total variance. In developing the attitude instrument, the researchers did not define the

psychological construct being measured nor did they concern themselves with validity or reliability. All of the adjective pairs were not relevant to the concept being measured. They combined adjective pairs and Likert-type items in the analysis. An evaluative dimension was not identified by the factor analysis of the data from the SD. A rationale was not provided for examining the relationship of the independent variables to attitude.

A one-way multivariate analysis of variance was used to determine the differences among CPAs, lawyers, pharmacists and physicians on the 64 questionnaire items. Responses to the 64 questionnaire items were subjected to an individual one-way analysis of variance because the multivariate effect was reported to be highly significant. The results revealed that pharmacists had more positive attitudes toward computers than did the three other groups. Experienced computer users were found to be more positive toward the computers than the inexperienced users.

Ingersoll et al. (1983) developed and used a SD as part of a study to measure attitude of teachers toward the advent of high technology in their instruction. The theoretical construct and attitudinal object were not defined. The SD was not available in the report nor was any information on its development, validity, or reliability. A copy of the SD was obtained directly from the researchers. At least one pair of adjectives was not relevant to the attitudinal object, and the response scale was not randomly altered to control for response set. The SD was administered to teachers during a series of teacher and administrator focus groups in various parts of the country to obtain teacher ratings of specific attitude toward the microcomputer. The number of teachers and attitudinal data were not provided. It was concluded that teacher attitude were positive toward microcomputers.

Williams et al. (1983) developed a SD for measuring American children's attitude toward small computers. Adjective pairs were identified by interviewing 106 first-time participants, ages 6 to 18 years, in a one-day computer camp. The most frequently used adjectives to describe small computers were identified and used to construct the

instrument. The final instrument consisted of 24 bipolar pairs of adjectives. Information about validity was not provided. The researchers stated the assumption that the scales were fully reliable. The scale direction was not randomly altered to account for response sets. This may have been a particular problem in this research since none of the mean scores on the scales exceeded 4.0. All four factors were used as a measure of attitude contrary to the suggestion by Osgood et al. (1957). All adjective pairs were not relevant to the concept under consideration. The sample was not representative of the population. A rationale was not provided for relating attitude to the independent variables. The instrument was administered to the 106 children individually about half-way through the day. The data were factor analyzed, revealed the following four factors. Each of the four factors were correlated to age and sex differences. The researchers concluded that children had multidimensional attitude toward small computers. Instrument validity and reliability were suggested as topics for future study.

Harvey and Wilson (1985) modified the SD developed by Williams et al. (1983) and used the modified instrument to measure attitude toward microcomputers of primary and secondary school students in England. The modified instrument contained 20 of the original 24 scales. The modification resulted from a pilot experiment; however, the rationale for eliminating four scales was not provided. The researchers did not concern themselves with establishing validity and reliability. They stated that content validity was assured, because the scales were derived from students who would be using the scales. The modified instrument was administered to 51 girls and 44 boys in primary school and 64 boys and 34 girls in secondary school in England. The data were compared to the data obtained by Williams et al. (1983) on American subjects. They also compared the differences in attitude between British boys and girls, owners and non-owners of computers, and primary and secondary school students. How the data were analyzed was not included. However, it was concluded that the British students exhibited favorable attitude toward microcomputers. There was no significant difference on 12 of

20 items when comparing British to American subjects. When comparing sex, only three items were found to be significantly different with boys rating computers as being more fun and smarter, and girls considered microcomputers as being more expensive. Owners of computers were more favorably disposed towards microcomputers than were non-owners. Primary school students considered microcomputers relatively more friendly, understandable, newer and bigger than did secondary school students.

Menis (1984) modified a SD developed by Minato (1983) for measuring attitude toward mathematics to measure students' attitude toward computers. Minato developed the instrument to measure Japanese eighth graders' attitude toward mathematics. Menis modified the instrument by simply substituting computer for mathematics as the attitudinal object and used it to measure attitude of Israeli grade 9 students toward the computers. He did this in spite of the fact that Minato stated in the article from which Menis obtained the instrument that a SD is not culture free. The modified instrument consisted of 17 pairs of bipolar adjectives on a seven-point numerical scale. Menis did not provide any details on how the instrument was originally developed nor did he provide any information concerning the validity and reliability of the modified instrument. Menis administered a general scientific attitudes and curiosity inventory to two intact groups of Israeli students, a control group consisting of 35 students and an experimental group consisting of 30 students, as part of a study to examine the question as to whether the computer had an effect on the development of student attitude toward the sciences by encouraging the students' levels of curiosity. He selected each group of grade 9 students from each of two schools and assumed they were equivalent, because they were drawn from two well-based general schools as well as they were both A group students. The attitude toward computers instrument was administered as a posttest only to the experimental group. How the data were analyzed was not included in the research report. He concluded, however, that the students were interested in and enthusiastic

about the computer. They were aware of certain difficulties in computer studies but were prepared to cope with it because they liked computers.

Kahn (1985) developed and used two semantic differential scales as part of an exploration of fifth grade students' attitude toward microcomputers. One SD included 16 bipolar adjective pairs to measure the attitude toward computers. The second consisted of 10 bipolar objectives to measure how microcomputers made the students feel about themselves. The researcher stated that some of the objective pairs were selected from existing lists of adjective pairs. Others were created to reflect common statements about the concepts being judged. Criteria for the selection of the objective pairs were not provided. Attitude and attitudinal object were not defined. The researcher stated that the interview process, including instruments, were field tested, but details were not provided. The items in the instrument were not subjected to a factor analysis. A five-point response category with an undefined scale position was used in data collection, but it was collapsed to three-points for data analysis. Validity and reliability were not mentioned.

The investigation was stated as being qualitative. The primary means used to gather information for the study were: (a) structured and unstructured interviews with individual students including closed and open-ended questions, (b) interviews with teacher and principal, (c) observation of the setting, (d) examination of documents relating to microcomputer use, and (e) responses to SD questions. The instruments used in this study were (a) student, teacher, and principal interview guides, (b) semantic differential scale for students and teacher, and (c) observer feedback forms. Twenty-three students and their teacher and principal participated in the study. The information was recorded by the researcher and the findings were verified by the two independent observers. The observers rated the findings as very high on degree of accuracy, thoroughness, and completeness. It was concluded that students enjoyed working with the computer and did not find the computer frustrating. All felt strongly positive about the computer and about themselves as computer users.

Oral Questions

Lieber and Semmel (1987) developed four questions and used one to measure students' attitude toward computers as part of an exit interview following a microcomputer experience. The purpose of the study was to investigate the effect of group size on students' attitudes toward microcomputers. The attitude question was "How did you feel about working at the microcomputer?" (p. 30). The others three questions concerned whether the students preferred working alone or with partners and who they wanted to work with if they had a choice. Attitude was not defined. Validity and reliability were not mentioned in the report. The subjects included 18 non handicapped and 19 learning handicapped boys from grades 4, 5, and 6 from two school districts. Details on how those students were drawn were not provided. The exit interview was audio taped, and responses to the question were transcribed for analysis. Seventeen of 19 learning handicapped and 16 of 18 non handicapped students were found to like working at the microcomputer. It was concluded that increasing group size did not diminish student enthusiasm for microcomputers. In fact some students preferred sharing their time at the computer to working alone.

Conclusions

A number of conclusions were drawn based on a critical review and analysis of 62 available research reports in which 59 attitude instruments to measure computer attitude were developed and/or modified. Emphasis was placed on the evaluation of the instruments and procedures used to develop instruments, including the reliability and validation processes, although attention was given to the use of instruments and adequacy of the research reports. The following list contains the conclusions drawn from the critical review.

1. The research was characterized by researchers who did not appear to be familiar with the recommended procedures, as stated in the psychometric and measurement literature for developing attitude instruments to provide valid and reliable reflection of attitude toward computers, or they simply chose to ignore these recommendations.

2. The development or modification of computer attitude instruments were further characterized by the failure to develop and/or report a clear, precise and comprehensive plan, accompanied by a convincing rationale for each step of the plan, for developing instruments to provide valid and reliable indicators of computer attitude.

3. A majority of the investigations, in which an instrument was developed and used to measure attitude toward computers, made no mention of validity and/or reliability.

4. In the investigations that discussed validity and/or reliability, terminology and procedures were used in such ways that it appeared the researchers were unaware that validity theory has evolved and that validity and reliability did not inhere in an instrument.

5. It was common practice for a researcher to modify an existing attitude instrument without correcting for the weaknesses of the instrument or for concerns raised about using the instrument in the original research report.

6. The inherent and false assumption that factor analysis ensured validity appeared to be held by many researchers who develop computer attitude instruments.

7. Research reports in the area of computer attitude instrument development were frequently incomplete, poorly written, and sloppy with respect to reporting data and using constructs with different meanings, such as attitude, opinion, belief, and anxiety, interchangeably.

8. The reports of the results of factor analytic techniques never included all the basic data necessary for interpreting and evaluating the analysis.

9. The research in which computer attitude instruments were developed and used were commonly devoted almost entirely to descriptions and comparisons of what was measured, treatment effects, and/or relationships among variables as if providing convincing evidence and arguments to establish the validity and reliability were unimportant aspects of the research and not the responsibility of the researcher.

10. A majority of the research reports in which computer attitude instruments were developed and used to make group comparisons to determine the effects of treatments, and/or to relate attitude towards computers to other variables; it was a common practice not to provide a rationale to make group comparisons, to apply treatments to attempt changing in computer attitude, or to relate computer attitude to other variables.

11. The Likert-type scale was the most common type instrument used to develop instruments which measured attitude toward computers.

12. The critical review of existing instruments to measure attitude toward computers revealed the need for the development of new and improved instruments to measure attitude toward computers with greater attention given to current validation theory and to review and follow recommendations from existing psychometric and measurement literature.

Relationship of Selected Variables to Attitude Toward Computers

An investigation of the statistical relationships between attitude toward computers and selected variables were identified in 55 research reports (Agnir, 1989; Albert, 1988; Anderson et al., 1982; Baack et al., 1991; Bear et al., 1987; Bolt, 1992; Brown et al., 1988; Cheamnakarin, 1993; Chu, 1991; Collis, 1985; Connell, 1991; Dambrot et al., 1985; Delos Santos, 1988; Dolgos, 1991; Francis, 1988; Gressard & Loyd, 1986; Griswold, 1983, 1985; Grogan, 1992; Harvey & Wilson, 1985; Holder, 1984; Hwang,

1990; Kammire, 1984; Kim, 1990; Knighton, 1989; Koohang, 1988; Lee, 1970; Limpisathian, 1993; Lin, 1993; Liu, 1989; Loyd & Loyd, 1985; McKeehan, 1983; Moe, 1984; Molla, 1988; Morris, 1988; Nikolaus, 1988; Norales, 1987; O'Neal, 1988; Popovich et al, 1987; Rafaeli, 1986; Raub, 1981; Roseboro, 1992; Sariya, 1992; Siann et al., 1990; Smith, 1986; Thaipakdee, 1992; Vermette et al., 1986; Whitfield & Bishop, 1986; Wiener, 1993; Wilder et al., 1985; Williams et al., 1983; Woodrow, 1990; Yuen, 1985; Yuen, 1988; Zoltan & Chapanis, 1982). The purpose of identifying the reports was simply an effort to obtain an approximate indication of the variables most frequently used by researchers in investigations involving the examination of relationships between attitude toward computers and selected variables.

The most frequently used variables in the identified research reports on attitude toward computers, in descending order, were sex, computer experience, age, grade level, computer ownership, and computer access. The reported results of the investigations of relationships between each variable and attitude toward computers were inconsistent and often contradictory. The quality of the attitude measures was one of several factors that could have accounted for these results. The critical review of identified research on the development of instruments to measure attitude toward computers brought into question the quality of existing instruments. As a result, the actual findings of the studies of the relationship between computer attitude and selected variables were questionable as well. Regardless of the findings, the frequency of use of the selected variables remained useful in that it provided a portion of the rationale for the selection of teacher variables, which were employed in this study to examine relationships between computer attitude and selected teacher variables.

Summary

This chapter provided a brief history, definitions, importance and renewed interest in measurement of the concept of attitude. It presented a critical review and analysis of research in which instruments were developed or modified to measure attitude toward computers, followed by the listing of conclusions drawn from the critical review and analysis. It concluded by identifying variables most frequently used by researchers who investigated the relationship between attitude toward computers and selected variables.

CHAPTER 3

METHODOLOGY

This chapter provides a description of the methodology used to develop and administer a Likert-type scale to provide valid and reliable measures of the computer attitude of preservice and inservice teachers at the elementary school level. It includes the identification and utilization of a theory of construction, consisting of thirteen steps. The rationale and methodology for each of the steps are described in separate sections. Embedded in the steps is the administration of the scale to several samples of preservice and inservice elementary school teachers, including preservice teachers enrolled in the MAT Program in Elementary Education at Oregon State University. Statistical relationships between the measures of attitude of the preservice teachers enrolled in the MAT Program in Elementary Education and selected teacher variables are examined. Also included is a description of the statistical analyses employed in the study, as well as a summary of the chapter.

Develop Theory of Construction

More than 60 investigations have been conducted in which attitude scales have been developed and administered in attempts to measure attitude toward computers of a variety of respondents. A critical analysis of these investigations in Chapter 2 revealed that the investigations were characterized by the failure to develop, employ, and report a theory of construction, that is, a clear and precise comprehensive plan made up of a series of steps, each consisting of one or more procedures, for instrument development, including a defensible rationale for each step in the plan. The position taken in this study was that the development of a theory of construction was a necessary prerequisite for the development of a scale to obtain valid and reliable measures of computer attitude. This

position was based primarily on the critical analysis of the research involving the development of scales to measure computer attitude and criticisms of attitude research by Gardner (1975a), Abdel-Gaid et al.(1986), and Haladyna et al. (1983).

The position requiring the establishment of a theory of construction did not include an assumption that a high level of validity was assured by establishing and following a theory of construction. It was understood that other factors such as the quality and comprehensiveness of the plan and how it was implemented were additional factors influencing validity. Establishing a theory of construction and following the procedures does, however, provide some evidence for validity. The American Psychological Association (1974) stated that the procedures followed in developing a scale may be used as part of the construct-related evidence for inferring validity. Without establishing and following a theory of construction, the validity of a scale cannot be properly inferred. Gardner (1975a) provided strong support for this position when he stated that failure to provide a theoretical rationale for scale construction made attitudes scale theory entirely inapplicable, and statistical procedures such as summation of scores, reliability, factor analysis and so on were completely irrelevant. Additional support was provided by Bohrnstedt (1970) when he reported that if a measure of some psychological construct was developed, it was up to the researcher to spell out the rationale which justifies calling a scale built on a partial set of items a measure of the construct.

The first step in this research was to establish a theory of construction for developing a Likert-type scale to provide valid and reliable measures of the computer attitude of preservice and inservice elementary school teachers. The theory of construction consisted of the identification of a clear and precise comprehensive plan for developing and administering a Likert-type attitude scale. The identified plan was made up of a series of logical steps, each consisting of one or more procedures derived from psychometric and measurement literature and research on the development and administration of attitude scales. The steps that were employed in this study for the

development and administration of a Likert-type attitude scale to provide valid and reliable measures of the computer attitude of preservice and inservice teachers at the elementary school level were as follows:

1. Develop Theory of Construction.
2. Establish Conceptual Framework.
3. Create Item Pool.
4. Construct Trial Scale.
5. Administer Trial Scale.
6. Conduct Item Analysis.
7. Select Items for Final Scale.
8. Construct Final Scale.
9. Test for Homogeneity.
10. Determine Reliability.
11. Test for Unidimensionality.
12. Administer Final Scale.
13. Infer Validity.

The theory of construction also included a description of the procedures or methodology used within each step, as well as the rationale for the methodology and the primary sources from which the methodology was derived.

Establish Conceptual Framework

The nature of and need for a conceptual framework were clearly identified by the American Psychological Association (1985) when they stated that:

the construct of interest for a particular test should be embedded in a conceptual framework, no matter how imperfect that framework may be. The conceptual framework specifies the meaning of the

construct, distinguishes it from other constructs, and indicates how measures of the construct should relate to other variables. (p. 9)

Further support was provided by Bohrnstedt (1970) who stated that it was necessary to spell out how the boundaries under study were determined and indicate how the items in the instrument capture the various meanings given the concept by theorists who had investigated the concept. Gardner (1975a, 1975b) and Mueller (1986) added additional support for establishing a conceptual framework when they pointed out that it was very important for researchers to provide a clear and precise definition of the construct and specify its relationship to related constructs, that is, other elements of the universe such as belief, value, and opinion. Mueller (1986) also stated that the attitudinal object must be precisely, thoroughly, and completely identified.

A conceptual framework was established following recommendations of the American Psychological Association (1985), Bohrnstedt (1970), Gardner (1975a, 1975b), Mueller (1986), Crano and Brewer (1973), and Shrigley et al. (1988). The conceptual framework consisted of (a) a clear and precise definition of attitude and attitudinal object; (b) distinguished the concept of attitude from the concepts of beliefs, values, and opinions; and (c) indicated how measures of computer attitude should relate to other variables in the respondent population such as age, grade level, computer ownership, computer access, and computer experience.

A definition of attitude and attitudinal object was selected based on recommendations by Mueller (1986) and Thurstone (1931, 1946). The definition of attitude was clear and precise, and it reflected the evaluative nature of attitude as recommended by Shrigley et al. (1988).

In this study, attitude was differentiated from values and opinions following the guidelines provided by and Shrigley et al. (1988). They stated the following:

researchers in education have little reason to confuse attitude with belief, value, or opinion. Beliefs list toward the cognitive; values are broader than attitudes and more culturally bound. Opinions are more

cognitive and are more useful in our verbal expression than research. Such related concepts support without supplanting the attitude concept. (p. 659)

The central, if not the only, attribute of attitude was seen by Shrigley et al. as being evaluation.

Attitude was differentiated from belief in this study following the guideline provided by Rokeach (1969). Beliefs were perceived as having an affective and behavioral component, as well as a cognitive component. The distinction between attitudes and beliefs was that an attitude is "an organization of interrelated beliefs around a common object, with certain aspects of the object being at the focus of attention for some persons, and other aspects for other persons" (p. 406).

An investigation was made of the statistical relationships between attitude and selected variables within the respondent population. The variables included grade level, age, computer ownership, computer access, and computer experience. They were chosen because they were among the variables most frequently investigated by researchers in the past who were concerned with relating computer attitude to variables within the respondent population. The variables were measured by administering a questionnaire attached to the attitude scale (see Appendix D) to a respondent population consisting of 72 preservice teachers enrolled in the MAT Program in Elementary Education at Oregon State University.

Prior to data collection it was hypothesized that among the respondent population: (a) attitude toward computers would not vary with grade level or computer access; (b) attitude toward computers would be negatively correlated with age; (c) respondents who considered themselves as experienced computer users would be significantly more positive in their attitude toward computers than those who considered themselves as inexperienced computer users; and (d) respondents who owned computers would be significantly more positive in their attitude toward computers than those who did not own computers. Correlation, t test, and one-way analysis of variance were used to analyze the

data. (see Administer Final Scale Section for a more detailed description of data collection and analysis.)

Create Item Pool

An item pool was derived from the responses of 365 preservice and inservice elementary school teachers to the following statement: Write a short description of your feelings about computers (see Appendix A). The respondents included 250 preservice elementary school teachers enrolled in teacher education programs at Oregon State University, Western Oregon State College, Utah State University, Old Dominion, University of North Carolina at Asheville, University of North Florida, and Kennesaw State College and 115 inservice elementary school teachers who were employed in the Linn-Benton Education Service District and the Lincoln County and North Douglas School Districts in Oregon. The responses were reviewed, and 62 statements were extracted which were judged by the researcher to belong within the content domain of computer attitude. The definition of computer attitude was used as the criterion for judging whether or not each statement belonged in the computer attitude domain. To the extent possible, language employed in the respondent statements was kept intact.

The rationale for using actual respondent statements from a wide range of respondents of their feeling about computers as a source of items was based on the recommendations of Crano and Brewer (1973), Edwards (1957), Mueller (1986). Edwards and Mueller suggested that a good source of items was to request individuals with positive and negative attitudes toward the attitudinal object in the target population write short descriptions of their feelings about the attitudinal object. Mueller also suggested that the researcher ask a diverse group of people, who had substantial knowledge about the attitudinal object, to write down several of their own feelings about the attitudinal object in order to tap a broad diversity of opinions about the attitudinal

object. Crano and Brewer stated that one of the threats to validity in scale development was the use of language within the scale that was different from the language characteristically used by the target population.

Once the 62 statements were judged to belong within the computer attitude domain, they were further subjected to criteria recommended by Likert (1932) and Edwards (1957), for editing and/or adding statements to an item pool. The criteria proposed by Likert included the following: (a) the item pool should contain more statements than are likely to be finally used, because after they are administered to a group of respondents, some items may be found to be unsatisfactory for the intended purpose; (b) one-half of the statements should be stated positively, and one-half should be stated negatively to reduce response set; (c) statements of fact should not be included in the item pool; (d) each statement should be clear, concise, straight-forward, containing one complete thought and not contain double negatives; (e) avoid statements that are likely to be responded to in the same way by the entire target group; and (f) statements should be assigned to the scale in random order. The following criteria proposed by Edwards were based on a summary of recommendations made by other researchers, including Likert.

1. Avoid statements that refer to the past rather than to the present.
2. Avoid statements that are factual or capable of being interpreted as factual.
3. Avoid statements that may be interpreted in more than one way.
4. Avoid statements that are irrelevant to the psychological object under consideration.
5. Avoid statements that are likely to be endorsed by almost everyone or by almost no one.
6. Select statements that are believed to cover the entire range of the affective scale of interest.
7. Keep the language of the statements simple, clear, and direct.
8. Statements should be short, rarely exceeding 20 words.
9. Each statement should contain only one complete thought.
10. Statements containing universals such as all, always, none, and never often introduce ambiguity and should be avoided.
11. Words such as only, just, merely, and others of a similar nature

- should be used with care and moderation in writing statements.
12. Whenever possible, statements should be in the form of simple sentences rather than in the form of compound or complex sentences.
 13. Avoid the use of words that may not be understood by those who are to be given the completed scale.
 14. Avoid the use of double negatives. (p. 13)

All 62 statements judged to be within the content domain were also judged to meet the criteria proposed by Likert and Edwards.

Develop Trial Scale

The 62 statements were then submitted to a panel of nine expert judges. The panel members were recommended by members of the research committee. The panel included two Professors of Educational Psychology, two Professors of Educational Research and Measurement, three Professors of Sociology, and two Professors of Psychology, each of which were faculty members at Oregon State University. The panel was asked to rate each statement as to the degree that it fell with the content domain of the construct. They were also requested to identify ambiguous and poorly written items. Each panel member received a cover letter which included a definition of attitude and explanation on how to complete the form. (see Appendix B for cover letter, list of panel members, directions for panel members, and list of potential item pool statements).

Asking panel members to judge whether or not a statement fell within the content domain of the construct should not be confused with content-related evidence for validity. They were simply asked to judge whether or not the individual statement belonged in the domain. They were not asked if the statements were representative of the entire domain. Bohrnstedt (1970) said that content-related evidence for validity is inappropriate for a construct such as attitude, because it is not possible to enumerate all of the elements in the domain and then sample them representatively.

The rationale for using the panel to edit the statements was provided by Mueller (1986) who suggested experts in attitude measurement might be used for collecting content-related evidence for validity. He stated that possibly the best use of judges was as an editorial board to eliminate poorly worded and ambiguous items.

A 90 % level of agreement among the panel members that an item was within the content domain of the construct and that the item required either none or very minor editing were established as the criteria for retaining an item. Feedback from the panel resulted in 12 statements being dropped from the item pool. One item was slightly revised but retained. The result was a pool of 50 trial attitude statements, 24 negatively and 26 positively worded statements. The trial statements were combined to form a trial attitude scale by attaching a response scale, ranging from strongly agree (5) to strongly disagree (1), to each statement and randomly assigning the statements new numbers of 1 to 50 (see Appendix C).

Administer Trial Scale

The rationale and procedure to administer the trial scale to a sample of the target population and to describe the composition of the sample were derived from recommendations by Gardner (1957b), Crano and Brewer (1973), Nunnally (1978), Borg and Gall (1989), Oppenheim (1966), and the American Psychological Association (1985). Gardner wrote that "an essential part of any serious research project is the preliminary trial of the instrument on a sample which is roughly comparable to the target population for which the instrument is ultimately intended" (p. 14). This position was further supported by Crano and Brewer and Nunnally. Borg and Gall and Oppenheim stated that a newly developed attitude scale should be pretested using a sample of respondents similar to those to be queried in the main survey in order to collect evidence for reliability and validity. The American Psychological Association added that the

"composition of the validation sample should be described in as much detail as is practical" (p. 14), including such information as gender, employment status and level of experience.

The psychometric and measurement literature did not provide a definitive number for the sample size to be employed in administering and analyzing the trial instrument. A sample size was selected after considering the suggestions by Tinsley and Tinsley (1987), Crano and Brewer (1973), and Comrey (1973). Generally, these researchers reported that the larger the sample size, the better. Tinsley and Tinsley stated, "as the sample size increases, random errors of measurement tend to cancel each other, [and] the items and test parameters begin to stabilize" (p. 415). Also analysis of large samples are more generalizable than those of small samples. More specifically, Comrey suggested a sample size of: (a) 100 subjects was poor; (b) 200 was good; (c) 300 was very good; and (d) 1000 was excellent. Crano and Brewer suggested a widely quoted rule of employing 5 to 10 times as many subjects in the sample as there are items to be analyzed. Tinsley and Tinsley pointed out that these two recommendations have resulted in their general recommendation of advocating 5 to 10 subjects per item up to a total of 300.

One further point should be made concerning the size of the sample, because the final instrument was administered to 72 preservice teachers enrolled in the MAT Program in Elementary Education and factor analyzed in an attempt to confirm the factor structure obtained with a sample of 592 inservice and preservice teachers (see Test for Unidimensionality and Administer Final Scale Sections). The sample of 72 respondents was smaller than the general recommendation for sample size; however, Tinsley and Tinsley (1987) suggested that there be some flexibility in the size of the sample employed in factor analysis. They suggested that, when the theoretical number of factors in a trial scale can be estimated and the number is expected to be small, the number of subjects in the sample can be less than their general recommendation of 5 to 10 subjects per item up to a total of 300. They supported their position by reporting the results of

another study where the responses of 78 subjects resulted in satisfactory factor stability using principal-components and principal-factors analyses.

A questionnaire, consisting of seven questions, was prepared to assist in describing the composition of the sample (see Appendix C). The same questionnaire was also later used in combination with the final version of the attitude scale to gather construct-related evidence for validity. The questions included whether the respondents were preservice or inservice teachers, grade level at which they taught or were aspiring to teach, age, sex, computer ownership, computer access, and whether or not they considered themselves experienced or inexperienced computer users.

A set of directions for completing the questionnaire and trial attitude scale was also prepared. The directions provided a brief statement asking for the respondents' assistance in the development of an attitude scale and provided information concerning their contribution to the research project by completing the questionnaire and scale. Respondents were asked to circle the choice which best represented their feelings toward each item on the scale. The response categories were strongly agree (5), agree (4), undecided (3), disagree (2), and strongly disagree (1). The directions concluded with a statement that there was no right or wrong answers to the items on the scale and ensured anonymity for the respondents and their associated schools.

The directions, questionnaire, and trial scale were distributed to representatives from eight teacher education programs and five education districts throughout the United States and Canada. An explanation was provided to each representative about the nature of the research, and each was asked to distribute, collect, and return by mail the completed questionnaire and scale to the researcher. Responses from the request resulted in a sample of 592 preservice and inservice elementary school teachers from the target population. The sample included 411 preservice elementary school teachers enrolled in teacher education programs at Utah State University, Willamette University, University of California at Hayward, Northern Illinois University, Western Oregon State College,

Kennesaw State College, Oregon State University, and University of Alberta. The 181 inservice teachers were currently employed as elementary school teachers in Hayward, California, Linn-Benton Education Service District, Lincoln County School District, Douglas Educational Service District, and Marion Education Service District in Oregon.

The demographic information obtained from these two groups revealed that the respondents consisted of 489 females and 103 males. Three hundred and two stated that they owned a computer, while 290 stated that they did not own one. Four hundred and twenty-six had unlimited access to a computer. Two hundred and ninety-six respondents considered themselves as experienced computer users, and 296 respondents considered themselves as inexperienced computer users. The ages of the respondents ranged from 19 to 62 years old, but the majority were between 20 to 25 years of age. Ten people did not give their age. The sample included preservice and inservice elementary school teachers from every grade level, K-8.

The sample included a diverse group of respondents from a wide range of elementary schools and elementary school teacher education programs throughout the United States and Canada. The sample of 592 subjects exceeded the number recommended by Tinsley and Tinsley (1987) and Crano and Brewer (1973) and was judged to be very good according to the suggestion of sample size by Comrey (1973).

Conduct Item Analysis

The first step following the administration of the trial scale to was to score each of the 592 subjects' responses for each item and to calculate a total score for each subject for all items on the trial scale. The response categories for each item ranged from strongly agree (5) to strongly disagree (1). The response categories and actual response of each subject to each of the negatively worded statements in the scale were reversed. Each respondent's total score was calculated by summing his or her responses to each of

the 50 items. The possible range of scores for an individual respondent was between 50 and 250 with higher scores representing respondents with more positive attitudes toward computers. The total score for each of the respondents was then ranked in descending order as a preliminary step for conducting an item analysis of the trial scale.

The rationale and procedure for conducting an item analysis of the 50 item trial scale in this study were derived from the recommendations of Likert (1932), Edwards (1957), Crano and Brewer (1973), and Shrigley and Koballa, (1984). Even though the exact procedure for item analysis varied somewhat among these researchers, each agreed on the necessity of conducting an item analysis for the purpose of reducing the number of items in the trial scale by retaining only the best items and discarding those that did not belong in the scale. For example, Likert (1932) suggested that an item analysis of trial statements be conducted as an objective check to reveal the satisfactoriness of each item for inclusion in a given scale. The item analysis provided checks to see if the numerical values of the response categories for individual statements within the scale were properly assigned and whether or not each statement was differentiating. That is, a differentiated statement measured the same thing that the total scale measured, and those respondents who scored at one end of the attitude continuum responded to the statement differently than those who scored at the other end of the attitude continuum. Likert stated that some of the reasons for an item not to differentiate was that the statement: (a) measured a different attitude continuum, (b) was answered the same way by nearly all the respondents, (c) was ambiguous, and (d) was a statement of fact which was accepted or rejected equally by respondents scoring at each end of the attitude continuum. Item analysis for Likert consisted of determining the correlation between individual items and the average score on all statements and calculating the difference between the average score on each statement by the respondents scoring highest and those scoring lowest on the scale. He also compared the results of item analysis to the results obtained with measures of internal consistency. He recommended the use of internal consistency

instead of item analysis because the criterion of internal consistency was easier to calculate and yielded essentially the same results.

Edwards (1957) proposed the *t* test as his preferred method for conducting an item analysis of statements in a Likert or summated rating scale. The procedure involved the calculation of *t* values for each statement between the means of respondents who scored in the top and bottom 25 % on the total scale. The individual statements were then ranked in descending order according to their *t* values. Statements with the highest *t* values were retained to construct the final scale. He mentioned the use of other methods to determine item discrimination, including correlations and the difference between the means of the high and low groups for each item. However, he stated his doubt that any of the other methods would result in a different ordering of items than the ordering obtained by the use of *t* values.

Crano and Brewer's (1973) procedure to accept or reject statements consisted of a consideration of the correlation of each item with the total score on the scale. The statements with the highest item-total correlations were retained, because they were judged to be the most predictive items with respect to the attitude under consideration.

Shrigley and Koballa (1984) suggested that only items with high emotional intensity should be retained in an attitude scale because emotional intensity, called evaluative quality by social psychologists, distinguished attitude from related psychological constructs. The type of item analysis proposed by the researchers to select items with high emotional intensity had statistical and qualitative dimensions. The statistical dimension included calculating the corrected item-total correlations, percentage of response to each response category for each item, and item means and standard deviations. Guidelines for retaining items were identified which allowed for variation within the statistical dimension. The qualitative dimension of the item analysis involved the decision of whether or not to accept an item when it varied with respect to one or more of the guidelines. An item was said to have emotional intensity when it had an

acceptable item-total correlation, a clustering of responses at both ends of the response continuum, and a low number of responses at the midpoint of the continuum.

The type of item analysis selected for analyzing the responses of the 592 subjects to the 50 trial items in this study was eclectic in that it employed procedures drawn from each set of recommendations by Likert (1932), Edwards (1957), Crano and Brewer (1973), and Shrigley and Koballa (1984). The rationale for this decision was to provide a maximum amount of data for selecting items for the final scale and to collaborate statements made by the researchers that several of the procedures provided essentially the same results. The item analysis included the following steps:

1. Respondents scoring in the top and bottom 27 % on the total scale were designated as contrasting criterion groups with high scores on the scale representing respondents with more positive attitude toward computers. An index of discrimination was calculated for each item by subtracting the mean score of the respondents who scored in the top 27 % on the total scale from the mean score of the respondents who scored in the lower 27 % on the total scale.
2. T values were calculated for each item between the mean scores of respondents scoring in the upper and lower 27 % on the total scale.
3. A corrected item-total correlation coefficient was calculated for each item using the Cronbach alpha formula. The procedure involved calculating a correlation coefficient between the score on each individual item and the sum of scores on the remaining items in the scale.
4. The mean and standard deviation for each item were calculated based on the responses of 592 respondents to each item.
5. The percent of all respondents who selected the undecided category was calculated for each item.

6. The response distribution of respondents scoring in the top and bottom 27 % on the total scale were contrasted pictorially by calculating and plotting the response distribution in a line graph for each item.

Select Items

Data provided by the item analysis were used to retain or reject each of the 50 trial items. The actual decision of whether to retain or reject each item was based primarily on the criteria and procedures for decision making suggested by Shrigley and Koballa (1984), although several of the criteria had been previously identified by Likert (1932), Edwards (1957), and Crano and Brewer (1973). Only items with high emotional intensity were retained. The criteria for deciding whether or not a trial item had high emotional intensity included a consideration of the following criteria:

1. The responses to the item should be spread across the response categories in both directions from the undecided category with mean score ranging from 2.5 to 3.5 and a standard deviation ranging from 1.0 to 1.5.

2. The response to the item by respondents with high total scores should be skewed toward the positive end of the continuum, while those having low total scores should be skewed toward the negative end of the continuum.

3. The responses to the undecided category should be 25 % or less.

4. An item should have a high discrimination index, t value and corrected item-total score correlation.

When an item did not meet every identified criterion at the specified level, it was subjected further to a qualitative analysis based on the degree to which it met the remaining criteria, particularly the item-total score correlation. Crano and Brewer and Shrigley and Koballa suggested that the item-total correlation coefficient was probably the most important criterion for retaining or rejecting trial items.

Construct Final Scale

Twenty-five of the 50 trial items were retained for inclusion in the final scale. Each of the 25 items was judged to have high emotional intensity. Although the items were not selected on the basis of whether or not they were positively or negatively worded statements, the 25 items included 12 positively and 13 negatively stated items. The items were randomly assigned new numbers from 1 to 25 and combined to form the final scale (see Appendix D). The final scale was given the title of the Evans Scale for Computer Attitude (ESCA).

Test for Homogeneity

An essential characteristic of a Likert-type scale is homogeneity. It refers to the degree to which the statements in a scale measure a common attribute and is normally established through correlational procedures. If the statements in the Likert-type scale did not measure the same common attribute, it would be inappropriate to sum the individual item responses into a total score (Crano & Brewer, 1973; Gardner, 1975a; Scott, 1960, 1968).

The procedure for testing the homogeneity of the ESCA was derived from Scott (1960, 1968), Green (1954), and Crano and Brewer (1973). It consisted of correlating each item score with the total score for each of the 592 respondents using the corrected Cronbach alpha formula. The item-total score correlations were then inspected for homogeneity, i.e., a positive correlation should exist between each of the items and total score on the remaining items. Crano and Brewer (1973) stated that it was safe to assume that an item was measuring a different attribute than that represented by the total score if the item failed to correlate significantly with the total score.

According to Scott (1968), the item-total correlation procedure could provide deceptive results with respect to homogeneity, particularly if the items in the scale were not measuring a single attribute. He recommend calculating intercorrelations among all pairs of items for assessing homogeneity if there was any reason to suspect that the items in the scale measured two or more attributes. However, it was hypothesized that the items in the ESCA were measuring a common factor or attribute because of the manner in which the items were generated and selected. Whether or not the ESCA measured a general factor was verified by principal components analysis, a factor analytic technique (see Test for Unidimensionality Section). Thus, the factor structure of the ESCA provided further evidence of the scale's homogeneity.

Additional evidence of homogeneity suggested by Scott (1968), Green (1954), and/or Mueller (1986) included high internal consistency of scale, low number of responses in the undecided category, and high level of item intersubject discrimination. Internal consistency of the ESCA was ascertained by means of the Cronbach alpha formula. Evidence of the level of response to the undecided category of each item and item inter subject discrimination were included in the Conduct Item Analysis and Select Items Sections of this chapter.

Determine Reliability

The guideline for establishing the reliability of the ESCA was derived from Green (1954) Mueller (1986), Crano and Brewer (1973), and Scott (1968). Green stated that "high reliability is an indispensable property of a scale (p. 338)." He further stated that the straightforward test-retest procedure for measuring reliability is normally precluded in psychological testing because of the effect of test taking on the second testing. Crano and Brewer (1973) suggested calculating reliability by recomputing a total score of the items in the final scale from the responses to the items in the trial scale.

Crano and Brewer set 0.80 as the arbitrary lower limit for acceptance for the alpha coefficient.

The reliability of the ESCA was established using the Cronbach alpha formula which provided a measure of internal consistency as a reliability-estimation procedure. Application of the formula resulted in the reliability of the scale being expressed as an alpha coefficient. The reliability of the 50 item trial instrument had been previously calculated based on the responses of 592 respondents to the trial scale. The alpha coefficient of the ESCA was calculated from the responses of the 592 respondents to the 25 items included in the ESCA and trial scale by recomputing the scores resulting from the administration of the trial instrument to 592 respondents.

Reliability of the ESCA was calculated again after administering the scale to a new respondent sample consisting of 72 preservice teachers enrolled in the MAT Program in Elementary Education at Oregon State University. The Cronbach alpha formula was used to establish a coefficient alpha (see Administer Final Scale Section).

Test for Unidimensionality

According to Green (1954), the scoring technique of the Likert scaling technique implied that the items in a given scale were mutually related to a single common attribute and that the aim was to distribute respondents along a dimension that represented the magnitude of the attribute that the scale was intended to measure. Respondents who obtained the same total score on the scale would have the attribute at approximately the same magnitude. In other words, the scale was unidimensional. Ideally, this means that if a Likert-type scale such as the ESCA has the property of unidimensionality, every item in the scale would measure, excluding random error, only the attribute the scale was designed to measure (Scott, 1968). However, Scott stated that this was not a realistic expectation for a scale. A more realistic expectation would be for the items in the scale

to reflect the intended attribute more than any other attribute. He further stated that the practical meaning of the property of unidimensionality in attitude testing was that the irrelevant determinants differed from one item to the next to the extent that a composite score predominantly represented the intended attribute.

Based on the suggestions of Guilford (1954), Green (1954), Thurstone (1946), Bohrnstedt (1970), Scott (1968), Dawes (1972), Gould (1981), Tinsley and Tinsley (1987), Comrey (1988), and DeVellis (1991), the unidimensionality of the ESCA was examined by means of principal components analysis, a factor analytic technique. The analysis also provided evidence of the scale's homogeneity (see Test for Homogeneity Section) and construct-related evidence for inferring validity (see Infer Validity Section). The procedure involved the use of principal components analysis to analyze the responses of the 592 respondents to each of the 25 trial items selected for inclusion in the final scale. The guideline for assisting in the decision on how many factors to extract was the scree test (Cattell, 1966) and Kaiser criterion. Three factors were extracted and rotated to approximate simple structure using the quartimax procedure.

It was predicted prior to analyzing the responses to the ESCA with principal components analysis that each of the 25 items in the scale would have high factor loadings on one general factor. The prediction was based on the manner in which the scale was developed and the test for homogeneity, which revealed very high item-total score correlations and a high level of internal consistency as measured by the Cronbach alpha formula. According to DeVellis (1991), conformation of the predicted factor structure by means of principal components analysis would provide construct-related evidence for inferring validity.

An attempt was made to confirm the results obtained in the initial principal components analysis by applying principal components analysis to the responses of a new sample of respondents, consisting of 72 preservice elementary school teachers, to the ESCA (see Administer Final Scale Section for a more complete description of the

respondent sample and procedures used in administering the scale). The purpose for this procedure was to further test whether or not the ESCA had the property of unidimensionality. Scott (1968) stated that a scale should not be considered unidimensional until the results of the test for unidimensionality had been replicated with a new sample of respondents. Confirmation of the factor structure of a scale on a new sample of respondents would also provide construct-related evidence for inferring validity. In addition, researchers, who employ descriptive methods of factor analysis such as principal components analysis, assume that the sample to be analyzed was representative of the entire respondent population. Regardless, Tinsley and Tinsley (1987) stated that generalization of the results to other subjects in the population would be inappropriate unless the factor structure had been replicated on other samples of subjects within the population. DeVellis (1991) and Crano and Brewer (1973) were not as adamant but did state that the best means of demonstrating generalizability of a factor analytic solution was replication on a separate sample of respondents.

Administer Final Scale

The ESCA and questionnaire were administered to four new samples of respondents for the purpose of collecting additional evidence to further support the position that the ESCA provided valid and reliable measures of the computer attitude of preservice and inservice teachers at the elementary school level. However, the data obtained by administering the ESCA to preservice teachers enrolled in the MAT Program in Elementary Education and examining statistical relationships between measures of computer attitude and selected teacher variables were also collected for a second purpose; to generate information for consideration in the development and implementation of effective teacher education programs at the elementary school level and to provide insights into future research and practice. Collecting data for the second purpose did not

require the identification of a rationale and sources for the methodology. However, some of the data collected for the second purpose was also used for scale development. In those cases where the data obtained by administering the ESCA to preservice teachers in the MAT Program in Elementary Education were used for both purposes, a reference is provided to the appropriate section of the chapter where the rationale and sources for the scale development methodology are identified.

Administer ESCA to Students in MAT Program in Elementary Education

The ESCA and a questionnaire (see Appendix D) were administered to 72 preservice teachers who were enrolled in the MAT program in Elementary Education at Oregon State University over a period of two academic years. The questionnaire measured teacher variables chosen from those most frequently used in previous research on the relationship between computer attitude and teacher variables. The variables included: (a) grade level, (b) age, (c) gender, (d) computer ownership, (e) computer access, and (f) computer experience.

The sample consisted of 72 respondents who were preservice elementary school teachers, representing all grade levels from K to 8. Sixty were female, and 12 were male. Their age ranged from 21 to 49 years. Thirty-two of the 72 respondents owned computers. Forty-five perceived themselves as experienced computer users, while 27 considered themselves as inexperienced computer users. Fifty-three of the respondents had unlimited and 19 had limited access to a computer.

Responses to the ESCA and questionnaire were scored for each of the 72 respondents. Three different statistical analyses were employed to explore the statistical relationships between computer attitude and five of the six teacher variables (see Establish Conceptual Framework Section). The statistical relationship between computer attitude and grade level was explored by means of a one-way analysis of variance.

Correlation was the means by which the statistical relationship between computer attitude and age were explored. A one-tailed t test was used to explore the statistical relationship between computer attitude and computer ownership, computer access, and computer experience.

Even though gender was among the variables most frequently investigated in previous research in attempts to relate computer attitude to respondent variables, it was not explored in this study. The rationale for this decision was based on the nature of the sample, i.e., the disproportionate number of males and females enrolled in the MAT Program in Elementary Education at Oregon State University.

The reliability of the new sample of responses to the ESCA were calculated by means of the Cronbach alpha formula. Reliability was expressed in terms of an alpha coefficient, a measure of internal consistency (see Determine Reliability Section).

The responses were also subjected to the scree test (Cattell, 1966) and principal components analysis. Four factors, satisfying the scree test and Kaiser's criterion, were extracted and rotated to approximate simple structure using the quartimax procedure in an attempt to replicate the factor analytic solution obtained on an earlier sample of 592 respondents. The purpose of the analyses was to gather construct-related evidence for validity, as well as to increase the generalizability of the conclusions initially reached by means of principal components analysis. (See Administer Trial Scale and Test for Unidimensionality Sections).

Administer ESCA to Known-Groups

The rationale and procedure for utilizing the known-groups method in scale development were derived from recommendations by Nettle and Golding (1946), Thurstone (1946), Crano and Brewer (1973), and Mueller (1986). The known-groups method for obtaining construct-related evidence in scale development was introduced by

Nettler and Golding in a study on the measurement of attitude toward the Japanese in America. The method involved the identification of two groups of people, one who held positive and one who held negative attitude toward the attitudinal object. The scale was administered, and the mean scores of the two groups were compared. Construct-related evidence for validity was obtained if the group means were found to be substantially different in the predicted direction.

Thurstone (1946) stated that the known-groups method suggested by Nettler and Golding was certainly a plausible method to check an attitude scale. Crano and Brewer (1973) provided further support for the method. They reported that the method had been widely used to test the goodness of a wide range of scales and that the results generally provided convincing evidence for validity. However, they did identify one difficulty with the method. In some cases, it might be difficult or impossible to identify groups of respondents who would be expected to substantially differ on the attribute under investigation. Mueller (1986) cautioned that the method did not result in a validity coefficient. Evidence for validity was provided by the statistical test of mean difference.

The ESCA was administered to a new sample of 172 preservice elementary school teachers enrolled in an introductory course in education. Following the administration of the scale, the respondents were asked to rate themselves as having positive or negative attitude toward computers on a five-point scale. The response categories were very positive (5), positive (4), neutral (3), negative (2), and very negative (1). The responses to this question were then used to identify two groups of respondents with contrasting attitude toward computers. One group consisted of 132 respondents who perceived themselves as having very positive or positive attitude toward computers. The second group included 23 respondents who perceived themselves as being very negative or negative attitude toward computers. The 17 respondents who perceived themselves as having a neutral attitude toward the computer were not included in the known-groups procedure.

Once the known-groups were identified, the responses of each respondent on the ESCA for each group were scored. A t test was utilized to determine whether or not the means of the known-groups were substantially different.

Administer ESCA with Experimental Intervention

Cronbach and Meehl (1955) stated that studies of change in test scores over occasions could provide construct-related evidence for validity. They further stated that whether or not a high level of stability was desirable depended upon the theory defining the construct. A number of examples of experiments involving experimental intervention were identified, one being change of score under alternative directions.

The ESCA was administered on two occasions with an experimental intervention to a new respondent sample of 55 subjects which consisted of 44 preservice and 11 inservice teachers at the elementary school level. On the first occasion, the respondents were directed to respond to the scale as if they had positive attitude toward computers. Immediately following the first administration of the scale, the respondents were asked to respond to the ESCA a second time. On the second occasion, they were asked to respond as if they had negative attitude toward computers. The responses for each respondent on both occasions were scored. It was predicted that substantial changes in score would occur as a result of the alternative directions. That is, the scores of the respondents, who assumed they were positive toward computers, would be substantially higher than their scores on a second occasion in which they assumed a negative attitude toward computers. Changes in scores between occasions were examined by means of the t-test for matched pairs.

Correlation with Similar and Dissimilar Constructs

Several researchers have pointed out that the study of the external structure of the construct under question, that is, its relationship to other constructs, was fundamental to the process of gathering construct-related evidence for validity (Crano & Brewer, 1973; Cronbach, 1971; Cronbach & Meehl, 1955; Messick, 1989; Mueller, 1986; Shepard, 1993). The predominate methodology has been to make predictions about the relationships that would be expected to exist between scores on the scale under study and measures of similar and dissimilar constructs and to attempt to confirm the predications by means of correlation. Such correlational procedures have been termed by Campbell and Fiske (1959) as convergent and divergent validation. Confirmation of the predicted relationships were taken as sources of evidence that the scale under study provided a valid indicator of the construct. Cronbach and Meehl, Crano and Brewer, Messick, and Shepard suggested, however, that failure to confirm a prediction must be interpreted with caution. The specific reason for a correlation to deviate from the expected could not be known without further study. The deviation could be the result of inadequate measurement of the constructs and/or accuracy of the predicted relationship.

In an attempt to relate computer attitude to similar and dissimilar constructs, the ESCA, Suydam-Trueblood Attitude Toward Mathematics Scale (Trueblood & Suydam, 1974), and Askov-Trueblood Attitude Toward Reading Scale (Weidler & Askov, 1983) were administered to 61 preservice elementary school teachers who were enrolled in an introductory curriculum course. It was predicted that the relationship between computer attitude and attitude toward mathematics would be low to moderate in a positive direction, while the relationship between computer attitude and attitude toward reading would be negligible. A total score for each scale was calculated for each subject. Relationships among these scores were examined by means of the Pearson product-moment correlation formula.

Infer Validity

Validity is the most important criterion for assessing the quality of an attitude scale or any other measurement device (American Psychological Association, 1985). Validity is a unitary concept that refers to the degree to which specific inferences made from a set of scores resulting from the administration of the scale to a given group of individuals are appropriate, meaningful, and useful. In other words, it is the interpretation arising from a set of scores obtained by administering the scale rather than the scale itself that is validated (Cronbach, 1971). A combination of logical argument and empirical evidence are required to infer the degree to which the interpretations arising from a set of scores are valid.

In this study, construct-related evidence was collected and utilized to infer whether or not scores which resulted from the administration of the ESCA to samples of preservice and inservice elementary school teachers provided valid indicators of their computer attitude. This decision was based upon primarily upon recommendations by Cronbach and Meehl (1955) and the American Psychological Association (1985). Construct-related evidence was judged to be the most appropriate type of evidence for inferring validity, because the ESCA was designed to measure attitude. Attitude is a construct, and as such, an entirely acceptable set of operations was not available nor was there an accepted delineation of the content domain. The decision to utilize construct-related evidence for validity was further reinforced by Shepard (1993) and Messick (1975, 1980, 1989), and Anastasi (1986). In her discussion of the evolution of construct validity, Shepard stated that today "all test interpretations require construct validation" (p. 417). Messick stated that "all measurement should be construct referenced" (p. 957). Anastasi pointed out that test validation has been continually undergoing development and that there is a growing recognition that all validation procedures are subsumed under construct validation.

Since no single piece of evidence is sufficient to argue validity (Mueller, 1986), construct-related evidence was collected from several different sources. The procedures involved in collecting the evidence included the following:

1. Derive and utilize a theory of construction to develop the attitude scale.
2. Include provisions to reduce the response bias and language difficulty.
3. Examine the internal structure of the scale, including item-total correlations, homogeneity, internal consistency, and unidimensionality.
4. Predict factor structure prior to applying a factor analytic technique.
5. Confirm the factor structure on a new sample of respondents.
6. Relate attitude scale scores to various nontest variables.
7. Examine change of scores under alternate directions.
8. Apply the known-groups method.
9. Correlate with similar and dissimilar constructs.

These procedures were derived from recommendations by the American Psychological Association (1974, 1985), Cronbach, (1971), Cronbach and Meehl (1955), Mueller (1986), Bohrnstedt (1970), Crano and Brewer (1973), Thurstone (1946), Nettler and Golding (1946), Guilford, (1954), DeVellis (1991), Messick, (1989), and Shepard, (1993). Each was described in detail in the preceding sections of this chapter.

Statistical Analyses

The SPSS/PC+Statistics 5.0 software package for the IBM PS/2 microcomputer was utilized for item analysis, principal components analysis, scree test, quartimax rotation, corrected item-total score correlations, and alpha reliability coefficients. Pearson product-moment correlations, one-way ANOVA, one-tail t test, and one-tail paired t test were calculated utilizing version 7.0 STATGRAPHICS software package for the IBM PS/2 microcomputer.

Summary

This chapter described the methodology employed in the development of a Likert-type scale to provide valid and reliable measures of the computer attitude of preservice and inservice teachers at the elementary school level. It included the identification and employment of a thirteen step theory of construction derived from psychometric, measurement, and research literature. Also included was the examination of statistical relationships between measures of the computer attitude of preservice teachers at the elementary school level and selected teacher variables.

CHAPTER 4

RESULTS OF THE STUDY

This chapter presents the results of the study. It is organized into two parts: (a) Development of the Scale and (b) Administration and Testing of the Scale. The results in each part are not entirely mutually exclusive; however, they are organized separately for the sake of clarity. Each part is further organized into sections. Development of the Scale consists of five sections: (a) Theory of Construction, (b) Item Pool, (c) Item Analysis, (d) Item Selection, and (e) Final Scale. Administration and Testing of the Scale is made up of nine sections: (a) Homogeneity, (b) Reliability, (c) Unidimensionality, (d) MAT Preservice Teachers, (e) Nontest Variables, (f) Known Groups, (g) Experimental Intervention, (h) Similar and Dissimilar Constructs, and (i) Validity.

Scale Development

Theory of Construction

A major result of the study is the development of a theory of construction which consists of a clear and precise comprehensive plan made up of a series of 13 logical steps, each of which includes one or more procedures, for scale development. The steps in the comprehensive plan are as follows:

1. Develop Theory of Construction
2. Establish Conceptual Framework
3. Create Item Pool
4. Construct Trial Scale
5. Administer Trial Scale
6. Conduct Item Analysis

7. Select Items for Final Scale
8. Construct Final Scale
9. Test for Homogeneity
10. Determine Reliability
11. Test for Unidimensionality
12. Administer Final Scale
13. Infer Validity

The plan also includes a description and rationale for each step in the plan and the procedures utilized within each step, as well as the identification of the sources from which the steps and procedures are derived. The rationale, sources, and description of the procedures for each step are presented in detail in chapter 3.

Item Pool

Table E-1 provides a summary of the responses of the expert panel to each of the 62 statements which comprise the item pool (see Appendix E). The item statements were derived from individual descriptions of how 365 preservice and inservice teachers at the elementary school level felt about computers. Each panel member was provided a definition of attitude toward computers and asked to judge each item on whether or not it fell within the domain of the construct, attitude toward computers. They were further asked to judge each item with respect to it being clear, concise, simple, direct, and unambiguous. A 90 % level of agreement among the panel member responses was established as the basis for accepting or rejecting an item.

From Table E-1, it can be seen that 50 of the item statements were accepted and 12 were rejected by the panel. The rejected item statements include the following: 1, 6, 14, 15, 19, 26, 29, 32, 41, 45, 51 and 58. Item 12 was accepted, but members of the

panel suggested that it be slightly altered by adding the phrase to write to the end of the statement. The Table shows the altered form of item 12.

Trial Scale

The 50 item statements, which were accepted by the panel consist of 24 negatively-worded items and 26 positively-worded items. A response scale, ranging from strongly agree (5) to strongly disagree (1), was attached to each of the 50 remaining item statements. These trial items were randomly assigned new numbers from 1 to 50 and combined to form a trial scale (see Appendix C).

Item Analysis

The 50 trial attitude items along with a seven item questionnaire designed to measure selected teacher variables were administered to 592 preservice and inservice elementary school teachers (see Appendix C). After the responses to the response categories of the negatively worded trial items were reversed, the responses of each subject were scored for each trial item and the total trial scale. The scores were subjected to an item analysis which included the calculation of a t value and index of discrimination between mean scores of upper and lower scoring respondents, corrected item-total correlation, item mean score and standard deviation, and percentage of responses on the undecided category. In addition to these calculations, item analysis included a graphic analysis of the distribution of responses to each item by those subjects.

Table 1 presents a t value, discrimination index, corrected item-total correlation, mean, standard deviation and percentage of responses in the undecided category for each of the 50 trial items. From the Table, it can be seen that the corrected item-total

Table 1

T Value, Discrimination Index, Item-Total Correlation, Mean, Standard Deviation, and Percentage of Responses on Undecided Category for Each of 50 Trial Items

Item ^a	T Value	Discrimination Index	Item-Total Correlation	Mean	S.D.	Percentage Undecided
1. ^b	17.45	1.42	.67	3.94	0.87	12.7
2.	15.65	1.62	.64	3.75	1.03	13.7
3. ^b	13.19	1.11	.54	4.24	0.84	8.4
4. ^b	21.81	1.96	.73	4.03	1.05	7.4
5.	21.07	1.66	.75	4.02	0.91	12.7
6.	10.90	0.85	.43	4.39	0.75	5.2
7. ^b	20.63	1.91	.67	3.77	1.11	13.7
8.	13.85	1.20	.55	4.07	0.86	8.3
9. ^b	21.86	2.00	.71	3.56	1.10	16.9
10. ^b	17.62	1.72	.65	3.92	1.06	12.0
11.	22.67	1.99	.72	3.33	1.08	24.2
12. ^b	14.13	1.35	.59	3.68	0.95	24.3
13.	24.22	1.80	.81	3.89	0.90	17.7
14. ^b	17.42	1.75	.61	3.12	1.14	19.3
15.	21.39	1.79	.73	3.38	1.00	35.3
16. ^b	8.71	1.04	.39	4.36	1.05	4.2
17. ^b	18.04	1.65	.68	3.89	0.98	12.3
18.	16.18	1.26	.65	3.98	0.80	6.7

Table 1 (continued)

Item ^a	T Value	Discrimination Index	Item-Total Correlation	Mean	S.D.	Percentage Undecided
19. ^b	20.68	1.64	.80	4.08	0.86	8.4
20.	15.90	1.24	.65	4.05	0.79	12.0
21. ^b	21.18	1.89	.69	3.52	1.07	18.9
22.	20.53	1.57	.76	3.86	0.86	20.1
23.	11.83	0.76	.46	4.54	0.65	4.2
24. ^b	27.48	2.06	.79	3.81	1.01	15.4
25.	25.58	1.88	.77	3.46	0.97	25.7
26.	16.75	1.19	.63	4.09	0.76	14.2
27. ^b	14.29	1.21	.56	4.03	0.87	16.4
28. ^b	14.72	1.41	.56	3.88	0.97	15.9
29.	16.46	1.27	.62	3.99	0.83	18.9
30.	23.50	1.83	.73	3.33	0.97	29.7
31. ^b	22.60	1.58	.78	4.11	0.81	11.5
32.	11.20	1.32	.50	3.63	1.07	15.2
33. ^b	18.69	1.46	.69	4.11	0.83	9.5
34. ^b	21.23	2.00	.67	3.58	1.14	16.4
35.	9.78	1.20	.40	2.89	1.17	24.5
36. ^b	17.13	1.47	.67	3.94	0.91	17.7
37.	14.05	0.97	.60	4.17	0.66	5.4
38.	14.63	1.38	.61	3.47	0.94	31.3

Table 1 (continued)

Item ^a	T Value	Discrimination Index	Item-Total Correlation	Mean	S.D.	Percentage Undecided
39. ^b	15.48	1.74	.56	3.41	1.23	8.1
40.	8.22	0.97	.35	3.14	1.10	27.9
41. ^b	13.01	1.26	.53	3.73	0.95	20.6
42. ^b	19.27	1.47	.74	4.01	0.82	13.2
43.	20.87	1.71	.74	3.64	0.92	20.6
44.	14.54	1.34	.58	3.80	0.93	25.2
45.	10.81	1.23	.44	3.49	1.09	19.9
46.	15.50	1.38	.64	3.76	0.91	18.9
47.	15.93	1.61	.60	3.01	1.08	32.6
48. ^b	11.69	1.16	.45	3.78	1.01	11.0
49.	12.75	1.06	.56	4.02	0.80	13.5
50. ^b	7.71	0.88	.34	3.71	1.03	16.4

^aItem refers to item number and corresponding statement in trial scale in Appendix C.

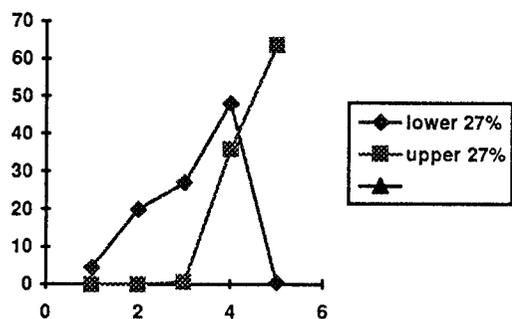
^bItem with a negatively worded statement.

correlation coefficient for each of the 50 items is relatively high, ranging from 0.34 to 0.81. A close inspection of the Table reveals that 32 of 50 trial items have a corrected item-total correlation coefficient of 0.60 or higher. The Table further shows that only items numbered 15, 25, 30, 38, 40, 44, and 47 exceed 25 % of responses in the undecided category, the percentage set by Shrigley and Koballa (1984) as the point to begin questioning the quality of the item.

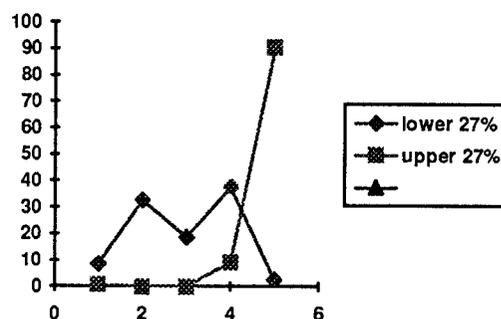
A comparison of items with the highest t values and discrimination indices in Table 1 reveals that the selection of 25 items with the highest t values for inclusion in a scale would result in an scale with 22 of the 25 items with the highest discrimination indices. The ordering of the 22 items, however, is significantly different. Further inspection of Table 1 reveals that the selection of 25 items with the highest t values and corrected item-total correlations would also result in a 25 item scale made up of 22 common items. Again, the rank order in which the 22 common items occur is significantly different between the data sets. This difference in ordering does not corroborate Edwards' (1957) stated doubt that item discrimination index would result in a different ordering of items than would be obtain by the use of t values nor Shrigley and Koballa's (1984) reported findings that the t value and item-total score correlation for an individual attitude statement are closely related and empirically provide similar results in item selection.

One of the criteria for selecting an item for the final scale was that the response distribution of the respondents who scored in the upper and lower 27 % on the total scale should be bipolar. That is, the distribution of responses to the item for respondents with high total scores should be skewed toward the positive end on the response continuum, and the responses of respondents with low total scores should be skewed toward the negative end of the response continuum. An item with a bipolar picture of the distribution indicated that the item discriminated between high and low scoring respondents in the appropriate direction. Figure 1 shows pictorially the response distribution for each item by respondents who scored in the upper and lower 27 % on the total scale.

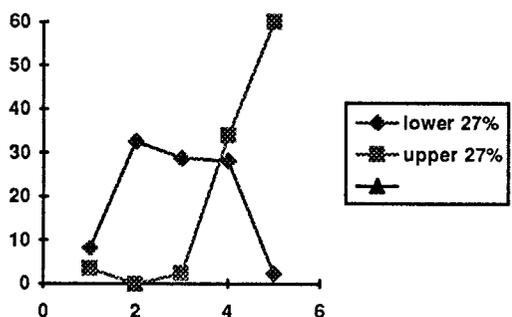
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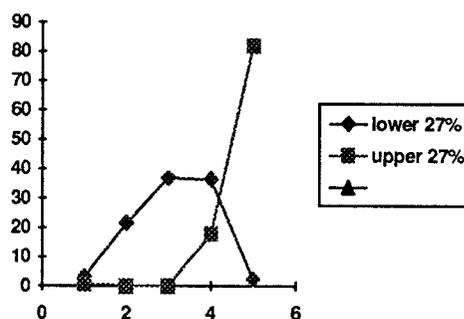
Item 4



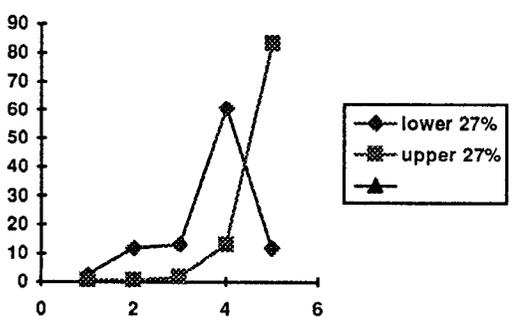
Item 2



Item 5



Item 3



Item 6

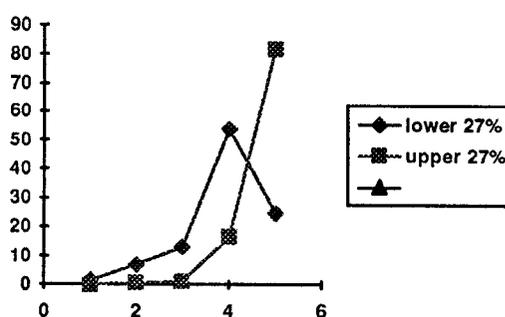
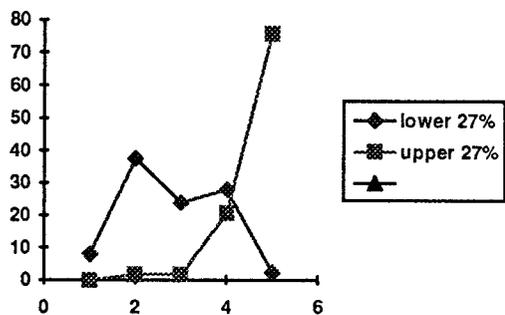
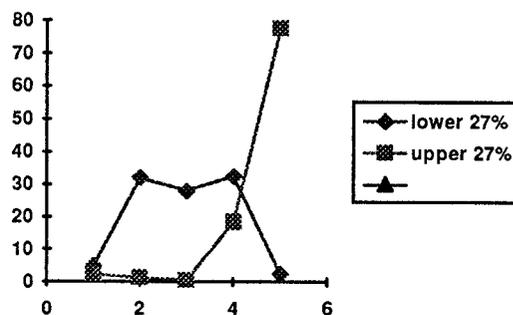


Figure 1. Response distribution of upper and lower 27 % on total scale for items 1 - 50. (The vertical axis of the graph is percent of response by groups. The horizontal axis represents the item response categories.)

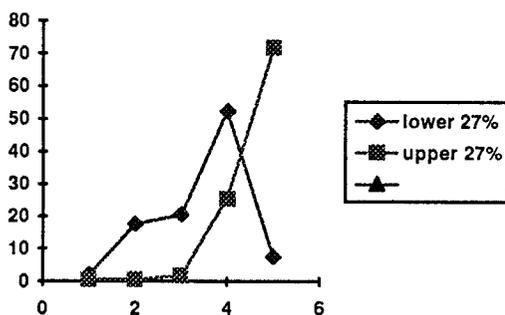
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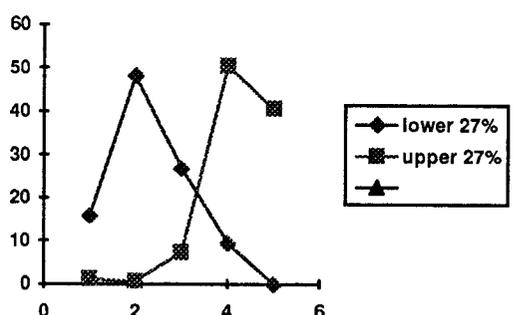
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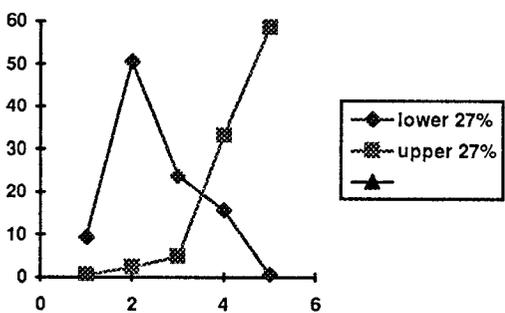
Item 8



Item 11



Item 9



Item 12

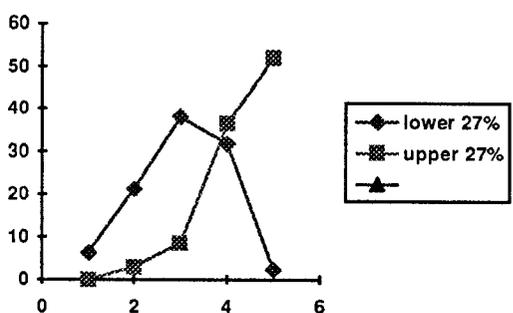
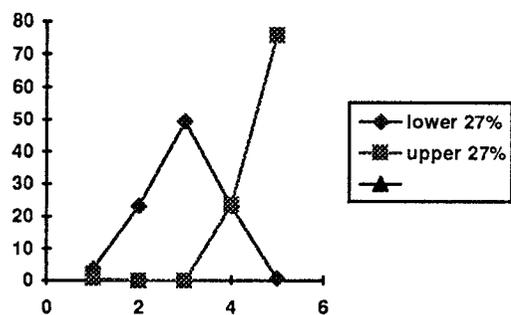
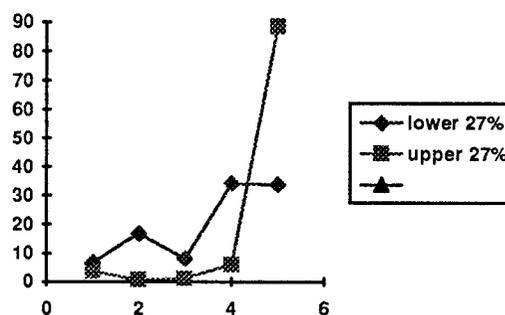


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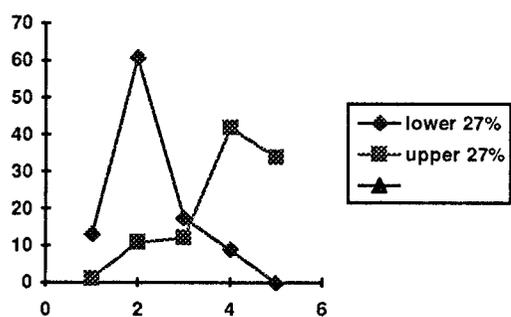
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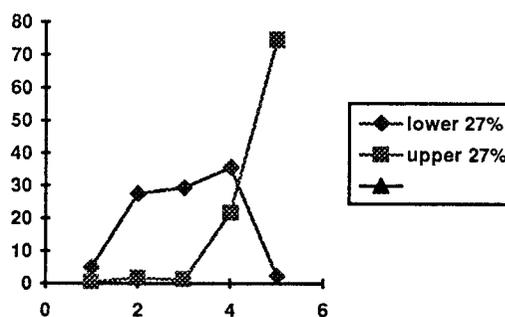
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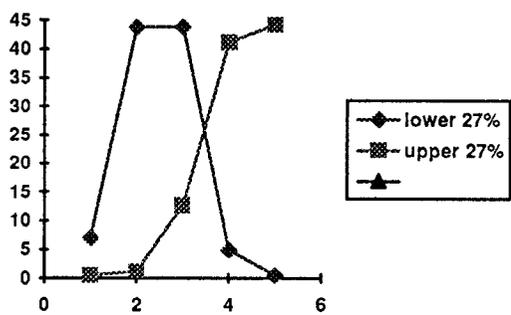
Item 14



Item 17



Item 15



Item 18

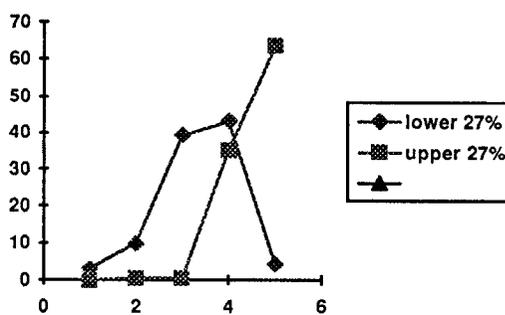
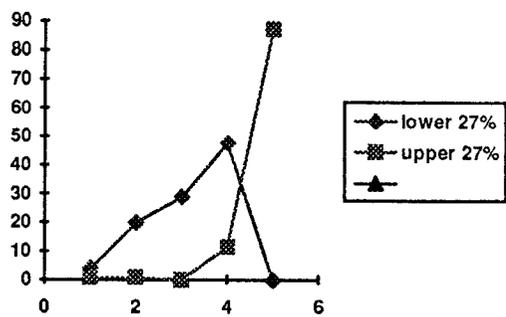
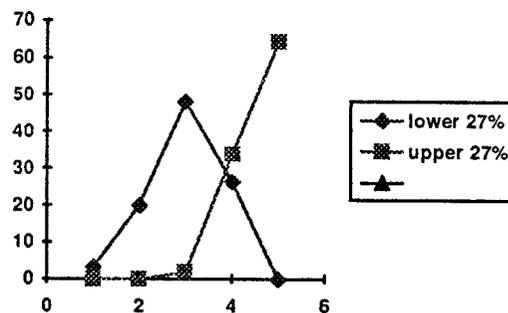


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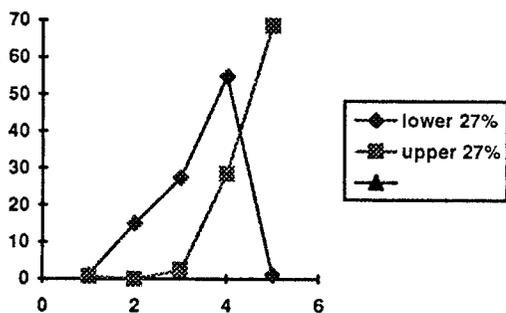
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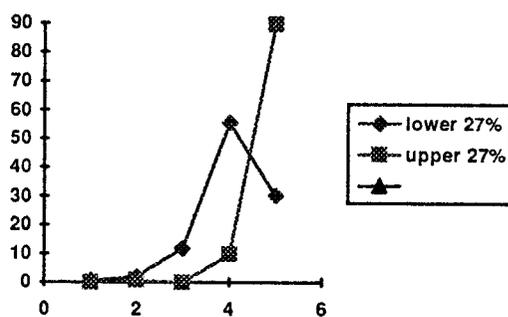
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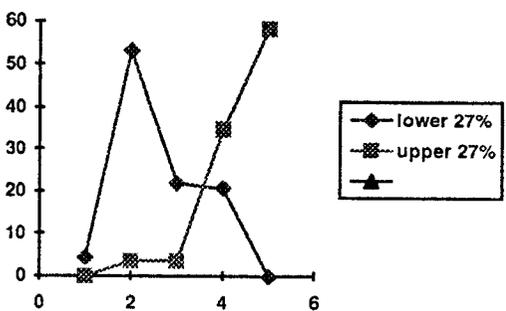
Item 20



Item 23



Item 21



Item 24

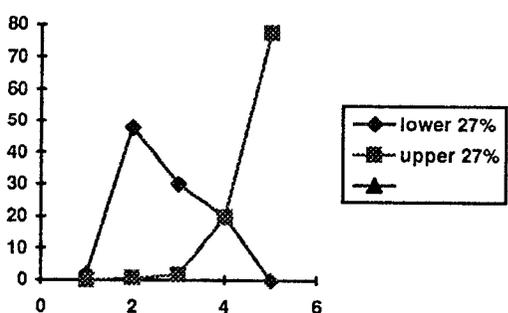
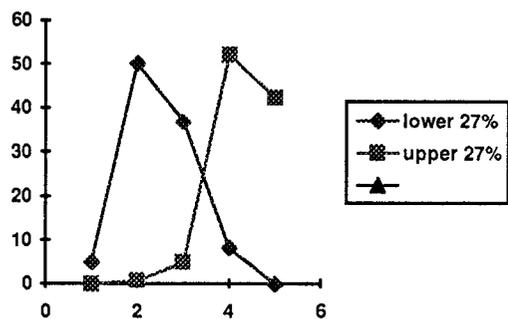
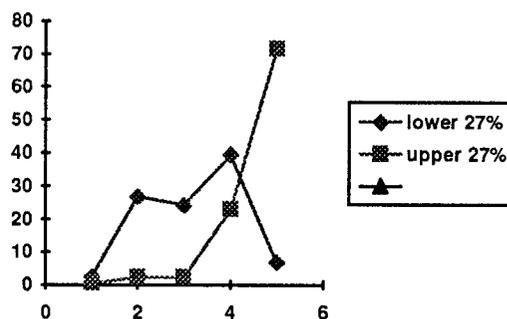


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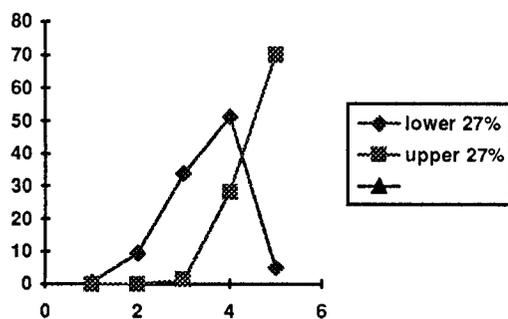
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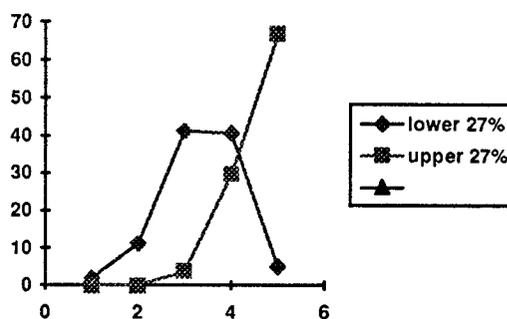
Item 28



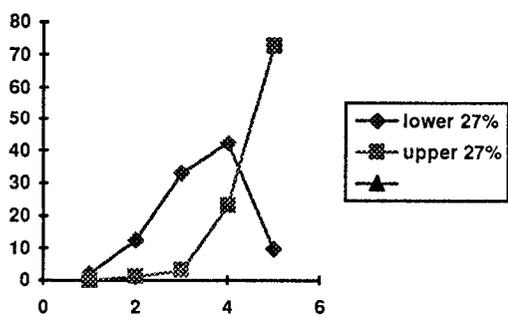
Item 26



Item 29



Item 27



Item 30

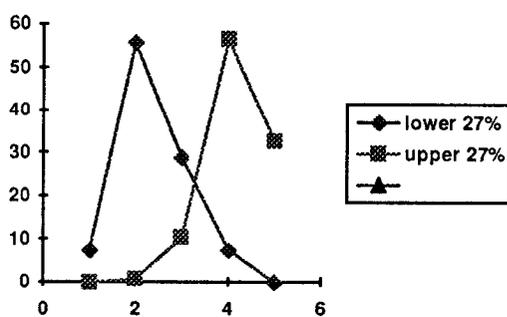
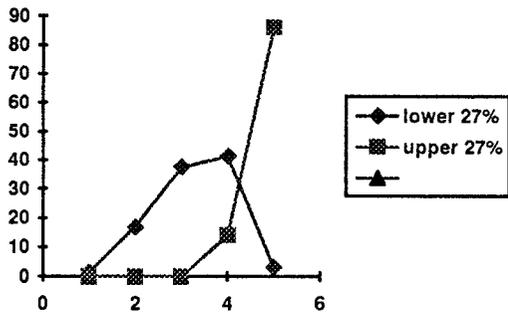
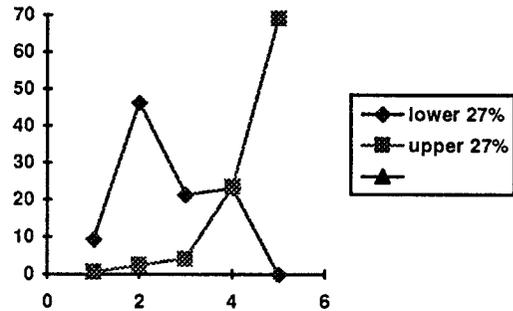


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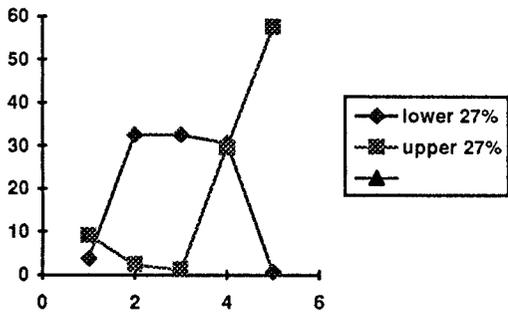
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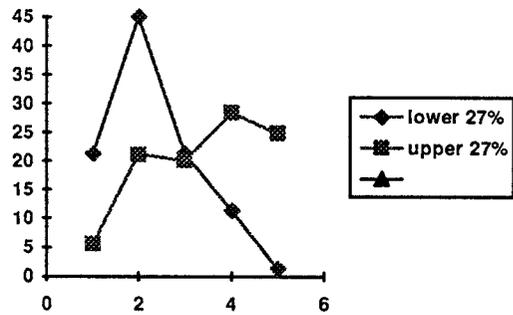
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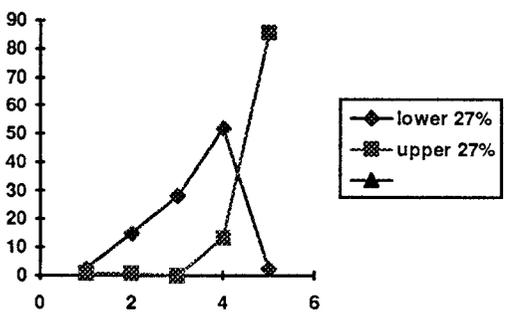
Item 32



Item 35



Item 33



Item 36

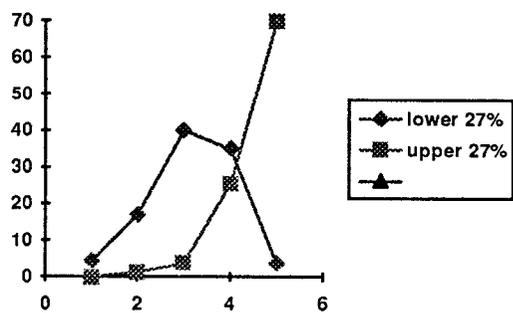
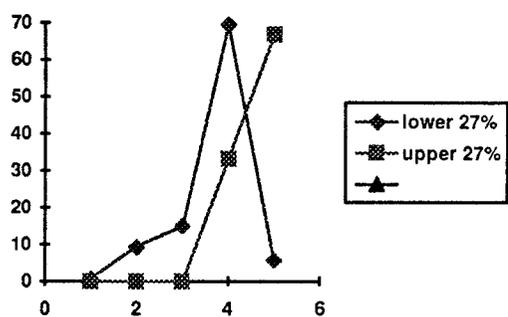
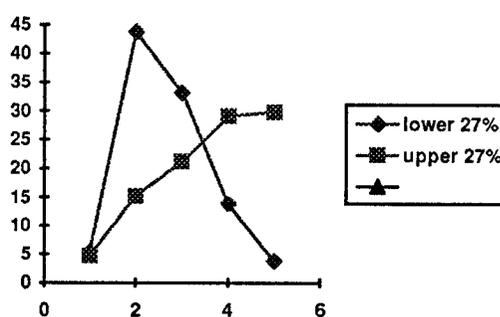


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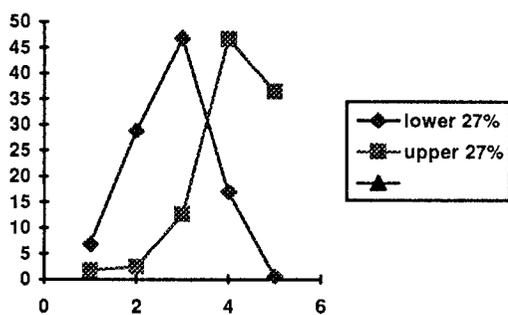
Item 37



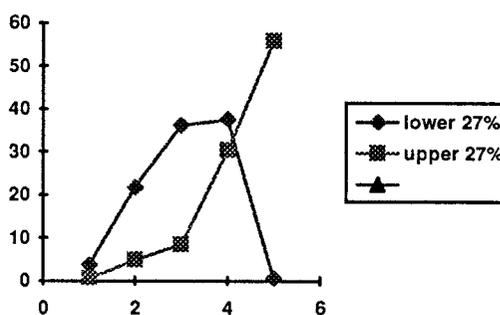
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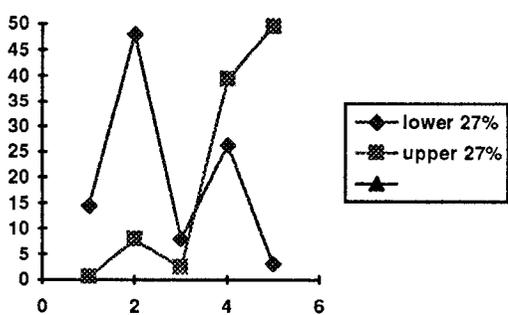
Item 38



Item 41



Item 39



Item 42

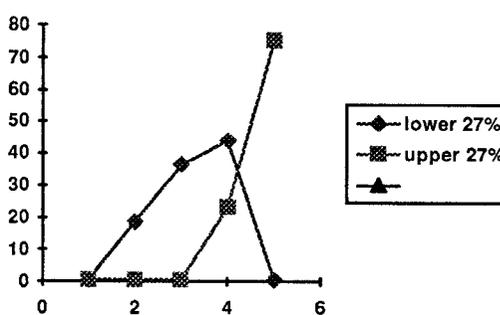
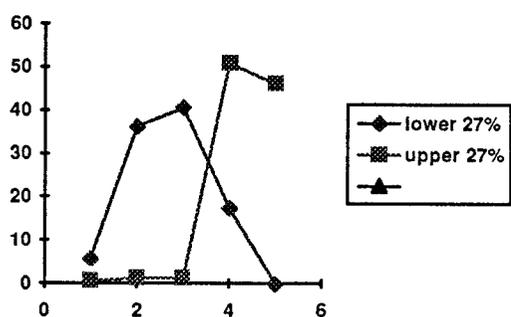
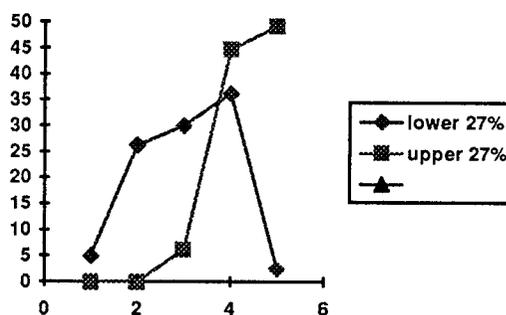


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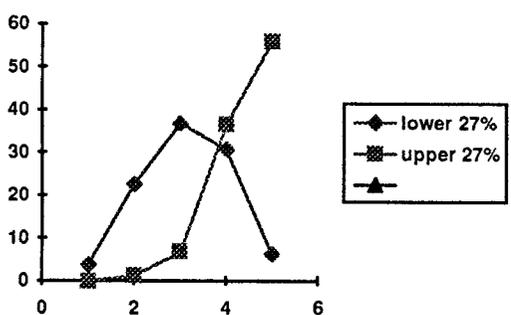
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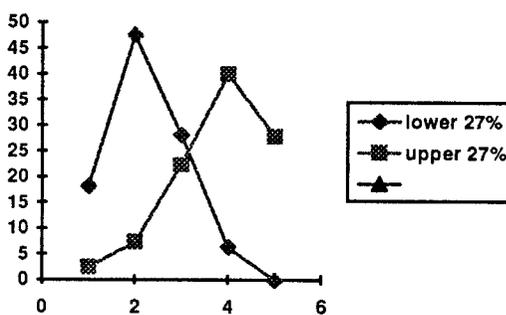
Item 46



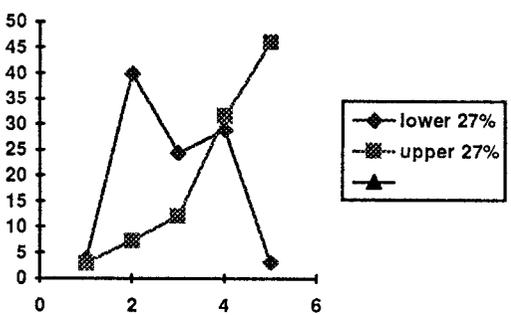
Item 44



Item 47



Item 45



Item 48

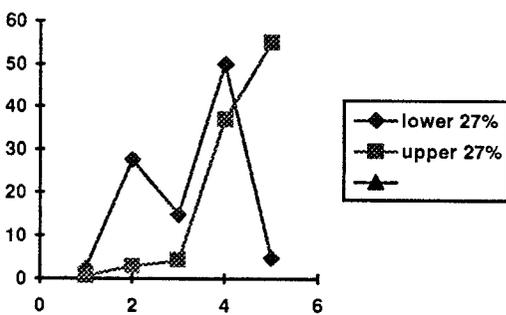
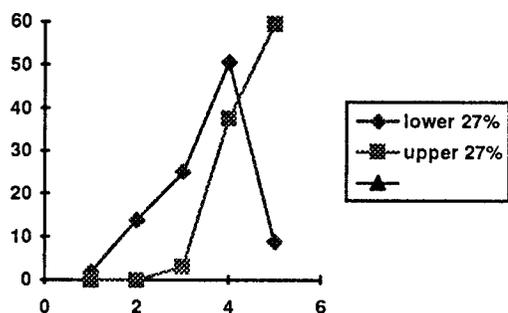


Figure 1 (continued)

Item 49



Item 50

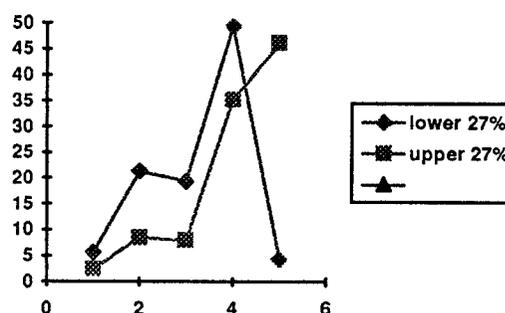


Figure 1 (continued)

Item Selection

The results shown in Table 1, combined with the graphic pictures from Figure 1 are the data needed to determine whether or not an individual item should be selected for inclusion in the final scale or eliminated. A scale of high quality required the selection of only items with high emotional intensity. The criteria for deciding if an item had high emotional intensity included each of the following: (a) responses spread across the response categories in both directions from the undecided category with a mean score ranging from 2.5 to 3.5 and a standard deviation ranging from 1.0 to 1.5; (b) bipolar response distribution with high scores skewed to the positive and low scores skewed to the negative end of the response continuum; (c) 25 % or less responses in the undecided category; and (d) high t value, discrimination index, and corrected item-total score correlation. When an item did not meet every criterion at the specified level, a subjective judgment was made based on the degree to which it met the remaining criteria, particularly the item-total score correlation. Table 2 shows the trial items judged to have

high emotional intensity and selected for possible inclusion in the construction of the final scale.

From Table 2, it can be seen that 27 of the 50 trial items are judged as having high emotional intensity based on the stated criteria. Fourteen of the items are worded positively, while 13 are worded negatively. The remaining 23 items, which are judged not to meet the criteria, are eliminated from consideration in the construction of the final scale.

The corrected item-total score correlations for the 27 items with high emotional intensity are presented in Table 3. An inspection of the Table reveals that the corrected item-total score correlations for all 27 items are relatively high, ranging from 0.40 to 0.82. Items 44 and 45 are the only trial items with recalculated item-total score correlation coefficients below 0.50.

Table 2

Trial Items With High Emotional Intensity

Item	Statement
2.	I feel comfortable using computers.
4. ^a	I try to avoid working with computers.
5.	I feel positive toward computers.
7. ^a	Computers make me feel stupid.
9. ^a	I feel tense when working with computers.
10. ^a	Computers scare me.
11.	I feel competent when using a computer.
12. ^a	I feel that computers are not user friendly.

Table 2 (continued)

Items	Statement
13.	I enjoy working with computers.
14. ^a	I get frustrated when using a computer.
15.	I love computers.
17. ^a	Computers cause me to feel inadequate.
21. ^a	I feel anxious when working with computers.
22.	Working with computers is fun.
24. ^a	Computers intimidate me.
25.	I feel confident when I use computers.
28. ^a	Hearing others talk about computers makes me feel uneasy.
30.	I feel in control when working with computers.
32.	I am not threatened by computers.
34. ^a	I am overwhelmed by computers.
36. ^a	Working with computers makes me angry.
38.	Computers are my friends.
39. ^a	When working with a computer, I fear that I might make mistakes I cannot correct.
43.	I feel capable when using a computer.
44.	Computers fascinate me.
45.	I lose track of time when I work with a computer.
47.	I enjoy solving problems related to the computer.

^aItem with a negatively worded statement.

Table 3

Corrected Item-Total Score Correlations for 27 Trial Items With High Emotional Intensity

Item ^a	Item-Total Correlation	Item ^a	Item-Total Correlation
2.	.67	24. ^b	.82
4. ^b	.71	25.	.81
5.	.72	28. ^b	.56
7. ^b	.70	30.	.76
9. ^b	.76	32.	.51
10. ^b	.69	34. ^b	.71
11.	.77	36. ^b	.65
12. ^b	.59	38.	.55
13.	.78	39. ^b	.58
14. ^b	.65	43.	.77
15.	.67	44.	.49
17. ^b	.72	45.	.40
21. ^b	.74	47.	.59
22.	.71		

^aItem refers to item number and corresponding statement in trial scale in Appendix C.

^bItem with a negatively worded statement.

Final Scale

The 25 trial items in Table 3 that are judged as having high emotional intensity and that have the highest recalculated item-total score correlation coefficients are selected for inclusion in the final scale. The 25 items are randomly assigned new numbers from 1 to 25 and given the title of the Evans Scale for Computer Attitude (see Appendix D). The 25 items in the final scale include 12 positively and 13 negatively worded statements.

Administration and Testing of Scale

Homogeneity

Tables 4 and 5 provide the corrected item-total score correlation coefficients for each of the 25 items in the ESCA. The coefficients in Table 4 were recalculated for the 25 items selected for inclusion in the scale from the response of 592 respondents to the trial scale. Table 5 shows the corrected item-total score correlations calculated after administering the ESCA to a new sample of 72 respondents enrolled in the MAT Program in Elementary Education at Oregon State University.

One of the stated criteria for testing for homogeneity was a high positive correlation between each of the items in the scale and the total score on the remaining items. Additional criteria included a high level of internal consistency and a factor structure that showed that all items in the scale measured a common attribute. Table 4 shows that the ESCA meets the first criterion. All 25 items in the ESCA have a high positive, corrected item-total score correlation when recalculated from the responses of 592 subjects to the trial scale.

Table 4

Corrected Item-Total Score Correlations for 25 Items in ESCA, N = 592

Item ^a	Item-Total Correlation	Item ^a	Item-Total Correlation
1. ^b	.58	14.	.56
2. ^b	.77	15.	.72
3.	.69	16. ^b	.58
4.	.65	17. ^b	.66
5.	.77	18.	.77
6.	.77	19.	.73
7. ^b	.83	20.	.52
8. ^b	.71	21. ^b	.59
9.	.77	22. ^b	.70
10. ^b	.71	23.	.53
11.	.82	24. ^b	.65
12. ^b	.73	25. ^b	.75
13.	.68		

^aItem refers to the item number and statement in the ESCA in Appendix D.

^bItem with a negatively worded statement.

Table 5

Corrected Item-Total Score Correlations for 25 Items in ESCA, N = 72

Item ^a	Item-Total Correlation	Item ^a	Item-Total Correlation
1. ^b	.59	14.	.60
2. ^b	.61	15.	.73
3.	.65	16. ^b	.68
4.	.73	17. ^b	.70
5.	.76	18.	.74
6.	.79	19. ^b	.80
7. ^b	.72	20.	.61
8. ^b	.71	21. ^b	.65
9.	.77	22. ^b	.72
10. ^b	.68	23.	.63
11.	.78	24. ^b	.68
12. ^b	.80	25. ^b	.75
13.	.79		

^aItem refers to item number and corresponding statement in ESCA in Appendix D.

^bItem with a negatively worded statement.

Table 5 confirms that the ESCA meets this criterion for homogeneity. From the Table it can be seen that all 25 items have high positive, corrected item-total correlations when the scale is administered to the new sample of 72 respondents.

Reliability

The Cronbach alpha formula provides a measure of internal consistency as a reliability-estimation procedure. In this procedure, reliability is expressed as an alpha coefficient. A summary of the results of applying the Cronbach alpha formula to the responses of two separate samples of respondents to the 25 items in the ESCA are presented in Table 6.

Table 6

Reliability Coefficients Calculated From Responses of Separate Samples to Items in the ESCA

Sample	N	Alpha Coefficient
1	592	0.96
2	72	0.96

From Table 6, it can be seen that the reliability, expressed as an alpha coefficient, is 0.96 when it is calculated from the responses of the 592 subjects to the trial scale, utilizing only those responses to the 25 items selected for inclusion in the ESCA. The Table further shows that the alpha coefficient is also 0.96 when it is calculated separately from the responses of a separate sample of 72 MAT preservice teachers, who responded only to the 25 items comprising the ESCA.

In addition to providing estimates of reliability, the high alpha coefficients in Table 6 provides evidence that the ESCA meets another of the identified criteria for judging homogeneity (see Homogeneity Section). The meaning of a high alpha

coefficient is that the scale has high internal consistency. All 25 items in the scale are positively interrelated.

Unidimensionality

An analysis of responses of two separate samples of respondents, consisting of 592 and 72 subjects, by means of principal components analysis provided evidence of the unidimensionality, stability of the factor structure, and homogeneity of the ESCA. The analysis further provided construct-related evidence for validity by substantiating the prediction that all 25 items in the scale would have a high factor loading on one general factor presumed to reflect the latent variable, attitude toward computers.

The number of factors in the analysis selected to represent the data were determined by a consideration of the amount of variance explained by each factor. The decision process included a consideration of the scree test and Kaiser's criterion, i.e., the inclusion of only the factors that had eigenvalues greater than 1. The results of applying the scree test to the responses of each sample are included in Figures 2 and 3.

Figure 2 shows the scree plot for the responses of the 592 respondents to the 25 items in the ESCA. From the Figure it can be seen that the elbow of the plot is on Factor 4. The three factors above the elbow have eigenvalues greater than 1 and account for substantially more of the variance than the remaining factors.

As a result of the scree plot in Figure 2, principal components analyses were performed on the responses of 592 subjects to the 25 items in the ESCA, and three factors were extracted. Quartimax rotation was utilized to rotate the extracted factors to approximate simple structure. Quartimax rotation converged in four iterations. The results of performing quartimax rotation on the three extracted factors are presented in Table 7.

Eigenvalues

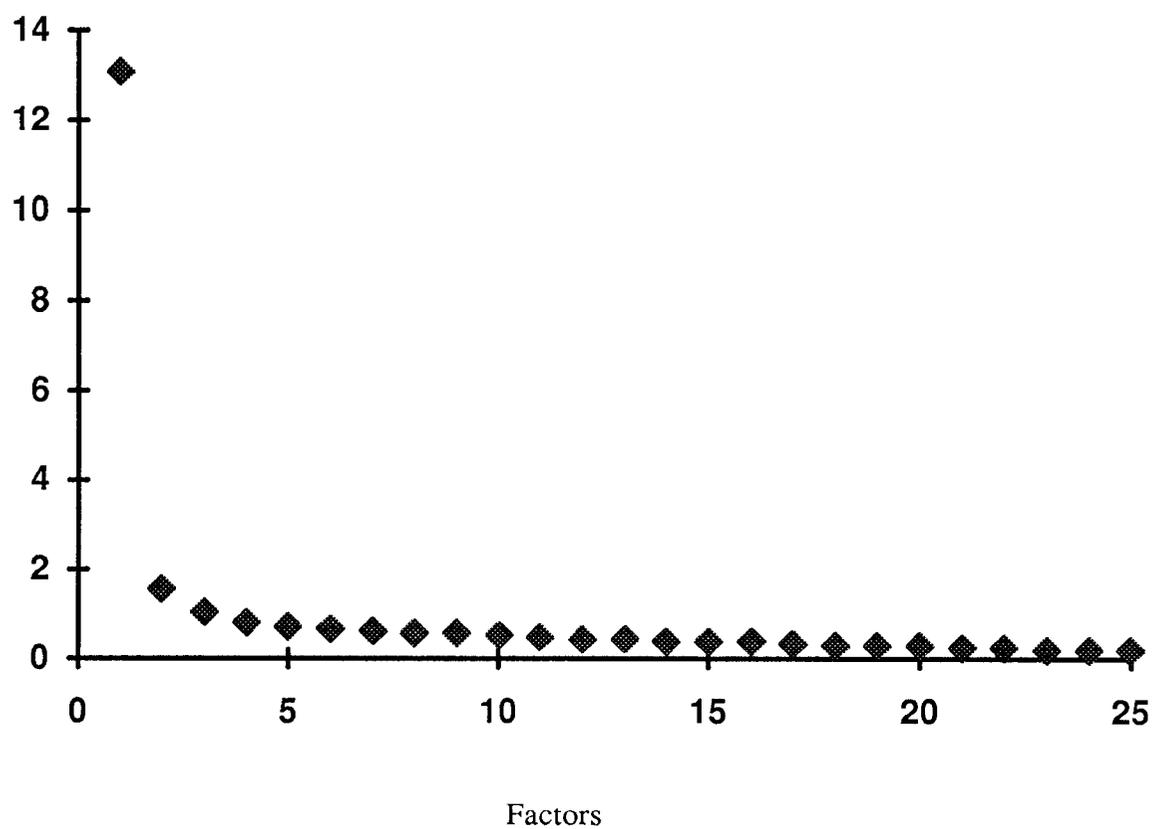


Figure 2. Scree plot for responses of 592 subjects to 25 items in ESCA.

Eigenvalues

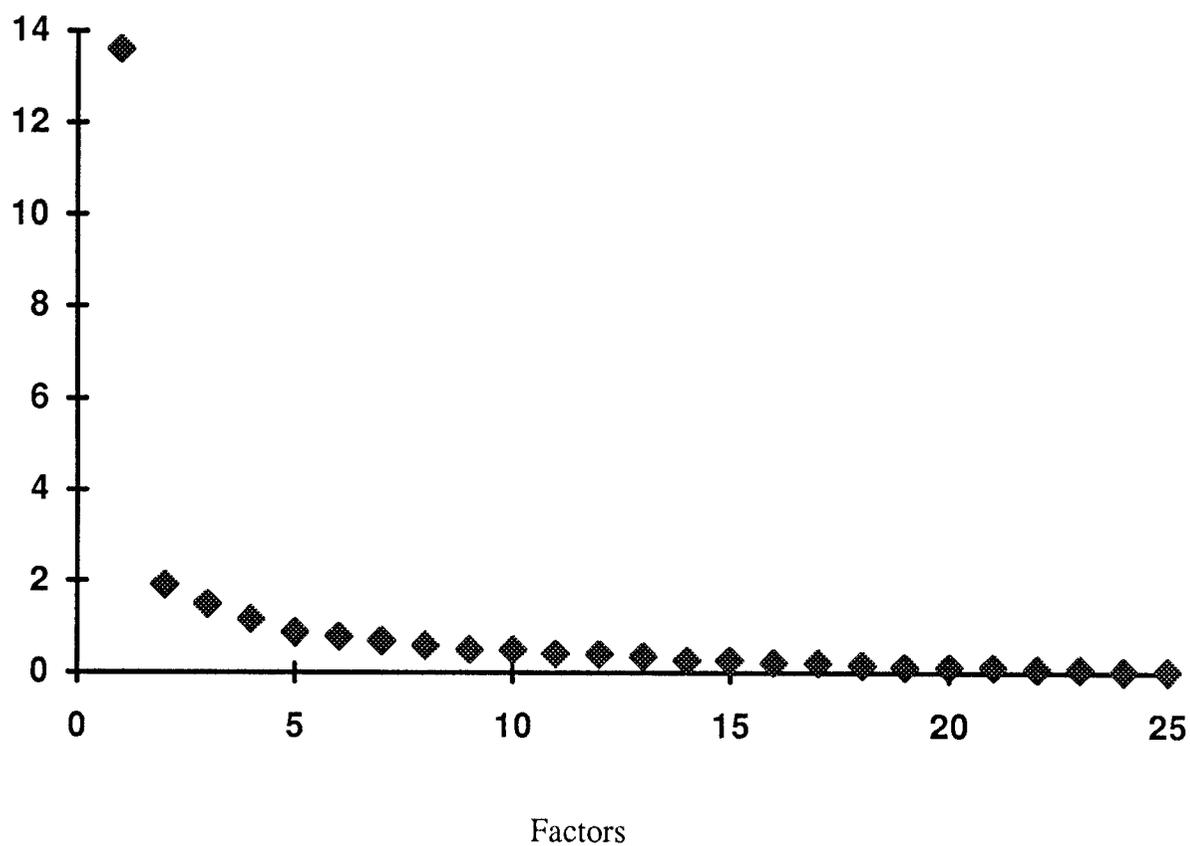


Figure 3. Scree plot for responses of 72 subjects to 25 items in ESCA.

Table 7

Quartimax Rotated Factor Matrix of 592 Responses to 25 Items in ESCA

Item ^a	1	Factor 2	3	h ²
1.	.62 (.39)	-.02 (.00)	-.05 (.00)	.39
2.	.82 (.67)	-.10 (.01)	-.13 (.02)	.70
3.	.65 (.42)	.54 (.29)	-.07 (.01)	.72
4.	.61 (.38)	.58 (.33)	.02 (.00)	.71
5.	.79 (.63)	.03 (.00)	.39 (.15)	.78
6.	.74 (.55)	.43 (.18)	.04 (.00)	.73
7.	.87 (.76)	-.11 (.01)	-.01 (.00)	.77
8.	.77 (.59)	-.11 (.01)	-.16 (.03)	.63
9.	.79 (.63)	.07 (.00)	.31 (.09)	.72
10.	.72 (.52)	.18 (.03)	.09 (.01)	.56
11.	.83 (.69)	.07 (.01)	.32 (.11)	.81
12.	.80 (.63)	-.16 (.03)	-.12 (.01)	.67
13.	.70 (.49)	.02 (.00)	.42 (.18)	.67
14.	.53 (.29)	.51 (.26)	-.02 (.00)	.55
15.	.70 (.49)	.32 (.10)	.14 (.02)	.61
16.	.62 (.38)	.02 (.00)	-.26 (.07)	.45

Table 7 (continued)

Item ^a	Factor			h ²
	1	2	3	
17.	.71(.50)	-.05 (.00)	-.16 (.03)	.53
18.	.79 (.62)	.05 (.00)	.29 (.09)	.71
19.	.78 (.60)	-.12 (.02)	.07 (.01)	.63
20.	.55 (.31)	-.01 (.00)	.06 (.00)	.31
21.	.61 (.37)	.21 (.04)	-.29 (.08)	.49
22.	.77 (.59)	-.18 (.03)	-.05 (.00)	.62
23.	.49 (.24)	.60 (.36)	-.00 (.00)	.60
24.	.69 (.47)	.09 (.01)	-.36 (.13)	.61
25.	.81 (.66)	-.18 (.03)	-.11 (.01)	.70
Eigenvalue	12.87	1.75	1.05	15.67
% Total Variance	51.48	7.00	4.20	62.68
% Trace Variance ^b	82.13	11.17	6.70	100.00

Note. Numbers in parentheses are the squares of the factor loadings.

^aItem refers to item number and corresponding statement in ESCA in Appendix D.

^bTrace variance = common variance.

Figure 3 shows a scree plot for the responses of a sample of 72 respondents to the ESCA. The elbow in Figure 3 is not as obvious as in Figure 2, but it is judged to be Factor 5. Thus, a four factor model is selected for the factor analytic technique, because the first four factors are above the elbow on the scree plot, have eigenvalues greater than 1, and account for substantially more of the variance than the remaining factors.

As a result of the scree plot in Figure 3, principal components analyses were performed on the responses of 72 subjects to the ESCA, and four factors were extracted. Quartimax rotation was performed on the extracted factors to approximate simple structure. Quartimax rotation converged in seven iterations. The results are presented in Table 8.

Table 7 shows that all 25 items have substantial factor loadings on Factor 1. The factor loadings for the 25 items range from 0.49 to 0.87 with only three items having factor loadings less than 0.60. Factor 1 accounts for 51.48 % of the total variance and 82.13 % of the common or trace variance. The Table further shows that Factor 1 is a global or general factor and does the best job of explaining covariation among the entire set of 25 items. The results in Table 7 confirm the prediction made prior to conducting the principal components analysis that all of the items would load on a general factor. This factor is presumed to reflect the latent dimension of attitude toward computers.

Table 7 further shows that items 3, 4, 6, 14, 15, and 23 have factor loadings in excess of 0.30 on Factor 2. In addition to covarying with the other 19 items on Factor 1, these six items covary on a second factor that accounts for 7 % of the total variance and 11.17 % of the common variance. Since the factors extracted from principal components analysis are orthogonal, Factors 1 and 2 are not correlated. Therefore, the six items in Factor 2 are measuring something in addition to attitude toward computers that is different from Factor 1. As a result of examining the six items, Factor 2 is interpreted as reflecting the respondent's positive emotional state which results from interaction with computers.

Table 8

Quartimax Rotated Factor Matrix of 72 Responses to ESCA

Item ^a	Factor				h ²
	1	2	3	4	
1.	.63 (.40)	-.36 (.13)	.11 (.01)	.20 (.04)	.58
2.	.62 (.39)	-.11 (.01)	-.04 (.00)	.64 (.41)	.81
3.	.64 (.41)	.52 (.27)	-.04 (.00)	.01 (.00)	.68
4.	.72 (.51)	.56 (.31)	.07 (.00)	.01 (.00)	.82
5.	.77 (.59)	.09 (.01)	.45 (.21)	-.02 (.00)	.81
6.	.77 (.60)	.50 (.25)	.00 (.00)	.05 (.00)	.85
7.	.74 (.55)	-.22 (.05)	.15 (.02)	.38 (.14)	.76
8.	.77 (.59)	-.27 (.07)	-.21 (.04)	.10 (.01)	.71
9.	.80 (.63)	-.04 (.00)	.45 (.20)	-.19 (.03)	.86
10.	.71 (.51)	.36 (.13)	-.20 (.04)	-.18 (.03)	.71
11.	.80 (.63)	-.07 (.00)	.36 (.13)	-.00 (.00)	.76
12.	.85 (.72)	-.18 (.03)	-.20 (.04)	-.07 (.00)	.79
13.	.82 (.68)	-.15 (.02)	.37 (.14)	-.22 (.05)	.89
14.	.59 (.35)	.27 (.08)	.09 (.01)	.27 (.07)	.51
15.	.73 (.54)	.36 (.13)	.29 (.08)	-.21 (.04)	.79
16.	.71 (.50)	.23 (.05)	-.28 (.08)	-.08 (.01)	.64
17.	.71(.51)	.05 (.00)	-.11 (.01)	.47 (.22)	.74
18.	.73 (.53)	.12 (.01)	.48 (.23)	.15 (.02)	.79

Table 8 (continued)

Item ^a	Factor				h ²
	1	2	3	4	
19.	.86 (.73)	-.24 (.06)	-.12 (.01)	-.13 (.02)	.82
20.	.66 (.43)	-.13 (.02)	.03 (.00)	-.02 (.00)	.45
21.	.71 (.51)	-.15 (.02)	-.18 (.03)	-.27 (.07)	.63
22.	.78 (.61)	-.09 (.01)	-.34 (.12)	-.12 (.01)	.75
23.	.63 (.40)	.34 (.12)	-.25 (.06)	-.20 (.04)	.62
24.	.71 (.51)	.14 (.02)	-.32 (.10)	.19 (.04)	.67
25.	.78 (.61)	-.05 (.00)	-.16 (.03)	.22 (.05)	.69
Eigenvalue	13.44	1.80	1.59	1.30	18.13
% Total Variance	53.76	7.20	6.36	5.20	72.52
% Trace Variance ^b	74.13	9.93	8.77	7.17	100.00

Note. Numbers in parentheses are the squares of the factor loadings.

^aItem refers to item number and corresponding statement in ESCA in Appendix D.

^bTrace variance = common variance.

From Table 7, it can be seen that items 5, 9, 11, and 13 have factor loadings in excess of 0.30 on Factor 3. These items covary and reflect a latent variable that is different from Factors 1 and 2. The results of examining the item statements of these four items suggest that Factor 3 reflects computer self-efficacy, i.e., how a respondent feels about himself or herself while working with computers.

Table 8 presents the rotated factor matrix for the responses of 72 preservice teachers enrolled in the MAT Program in Elementary Education at Oregon State University to the ESCA. From the Table it can be seen that the factor structure for the first three factors replicates the factor structure obtained with the first sample of 592 respondents. All 25 items have substantial factor loadings on Factor 1, ranging from 0.59 to 0.86. All but one of the items have factor loading at 0.62 or higher. Factor 1 accounts 53.76 % of the total variance and 74.13 % of the common or trace variance. Table 8 reveals that Factor 1 is a global or general factor and does the best job of explaining covariation among the entire set of 25 items. These results further confirm the prediction made prior to conducting the analysis that all of the items would load on a general factor. Thus, Factor 1 is presumed to reflect the latent dimension of attitude toward computers.

Table 8 shows that items 3, 4, 6, 10, 14, 15, and 23 load substantially on Factor 2. These items, with the exception of item 10, are the same items that loaded on Factor 2 in the analysis involving 592 subjects. Factor 2 accounts for 7.2 % of the total variance and 9.93 % of the common or trace variance. The seven items in Factor 2 are measuring something in addition to attitude toward computers that differs from Factor 1. As a result of examining the item statements of the seven items, Factor 2 is interpreted as reflecting the respondent's positive emotional state resulting from his or her interaction with computers.

From Table 8, it can be seen that items 5, 9, 11, 13, and 18 have factor loadings in excess of 0.30 on Factor 3. Item 18 in Table 7 has a factor loading of 0.29. If it is included in Factor 3 with this slightly lower loading, then Factor 3 consists of exactly the same items in both samples. Table 8 shows that Factor 3 accounts for 6.36 % of total variance and 8.77 % of common or trace variance. Factor 3 in Table 8, similar to Factor 3 in Table 7, is interpreted as reflecting computer self-efficacy, defined as how a respondent feels about himself or herself while working with computers.

Table 8 also shows that items 2, 7, and 17 load on Factor 4 in excess of 0.30. This factor was not extracted in the analysis of the larger sample. Factor 4 in Table 8 accounts for 5.20 % of total variance and 7.17 % of common or trace variance. The item statements of the three items in Factor 4 and the negative loadings of two of these items on Factor 2 can be interpreted as reflecting the respondents' negative emotional state as a result of working with computers. It appears to be the inverse of Factor 2. It is possible, however, that Factor 4 was extracted because of error variance resulting from a smaller number of respondents in the sample. Table 8 shows that the 1.3 eigenvalue of Factor 4 is only slightly larger than Kaiser's criterion extraction. Regardless, Factor 4 is not replicated in the analysis of the sample involving 592 respondents. As a result Factor 4 cannot be generalized to other subjects or variables.

MAT Preservice Teachers

The responses of 72 subjects to the ESCA provided the data for examining the computer attitude of preservice teachers enrolled in the MAT Program in Elementary Education at Oregon State University. The range of scores possible on the ESCA was 25 to 125 with higher scores reflecting a positive attitude toward computers. Analysis of the responses reveal that the scores of the 72 preservice teachers range from 39 to 125 with a mean score of 94.29.

Table 9 presents the mean scores for the 72 MAT preservice teachers for each of the 25 items included in the ESCA. The scores on negatively worded items are reversed so that respondents who had a positive attitude toward computers would score higher than those who had a negative attitude toward computers.

From Table 9 it can be seen that all 25 items have mean scores higher than 2.5 on a scale of 1 to 5. Only item 14 has a mean score less than 3.44. The means scores for

Table 9

Summary of Mean Scores for 72 MAT Preservice Teachers for Each Item in ESCA

Item	Mean	Item	Mean
1. ^b	3.69	14.	2.93
2. ^b	4.04	15.	3.92
3.	3.86	16. ^b	3.89
4.	3.44	17. ^b	3.56
5.	3.71	18.	3.46
6.	3.76	19. ^b	4.00
7. ^b	3.75	20.	3.63
8. ^b	3.99	21. ^b	3.82
9.	3.85	22. ^b	4.22
10. ^b	4.25	23.	3.44
11.	3.64	24. ^b	3.97
12. ^b	4.00	25. ^b	3.83
13.	3.83		

Note. Scores are reversed with respect to response categories for items with negatively worded statements.

^bItem with negatively word statement.

each item in Table 9 and the mean score of 94.29 for all 25 items reveal that the MAT preservice teachers as a group have positive attitude toward computers.

Nontest Variables

The responses of 72 MAT preservice teachers to the ESCA and a questionnaire measuring six nontest variables provided the data for examining whether or not computer attitude varied with respect to selected nontest variables. The nontest variables being measured by the questionnaire included the grade level at which the preservice teacher was preparing to teach and the gender, age, computer ownership, computer access, and computer experience of the preservice teacher. The following is a summary of the responses of MAT preservice teachers to the questionnaire.

1. The distribution of the preservice teachers according to grade level includes 10 in kindergarten, 14 in first grade, 9 in second grade, 17 in third grade, 11 in fourth grade, 5 in fifth grade, 5 in sixth grade, and 1 in eighth grade.

2. Ages range from 21 years to 49 years.

3. The sample includes 12 males and 60 females.

4. Thirty-two preservice teachers own a computer, while 40 did not own a computer.

5. Fifty-three of the preservice teachers have unlimited access to a computer, and 19 have limited access to a computer.

6. Forty-five preservice teachers perceive themselves as experienced computer users, while 27 perceive themselves as inexperienced computer users.

The relationship between computer attitude and gender is not examined because of the small representation of males in the sample.

Grade Level and Attitude Toward Computers

A one-way analysis of variance (ANOVA) was performed to determine if computer attitude varied according to the grade level at which 72 MAT preservice teachers were preparing to teach. The results of the analysis are presented in Table 10.

Table 10

Summary of One-Way ANOVA With Computer Attitude and Grade Level As Variables

Source	df	Sum of Squares	Mean Squares	F Ratio	F Probability
Between groups	7	1260.74	180.11	.546	.796
Within groups	64	2109.13	329.66		
Total	71	22358.88			

Table 10 presents a summary of a one-way ANOVA between grade level and attitude toward computers for 72 MAT preservice teachers. The F probability of 0.796 reveals that there is no significant difference at the 0.05 level in computer attitude with respect to the grade levels for which the preservice teachers are preparing to teach. This finding confirms the prediction made as part of the conceptual framework of the study concerning the relationship between computer attitude and grade level.

Age and Attitude Toward Computers

Correlation was utilized to examine the relationship between age and computer attitude for 72 MAT preservice teachers. A Pearson product-moment correlation

coefficient of -0.40 ($p < .001$) reveals that computer attitude varies with age in a negative direction; the higher the age of the preservice teacher, the less positive is his or her attitude toward computers. This finding confirms the prediction made in the conceptual framework of the study regarding the statistical relationship between age and computer attitude.

Computer Ownership and Attitude Toward Computers

A one-tail t test was performed to examine whether or not the computer attitude of 72 MAT preservice teachers varied with respect to being an owner or non owner of a computer. Table 11 presents a summary of the analysis.

It can be seen from Table 11 that the mean scores of computer owners and non owners are 94.88 and 93.83, respectively. The one-tail probability of 0.403 reveals that the calculated t value of 0.248 with 70 degrees of freedom does not equal or exceed the critical t value at the 0.05 level. Thus, the attitude toward computers between computer owners and non owners of MAT preservice teachers is not significant at the 0.05 level.

Table 11

Summary of One-Tail T Test Comparing Attitude Toward Computers of Computer Owners and Non Owners

Group	Number	Mean	SD	T Value	One-Tail Probability
Owners	32	94.88	20.11	.248	.403
Non owners	40	93.83	15.85		

Note. $df = 70$.

This result is contrary to the prediction made in the conceptual framework of the study that owners of computers would have a more positive attitude toward computers than non owners of computers.

Computer Access and Attitude Toward Computers

A one-tail t test was performed to examine whether or not 53 MAT preservice teachers, who had unlimited access to a computer, were more positive in their attitude toward computers than 19 MAT preservice teachers, who had limited access to a computer. A summary of the analysis is presented in Table 12.

The one-tail probability in Table 12 reveals that the calculated t value of 0.188 does not equal or exceed the critical value of t with 70 degrees of freedom at the 0.05 level. Thus, computer attitude does not differ significantly at the 0.05 level between MAT preservice teachers who have limited and unlimited access to a computer. This

Table 12

Summary of One-Tail T Test Comparing Attitude Toward Computers of Preservice Teachers With Limited and Unlimited Access to Computers

Group	Number	Mean	SD	T Value	One-Tail Probability
Unlimited	53	94.53	17.30	.188	.426
Limited	19	93.63	19.40		

Note. df = 70.

result confirms the prediction stated in the conceptual framework of the study with respect to the relationship between computer attitude and computer access.

Computer Experience and Attitude Toward Computers

A one-tail t-test was performed to examine whether or not 45 MAT preservice teachers, who perceived themselves as being experienced computer users, had a more positive attitude toward computers than 27 MAT preservice teachers, who perceived themselves as inexperienced computer users. Table 13 presents a summary of the one-tail t test.

The one-tail probability of 0.000 in Table 13 reveals that the calculated t value of 4.380 with 70 degrees of freedom exceeds the critical value of t at the 0.01 level. Thus, MAT preservice teachers, who perceived themselves as experienced computer users, have a significantly more positive attitude toward computers at the 0.01 level than the computer attitude of those who perceived themselves as inexperienced computer users.

Table 13

Summary of One-Tail T Test Comparing Attitude Toward Computers of Experienced and Inexperienced Computer Users

Group	Number	Mean	SD	T Value	One-Tail Probability
Experienced	45	100.62	15.27	4.380*	.000
Inexperienced	27	83.74	16.75		

Note. df = 70.

*p < .01

This result confirms the prediction made in the conceptual framework of the study regarding the relationship between computer attitude and computer experience.

Known-Groups

The responses to the ESCA of a sample of 132 preservice teachers, who were known to have a positive attitude toward computers, and a sample of 23 preservice teachers, who were known to have a negative attitude toward computers, were compared by means of a one-tail t test. A summary of the analysis is shown in Table 14.

From Table 14, it can be seen that the mean scores of 98.71 and 61.61 differ with the known positive group scoring higher than the known negative group. The one-tail probability of 0.000 in the Table reveals that the difference between the two groups is significant at 0.01 level. This result provides construct-related evidence for validity by supporting the assertion that scores on the ESCA by 132 preservice teachers at the elementary school level are a valid reflection of computer attitude.

Table 14

Summary of One-Tail T Test Comparing Attitude Toward Computers of Known-Groups

Group	Number	Mean	SD	T Value	One-Tail Probability
Positive	132	98.71	14.00	14.956*	.000
Negative	23	61.61	10.12		

Note. df = 153.

*p < .01

Experimental Intervention

The ESCA was administered to a sample of 55 preservice and inservice elementary teachers at the elementary school level on two occasions. On the first occasion, the subjects were asked to respond to the scale as if they had positive attitude toward computers. On the second occasion the subjects were asked respond to the ESCA as if they had negative attitude toward computers. Changes in score were analyzed by means of a one-tail paired t test. The results of the analysis are presented in Table 15.

Table 15

Summary of One-Tail Paired T Test Analyzing the Effects of Experimental Intervention on Attitude Toward Computers

Group	Number	Mean	SD	T Value	One-Tail Probability
Positive	55	110.38	11.90	27.462*	.000
Negative	55	40.36	11.98		

Note. df = 54.

*p < .01

Table 15 shows that the mean score on the ESCA is 110.38 when the subjects responded to the scale as if they had a positive attitude toward computers. The mean score is 40.36 when the subjects responded as if they had a negative attitude toward computers. The one-tail probability of 0.000 reveals that the responses as a result of experimental intervention are significantly different at the 0.01 level. This significant difference in scores by preservice and inservice teachers at the elementary school level

provides construct-related evidence for validity in that the scores on the ESCA with experimental intervention reflect different levels of magnitude of computer attitude.

Relationship to Similar and Dissimilar Constructs

The relationship of computer attitude to attitude toward mathematics and attitude toward reading was examined by correlating the responses of 61 preservice teachers on the ESCA to their responses on the Suydam-Trueblood Attitude Toward Mathematics Scale (Trueblood & Suydam, 1974) and Askov-Trueblood Attitude Toward Reading Scale (Weidler & Askov, 1983). The results show a Pearson product-moment correlation coefficient of 0.142 between computer attitude and attitude toward reading and a Pearson product-moment correlation of 0.243 between computer attitude and attitude toward mathematics. Neither correlation coefficient is significant at the 0.05 level with 59 degrees of freedom. These results confirm the predicted relationship made prior to the analysis between preservice teachers' computer attitude and attitude toward reading, but the results are contrary to the predicted relationship made prior to the analysis between preservice teachers' computer attitude and attitude toward mathematics.

Validity

A more encompassing result of the data analysis is that scores on the ESCA provide valid indicators of the attitude toward computers of preservice and inservice teachers at the elementary school level. This result is inferred utilizing logical argument and empirical evidence regarding the internal structure of the scale and external relationship of the scale to other variables. The logical argument and empirical evidence are presented in detail in the preceding sections. The following is a summary.

1. The ESCA is developed by (a) identifying a theory of construction based on a series of logical steps drawn from psychometric and measurement literature and research on the development and administration of attitude scales, and (b) implementing the theory in the construction and testing of the scale.

2. Construction of the scale includes provisions to reduce language difficulty by selecting statements for the item pool from actual statements written by a wide range of respondents of their feelings toward computers.

3. Construction of the scale includes provisions to reduce response bias by randomly assigning approximately equal numbers of positively and negatively worded statements in the final scale and by assuring anonymity for the respondents.

4. The item-total score correlations for the responses of two separate samples of 592 and 72 respondents on the ESCA are positive and at a level of 0.52 or higher for all 25 items (see Tables 4 and 5).

5. The internal consistency of the scale is high as evidenced by an alpha coefficient of 0.96 on two separate samples of 592 and 72 respondents (see Table 6).

6. The results of principal components analysis of the responses of separate samples of 592 and 72 subjects to the ESCA reveal that all 25 items load significantly on a general factor, providing evidence for the unidimensionality and additional evidence for the homogeneity of the scale (see Tables 7 and 8).

7. The loading of all 25 items on a general factor as predicted prior to analysis is confirmed (see Tables 7 and 8).

8. The factor structure obtained with the responses of 592 subjects to the ESCA is replicated with a new sample of 72 respondents (see Tables 7 and 8).

9. Scores on the ESCA relate as predicted to the nontest variables of grade level, age, computer access, and computer experience; however, they did not relate as predicted with computer ownership (see Tables 10, 11, 12, and 13).

10. Scores on the ESCA correlate as predicted with attitude toward reading, but they did not correlate as expected with attitude toward mathematics.

11. Experimental intervention results in significantly different scores on the ESCA by a group of 55 respondents who are directed to answer on one occasion as if they are positive toward computers and on a second occasion as if they are negative toward computers (see Table 15).

12. A group of 132 preservice and inservice teachers at the elementary level, who are known to have positive attitude toward computers, scored significantly higher on the ESCA than a group of 23 preservice and inservice teachers at the elementary school level, who are known to have negative attitude toward computers (see Table 14).

CHAPTER 5

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

The chapter is organized into four sections. The first section provides a brief summary of the purpose, methodology, and results of the study. Conclusions are identified in the second section, followed by a discussion of the conclusions in the third section. The final section is devoted to recommendations for future practice and research.

Summary of the Study

The purpose of this study was to: (a) develop a comprehensive plan consisting of a series of logical steps based upon recommendations derived from psychometric, measurement, and research literature and to utilize the comprehensive plan to develop a Likert-type scale to provide valid and reliable measures of the attitude of preservice and inservice elementary school teachers toward computers; (b) administer the developed scale to measure the computer attitude of preservice teachers enrolled in the MAT Program in Elementary Education at Oregon State University; and (c) investigate relationships that may exist between attitude toward computers and selected variables associated with preservice teachers enrolled in the MAT Program in Elementary Education at Oregon State University. The selected variables included grade level, age, computer ownership, computer access, and computer experience. To meet this purpose, the following steps were accomplished.

1. A critical review and analysis of psychometric and measurement literature and research associated with the development and administration of attitude scales were conducted and resulted in the identification of a theory of construction for the development of a Likert-type scale to provide valid and reliable measures of attitude toward computers.

2. The ESCA was developed as a result of following each step and procedure in the identified theory of construction. Validity was inferred utilizing construct-related evidence. The evidence included the manner in which the scale was developed, item-total score correlations for two separate samples of respondents, measures of internal consistency, determination and replication of factor structure by means of principal components analysis, prediction and conformation of a general factor on which all items had significant loadings, relationships of scale scores to nontest variables, correlation of computer attitude scores to similar and dissimilar constructs, comparison of scores with experimental intervention, comparisons of responses of groups with known positive and negative attitude toward computers. Reliability was measured on two occasions by means of the Cronbach alpha formula.

3. As part of the theory of construction, the ESCA and a questionnaire, measuring selected nontest variables, were administered to 72 preservice teachers enrolled in the MAT Program in Elementary Education at Oregon State University.

4. Relationships between attitude toward computers and grade level, age, computer ownership, computer access, and computer experience of the MAT preservice teachers were investigated by means of the one-way ANOVA, Pearson product-moment correlation, and t test.

The major results of the study were the identification of a theory of construction for developing a Likert-type attitude scale and the ESCA, which was developed by following each step and procedure in the identified theory of construction. The identified theory of construction consisted of a series of logical steps, each made up of one or more procedures, the rationale for and description of each step and procedure, and the sources from which they were derived. The steps in the theory of construction were as follows: (a) develop a theory of construction, (b) establish a conceptual framework, (c) create an item pool, (d) construct a trial scale, (e) administer the trial scale, (f) conduct an item analysis, (g) select items for the final scale, (h) construct final scale, (i) test for

homogeneity, (j) determine reliability, (k) test for unidimensionality, (l) administer final scale, and (m) infer validity.

The ESCA is a Likert-type scale for measuring the computer attitude of preservice and inservice teachers at the elementary school level. The scale consists of 25 items, 12 positively and 13 negatively worded item statements randomly assigned to the scale. The response categories range from strongly agree (5) to strongly disagree (1). The statements were selected from written responses of a wide range of preservice and inservice teachers at the elementary school level of their feelings toward computers. The written directions for completing the scale stated that there was not a right or wrong response for each item and assured the respondents of anonymity. It was inferred that the ESCA provided valid measures of the attitude of preservice and inservice teachers at the elementary school level toward computers based on construct-related evidence. Reliability was measured and found to be 0.96 on two separate samples of respondents.

The following were additional results of the study.

1. Each item in the scale had a high level of emotional intensity and a high corrected item-total score correlation.
2. The ESCA was judged to have the quality of homogeneity based on high corrected item-total score correlations, high internal consistency, and a high factor loading for all 25 items on a general factor presumed to reflect the latent variable, attitude toward computers.
3. The ESCA was judged to have the quality of unidimensionality because all 25 items had significantly high loadings on a general factor on two separate samples of respondents.
4. The predicted factor structure was confirmed and replicated on two separate sample of respondents.
5. Preservice teachers enrolled in the MAT Program in Elementary Education at Oregon State University had a mean score on the ESCA of 94.29.

6. The attitude toward computers of the MAT preservice teachers was not significantly related to grade level for which the preservice teachers were preparing to teach.

7. A significant correlation of -0.40 was found between the attitude toward computers and age of the preservice MAT teachers.

8. MAT preservice teachers who owned computers were not found to have significantly more positive attitude toward computers than MAT preservice teachers who did not own computers.

9. MAT preservice teachers who had unlimited access to a computer were not found to have significantly more positive attitude toward computers than MAT preservice teachers who had limited access to a computer.

10. MAT preservice teachers who perceived themselves as experienced computer users had significantly more positive attitude toward computers at the 0.01 level than MAT preservice teachers who did not perceive themselves as experienced computer users.

11. Preservice and inservice teachers at the elementary school level who were known to have a positive attitude toward computers scored significantly higher on the ESCA at the 0.01 level than those who were known to have a negative attitude toward computers.

12. Preservice and inservice teachers at the elementary school level who were asked to respond to the ESCA on one occasion as if they had a positive attitude toward computers scored significantly higher on the ESCA at the 0.01 level than they scored on a second occasion when they were asked to respond as if they had a negative attitude toward computers.

13. A Pearson product-moment correlation coefficient of 0.142 was found between the attitude toward computers of 61 preservice elementary school teachers and their attitude toward reading. The correlation was not significant at the 0.05 level.

14. A Pearson product-moment correlation coefficient of 0.243 was found between the attitude toward computers of 61 preservice elementary school teachers and their attitude toward mathematics. The correlation was not significant at the 0.05 level.

Conclusions

The following conclusions were drawn from the results of the study. First, the ESCA provided valid and reliable measures of the computer attitude of preservice and inservice teachers at the elementary school level. Second, the theory of construction, which was derived from psychometric, measurement, and research literature, was judged to be an effective plan for developing a Likert-type scale for measuring the attitude toward computers of preservice and inservice teachers at the elementary school level. Third, the preservice teachers enrolled in the MAT Program in Elementary Education at Oregon State University as a group have a positive attitude toward computers. Fourth, the computer attitude of preservice teachers enrolled in the MAT Program in Elementary Education is significantly related in a positive direction with computer experience and in a negative direction with age.

Discussion

The critical analysis of research on the development and use of instruments to measure attitude toward computers in Chapter 2 echoed the criticisms of attitude research by Gardner (1975a, 1975b), Abdel-Gaid et al. (1986), Haladyna et al. (1983), and Koballa (1988). Attempts to measure attitude, particularly computer attitude, have been largely ineffectual. The research is characterized by: (a) a lack of theoretical perspective, (b) inconsistent definition of attitude within individual investigations, (c) startling technical difficulties, and (d) failure to develop and/or report a clear and precise comprehensive plan, accompanied by a convincing rationale for each step of the plan, for

developing an instrument to provide valid and reliable measurements, and (e) a lack of congruence between validity theory and instrument development, administration of instrument, interpretation of scores, and reporting of the research.

In the research in which computer attitude instruments were developed and used, the research reports commonly were devoted almost entirely to descriptions and comparisons of what was measured, treatment effects, and relationships among variables with little or no mention of validity or reliability, as if these were unimportant aspects of the research. It was common practice to obtain an attitude instrument by adopting an instrument developed in another study, modifying an existing instrument, or simply constructing an instrument by combining items borrowed from several instruments and to administer the instrument in another setting to respondents from an entirely different population for which the instrument or items were originally developed without any mention of the need for validation. The computer attitude research and reporting of the research suggested that the researchers were not familiar with the fact that the meaning of validity has evolved over time. The critical review of the research on computer attitude revealed that researchers of computer attitude as a whole are either not familiar with the recommended procedures, as stated in psychometric and measurement literature for developing instruments to obtain valid and reliable measures of attitude toward computers, or they simply have chosen to ignore these recommendations.

The development and administration of the ESCA represented a response to the criticisms stated by the critics of attitude research and the critical analysis of research on the development of instruments to measure attitude toward computers in Chapter 2. It began with a review of psychometric, measurement, and research literature. A theory of construction was derived from the review for developing a Likert-type scale for measuring the computer attitude of preservice and inservice teachers at the elementary school level. The theory of construction consisted of a clear, precise, and comprehensive plan made up of a series of logical steps. It included a description of the steps and

procedures used within each step, defensible rationale for each step and procedure, and the sources from which the steps and procedures were derived. The ESCA was constructed and administered through the implementation of the theory of construction. Responses to the ESCA by preservice and inservice teachers at the elementary school level were shown to be reliable and were inferred as being valid reflections of the construct, attitude toward computers. Thus, the conclusions were drawn that the theory of construction was an effective approach for developing a Likert-type scale for measuring attitude toward computers and that the ESCA provided valid and reliable measures of the attitude toward computers of preservice and inservice teachers at the elementary school level. These conclusions and the manner in which they were reached represented an intentional and largely successful response to many of the criticisms directed toward attitude research in general and computer attitude research in particular.

It was concluded that the preservice teachers enrolled in the MAT Program in Elementary Education at Oregon State University as a group have a positive attitude toward computers. This conclusion was based on a comparison between the mean score of 94.29 on the ESCA by the MAT preservice teachers and the mean score of 98.71 by 132 preservice teachers at the elementary school level, who were known to have a positive attitude toward computers, and a mean score of 110.38 by 55 preservice and inservice teachers at the elementary school level, who responded to the scale as if they had a positive attitude toward computers.

Although the mean score for the MAT preservice teachers was relatively high, it did not provide an adequate description of individual scores. Twelve of the 72 MAT preservice teachers scored in the range of 39 to 74. Four scored 63 or below. A comparison of these scores with the mean score of 61.61 by 23 preservice teachers, who were known to have negative attitude toward computers, revealed that a fairly large number of the MAT preservice teachers will complete the teacher education program and become certified elementary school teachers with a negative attitude toward computers.

This situation, coupled with the general acceptance of the position that attitude strongly effects the decisions a person makes, is contrary to the expectation of the Northwest Council for Computer Education and Oregon State University (Neiss, 1990). Elementary school teachers are expected to have and use an increasing number of computer competencies in their teaching and training. It suggests a need to make changes in the curriculum of the MAT Program in Elementary Education at Oregon State University and/or the selection process for entrance into the program.

The attitude toward computers of the 72 MAT preservice teachers was significantly related in a positive direction with computer experience and significantly related to age in a negative direction. These relationships confirmed predictions that were made prior to the analyses. They have implications for the MAT Program in Elementary Education at Oregon State University. One-half of the preservice teachers enrolled in the program did not perceive themselves as experienced computer users. If a positive attitude toward computers is a desirable characteristic of an elementary teacher, then it seems logical that computer experience should become an integral part of the teacher education program, particularly for those preservice teachers who are older.

Failure to find a significant relationship between attitude toward computers and computer ownership of the preservice MAT teachers was a surprising result which was not predicted. One possible explanation for the finding can be derived by examining the nontest variable data. Only 32 of the preservice teachers owned a computer. However, 45 perceived themselves as experienced computer users, and 53 reported that they had unlimited access to a computer. It seems reasonable that some of the experienced computer users, who did not own a computer, did not have the need to purchase one because they had unlimited access to a computer. Further examination of the data revealed that 16 of the experienced computer users, who did not own computers, responded that they had unlimited access to a computer.

Recommendations

Future Practice

It was pointed out in the theoretical framework of this study that: (a) elementary school teachers are expected to have and use an increasing number of computer competencies in their teaching and learning, (b) attitudes strongly influence all the decisions a person makes, and (c) the importance of obtaining valid and reliable measures of the attitude toward computers of preservice and inservice school elementary teachers to be used in the development and implementation of preservice and inservice teacher education programs. Since scores on the ESCA were shown to reflect the magnitude of attitude toward computers held by preservice and inservice elementary school teachers, it provides an effective assessment tool for gathering attitude toward computers data for a variety of purposes, including the development and implementation of preservice and inservice teacher education programs. In addition to providing valid and reliable scores, the ESCA is quick and easy to administer, score, and interpret.

It is recommended that the ESCA be administered to students enrolled in elementary teacher education programs to obtain pre and post program measurements of the attitude toward computers of the preservice teachers. The data resulting from the pre program administration of the scale should be used to make decisions on whether or not the existing program should be changed to meet the expectation that elementary school teachers should have or develop a positive attitude toward computers, which is presumed to enhance their development and use of an increasing number of computer competencies in their teaching and learning. The data resulting from the post program administration of the scale should be used in assessing the effectiveness of how well the program contributes to or builds upon the attitude toward computers that the preservice students bring into the program.

The relationship between age and attitude toward computers found in this study for the MAT preservice teachers cannot be generalized directly to inservice teachers, but it reinforces the need to measure the attitude toward computers of inservice teachers at the elementary school level. Since inservice teachers are generally older than preservice teachers, it may be that their attitude toward computers as a whole may be more negative than preservice teachers at the elementary school level. Regardless, it is recommended that the ESCA be administered to inservice teachers at the elementary school level and that these scores be used in the planning and assessment of inservice education programs designed to improve the attitude toward computers of inservice teachers.

Future Research

Shepard (1993) stated that most treatises on construct validation contain a caveat that the gathering of construct-related evidence for validity is a process that is never-ending. Although this statement in one form or another was reviewed several times, its significance became more apparent during the developmental phase of the ESCA, because each phase of the study provided insights into other appropriate investigations. The fact that psychometric and measurement literature provided guidelines and standards for constructing computer attitude scales and for gathering construct-related evidence for validity but did not provide an indication of how much construct-related evidence was enough made decisions as to what construct-related evidence to gather in the development of the ESCA more difficult. However, Cronbach (1971) was correct in his assertion that the developer of a scale, such as the ESCA, does not have enough time and resources to investigate every avenue that would be relevant to the validation process. Thus, the investigations chosen for this study to gather construct-related evidence for validity and the results of these investigations, combined with the nature of construct-

related evidence and lack of standards as to what constitutes enough construct-related evidence for validity, suggested a number of recommendations for future research.

There are many additional relationships between computer attitude and other constructs and nontest variables not considered in this study that should be investigated in future research. The results of setting up and testing of hypotheses regarding these relationships are essential components for establishing a conceptual network (Shepard, 1993) or nomological network (Cronbach & Meehl, 1955) for the construct, attitude toward computers. Administering the ESCA in these investigations would provide additional construct-related evidence and further clarify the meaning of the construct. As these relationships become empirically established, the meaning of the construct, attitude toward computers, will become more explicit.

Although it seemed logical that attitude toward computers and attitude toward mathematics should be related, the relationship was not found in this study nor was it found in a study by Abdel-Gaid et al. (1986). Failure to confirm the relationship may have resulted from the utilization of poor measurement devices or sampling biases. Another possibility is that the hypothesized relationship does not exist in the present population from which the samples were drawn. Could it have existed when desktop computers were first introduced, a time when the effective use of computers required more time manipulating abstract symbols in the writing and testing programs? Currently, an abundance of computer programs are readily available and easy to use. This allows people, who cannot or dislike to manipulate abstract systems, to interact with and utilize computers effectively. Could it be that the relationship between computer attitude and attitude toward mathematics might still exist among older people or among people who are not familiar with many of the current programs which are available? Regardless, the relationship between computer attitude and attitude toward mathematics needs further investigation.

The significant relationships found between attitude toward computers and age and computer experience in this study were based on a sample of preservice teachers enrolled in the MAT Program in Elementary Education at Oregon State University. Future research should be conducted on these relationships using samples which include inservice teachers at the elementary school level.

The significant relationship between attitude toward computers and age raises an interesting question in need of future research. If younger preservice and inservice teachers are more positive toward computers, will this relationship diminish in time as more older inservice and preservice teachers obtain more computer experience or older inservice teachers become replaced with younger inservice teachers?

The ESCA was administered to five samples of respondents representing 952 preservice and inservice teachers at the elementary school level. However, the proportion of preservice teachers was larger than the proportion of inservice teachers. In addition, the responses of all 952 respondents were not maximally utilized in every step of the validation process. For example, the investigation of the relationship between computer attitude and nontest variables was limited to 72 preservice teachers enrolled in the MAT Program in Elementary Education at Oregon State University. Also, the 72 preservice teachers were not utilized in the investigation of the relationship between attitude toward computers and similar and dissimilar constructs. As a result, further research is recommended which administers the ESCA to larger and more representative samples of preservice and inservice teachers at the elementary school level and that the responses of the respondents be utilized maximally in gathering new construct-related evidence for validity or confirming that which has been previously collected.

Administration of the ESCA to larger samples of preservice and inservice elementary school teachers would allow for additional investigation of the factor structure obtained in this study. Although the factor structure obtained with the first sample was basically confirmed with a smaller second sample, further research is

recommended concerning the loading of three items in the smaller sample on a factor presumed to measure negative mental state as a result of working with computers.

In addition to the general factor, two factors measuring constructs other than attitude toward computers were identified and confirmed. Although only a relatively few items loaded at 0.30 or above on these factors, they were called positive mental state as a result of working with computers and computer self-efficacy. It is recommended that future research be directed toward a better understanding of these factors. Additional items and scales to measure these factors could be developed and utilized to investigate their distribution within a variety of respondent populations.

The theory of construction developed and utilized in this study proved to be an effective approach for developing a Likert-type scale for measuring computer attitude. However, what modifications could be made to improve its effectiveness? Would it prove to be as effective in the development of scales to measure other constructs? These are questions that need to be addressed in future research.

Validity is not all or none proposition. Rather, it is a matter of degree. Consequently, it is recommended that future research be conducted to improve the ESCA even though it was inferred that the responses to the scale provided valid and reliable reflections of computer attitude. For example, the high alpha coefficient obtained with 25 items suggested that the number of items could be reduced and still maintain high reliability. Also, even though all 25 items had significantly high loadings on the latent dimension presumed to be computer attitude, some of the items also had a fairly high loading on other factors presumed to measure different constructs. In other words, the factor analytic technique and quartimax rotation did not truly result in simple structure. Research could be conducted on the effects of eliminating the items with the highest loadings on other factors from the scale, replacing the item statements with new statements, and/or modifying the item statements.

Cronbach (1971) stated that the use of the phrase scale validation implied that it was just the set of measures obtained by administering the scale that was the subject of a validation study. However, he went on to state that the setting and procedures utilized in administering the scale may have influenced the responses to the scale. Messick (1989) referred to this as the context of measurement and stated that test responses are a function of the items in scale, experiential history of persons responding, and context of measurement, which includes factors in the environmental background and assessment setting. Thus, it is recommended that future research be conducted to examine the effect upon respondent scores of every aspect of the setting and procedures utilized in administering the ESCA, as well as the environmental background and experiential history of persons responding.

Shepard (1993) stated that the validation process should contain investigations that considered competing explanations for what a test measures by generating and testing rival hypotheses. For example, do responses on the ESCA reflect different magnitudes of attitude toward computers or have they been distorted by factors such as item bias or context variables? Future investigations should be conducted to explore counter explanations of the meaning of responses to the ESCA. The results of the investigations would provide additional construct-related evidence for inferring validity.

The ESCA was developed for preservice and inservice teachers at the elementary school level, and the validation process was conducted utilizing the responses of representatives from this population. It is recommended that future research be conducted on whether or not the ESCA provided valid and reliable measures of the computer attitude of representatives of from other populations, such as secondary teachers, school administrators, and/or secondary school students.

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APPENDICES

Appendix A

Request for Feelings About Computer

Dear preservice and inservice elementary school teachers:

Thank you for assisting us in the development of scale to provide valid and reliable measures of the computer attitude of preservice and inservice teachers at the elementary school level. Our first step is to gather statements from preservice and inservice elementary school teachers concerning their feelings toward computers.

Please take a few minutes to think about and respond to the following statement. We assure you that we will keep the responses confidential. We are in no sense attempting to evaluate teachers, programs, or schools.

Thank you very much for your assistance with our research.

ELEMENTARY SCHOOL GRADE LEVEL
TEACHING OR PREPARING TO TEACH _____

WRITE A SHORT DESCRIPTION OF YOUR FEELINGS ABOUT COMPUTERS

Appendix B

Cover Letter, Panel Members, Directions for Panel
Members, and Potential Item Pool StatementsCover Letter

Dear _____:

Thank you for agreeing to assist me in my doctoral research by serving on a panel to critically review a list of items for possible inclusion in an item pool. One purpose of my research is the development of a Likert-type scale to obtain valid and reliable measures of the computer attitude of preservice and inservice teachers at the elementary school level. One of the first steps in the development of the scale is to establish a pool of items, each of which falls within the domain of the construct. The attached list of potential statements for the item pool was derived from statements made by inservice and preservice elementary school teachers concerning their feelings toward computers. I will select the statements to be included in the item pool from this list based on judgments and comments made by you and other panel members.

I need your assistance in establishing the item pool by judging whether or not each statement in the list is clear, concise, simple, direct, unambiguous, and falls within the domain of attitude toward computers. The definition of attitude selected for the research is one provided by Daniel Mueller in Measuring Social Attitudes. Attitude refers to the intensity of " (1) affect for or against, (2) evaluation of, (3) like or dislike of, or (4) positiveness or negativeness toward a psychological object." Please record your judgments on the attached list of potential items. A space is provided after each item for any comments you would like to make.

An envelope is enclosed for your convenience. If you have questions or would like to talk with me directly concerning the list, please call me at 752-7328 (home), or leave a message for me on the message phone on campus at 7-5985. The message will be forwarded to me.

Thank you again for your assistance.

Sincerely,

Panel Members

Dr. Kenneth M. Ahrendt, Associate Professor of Education
Dr. Frank Bernieri, Associate Professor of Psychology
Dr. Sheila M. Cordray, Associate Professor of Sociology
Dr. E. Wayne Courtney, Professor Emer. of Education
Dr. Jodi Engel, Associate Professor of Education
Dr. Thomas P. Evans, Professor of Education
Dr. Knud S. Larsen, Professor of Psychology
Dr. Stan E. Shively, Associate Professor of Sociology
Dr. Rebecca Warner, Associate Professor of Sociology

Directions for Panel Members

Please respond to each item. Judge whether or not the statement is clear, concise, simple, direct, unambiguous, and falls within the domain of attitude toward computers. Attitude refers to the intensity of "(1) affect for or against, (2) evaluation of, (3) like or dislike of, or (4) positiveness or negativeness toward a psychological object" (Mueller, 1986).

A space is provided after each statement for any comments or suggestions you would like to make. Comments and suggestions are welcomed whether or not they are related to the identified criteria.

Potential Item Pool Statements

1. I like working with computers.
2. I feel anxious when working with computers.
3. I want to have a computer in my classroom.
4. I feel comfortable using computers.
5. I feel positive toward computers.
6. I feel uncertain when working with computers.
7. I feel negative toward computers.
8. I want to learn more about computers.
9. Computers are too complex for me.
10. I get frustrated when using a computer.
11. Working with computers is fun.
12. I am interested in working with computers.
13. Computers intimidate me.
14. Computers are difficult for me.
15. Computers are confusing to me.

16. I try to avoid working with computers.
17. I feel tense when working with computers.
18. Computers scare me.
19. I feel incompetent when using a computer.
20. I feel competent when using a computer.
21. Computers make me feel stupid.
22. I enjoy working with computers.
23. I love computers.
24. I would rather use a typewriter than a computer.
25. Computers cause me to feel inadequate.
26. Computers make me nervous.
27. I think computers are wonderful.
28. I enjoy learning more about computers.
29. Working with computers is too time consuming for me.
30. I feel confident when I use computers.
31. Computers are great.
32. I feel uncomfortable when using computers.
33. I don't like working with computers.
34. Computers are dehumanizing.
35. I feel that computers are not user friendly.
36. Computers are boring.
37. I am afraid of computers.
38. Hearing others talk about computers makes me feel uneasy.
39. Computers are exciting.
40. I feel in control when working with computers.
41. I do not feel in control when working with computers.
42. I am not threatened by computers.
43. I am overwhelmed by computers.
44. I cannot live without my computer.
45. I do not like the mechanical posture of buttons, blips, cords and annoying noises of computers.
46. I do not like the physical experience of sitting at the keyboard and looking at the screen.
47. I think computers are interesting.
48. Working with computers makes me angry.
49. Computers are my friends.
50. I wouldn't want to teach without a computer in my classroom.
51. Computers hate me.
52. Computers are cold and impersonal.
53. Computers make me feel helpless.
54. I feel capable when using a computer.
55. Computers fascinate me.
56. I lose track of time when I work with a computer.
57. Working with computers is important to me.

58. Working with a computer is motivating for me.
59. I enjoy solving problems related to the computer.
60. When working with a computer, I feel I might damage it in some way.
61. When working with a computer, I fear that I might make mistakes that I cannot correct.
62. Learning about computers is important to me.

Appendix C

Demographic Data and Trial Scale

Dear preservice and inservice elementary school teachers:

I would like to request your assistance in the development of a scale to provide valid and reliable measures of the computer attitude of preservice and inservice teachers at the elementary school level. Development of the instrument involves numerous steps. The step on which I am currently working requires the responses of preservice and inservice elementary school teachers to 50 Likert-items, each of which is being considered for possible inclusion in a final scale consisting of approximately 25 items.

Attached is a questionnaire. It consists of two parts. The first part asks for demographic information. The second includes the trial items being considered for inclusion in the final scale. Please take a few minutes to think about and respond to the statements. I am interested in responses to individual items; therefore, do not be concerned that some of the items seem redundant. Record your responses on the attached questionnaire. The demographic data are included to assure a broad sampling of subjects. There are no right or wrong answers to the attitude items. No attempt will be made to identify any individual, program, or school.

Thank you in advance for your assistance.

Part I : Demographic Data

Directions: Please answer all questions. For each question, please circle the letter or fill in the response that best represents yourself.

1. I am
 - a. an elementary school teacher.
 - b. preparing to be an elementary school teacher.
2. I teach or am preparing to teach at the _____ grade level.
3. I am _____ years of age.
4. I am
 - a. female
 - b. male
5. I own a computer.
 - a. Yes
 - b. No

6. I have unlimited access to a computer.
 - a. Yes
 - b. No

7. I consider myself to be
 - a. an experienced computer user.
 - b. an inexperienced computer user.

Part II : Computer Attitude

Directions: The following statements intend to measure your attitude toward computers. Please answer all statements using the following response categories:

- SA : Strongly agree = 5
 A : Agree = 4
 U : Undecided = 3
 D : Disagree = 2
 SD : Strongly disagree = 1

Circle the number that best represents your level of agreement or disagreement to each statement.

	SA	A	U	D	SD
1. Computers are too complex for me.	5	4	3	2	1
2. I feel comfortable using computers.	5	4	3	2	1
3. Computers are boring.	5	4	3	2	1
4. I try to avoid working with computers.	5	4	3	2	1
5. I feel positive toward computers.	5	4	3	2	1
6. I want to learn more about computers.	5	4	3	2	1
7. Computers make me feel stupid.	5	4	3	2	1
8. I am interested in working with computers.	5	4	3	2	1
9. I feel tense when working with computers.	5	4	3	2	1
10. Computers scare me.	5	4	3	2	1
11. I feel competent when using a computer.	5	4	3	2	1

	SA	A	U	D	SD
12. I feel that computers are not user friendly.	5	4	3	2	1
13. I enjoy working with computers.	5	4	3	2	1
14. I get frustrated when using a computer.	5	4	3	2	1
15. I love computers.	5	4	3	2	1
16. I would rather use a typewriter than a computer to write.	5	4	3	2	1
17. Computers cause me to feel inadequate.	5	4	3	2	1
18. I think computers are wonderful.	5	4	3	2	1
19. I do not like working with computers.	5	4	3	2	1
20. I enjoy learning more about computers.	5	4	3	2	1
21. I feel anxious when working with computers.	5	4	3	2	1
22. Working with computers is fun.	5	4	3	2	1
23. I want to have a computer in my classroom.	5	4	3	2	1
24. Computers intimidate me.	5	4	3	2	1
25. I feel confident when I use computers.	5	4	3	2	1
26. Computers are great.	5	4	3	2	1
27. Computers are dehumanizing.	5	4	3	2	1
28. Hearing others talk about computers makes me feel uneasy.	5	4	3	2	1
29. Computers are exciting.	5	4	3	2	1
30. I feel in control when working with computers.	5	4	3	2	1
31. I feel negative toward computers.	5	4	3	2	1
32. I am not threatened by computers.	5	4	3	2	1

	SA	A	U	D	SD
33. I am afraid of computers.	5	4	3	2	1
34. I am overwhelmed by computers.	5	4	3	2	1
35. I cannot live without my computers.	5	4	3	2	1
36. Working with computers makes me angry.	5	4	3	2	1
37. I think computers are interesting.	5	4	3	2	1
38. Computers are my friends.	5	4	3	2	1
39. When working with a computer, I fear that I might make mistakes I cannot correct.	5	4	3	2	1
40. I would not want to teach without a computer in my classroom.	5	4	3	2	1
41. Computers are cold and impersonal.	5	4	3	2	1
42. Computers make me feel helpless.	5	4	3	2	1
43. I feel capable when using a computer.	5	4	3	2	1
44. Computers fascinate me.	5	4	3	2	1
45. I lose track of time when I work with a computer.	5	4	3	2	1
46. Working with computers is important to me.	5	4	3	2	1
47. I enjoy solving problems related to the computer.	5	4	3	2	1
48. When working with a computer, I feel I might damage it in some way.	5	4	3	2	1
49. Learning about computers is important to me.	5	4	3	2	1
50. I do not like the physical experience of sitting at the computer keyboard.	5	4	3	2	1

Appendix D

Demographic Data and Final Scale

Dear preservice and inservice elementary school teachers:

I would like to request your assistance in a research project by filling out the following questionnaire. The questionnaire consists of two parts. The first part asks for demographic information. The second includes a scale to measure your attitude toward computers. Please take a few minutes to think about and respond to each item in the questionnaire. Record your responses directly on the questionnaire. The demographic data are included to assure a broad sampling of subjects. There are no right or wrong answers to the attitude statements. No attempt will be made to identify any individual or school.

Thank you in advance for your assistance.

Part I : Demographic Data

Directions: Please answer all questions. For each question, please circle the letter or fill in the response that best represents yourself.

1. I am
 - a. an elementary school teacher.
 - b. preparing to be an elementary school teacher.
2. I teach or am preparing to teach at the _____ grade level.
3. I am _____ years of age.
4. I am
 - a. female
 - b. male
5. I own a computer.
 - a. Yes
 - b. No
6. I have unlimited access to a computer.
 - a. Yes
 - b. No

7. I consider myself to be
- an experienced computer user.
 - an inexperienced computer user.

Part II : Evans Scale for Computer Attitude

Directions: The following statements intend to measure your attitude toward computers. Please answer all statements using the following response categories:

- SA : Strongly agree = 5
 A : Agree = 4
 U : Undecided = 3
 D : Disagree = 2
 SD : Strongly disagree = 1

Circle the number that best represents your level of agreement or disagreement to each statement.

	SA	A	U	D	SD
1. When working with a computer, I fear that I might make mistakes I cannot correct.	5	4	3	2	1
2. I feel tense when working with computers.	5	4	3	2	1
3. Working with computers is fun.	5	4	3	2	1
4. I love computers.	5	4	3	2	1
5. I feel competent when using a computer.	5	4	3	2	1
6. I enjoy working with computers.	5	4	3	2	1
7. Computers intimidate me.	5	4	3	2	1
8. Computers make me feel stupid.	5	4	3	2	1
9. I feel capable when using a computer.	5	4	3	2	1
10. I try to avoid working with computers.	5	4	3	2	1
11. I feel confident when I use computers.	5	4	3	2	1
12. Computers cause me to feel inadequate.	5	4	3	2	1

	SA	A	U	D	SD
13. I feel comfortable using computers.	5	4	3	2	1
14. I enjoy solving problems related to the computer.	5	4	3	2	1
15. I feel positive toward computers.	5	4	3	2	1
16. Hearing others talk about computers makes me feel uneasy.	5	4	3	2	1
17. I get frustrated when using a computer.	5	4	3	2	1
18. I feel in control when working with computers.	5	4	3	2	1
19. I am overwhelmed by computers.	5	4	3	2	1
20. I am not threatened by computers.	5	4	3	2	1
21. I feel that computers are not user friendly.	5	4	3	2	1
22. Computers scare me.	5	4	3	2	1
23. Computers are my friends.	5	4	3	2	1
24. Working with computers makes me angry.	5	4	3	2	1
25. I feel anxious when working with computers.	5	4	3	2	1

Appendix E

Table E-1

Summary of Responses of Expert Panel to Statements in Item Pool

Item Statement	Response ^a
1. I like working with computers.	reject
2 . I feel anxious when working with computers.	accept
3. I want to have a computer in my classroom.	accept
4. I feel comfortable using computers.	accept
5. I feel positive toward computers.	accept
6 . I feel uncertain when working with computers.	reject
7. I feel negative toward computers.	accept
8. I want to learn more about computers.	accept
9. Computers are too complex for me.	accept
10. I get frustrated when using a computer.	accept
11. Working with computers is fun.	accept
12. I am interested in working with computers.	accept
13. Computers intimidate me.	accept
14. Computers are difficult for me.	reject
15. Computers are confusing to me.	reject

Table E-1 (continued)

Item Statement	Response ^a
16. I try to avoid working with computers.	accept
17. I feel tense when working with computers.	accept
18. Computers scare me.	accept
19. I feel incompetent when using a computer.	reject
20. I feel competent when using a computer.	accept
21. Computers make me feel stupid.	accept
22. I enjoy working with computers.	accept
23. I love computers.	accept
24. I would rather use a typewriter than a computer to write.	accept
25. Computers cause me to feel inadequate.	accept
26. Computers make me nervous.	reject
27. I think computers are wonderful.	accept
28. I enjoy learning more about computers	accept
29. Working with computers is too time consuming for me.	reject
30. I feel confident when I use computers.	accept
31. Computers are great.	accept
32. I feel uncomfortable when using computers.	reject
33. I don't like working with computers.	accept

Table E-1 (continued)

Item Statements	Response ^a
34. Computers are dehumanizing.	accept
35. I feel that computers are not user friendly.	accept
36. Computers are boring.	accept
37. I am afraid of computers.	accept
38. Hearing others talk about computers makes me feel uneasy.	accept
39. Computers are exciting.	accept
40. I feel in control when working with computers.	accept
41. I do not feel in control when working with computers.	reject
42. I am not threatened by computers.	accept
43. I am overwhelmed by computers.	accept
44. I cannot live without my computer.	accept
45. I do not like the mechanical posture of buttons, blips, cords and annoying noises of computers.	reject
46. I do not like the physical experience of sitting at the keyboard and looking at the screen.	accept
47. I think computers are interesting.	accept
48. Working with computers makes me angry.	accept
49. Computers are my friends.	accept
50. I wouldn't want to teach without a computer in my classroom.	accept

Table E-1 (continued)

Item Statements	Response ^a
51. Computers hate me.	reject
52. Computers are cold and impersonal.	accept
53. Computers make me feel helpless.	accept
54. I feel capable when using a computer.	accept
55. Computers fascinate me.	accept
56. I lose track of time when I work with a computer.	accept
57. Working with computers is important to me.	accept
58. Working with a computer is motivating for me.	reject
59. I enjoy solving problems related to the computer.	accept
60. When working with a computer, I feel I might damage it in some way.	accept
61. When working with a computer, I fear that I might make mistakes that I cannot correct.	accept
62. Learning about computers is important to me.	accept

^aResponse represents 90 % or higher agreement among panel members.