THE EFFECTS OF AN INTERVENTION USING A PRECISION TEACHING MODEL ON GRADE FOUR STUDENTS' ARITHMETIC SELF-CONCEPT

by

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ABSTRACT

The development of a positive academic self-concept has been a professed objective of almost all educational programs from kindergarten to high school. However, there exist few experimentally researched, theory-based interventions which address the problem of low academic self-concept.

The present research sought to utilize the multifaceted and hierarchical theory of self-concept as proposed by Shavelson, Huber and Stanton (1976) to design an intervention aimed at enhancing academic self-concept. Specifically, the study was designed to apply a Precision Teaching intervention to the specific facet of multiplication in arithmetic. The effects of this intervention were subsequently measured at the level of arithmetic self-concept and academic self-concept. Differences between males and females on arithmetic self-concept were also examined before and after the intervention.

The study involved 185 grade four students of approximately nine years of age. Academic self-concept and arithmetic self-concept were measured by the Student's Perception of Ability Scale. A 2x4, gender by groups, factorial analysis of variance design was used to investigate the effects of the intervention. Given that the study utilized intact preselected classroom groups, the design was quasi-experimental.

The data indicated that the Precision Teaching intervention had a significant impact on enhancing the arithmetic self-concept of the experimental groups. Also, there were no significant differences between males and females at the grade four level in arithmetic self-concept.

On a theoretical level, the findings of the study seem to support the multifaceted and hierarchical nature of self-concept. At a practical level, the results of the study support Precision Teaching as an educational practice that positively influences student's academic self-concept.

As there has only been a small amount of research done to examine techniques for developing positive attitudes and modifying negative attitudes toward different subjects, it was concluded that further studies were necessary to examine and replicate the findings using other facets of academic self-concept. Similarly, there exists a need for studies extending over longer periods of time to examine the durability of academic self-concept change.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

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1. THE NATURE OF THE STUDY

A. INTRODUCTION

Stated in the objectives of almost all educational programs from kindergarten to high school, for normal, gifted and mentally or physically handicapped students, is the development of a positive self-concept. The British Columbia Ministry of Education's Curriculum Guide and Resource Book for kindergarten students, for example, states:

> Consideration for the emotional development of children is important not only in ensuring that their self-concept is positive and realistic but also in ensuring that they are able to develop cognitively. Children who are confident of themselves and are secure in their environment are ready for new learning. Successful learning, in turn, enhances self-esteem.
>
> Children with self-esteem are more enthusiastic, more willing to accept challenges, and more able to concentrate and to persevere. Supportive teachers foster the natural development of self-esteem as children attempt to explore and master their own goals. (p. 7)

However, after expounding on the importance of positively developing children's self-concept, seldom if ever are any practical recommendations given on how to enhance self-concept effectively. For instance, the only advice offered to the kindergarten teacher in the Curriculum Handbook is the quotation from E. L. Widmer taken from The Critical Years: Early Childhood Education at the Crossroads, which states,

> The fundamental step in helping a child feel worthwhile . . . is to believe in the intrinsic worth of all children, to believe they can grow as basic human beings. Believing in children is a powerful medicine that can work wonders. (p. 38)

However, according to self-concept research this simplistic approach does little to develop positive self-concept in children (Hilton, 1986; Crosby, 1982; Luftig, 1982).

Within the body of research devoted to self-concept, one of the most consistent lines of inquiry has been directed towards the link between performance or achievement and students' self-concept.

Numerous investigators have observed a positive correlation between self-concept and academic achievement. In a six-year investigation, Brookover and associates (Brookover, Paterson & Thomas, 1964; Brookover, Erickson & Joiner, 1967) followed the progress of students from seventh grade through twelfth grade in an effort to determine the relationship of students' self-concept to their academic achievement. Self-concept of scholastic ability or academic self-concept was reported to be significantly and positively related to academic achievement among both males and females. This relationship was found to be substantial even when I.Q. was controlled. Piers and Harris (1964) reported similar findings for elementary school children.

However, as pointed out by Hansford and Hattie in their 1982 meta-analysis on the relationship between various self-measures and measures of performance and achievement, it is possible to find support for virtually any viewpoint regarding the relationship between self and academic performance.

Bloom (1976) states that a schedule of success and approval or failure and disapproval over a number of years will lead to a student's generalizing about him or herself as a learner. He concludes that academic self-concept is a critical variable that influences both motivation and perseverance on school related tasks and that a student's academic self-concept is based on the feedback he or she receives from grades, tests, teachers, parents and peers about his or her schoolwork. He states:

> The learner is not born with a view about reading, science, or mathematics. Rather, the student acquires it during his school experiences. If the school can assure a history of successful experiences in school learning, especially during the elementary school period, the student's subsequent school history is likely to be positive with respect to cognitive achievement learning outcomes. (p.105)

Paralleling Bloom's line of thought, Brookover and Gotleib (1964) see academic self-concept as a "functionally limiting" factor in school achievement and success. They state,

> Functional limit is the term used to emphasize that we are speaking not of genetic organic limits on learning but rather of those perceptions of what is appropriate, desirable, and possible for the individual to learn. We postulate the latter as the limits that actually operate within broader organic limits, in determining

> the nature or extent of the particular behavior learned. (p. 469)

Burns (1982) conceptualizes the self-concept as having three main functions. He describes these as maintaining inner consistency, determining how experiences are interpreted, and providing a set of expectancies. He states that:

> What an individual thinks about himself is a vital part of internal consistency. Therefore, the individual will act in ways which he thinks are consistent with how he sees himself. If he feels he cannot do a task and that he is 'thick,' then he is likely to act and behave in such a way as to come out looking 'thick.' (p. 9)

B. THE PROBLEM

It appears that two of the most important roles played by the elementary schools are the development of basic academic skills and the enhancement of students' self-concept (Burns, 1982). Witnessing the volume of literature concerned with different aspects of the self-concept in educational settings, it is clear that self-concept is considered an important variable in educational research (e.g., Bloom, 1976; Byrne, 1984; Kifer, 1975; Purkey, 1970).

With this vision, numerous researchers have attempted to design interventions which have focused on self-concept enhancement (e.g., Hunt and Hardt, 1969; Kenemuth, 1975; Poudrier, 1976). However, in past intervention studies, measurement has been predominantly at the general self-concept level without regard to the multifaceted and hierarchical structure of the self-concept.

If as Shavelson et al. (1976) have suggested, self-concept is a hierarchical construct with general self-concept at the apex and situation specific self-concepts at the base, and if self-concept changes operate from the base of the hierarchy upward, then it would seem appropriate to look for changes in self-concept after remediation or intervention not solely at the apex of the hierarchy but at the ascending levels of the hierarchy, such as, academic self-concept, specific subject self-concept, and evaluation of behavior in specific situations. The present study was an attempt to do this. The present study also was an attempt to research a practical intervention that could provide classroom teachers with a viable method of enhancing low subject-specific self-concept.

C. BACKGROUND TO THE PROBLEM

It is interesting to note, however, that although there has been an abundance of self-concept research examining all ages of students in a multiplicity of settings and interventions, the research findings have been inconsistent and indeterminate. Researchers have suggested that weaknesses in self-concept research in academic settings can be attributed in part to theoretical problems and/or methodological problems (Scheirer & Kraut, 1979; Wells & Marwell, 1976; Wylie, 1961, 1974).

The issue of definition, in particular, has affected both the theoretical aspect as well as the measurement aspect of self-concept research, although many self-concept definitions overlap in various ways, definitions of self-concept have been as numerous and varied as the instruments designed to measure the construct. Unfortunately, this absence of an accepted definition of self-concept has hindered a systematic investigation into the role of self-concept in academic settings.

However, through the research of Shavelson and his associates (Shavelson, Huber, & Stanton, 1976; Shavelson, Burstein, & Keesling, 1977; and Shavelson & Bolus, 1982), a concise definition of self-concept is emerging. In their 1976 study, Shavelson, Huber and Stanton attempted to amalgamate the existing operational definitions of self-concept from the literature. From this extensive study, Shavelson et al. (1976) posited that there are seven crucial characteristics that can be attributed to the self-concept construct. These can be summarized as:

(a) Self-concept is organized or structured, in that people categorize the vast amount of information they have about themselves and relate the categories to one another.

(b) It is multifaceted, and the particular facets reflect the category system adopted by a particular individual and/or shared group.

(c) It is hierarchical, with perceptions of behavior at the base moving to inferences about self in subareas (e.g., academic - English, history), then to inferences about self in academic and nonacademic areas, and then to inferences about self in general.

(d) General self-concept is stable, but as one descends the hierarchy, self-concept becomes increasingly situation specific and as a consequence less stable.

(e) Self-concept becomes increasingly multifaceted as the individual develops from infancy to adulthood.

(f) It has both a descriptive and an evaluative dimension such that individuals may describe themselves (I am happy) and evaluate themselves (e.g., I do well in school).

(g) It can be differentiated from other constructs such as academic achievement.

Of the existing theoretical models of self-concept proposed to date, Shavelson et al.'s (1976) model has undergone an intensive examination in both cross-sectional and longitudinal designs (Byrne & Shavelson, 1986). The components of academic self-concept as posited by Shavelson et al. (1976) are presented in Figure 1.

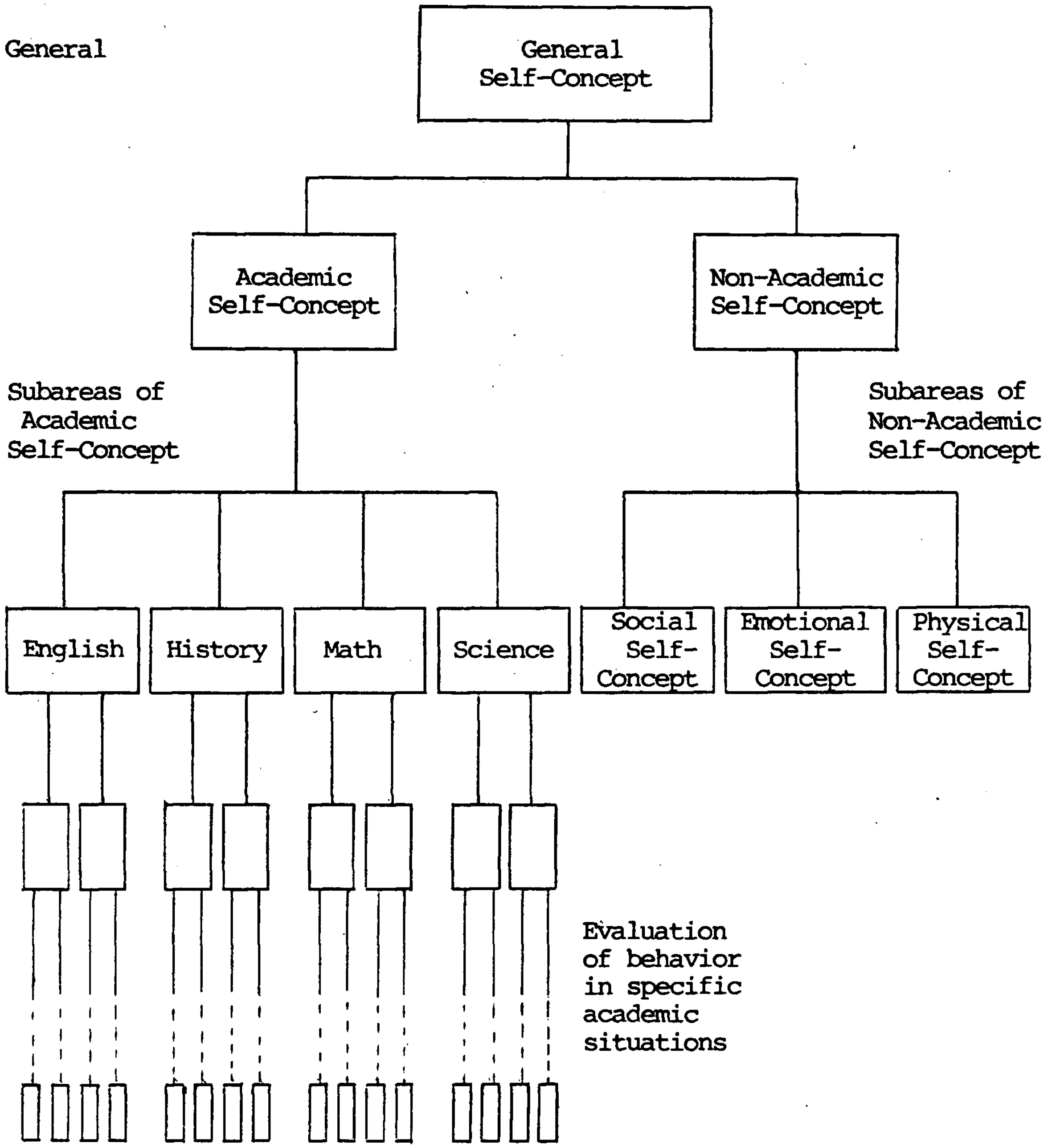

Fig.1: A Representation of the Components of Self-Concept*

* Shavelson et al. (1976)

In testing the hypothesis that self-concept is hierarchically structured, Fleming and Courtney (1984), Byrne (1986) as well as Shavelson and Bolus (1982) reported support for the hierarchical structure of the self-concept with general self-concept at the apex followed by academic self-concept; subareas of academic self-concept, such as, English and mathematics, and, finally at the base, evaluation of behavior in specific situations.

The multidimensional nature of self-concept has been examined by Marsh and O'Neill (1984), Marsh, Parker, and Smith (1983), as well as, Shavelson and Bolus (1982) and Byrne (1986). Findings of these studies have supported the multidimensionality of self-concept.

These findings now make possible a more systematic investigation into the measurement of the various facets of self-concept and consequently into interventions such as the present intervention which are structured on the multidimensionality of self-concept.

D. THE PURPOSE OF THE STUDY

Realizing that the two most important roles played by our elementary schools are the development of basic academic skills and the enhancement of students' self-concept, and further, that many researchers have observed a positive correlation between self-concept and academic achievement, it seems pertinent to research practical interventions that could enhance the self-concept as well as enhance basic academic skills. This investigation proposes to study the influence of a practical intervention to enhance academic self-concept. Specifically, this study looked at the effects of a Precision Teaching intervention on academic self-concept and arithmetic self-concept of grade four elementary school students.

Drawing on the theoretical framework of a hierarchical and multidimensional self-concept as proposed by Shavelson et al. (1976), this study proposed that changes in evaluation of behavior in specific situations at the base of the hierarchy would be able to be measured as changes in academic self-concept in subareas of the hierarchy. In addition, this study served to explore differences, if any, between male and female grade four students' academic self-concept when given a daily feedback intervention.

Also, as Precision Teaching strategies can be seen as an innovation in the classroom that differs significantly from current practice, a social validation of the intervention was conducted. This was done by a questionnaire which was given to both students and parents who co-charted progress with their children.

E. THE CONTEXT OF THE STUDY

The primary goal of the present study was to utilize the self- concept definition and theory of Shavelson et al. (1976) in designing a practical intervention to enhance the academic self-concept of grade four students. Specifically this intervention included the use of parents and Precision Teaching practices. The benefits of the investigation will be mainly at a practical level. To facilitate external validity, the investigation was conducted in a naturalistic setting. As noted by Campbell and Stanley (1963), educational research done outside laboratory settings often has to incorporate into its design naturally assembled collectives such as classroom groups. These factors unfortunately can impose certain constraints on the design and procedure of the study. The present study is no exception and consequently makes use of a quasi-experimental design to test the hypotheses.

F. SIGNIFICANCE OF THE STUDY

A study using the theoretical framework of the self-concept model proposed by Shavelson et al., 1976; Shavelson and Bolus, 1982; and Byrne and Shavelson, 1986, to examine self-concept change would make a contribution to compensatory education programmers. Self-enhancement theorists uphold that the focus in compensatory programs should be to increase the general self-concept of children. However, if changes in self-concept operate from base to apex, and if self-concept becomes increasingly stable toward the apex, then it would seem more productive to concentrate on creating changes at the lower levels of the hierarchy of self-concept, such as, specific areas of academic self-concept.

Of further significance, the present study offers classroom teachers a theory-based, researched and readily implementable, practical intervention capable of enhancing the academic self-concept of students.

II. REVIEW OF THE LITERATURE

There are many variations in emphasis on the nature and role of the self in self-concept research, however, generally speaking, most schools of thought see the self as a crucial factor in the understanding and predicting of human behavior. Going a step further, most self-concept theories imply that to explain and predict human behavior without knowledge of the perceptions held by individuals with respect to themselves and their environment is impossible (Boersma & Chapman, 1977).

This chapter provides an overview and review of the salient theoretical and empirical literature related to the two variables of interest in the present study--self-concept and Precision Teaching. In the first part (A), definitions of self-concept and the theoretical background of the construct are discussed. Next, in Part B, the theoretical framework for the present study is discussed and the model of self-concept proposed by Shavelson, Huber, and Stanton (1976); Shavelson and Bolus (1982); and Shavelson and Byrne (1986) is presented.

This is then followed (Part C) by an examination of academic self-concept, and self-concept, and academic achievement (Part D). This leads into a discussion of self-efficacy and classroom learning (Part E) and finally to Precision Teaching and the behavioral approach to teaching (Part F). The chapter concludes with a summary (Part G) of the preceding parts.

A. DEFINITIONS OF SELF-CONCEPT AND THEORETICAL BACKGROUND

There have been many attempts to describe and define the complex construct of self-concept. Of these many attempts, perhaps the simplest was put forth by Kinch (1963) who saw self-concept as, ". . . that organization of qualities that the individual attributes to himself." Samuels (1977), however, points out the problem with this definition is that one does not necessarily get an accurate picture of an individual's self-feelings from what the individual reveals since defense mechanisms can allow individuals to deceive themselves and others in order that self-concept enhancement can occur. Sigmund Freud (1962), with his emphasis on unconscious motivation, was a proponent of this theory.

Burns (1982) like Kinch (1963) viewed the self-concept as the composition of all the beliefs and evaluations an individual has about him or herself. Burns states, "These beliefs (self-images) and evaluations (self-esteem) actually determine not only who you are but what you think you are, what you think you can do, and what you think you can become." (p.1)

Historically, William James is generally recognized as the earliest "self" psychologist. To date his writings are standard reference when examining self-esteem or self-concept. Wells and Marwell (1976) summarize James' description of the self:

> A man's self is the sum total of all he can call his--the notion of appropriation and/or identity--divided it into three constituent parts: the material Me, the social Me, and the spiritual Me . . . . In order to understand Me in the total sense, James said, we must look not only at the constituents of the Me, but also at the feelings and emotions they arouse (self-appreciation) and the acts which they prompt (self-seeking and self-preservation). To the extent that people experience successes, they experience heightened self-esteem, although this was not described as some kind of stable self-evaluation, but rather as a barometer which rises and falls from one day to another. (p. 18)

An important theoretical model of the self-concept, symbolic interaction theory, is derived from the work of G. H. Mead who saw the self as "a social phenomenon, a product of interactions in which the person experienced himself as reflected in the behavior of the other" (Wells and Marwell, 1976, p. 17). Mead posited that the labels applied to one's self are learned during everyday interaction within one's network of social relationships and that for children first acquiring labels the most important social influences are those of the parents (Mead, 1934).

Initially identified with Carl Rogers, another theory emerged during the fifties which influenced self and self-concept theory. This clinical perspective in personality theory became known as client centered. In <u>Client Centered Therapy</u> (1951), Rogers defined self-concept as:

> An organized configuration of perceptions of the self which are admissible to awareness. It is composed of such elements as the perceptions of one's characteristics and abilities; the percepts and concepts of the self in relation to others and to the environment; the value qualities which are perceived as associated with experiences and objects; and goals and ideals which are perceived as having positive or negative valence. (p. 136)

A noteworthy aspect of Rogers' definition is the implication that only when a feeling or alertness about the self comes into awareness will it influence behavior. Another aspect of the self-concept noted by Rogers was that of consistency. Rogers proposed that behavior inconsistent with the self-concept tended to cause tension and confusion. He labeled this state one of incongruence between self and experience. In order to avoid this state, Rogers theorized that the individual's anxiety aroused defence mechanisms that either distorted or denied the experience, thereby maintaining the individual's consistent perception of self (Rogers, 1979). As previously pointed out, most self-concept definitions overlay in various ways and it was through the work of Shavelson, Huber, and Stanton (1976) that an amalgamation of these pre-existing definitions occurred. As identified by Shavelson et al. (1976), the seven features critical to the self-concept construct definition are identified as: organized, multifaceted, hierarchical, stable, developmental, evaluative, and differentiable.

B. SUMMARY OF SHAVELSON ET AL'S (1976) DEFINITION OF SELF-CONCEPT

Generally, self-concept is perceived to be a person's perception of him- or herself. The formation of this perception is the result of one's experience with and interpretation of one's environment. The perception one has of him- or herself is especially influenced by reinforcements, evaluations by significant others, and one's attributions for one's own behavior (Shavelson et al., 1976).

1. The Self-Concept as Organized

It is each individual's diversified life experiences that form the data on which he or she bases his or her perceptions of self. Because of the complexity of experiences, the individual reduces experiences into categories to give them meaning. Hence, the categories represent a way of organizing experiences and giving them meaning. Shavelson et al., 1976). Examples of categories could include physical attractiveness and ability, school ability, and social acceptance ability.

2. The Self-Concept as Multifaceted

The second-feature of the self-concept is that it is multifaceted, and that the particular facets mirror the category system chosen by the individual. The category system appears to include the areas of school, social acceptance, physical attractiveness, and ability.

3. <u>The Self-Concept as Hierarchical</u>

The multifaceted structure of self-concept can also be seen as hierarchical, meaning that facets of self-concept may form a hierarchy from individual experiences in isolation at the base of the hierarchy to general self-concept at the apex. Further, Shavelson et al. (1976) divided one's general self-concept into the two components of academic self-concept and non-academic self-concept. Academic self-concept is then further divided into subject matter areas and then into specific areas within a subject matter. Non-academic self-concept may be divided into social and physical self-concepts and then divided into the more specific facets as in academic self-concept.*

4. <u>The Self-Concept as Stable</u>

Although Shavelson et al. (1976) envision the self-concept as stable, they also point out that as one descends the self-concept hierarchy, self-concept depends increasingly on specific situations and becomes less stable. It is hypothesized that at the base of the hierarchy that self-concept varies greatly with variations in situations. Further, it is speculated that to change general self-concept at the apex of the hierarchy, many instances inconsistent with general self-concept would be required.

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* See page 8 for diagram.

5. The Self-Concept as Developmental

As children mature and learn from an ever broadening set of experiences, differentiation of self from environment begins. Shavelson (1976) points out that with increasing age and experience (especially acquisition of verbal labels) self-concept becomes increasingly differentiated and that as the child interprets the various parts of his or her self-concept one can speak of a multifaceted, structured self-concept.

6. The Self-Concept as Evaluative

Of the evaluative feature of the self-concept, Shavelson et al. (1976) state:

> Not only does the individual develop a description of himself in a particular situation or class of situations, he also forms evaluations of himself in these situations. Evaluations can be made against absolute standards, such as the 'ideal,' and they can be made against relative standards, such as peers or perceived evaluations of 'significant others.' (p. 414)

7. The Self-Concept as Differentiable

The seventh feature of self-concept in Shavelson et al's (1976) definition is that it is differentiable from the other constructs with which it is theroetically related. In clarifying this, Shavelson et al. (1976) state:

> Self-concept is influenced by specific experiences. Therefore, the more closely self-concept is linked with specific situations, the closer is the relation

> ship between self-concept and behavior in the situation. If one were to focus on the academic side of the hierarchy, one could hypothesize that (a) self-concept of mental ability should be more closely related to academic achievement than to ability in social and physical situations, and (b) self-concept of academic ability in science should be more closely related to achievement in sience than to achievement in, say, English or overall grade-point average. (p. 425)

C. ACADEMIC SELF-CONCEPT

Academic self-concept may be defined as a student's concept of his or her ability to perform academic tasks in the school setting.

As noted by Purkey (1970), after the home, the school probably is the next strongest force in shaping and maintaining a child's self-concept. Consequently, a school atmosphere offering success and approval or failure and disappoval over a number of years will lead to a student generalizing about him or herself as a learner (Bloom, 1976). Further, a child who comes to school with a low academic self-concept for whatever reason frequently doesn't actively become involved in new learning tasks (Samuels, 1976). Research done as early as 1940 (Sears) found children with low academic self-concept often were either over cautious and set goals below their present achievement, or set goals extravagantly high beyond possible accomplishment. This study indicated the need for parents and teachers to help students set realistic goals thus enabling students to more readily succeed and gain confidence as a result of their success.

Purkey and Graves (1970) report that individualized teaching improved the academic self-concepts of elementary school children. Similarly, by designing individualized learning programs in which students charted their own success, Howard (1974) improved the academic self-concepts of second- through fifth-grade children.

D. SELF-CONCEPT AND ACADEMIC ACHIEVEMENT

Numerous investigators have observed a positive correlation between self-concept and achievement. Studies using children after the first grade have found that children with learning difficulties tend to see themselves as being less adequate than those who were doing well (Coopersmith, 1959; Purkey, 1970; Kifer, 1973). Felker and Thomas (1971) report in their research that children with high self-concepts made positive statements about themselves while doing schoolwork, whereas those with low self-concepts did not do so.

Generally speaking, research reports investigating self-concept and achievement have suggested that elimination of excessive failure experiences and the creation of conditions that maximize success and intrinsic motivation will lead to a positive self-concept.

In a 1962 study done by Brookover, Paterson and Thomas with grade seven students, it was found that a student's self-concept of ability is positively related to the image he or she perceives significant others hold of him or her, when parents are identified as significant others. Further to this, as part of Brookover's longitudinal study (Brookover & Erickson, 1969; Brookover et al., 1965), several studies were conducted to investigate sources of influence on students' self-concepts. Parents, a counselor working individually with students, and a university expert who provided informational pep talks to groups of students in their classrooms were used as sources of influence. It was found that only the experimental condition with parents succeeded in increasing students' self-concept of ability and academic achievements. Brookover and Associates (1976) concluded that to be maximally efficient, a strategy to change the self-concept of students' ability should involve individuals who are already significant others and that parents of public school children are more likely to be academic significant others to their children than are the children's teachers (Brookover & Erickson, 1964). To date, few studies have investigated elementary children's self-concepts and the effects of home environment on enhancing self-concept.

A correlational study done by Brookover, Thomas and Paterson (1964) found a strong relationship between children's self-concept and their academic achievement. In this study three major hypotheses were tested: (1) Self-concept of ability in school is significantly and positively related to the academic performances of students even with an ability dimension controlled; (2) Self-concept is differentiated into specific self-concepts which correspond to specific subject-matter areas; and (3) Self-concept is significantly and positively correlated with the child's perception of how significant others view his or her ability. These hypotheses were tested using a sample of 1,050 grade-seven students who were given the Self-Concept of Ability Scale to determine his or her concept of ability, both in general and in particular subjects. After the effect of I.Q. was factored out, the students' reported concepts of their own ability and their grade-point averages were found to be significantly and positively correlated. It was also found that specific self-concepts of ability related to specific areas of academic achievement and that in some areas these were better predictors of achievement in the subject than general self-concept of ability. Finally, the self-concept of students was found to be significantly and positively correlated with the perceived evaluations of the student by other significant people. In summarizing their research, Brookover, Paterson and Thomas (1964) concluded that self-concept of academic ability is associated with academic achievement.

Purkey (1970) provides a review of research done since 1967 which also points to the significant relationship between self-concept and academic achievement. In 1967, Bledsoe examined the relationship of the self-concept of fourth- and sixth-grade students to their achievement, anxiety, intelligence, and interests. This research revealed significant correlations between the professed self-concept and achievement of boys but non-significant correlations for girls. Also in 1967, Campbell reported a low positive correlation between the Coopersmith-Self-Esteem Inventory, a self-report questionnaire, and the achievement of fourth, fifth, and sixth-grade children. Even though the above-mentioned studies do not provide unequivocal evidence that self-concept influences academic achievement, they have, however, encouraged educators to believe that interventions to enhance a student's self-concept may increase his or her academic achievement.

One of the largest American educational experiments undertaken was the federally sponsored Follow Through Planned Variations project which compared different theoretical models for compensatory educational interventions in the primary grades. Scheirer and Kraut (1979) reviewed several of the evaluations of this project which were of national scope, including the Stanford Research Institute's observational study done by Stallings and Kaskowitz (1974). Scheirer and Kraut (1979) summarize:

> . . . This massive research effort combining results from from numerous sites across the nation does not support the assumption of the open education theorists that the child's internal developmental needs, including a positive self-concept, must be the basis for educational progress. On the contrary, the more highly structural models were associated with advances in both academic achievement and self-esteem. (p. 135)

Generalizing from the Follow Through Planned Variations project it seems that self-concept changes, if they do occur, are thought to be a consequence of academic success rather than an intervening variable necessary for learning to occur. This generalization supports the behaviorists' vision who see learning as the result of the structured teaching of specific skills needed for academic success coupled with the use of positive reinforcement to strengthen correct responses.

A study by Hunt and Hardt (1969) examined changes in self-esteem and academic achievement of high school students in the Upward Bound program. Significant positive increases were found in global self-concept over the twenty-one month period of testing; however, these changes were not accompanied by changes in the students' grade-point averages. This research supports the proposition that global self-concept change doesn't necessarily lead to enhanced academic achievement.

Since 1971 there have been many doctoral dissertations summarized in Dissertation Abstracts which have attempted to link academic achievement with self-concept change. Full details on some aspects of these studies were not always included; however, overall results were reported. Poudrier (1975) investigated the effects of a self-concept intervention program on the self-concept and academic achievement of fourth-grade boys and girls. The sample consisted of 74 students with 38 students in the experimental group participating in the

Developing Understanding of Self and Others Program (DUSO) for 13 weeks. The control group participated in the Lippincott Spelling Program for 13 weeks. The groups were pretested and posttested with the Wide Range Achievement Test (WRAT) and the Self-Esteem Inventory. Significant differences favoring the control group were found on the reading and spelling sections of the WRAT. The conclusions of this study were that the DUSO Program was not an effective program for improving the academic achievement or self-concept of the fourth-grade students in the study.

A comparison of two methods of teaching in the elementary school as related to achievement in reading, mathematics, and self-concept of students was undertaken by Bradford (1972). The major reported findings of this study were that the students' gains in mathematics were significantly greater in the experimental group which used an Individually Guided Education Program (IGE) as compared to the gains in mathematics in the control group. Also, students' gains were significantly greater in self-concept in the experimental group when compared to the gains in self-concept in the control group. Significant gain scores were not found in reading achievement. However, as Scheirer and Kraut (1979) point out in their review, the use of only one school for each type of program confounds the potential program effects with other possible differences between the schools.

A study done by Lawson (1974) looked at a comparison of the development of self-concept and achievement in reading of students in the first, third, and fifth year of attendance in graded and non-graded elementary schools. Results found higher reading achievement for the non-graded schools at all three levels, but higher self-concept scores in the non-graded school only for the fifth-year students. It appears that self-concept change in this study was an outcome of reading success rather than an intervening variable.

An examination of studies by Smith (1975), Hopke (1974), and Pine (1975) revealed that none of the educational programs used showed measurable effects on the target groups' self-concept scores while at the same time increasing academic achievement. In no cases were changes in achievement unambiguously associated with changes in self-concept. However, because all the doctoral dissertations examined did produce some measurable results, the lack of evidence for a connection between improving self-concept and achievement cannot be attributed totally to inadequate measuring instruments or a failure to carry out the intended intervention.

The negative results found when reviewing the literature concerned with interventions aimed at increasing self-concept and subsequent positive changes in achievement indicate that perhaps the underlying theory is wrong. Scheirer and Kraut (1979) suggest an alternative view that motivation for academic learning comes from the reinforcements of one's social environment for specific learned skills. In this view, self-concept changes are likely to be an outcome of increased achievement with accompanying social approval rather than an intervening variable necessary for achievement to occur. From the literature, it seems the assumption that enhancing a student's feelings about him or herself will lead to academic achievement needs to be met with caution.

E. SELF-EFFICACY AND CLASSROOM LEARNING

According to Bandura (1981) self-efficacy refers to personal judgments of performance capabilities in a given domain of activity that may contain novel, unpredictable, and possibly stressful features. Schunk (1984) hypothesized that educational practices are an important contextual influence on students' self-efficacy. He states:

> Some educational practices may validate this sense of efficacy by clearly conveying that students are acquiring skills and knowledge, which should help to sustain motivation and develop self-efficacy and skills. Other practices may offer less clear information about skill acquisition or even convey that students are not particularly skillful. In these latter situations, motivation may suffer and students may remain uncertain of their capabilities. In short, educational practices are hypothesized to be important contextual influences on students' self-efficacy. (p. 209)

When acquiring new skills, students often meet with failures and setbacks. However, according to Schunk (1984), the perception of progress can promote students' sense of efficacy for further improvement. To develop self-efficacy, students need clear information that they are acquiring knowledge and skills. Unfortunately, when progress is slow such as during complex skill learning where students have to master many component skills, acquisition of success information becomes problematic. However, students can gain capability information through charts of their daily progress toward a goal.

A study done by Schunk (1983) demonstrated that explicit performance feedback enhances self-efficacy. Elementary school children who lacked subtraction skills received instruction and individually solved problems in a training packet over several sessions. At the end of each session, some students recorded the number of pages of problems they completed (self-monitoring); others had their pages recorded by an adult proctor (external monitoring); and students in a third condition worked on the packet but did not receive any feedback. In this study both forms of feedback were equally effective and led to higher self-efficacy and skillful performance compared with the no feedback condition. Schunk (1983) explains the results of this study as follows:

> As children observe their progress during training, they develop a heightened sense of efficacy. Subsequent monitoring directs children's attention to work they completed and provides an objective indicant of progress, which helps to validate perceived efficacy. . . . Conversely, when children's performances are not monitored they are on their own to assess their progress. Even though skills develop, children may be unsure of their capabilities. (p. 92)

When students are given or select a goal, they are apt to feel motivated and experience a sense of self-efficacy for attaining it (Schunk, 1985). Specific goals raise self-efficacy more than do general goals because progress toward an explicit goal is easier to gauge (Schunk, 1985). Like general goals, progress toward a distant goal is more difficult to gauge, thus students receive imprecise information about their skills. In a subtraction skill-development program (Bandura & Schunk, 1981), students individually worked on a training packet consisting of seven sets of material. Some students worked toward a proximal goal of completing one packet each session; a second group was given the goal of completing all sets of material by the end of the seventh session; and a third group was given the general goal of working productively. The results showed that proximal goals heightened task motivation, and led to the highest self-efficacy and subtraction skill.

F. PRECISION TEACHING

An instructional strategy which provides for very specific goals is Precision Teaching. Precision Teaching can be defined as an evaluation system characterized by daily reinforcement feedback and the visual display of this data (Fox, 1983). It is a proposition of the present study that through an intervention of the use of Precision Teaching practices, elementary students' subject-specific academic self-concepts can be improved.

The following discussion regarding the behavioral approach to teaching will serve to clarify some of the basic tenets of this method.

1. The Behavioral Approach to Teaching

The essence of the behavioral approach to teaching can be located originally in the work of Thorndike and Skinner. Generally, this approach is based on the premise that the environment greatly influences behavior. Many researchers have been successful in using the behavioral approach in education to alleviate a variety of academic deficits in a variety of populations. These include: the mentally retarded (Clark & Walberg, 1979); the underachieving (Hendler, 1985; Peterson, 1985), the emotionally and behaviorally disturbed (O'Leary & Becker, 1967), and the regular school population (Harris & Sherman, 1972).

2. Data-Based Instruction

Data-based instruction is a direct skill model of instruction that focuses on the direct and continuous measurement of student progress toward specific instructional objectives (Blankenship & Lilly, 1981). Benefits of this model of instruction have been reported by many educators including (Lovitt, 1984; Haring and Krug, 1975). Moreover there is a growing body of research that suggests that direct and frequent measurement of school behaviors can be used to increase student motivation (Mirkin, Deno, Tindal & Kuehule, 1979). Ysseldyke, Thurlow, Graden, Wesson, Algozzine, and Deno (1983) report in their "Generalizations from Five Years of Research on Assessment and Decision Making" that teachers found that their students were more aware of their own progress because of the frequent charting required by a data-based system and that the charting also increased the motivation of both teachers and students toward reaching goals and objectives.

According to Treiber & Lahey (1983), the behavioral approach to the remediation of academic related behaviors is defined by three characteristics.

> (1) Individualization and mastery learning. The child's strengths and weaknesses are assessed and progression is made at the child's own rate after the successful mastery of each task.
>
> (2) Direct teaching. Basic principles of learning are used in directly modifying the behaviors that need to be altered.
>
> (3) Emphasis on measurement. A vital aspect of the behavior approach is the continuous measurement of the behavior that is being treated. This procedure results in immediate feedback as to the effectiveness of the treatment program and permits changes when appropriate. (p. 42)

There are many terms characteristic of the behavioral viewpoint. Some of these being operant conditioning, direct instruction, behavior modification, direct measurement, and Precision Teaching. However, usually all these terms are interwoven in a behavioral approach (Mercer, 1987).

3. Data-Based Instruction and Precision Teaching

As data-based instruction focuses on the direct and continuous measurement of students' progress, Precision Teaching is often utilized as the evaluative system of data-based instruction. Generally speaking, data-based instruction is comprised of five components. These include: (1) selecting a target skill or behavior; (2) developing a task sheet or probe for measurement of pupil progress in daily timings; (3) collecting and graphing data; (4) setting instructional aims and designing instructional program; and (5) making instructional decisions and analyzing data (Mercer, 1987). It should be noted, however, that Precision Teaching per se does not dictate what should be taught or how instruction should proceed, rather it represents an approach to the systematic evaluation of whatever instructional tactics and curricula teachers utilize (White, 1986).

In the data-based instruction model, when selecting a target skill, the student is assessed in terms of skill mastery, and instruction begins at the lowest skill not mastered (Mercer, 1987). When selecting target skills, it is pertinent that skills or responses be described in such a way that it will be obvious to the student and teachers of that student that the skill was or was not displayed. Furthermore, it is compulsory that the skill be repeatable. As pointed out by West and Young

(1985), it is also important that each instance of a target skill be of similar duration. For example, it would be inappropriate to mix simple addition fact problems with long division problems when the goal of a student was to master thirty problems in a minute.

It is commonly agreed upon among researchers of the behavioral approach to teaching that one of the most salient features of data-based instruction is direct, continuous and precise measurement of behavior (White & Haring, 1980; Van Houten, 1980). As no single instructional strategy works all the time and even the most carefully planned program can lose effectiveness, frequent evaluation of pupil progress is paramount in determining when and how a program should be modified (White, 1985). Also, since the effective use of feedback hinges on providing precise feedback following small improvements, it is essential that teachers and parents be able to measure and recognize instances of success in their students (Van Houten, 1980). The Precision Teaching evaluation system is an effective method for doing this.

The term, continuous measurement, necessitates that a behavior be counted and recorded over time; whereas the term, precise measurement, requires that recording systems be reliable (Mercer, 1987).

With respect to collecting and graphing data, changes in performance can be studied more easily when scores are plotted on a graph and inspected visually. Graphs also enable the inspection and comparison of multiple data points without examining vast quantities of raw performance scores (West & Young, 1985). Consequently, in data-based instruction, graphing is the most common way of presenting data (Mercer, 1987).

Graphs serve three purposes generally: (1) they summarize data; (2) they communicate intervention effects; and (3) they provide feedback and reinforcement to the learner and teachers (Kerr & Nelson, 1983). Unfortunately, however, it is possible that the format of the graph can exaggerate or obscure the quantitative dimensions of the data and thus confuse interpretation. One way of avoiding this is through the use of a standard behavior chart.

4. The Standard Behavior Chart, A Precision Teaching Tool

The standard behavior chart* is a scale that can span a wide range of performance values but requires little space. This is done by the use of a ratio or logarithmic scale.

West and Young (1985) state:

> The logarithmic scale is important for reasons other than its ability to display widely varying scores. It also enables the teacher to study a picture of learning that is more easily interpreted. When the measures of performance are plotted on the more typical "equal interval" or "arithmetic" scale, learning

* See Appendix A.

> (represented by a line or function which "best fits" the data) is found to accelerate. In other words, a curve with an ever-steeper slope is created. When data are plotted on the standard behavior chart, learning is generally represented by a straight or nearly straight line. The value of the slope of the line which best fits the distribution of the values plotted on the logarithmic scale is thought of as an "index of learning." The steeper the slope, the faster the learning is; the flatter the slope, the slower the learning is. (p. 6)

Another useful component of the logarithmic scale is that equal units on the scale correspond to equal ratios, and equal distances from one point on the logarithmic scale to another point consistently reflect equal proportional changes (West & Young, 1985). This is of importance when considering the definition given to learning by West and Young (1985) in which learning is seen as a "change in the relative values of repeated performance measures." Given this definition it would seem appropriate to inspect relative changes in a logarithmic scale.

5. Data-Based Decision Making

Ysseldyke et al. (1983) in a longitudinal study of research on assessment and decision-making strategies state:

> Student performance can be improved by applying data utilization strategies. Students make more progress when their performance data are used systematically and teachers are satisfied with the procedures. Collecting more frequent data on student performance leads to more accurate decisions. (p. 83)

Similarly, Mirkin, Deno, Tindal, & Kuehule (1979) found evidence that frequent evaluation of student performance can lead to improved student achievement. However, to derive the maximum benefit of Precision Teaching, it is not sufficient to simply monitor performance of a learner on a standard chart. Evaluation of the data must be used to make systematic decisions on how instruction should continue (White, 1986).

Numerous Precision teachers have developed guidelines to assist educators in deciding when and how a learning program should be changed (Eaton, 1978; Haring, Liberty, and White, 1980; White & Liberty, 1976).

Eaton (1978) has pointed out that when a series of data points is graphed, it is then possible to calculate the slope of the student's progress line and from this determine if the program should continue or be redirected. By using data on slope, it is now possible to move instruction into the area of applied science (Deno, 1985). This offers a contrast to the findings of Fuchs, Fuchs and Warren (1982) who found that the overall discrepancy between actual student performance and teacher judgment of non-precision teachers to be statistically significant.

The decision rules of Precision Teaching have been developed to be an objective set of guidelines that can be applied very precisely using only the data displayed on the standard behavior chart (White, 1986). However, even though numerous research studies have supported findings that data analysis and decision-making guidelines improve academic performance in learners of various ages, educators must remain aware of the fundamental guiding principle of Precision Teaching that the "learner knows best" or as White (1986) states;

> Existing data decision rules provide useful guidance, but educators must always look to the individual learner for confirmation that their efforts are appropriate. (p. 523)

In summary, as previously noted, Precision Teaching is not regarded as a way of teaching but rather as a way of evaluating the curricula and teaching strategies being used. However, as an evaluation system, Precision Teaching has been used successfully to facilitate the progress of learners ranging from the severely handicapped to university graduate students (White, 1986). Lovitt and Fantasia (1983 and 1985), reviewed several studies they conducted to evaluate the effects of Precision Teaching instruction on the academic performance of elementary-age, mildy handicapped children. The data from these studies indicated that Precision Teaching or certain of its features, was related to pupils' significant achievement gains in reading, arithmetic, and spelling with the greatest effects seen in reading. Three extensive well-controlled studies done with elementary school students are summarized in Table 1.

Table 1

Summary of Precision Teaching Studies

Study	Design	Measures	Results
Great Falls Precision Teaching Project 1976	Children with skill deficits in grades 1, 2, & 3 in six schools; 3 schools employed precision teaching (PT), 3 schools did not. Total experimental n=532; control n=476. Pretest/ posttest design over circa 1 school year.	Time probes in writing numbers randomly, writing numbers dictated, and saying letters (dist. screening procedures).	PT group posttests significantly superior in 15 (79%) of the comparisons, no differences in 3 (16%) of the comparisons; non-PT group superior in 1 (5%) of the comparisons.
Great Falls Precision Teaching Project 1979	Study 1:134 regular 1st, 2nd, & 3rd graders in a school using PT compared pre/post over one school year with 155 similar children in a carefully matched school not using PT.	Iowa Test of Basic Skills, math and reading subsections.	Study 1:No initial differences; 1st and 2nd grade PT groups significantly superior in math. In no case did the non-PT group significantly outperform the PT group.
	Study 2: Regular fourth graders at a PT school (n=294) compared with students in a matched non-PT school (n-312) over a period of 4 years.		Study 2:By the end of four years, the PT 4th graders were performing at the 95 percentile in reading and the 86th percentile in math; the non-PT school students were performing at the 71st and 54th percentile, respectively.
Great Falls Precision Teaching Project 1981	538 2nd, 3rd, and 4th graders and 30 teachers assigned to 4 groups:(1) non-PT; (2) PT daily assessments (3) PT daily assessments + charting; (4) PT daily assessments + charting + use of special data-decision rules. Pre-post assessments over 7 months.	Iowa Test of Basic Skills, math subsection.	10 or 11 comparisons showed significant differences found in the 11th comparison. The use of prespecified decision rules (the third PT condition) proved superior in 7 (63%) of the comparisons.

Exerpted from White, O. R. (1986)

6. Stages of Learning

Numerous practitioners of the behavioral approach to teaching posit that there are distinct stages of student learning that are fundamental to designing and implementing instruction (Haring, Lovitt, Eaton, & Hansen, 1978). Smith and Lovitt (1976), define these stages as acquisition, proficiency, and maintenance. The acquisition stage occurs when the behavior to be learned is not in the repertoire of the student and the student doesn't know how to perform the task. Once the student can accurately complete the task, he/she enters into the proficiency stage. At this stage, the student is still not sure of the process and consequently is slow at performing the task. The third stage or maintenance is the stage where the student has acquired the new skill and is proficient in his/her performance of the skill. At the maintenance stage, the teacher must ensure that the student maintains the required level of proficiency.

Research studies that demonstrate the effectiveness of reinforcement in improving academic performance are plentiful. However, some researchers (Smith & Lovitt, 1976) have reported that reinforcement is not always successful in improving academic performance. Smith & Lovitt (1976) found that when students were learning how to solve arithmetic problems (or in the acquisition of learning), reinforcement was ineffective. Conversely, when students were presented with arithmetic problems they knew how to solve accurately (proficiency stage), but at which they worked too slowly, reinforcement contingencies proved successful. Smith & Lovitt (1976) suggest that these studies demonstrate the importance of careful diagnosis of children's academic deficiencies and that many arithmetic interventions are effective with only certain types of performance. However, when students' computational proficiency needs improvement, reinforcement contingencies can influence computational speed.

G. THE ELEMENTARY SCHOOL STUDENT'S SELF-CONCEPT

It can be noted that researchers are in agreement that when children enter elementary school their self-concepts are already forming but are still very much susceptible to change (Burns, 1982). Generally speaking, once in the public school system, the most dominant value operating is that of academic achievement. Evaluation of each student's academic achievement is pervasive and is both verbal and non-verbal. After a student encounters a sufficient number of failing experiences, he or she will eventually succumb to a negative or inadequate self-concept in the specific area of failure. Similarly, for successful encounters, a student will eventually come to view him or herself as adequate in this area (Glasser, 1964). Further, Burns (1982) points out:

> A few successful or unsuccessful experiences may not have a major effect on the self-concept--in fact, it is possible that occasional experiences which can be turned by the individual into successful experiences may be of special significance in strengthening the individual's self-image. However, it is the frequency and consistency of adequacy over a period of years which has its major effects on self-concept. (p. 204)

Morse (1964) has pointed out that between second and seventh grade there is a consistent decline in children's self-esteem. Torrance (1967) hypothesized that certain periods of stress in children's lives contribute to behaviors that cause discontinuities in creative growth and, in a longitudinal, cross-cultural study, found that a significant decline in creative thinking occurred in the fourth grade.

Building from the work of Torrance (1967), Williams (1976) discovered that fourth-grade students (at nine years of age) also experienced a significant decline in academic self-concept and motivation but did not experience a decline in general self-concept. Williams states,

> This is not surprising as one views the typical educational program in many elementary schools; for at that time in pupils' lives they are expected to be rather well regimented into a certain academic mold imposed by teacher, peer, and parent pressures for school success. This is especially true in the skill areas of reading, mathematics, and language.(p. 24)

Drawing from his 1976 study, Williams recommends several preventative measures for educating pupils in the grade-four age group to reduce their feelings of academic inadequacy. He posits that a possible solution is for teachers to set attainable goals for students and to be able to recognize movement towards these goals no matter how small the movement. Precision Teaching is one way this could be done in the classroom.

Using the work of Torrance (1967) and Williams (1976) as a rationale, the present study used fourth-grade students as subjects.

Like reading and language skills, success in arithmetic is an important aspect of academic self-concept. Combs and Soper (1963) have established that for kindergarten and first-grade children academic self-concept is already differentiated into particular areas of competency, for example, reading and arithmetic.

Aitken (1970), in a review of research on attitudes toward mathematics, states that there are many methods of measuring these attitudes. He lists these as: (1) observational methods; (2) interviews; and (3) self-report methods such as questionnaires, attitude scales, or projective techniques. Further, Aiken (1970) states that although the majority of investigations have dealt with attitudes toward mathematics in general, attitudes toward specific types of mathematics problems can also be assessed.

Generally, it is recognized that attitudes toward mathematics in adults can be traced to childhood (Morrisett & Vinsonhaler, 1965). It would seem reasonable that the grades which stressed arithmetic strongly would be the grades that would be most influential in early arithmetic attitude formation.

Researchers have observed that consistent failure in arithmetic causes students to lose self-confidence and develop a negative attitude toward the subject (Lerch, 1961). To alleviate negative attitudes, the teacher must provide success experiences for the student as well as set reasonable goals that culminate in the reward of success (Aiken, 1970). The use of Precision Teaching is one way of doing this.

According to Aiken (1970), techniques for developing positive attitudes and modifying negative attitudes toward arithmetic have been little studied or researched. The present study was an attempt to utilize Precision Teaching as a technique for developing positive attitudes toward arithmetic.

Sex-related differences in mathematics performance have often been attributed to the cognitive variable, spatial visualization. Aiken (1973) came to the conclusion that spatial-perceptual ability was one of the most salient factors contributing to mathematical achievement. However, Fennema and Sherman (1977) specifically investigated the relationship between mathematic achievement and spatial-visualization skills. The data from this study did not support the idea that differences in mathematics achievement of males and females could be explained by differences in spatial-visualization ability. More specifically, in this study of males and females enrolled in grades six through twelve, few sex-related differences in either mathematics achievement or spatial-visualization skills were found. The two were related ($r \cong .5$) for both sexes and spatial-visualization ability appeared to influence both females and males equally to continue studying mathematics.

Mathematics self-confidence and anxiety as related to mathematics learning are seen in the literature as important affective variables that help explain sex-related differences in mathematics learning. Bachman (1970) and Fink (1969) have recognized the importance of academic self-concept in learning mathematics. In the Fennema-Sherman Study (1977), at each grade level from six through twelve, boys were significantly more confident in their ability to deal with mathematics than were girls. Confidence in learning mathematics was more highly correlated with mathematics achievement than was any other affective variable.

Generally speaking, before a student can become proficient in arithmetic, he or she must know how to solve specific types of problems. Smith and Lovitt (1976) state:

> The child working arithmetic problems too slowly does not complete his work as fast as his classmates. As arithmetic assignments become more complex, this child often works even slower and completes fewer problems. Frequently, the reason for the difficulty is a lack of proficiency in using the basic facts that are the rudiments of larger problems (p. 22).

H. SUMMARY OF REVIEW

This review started with a discussion of the construct self-concept. The literature revealed that there have been many and various overlapping definitions of this complex construct. However, through the theoretical framework and model of self-concept proposed by Shavelson et al. (1976); Shavelson & Bolus, 1982; and Shavelson & Byrne, 1986, a concise definition of the self-concept has emerged that now enables researchers to examine facets of the construct with greater clarity.

The role of and importance of academic self-concept and self-concept of academic achievement is discussed.

The literature revealed that numerous researchers have observed a positive correlation between students' academic self-concept and their achievement in academic subjects. Likewise, the literature revealed that many self-concept researchers have attempted various strategies and interventions to enhance student achievement and global self-concept. However, when reviewing the literature, it appears that many educational programs were unable to influence self-concept. When analyzing the reasons for this, it appears that a more explicit examination of self-concept theories and definitions needs to be incorporated into the self-concept educational intervention programs.

Self-concept, it seems, cannot be conceptualized as a simple phenomenon but rather needs to be viewed as a complex construct. However, the literature reveals an absence of intervention studies based on a multidimensional self-concept. Going a step further, data-based searches failed to reveal any intervention studies drawing on the multidimensional and hierarchical model of self-concept proposed by Shavelson et al. (1976) or Shavelson and Bolus (1982). To this end, the present study was conceived.

Studies that investigated self-efficacy were also examined. From these studies it was learned that some educational practices build efficacy by clearly conveying that students are acquiring skills and knowledge. In sum, educational practices are hypothesized to have important contextual influences on students' self-efficacy. Results of research have shown that working toward proximal goals and the use of precise feedback heightened motivation and led to enhanced self-efficacy of various tasks.

The literature surveyed revealed that researchers of the behavioral approach to teaching have been successful in using this method to alleviate a variety of academic deficits. Similarly, there is a growing body of literature that indicates direct and frequent measurement of school tasks increases student motivation and academic skills. Also revealed in the literature was the concept that the effective use of feedback hinges on providing precise feedback following small improvements. To this end, Precision Teaching practices give explicit performance feedback to students, teachers, and parents thus fostering awareness of progress in the curriculum.

In summary, this review has examined the theoretical speculation by Shavelson et al. (1976) of the multidimensional self-concept hierarchy as well as an accumulation of evidence in regards to teaching strategies to enhance academic self-concept. Also, upon close investigation of these two areas, there appears to be an absence of studies done at the practical level that build on Shavelson et al.'s (1976) theory of a multidimensional and hierarchical structure of self-concept. Specifically, one is left to wonder: Can this theory be drawn upon when designing interventions to enhance academic self-concept and can these interventions be successful?

The hypotheses and methodology of the present study are presented in the following chapter.

III. HYPOTHESES, QUESTIONS, AND METHOD

This chapter serves to delineate the hypotheses and exploratory questions of the present study as well as to detail the research methodology that was used.

A. RATIONALE FOR HYPOTHESES AND EXPLORATORY QUESTIONS

Broadly defined, self-concept is a person's perceptions of him or herself. According to Shavelson and Bolus (1982), these perceptions of self are formed through one's experience with and interpretations of one's environment and are "influenced especially by reinforcements, evaluations by significant others, and one's attributions for one's own behavior." Further, Shavelson et al., (1976) and Shavelson and Bolus (1982) have theorized that the construct self-concept is organized or structured, multifaceted, hierarchical, and stable at the apex. As one descends the hierarchy, however, self-concept becomes increasingly situation specific and, consequently, less stable. Self-concept also becomes increasingly multifaceted as the individual develops, and has both a descriptive and an evaluative dimension, and can be differentiated from other constructs, such as, academic achievement.

By drawing on the theoretical framework of a hierarchical and multidimensional self-concept, and by incorporating the theory that one's perceptions of self are "influenced especially by reinforcements and evaluations by significant others and one's attribution for one's own behavior" (Shavelson et al., 1976), the present study was conceived.

The present study was designed to investigate the effects of an experimental intervention that incorporated reinforcement and evaluation by significant others as well as students' attributions for their behavior on academic and arithmetic self-concept.

More specifically, the study was designed to apply an intervention to a specific situational level, or low level, of the hierarchy and to subsequently measure at a higher level of the hierarchy for effects of the intervention. The following Figure 2, adapted from Shavelson et al. (1976), serves to pictorially represent this intention.

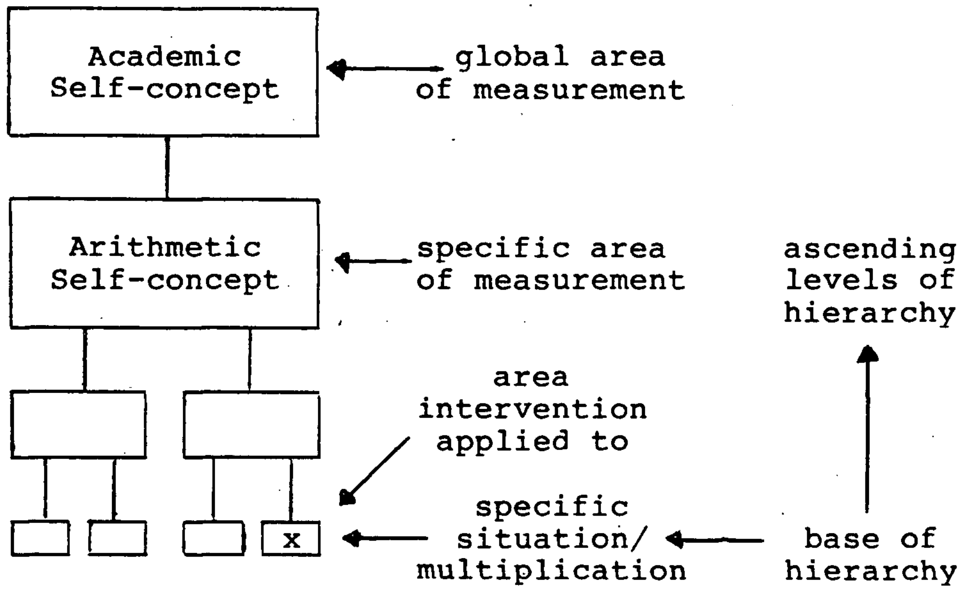

Fig. 2: Representation of Intervention Application and Areas of Measurement*

The literature reveals some controversy on the effects of feedback on performance for males and females. Two studies done by Eagly and Whitehead (1972) and Feather and Simon (1971) found females to be more sensitive to feedback on performance.

Since a salient portion of the designed intervention involves performance feedback and since most of the studies on the effect of feedback have not analyzed data for sex differences

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* See page 8 for Shavelson et al. (1976) original diagram.

(Calsyn & Kenny, 1977), another goal in the present study was to discover if the intervention effected greater change with one sex or the other.

Many educators of mathematics have used gender as a variable when examining mathematic achievement. According to Fennema (1980), all reviews published before 1974 concerned with sex-related differences in mathematic achievement were in agreement that male superiority was always evident by the time learners were in upper elementary school or junior high school. However, reviews published after 1974 have not shown the same consensus in regards to male superiority (Fennema, 1980). In her 1974 review, Fennema concluded, after reviewing thirty-six studies, that there were no sex-related differences in elementary school children's mathematics achievement and subsequently found little evidence that differences exist between male and female students at the high school level when amount of course-taking is controlled.

In contrast to this, Marsh, Smith, and Barnes (1985) found that fifth-grade girls had lower mathematic self-concept than did boys, even though their mathematics performance was better on standardized tests and teacher ratings.

B. HYPOTHESES AND EXPLORATORY QUESTIONS

1. Hypotheses

This study was an attempt to test hypotheses concerning (a) the effects of an experimental intervention (Precision Teaching) on grade four students' arithmetic self-concept and academic self-concept as measured by the SPAS, and (b) gender differences in arithmetic self-concept and academic self-concept at the grade four level.

Hypothesis 1: Arithmetic self-concept as measured by the SPAS will be enhanced by the daily experimental intervention, Precision Teaching.

Hypothesis 1a: Global academic self-concept as measured by the SPAS will be enhanced by the daily experimental intervention, Precision Teaching.

Hypothesis 2: There will be a difference between males and females in their arithmetic self-concept at the grade four level.

Hypothesis 2a: There will be a difference between males and females in their global academic self-concept at the grade four level.

2. Exploratory Questions

The present study also sought answers for questions of exploratory interest. These questions were concerned with a social validation of the experimental intervention. To this end, two Likert type scales were constructed to gain feedback from both students and parents involved in the intervention. The information the experimenter wanted to gain from the parents involved in the study centered around the following issues:

(a) Did parents like knowing how their children did in arithmetic each day?

(b) Did parents find the time to chart with and reinforce their children's progress each day?

(c) Did parents find the intervention motivating for their children?

(d) Did parents think their children's arithmetic self-concept changed?

Similarly from the students involved in the study, the experimenter wanted to know:

(a) Did students like charting their arithmetic results daily?

(b) Did students like being timed on their work sheets?

(c) Did students like knowing how they were doing in arithmetic each day?

(d) Did students think they had improved in multiplication during the program?

C. METHODOLOGY

1. Design

As noted by Campbell and Stanley (1966), educational research done outside laboratory settings often has to incorporate into its design naturally assembled collectives such as classroom groups. The present study, done in the natural school setting is no exception and consequently makes use of a quasi-experimental design. It should be added that like Campbell and Stanley's (1966) Non-equivalent Control Group Design, assignment of the experimental treatment to one group or the other is random and under the experimenter's control; however, the experimental group and the control group do not have pre-experimental sampling equivalence. Campbell and Stanley (1966) state:

> The more similar the experimental and the control groups are in their recruitment, and the more this similarity is confirmed by the scores on the pretest, the more effective this control becomes. Assuming that these desiderata are approximated for purposes of internal validity, we can regard the design as controlling the main effects of history, maturation testing and instrumentation, in that the difference for the experimental group between pretest and posttest (if greater than that for the control group) cannot be explained by main effects of these variables such as would be found affecting both the experimental and the control group. (p. 48)

A 2x4 (gender by groups) factorial analysis of variance design was used to investigate the effects of the intervention. The schematic is presented in Figure 3.

	Group 1	**Group 2**	**Group 3**	**Group 4**	
	Precision Teaching at School and Home.	Experimenter in Classroom but no Precision Teaching.	Precision Teaching at School Only.	Experimenter in class for Pre and Posttest Only.	
Male	Y . . n=26	Y . . n=26	Y . . n=22	Y . . n=15	N=89
Female	Y . . n=22	Y . . n=25	Y . . n=28	Y . . n=21	N=96
N=185	N=48	N=51	N=50	N=36	

Y = academic self-concept / arithmetic self-concept

Fig. 3: Schematic of Experimental Design

As there is no one prescribed way to evaluate the hypotheses in quasi-experimental studies, three analysis procedures were used (cf: Cook & Campbell, 1979; Campbell & Stanley, 1966). These procedures were ANOVA, ANCOVA, and repeated measures ANOVA.

The dependent variable of the present study was academic self-concept as measured by the Student's Perception of Ability

Scale (Boersma & Chapman, 1977). The independent variables were gender and experimental conditions. The dependent variables for the exploratory questions were the affective characteristics toward the intervention.

2. Sample

The sample consisted of 185 grade four students. The mean age of the subjects was approximately nine years. The subjects resided in a middle-class, socio-economic community and were predominantly white.

The sample size of 185 students was considered sufficiently large in order to detect moderate to high effects of the independent variable given the design of the study.

All principals of schools within the lower mainland British Columbian suburban school district which contained non-split grade four classes were contacted. Principals were asked by the experimenter for access to grade four teachers willing to participate in the study. Twenty-one classroom teachers responded positively to being included in the study. Subsequently, all willing teachers and/or classes were then pooled and from the pool eight classes were randomly assigned to experimental conditions. This random assignment from the pool was necessary as in Non-Equivalent Control Group Design, assignment of classes to one group or the other is assumed to be random and under the experimenter's control. Four of the classes formed the Precision Teaching groups (two in the Precision Teaching at School and Home group and two in the Precision Teaching at School Only group), and four formed the control groups (two in the full control group and two in the Experimenter in Classroom but No Precision Teaching group). Prior to the experimenter commencing the study, parental permission was obtained for all students in the study. Parents of eight students declined involvement in the study. Teachers of these students decided that these students would work on other projects during the experimental time of the study.

The total number of students involved in the study was 185 with 89 males and 96 females. The breakdown of boys and girls in each condition was as follows: Group 1, Precision Teaching at School and Home group, 26 males, 22 females, total 48; Group 2, Experimenter in Classroom but No Precision Teaching group, 26 males, 25 females, total 51; Group 3, Precision Teaching at School Only group, 22 males, 28 females, total 50; Group 4, Experimenter in Class for Pre and Posttest Only group, 15 males, 21 females, total 36.

Table 2 contains an elaborated breakdown of the differences between the four groups.

Table 2

DIFFERENCES BETWEEN GROUPS

Group 1	Group 2	Group 3	Group 4
Precision Teaching at School and Home Group	Experimenter in Class But No Precision Group	Precision Teaching at School Only Group	Experimenter in Class Only for Pre and Post Test Group
Students experienced daily intervention at school. Parents were actively involved daily at home as part of the intervention.	Experimenter visited class daily for 3 week period for 10 minutes of arithmetic review. No intervention was attempted.	Students experienced daily intervention for 10 minutes. Parents were not involved in intervention.	Experimenter visited class only for pre- and posttest.
n=48	n=51	n=50	n=36

The rationale for the use of grade four students was drawn from the research of Williams (1976) who found that fourth-grade students (at nine years of age) experienced a significant decline in academic self-concept and motivation but did not experience a decline in general self-concept. Williams (1976) states:

> This is not surprising as one views the typical educational program in many elementary schools; for at that time in pupils' lives they are expected to be rather well regimented into a certain academic mold imposed by teacher, peer, and parent pressures for school success. This is especially true in the skill areas of reading, mathematics, and language. (p. 24)

All grade-four students had previously studied multiplication facts to the nine-times level. It was assumed by teachers that students knew their multiplication facts. The stage of development that would characterize student learning at this point in multiplication was that of initial proficiency (cf. Lovitt, 1977). Characteristic of this stage, the students could respond correctly to almost all of the items; however, answers were not automatic and students had to think before responding. The level of development of the learners in this particular study was of utmost importance as their developmental learning stage determined the appropriate intervention technique. According to some researchers, the most appropriate technique to use during initial proficiency is reinforcement (e.g., Lovitt, 1977).

3. Instruments

The present study utilized two instruments: the Student's Perception of Ability Scale (SPAS) and an experimenter designed social validation scale. The SPAS was used as the instrument for measuring academic self-concept and arithmetic self-concept. This scale, developed by Boersma & Chapman (1977), measures both general academic self-concept as well as self-perceptions of ability in specific academic subject areas at the elementary school level. The scale, as can be seen in Appendix C, consists of seventy forced-choice "yes-no" items asking children about their perceptions of their general ability, their perceptions of their abilities in reading, spelling, penmanship, arithmetic, neatness, school satisfaction, and confidence in their academic abilities. The authors of the SPAS define the term "self-perception of ability" as the manner in which individuals describe and distinguish themselves as unique among others in terms of interactions and performances on school tests (Boersma, Chapman & Maguire, 1979).

General academic self-concept scores are calculated from a subject's scores on all seventy items and specific subject areas can be calculated from one of five subtests. Table 3 contains the breakdown of all items for full and subscale scores. Items on the SPAS are scored in the direction of high scores being an indicator of high academic self-concept.

The SPAS scale can be scored either by using a scoring template, or by having item responses keypunched from the booklets and fed into a computer for scoring. In the present study, the SPAS item results were scored by computer.

The present study also utilized two self-report scales designed to measure social and affective information about the intervention. Both of these measures are included in Appendixes G and H.

Table 3

Breakdown of Items on SPAS for Full and Subscale Scores

	Number of Items
Full Scale	70
General Ability	12
Arithmetic	12
School Satisfaction	12
Reading/Spelling	12
Penmanship/Neatness	12
Confidence	10

4. Psychometric Characteristics of Measure

Normative data were collected during April/May of 1977 on a sample of 642 children in Grades 3 to 6 from two middle-class, public, elementary schools within the Edmonton, Alberta, area. The sample contained seven Grade 3, seven Grade 4, six Grade 5 and five Grade 6 classes. From Table 4, it can be seen that the SPAS has good psychometric properties - the reliabilities are high.

Table 4

Statistics and Reliabilities for Full and Subscale
SPAS Scores Summed Over Grades 3, 4, 5 and 6
of Norming Group (N = 642)

	Number of Items	Mean	SD	SEm	Conbach's Alpha	Test Retest*
Full Scale	70	46.24	11.71	4.77	.915	.834
General Ability	12	7.91	3.01	1.51	.785	.750
Arithmetic	12	9.17	3.01	1.39	.837	.787
School Satisfaction	12	7.99	2.78	1.49	.741	.714
Reading/Spelling	12	9.07	3.13	1.31	.855	.824
Penmanship/Neatnes	12	7.89	3.00	1.41	.822	.780
Confidence	10	4.21	2.25	1.14	.686	.742

*Test-retest interval 4 to 6 weeks (N = 603)

A more detailed breakdown of normative data for boys and girls at each grade level is presented in Table 5. (Source: Boersma & Chapman, SPAS Manual, 1979). It can be seen from the t-values that sex effects were found at Grades 3, 4, and 5, with most of these occurring at the grade four level.

Table 5 Descriptive Statistics of Norming Sample for Full and Subscale SPAS Scores as a Function of Sex and Grade Level

Level	Boys				Girls				
	Mean	SD	SEm	α	Mean	SD	SEm	α	t
Grade 2	(n = 95)				(n = 76)				
Full Scale	47.69	13.33	3.35	.937	48.82	13.69	3.21	.945	.54
General Ability	7.63	3.11	1.44	.785	6.87	2.96	1.52	.735	1.63
Arithmetic	8.92	2.94	1. 27	.815	9.12	2.95	1.99	.835	.44
School Satisfaction	8.57	2.71	1.36	.747	9.34	2.75	1.21	.808	1.83
Reading/Spelling	9.17	2.95	1.21	.833	9.47	2.91	1.14	.847	.67
Penmanship/Neatness	8.60	3.00	1.25	.827	9.20	3.17	1.12	.876	1.33
Confidence	4.81	2.26	1.34	.649	4.83	2.39	1.33	.689	.06
Grade 3	(n = 84)				(n = 87)				
Full Scale	47.17	11.83	4.05	.916	48.36	12.29	4.45	.929	.64
General Ability	7.86	2.95	1.55	.762	7.76	3.16	1.29	.809	.21
Arithmetic	9.13	3.22	1.23	.868	8.71	2.97	0.62	.816	.88
School Satisfaction	7.85	2.88	1.60	.762	9.09	2.65	1.44	.763	2.93*
Reading/Spelling	9.40	2.81	1.01	.823	9.91	2.55	1.14	.813	1.24
Penmanship/Neatness	8.02	3.08	1.19	.821	8.34	3.03	1.30	.841	.71
Confidence	4.92	2.52	1.21	.739	4.54	2.36	1.09	.705	.89
Grade 4	(n = 92)				(n = 77)				
Full Scale	41.91	12.75	4.87	.924	49.03	11.45	3.68	.922	3.82**
General Ability	7.07	3.20	1.65	.804	7.91	3.09	1.56	.802	1.73
Arithmetic	8.34	3.43	1.48	.865	9.26	3.81	1.62	.814	1.92
School Satisfaction	7.72	3.09	1.47	.788	9.13	2.35	1.19	.686	3.37**
Reading/Spelling	8.32	3.42	1.27	.862	9.38	3.04	0.91	.867	2.13**
Penmanship/Neatness	6.54	3.10	1.02	.812	9.40	2.38	0.96	.764	6.54**
Confidence	3.84	2.13	1.12	.656	4.21	2.29	1.11	.745	1.08
Grade 5	(n = 91)				(n = 71)				
Full Scale	45.29	12.75	4.70	.883	47.83	9.96	2.97	.819	1.42
General Ability	8.12	3.20	1.52	.738	8.11	3.02	1.14	.800	.02
Arithmetic	9.36	3.43	1.51	.822	9.61	2.68	0.81	.811	.52
School Satisfaction	7.31	3.09	1.30	.776	8.54	2.07	0.99	.549	3.03**
Reading/Spelling	8.84	3.42	1.35	.836	9.13	3.28	1.21	.880	.55
Penmanship/Neatness	7.30	3.10	1.50	.811	8.37	2.42	1.10	.747	2.47
Confidence	4.36	2.13	1.18	.557	4.08	2.01	0.82	.644	.86
Grade 6	(n = 74)				(n = 66)				
Full Scale	44.85	11.90	4.12	.922	46.14	10.79	3.69	.910	.65
General Ability	8.36	2.83	1.17	.779	8.36	2.71	1.05	.757	.00
Arithmetic	9.76	2.58	0.91	.805	9.44	3.01	1.28	.857	.67
School Satisfaction	6.84	2.52	1.39	.678	7.32	2.28	1.04	.602	1.06
Reading/Spelling	8.42	3.51	1.38	.877	9.21	2.98	1.12	.848	1.44
Penmanship/Neatness	7.46	3.09	1.32	.842	8.20	2.90	1.43	.842	1.46
Confidence	4.00	2.17	1.01	.662	3.61	2.17	1.16	.733	1.06

* $p<.05$
** $P<.01$
Taken from Boersma & Chapman SPAS Manual 1979.

In terms of experimental validity, data reveal that the SPAS differentiates clearly between children having learning problems and those who do not and that it is sensitive to change following remedial intervention (Boersman, Chapman, and Battle, 1979).

A number of studies have been conducted in order to derive support for the external validity of the SPAS. A study done by Chapman and Boersma (1979) tested 81 learning disabled (LD) and 81 normally achieving children in Grades 3 to 6 from two large suburban elementary schools. Both groups of students had similar socio-economic backgrounds and ages and all children had normal range group-test IQ's although there was a statistically significant tendency for the LD group to have slightly lower overall IQ scores. Results show there was a statistically significant difference of 11.84 points ($p < .001$) between the LD and normal group with LD children reporting considerably lower self-perception of ability than normal achievers.

5. Data Collection Procedure

After approval from the university ethics committee and the school board office, grade-four classes in the district were sought to voluntarily participate in the study.

Initially, after meeting the classes and obtaining parental permission, all classes were given the pretest of the academic self-concept measure. The same experimenter administered the

SPAS scale to all classes in their regular arithmetic class and all classes were given identical oral directions.

The directions were designed to put the students at ease and to encourage them to give honest answers. The oral directions stated were:

> *This questionnaire is to find out something about how kids feel about school and schoolwork. It is NOT a test. There are no right or wrong answers to the questions. The answers you give will be kept very private and it is very important to give an honest answer. The answers you give will be used to try and make schools better places to learn in.*

The experimenter then read aloud the statements from the scale and students marked yes/no on their forms to each item. Any difficulties or questions students had were resolved and students were urged to keep their answers confidential.

After the first reading of the statements to the class, the experimenter informed the class how she would respond to certain statements. For example:

> *Class, I would like to share with you how I would answer some of these statements. Take for example Statement 1 which states, "I always understand everything I read." Boy! I wish that were true . . . Sometimes I have to ask someone what I've read means, so for this statement, I'd have to put NO. However, class, this doesn't mean I'm a stupid person; it simply means I don't always understand everything I read. It's not a reflection on my character.*

After this self-disclosure from the experimenter, the statements were reread and students were allowed to change any statements thay had made if necessary. The SPAS measure was conducted with the regular teacher absent from the classroom and confidentiality of responses was assured. Students were informed teachers and parents would not see their responses. Time alotted for pretest was approximately 20 minutes.

As outlined in the Experimental Design section, the study consisted of randomly assigned classes into four groups each encountering different conditions. Group 1 or the Precision Teaching at School and Home group encountered a daily intervention designed to increase arithmetic self-concept. The intervention included: daily visual progress reinforcement from charts and verbal performance feedback from parents or primary caregiver on the daily arithmetic probe; daily self-charting of arithmetic performance with the experimenter in the classroom; participation in goal setting of arithmetic aims; and recognition and positive reinforcement by parents and teacher upon movement toward or reaching these goals.

The experimental intervention was conducted daily for approximately ten minutes in the regular classroom for a three-and-a-half-week period by the experimenter. The first three days of this time was used to familiarize the students with the conventions of Precision Teaching. These conventions included: how to take a probe; how to chart these results on a standard behavior chart; how to interpret chart results; and how to practice for taking a probe. During this preliminary time, parents were instructed by letter on the Precision Teaching

Conventions.* Parents were urged to contact the experimenter if any questions arose as to their responsiblities during the intervention. Four parents had questions and referred their questions to the regular classroom teacher who resolved the questions.

During this initial time, individual aims on the multiplication probes were set. This was done by having students write the digits zero through nine on a one-minute timing. This was carried out twice daily for three days and then the average number of digits written per minute was computed and became the student's initial aim of digits per minute on the arithmetic probes. Aim lines were then marked on the students charts at school and at home. Before the daily one-minute timings, students were made aware of their aim lines and their progress to these goals. This was followed by two minutes of visual review using the correct answers at the top of the probes.** After the timing, students circled their last written answer and then self-corrected their probes with the answers provided on their probes. Results of corrects and errors for that day were then charted on student charts and noted on post-it paper to be taken home that day to parents for home charting. Students who reached aim or made improvement were congratulated by the experimenter and peers. Techniques of "patting yourself on the back" were also promoted.

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* See Appendix E for copy of parent material.
** See Appendix I for copy of probes.

All students entered the first probe level of multiplication at the onset of the study which was the one-times table. When students reached their individual rates per minute or aim on the probes, they immediately advanced to the next level. Any student who failed to progress or remained at the same count for three days consecutively was given a further intervention. On the two occasions this happened during the study, the intervention consisted of distributed practice with continuing reinforcement.

The Precision Teaching at School Only group subjects received similar conditions as the Precision Teaching at School and Home group with the exception of parental reinforcement and involvement. The conditions consisted of: daily multiplication probes, the setting of proximal aims, charting of results, and reinforcement from teacher and peers.

At the conclusion of the intervention, all groups, Precision Teaching at School and Home, Precision Teaching at School Only, and Non Precision Teaching, were once again given the academic self-concept scale. Directions for this were identical to the first administration of the measure. Also at this time, the social validation scale was given to both students and parents of the Precision Teaching at School and Home group.*

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* See Appendixes G and H for copies of scales.

Owing to the locations of the selected schools, the experimenter conducted the intervention with four classes in the morning and two in the afternoon. All procedures were carefully replicated in each group.

In an attempt to control the situational variable of the experimenter implementing the intervention and to guard against the Hawthorne effect, two classes were randomly selected to form an Experimenter in Classroom but No Precision Teaching group. The experimenter spent ten minutes daily in these classrooms working with the students on multiplication drill worksheets; however, no intervention techniques were applied. Students did not work towards aims or goals and did not record their progress or have any parental involvement.

The analyses of the data and the results are presented in the following chapter.

IV. ANALYSIS AND RESULTS

This chapter presents the results of the study in three parts. The first part (A) presents the descriptive statistics and reliability estimates of the Student's Perception of Ability Scale (SPAS). The tests of the research hypotheses posed in Chapter Three are presented in the second part (B). These results show the effects of the experimental intervention on arithmetic self-concept and academic self-concept as well as gender differences in arithmetic self-concept and academic self-concept at the grade four level. The third part (C) includes the results for the exploratory questions concerning the social validity of the intervention.

The analysis was done using SPSS:X statistics software (Nie, 1983). All test statistics were interpreted at the conventional alpha level of .05.

A. DESCRIPTIVE STATISTICS AND RELIABILITY ESTIMATES OF THE SPAS

Table 6 presents a detailed breakdown of the subscale means and standard deviations for both the present Research group and the original Norming sample for comparison.

From the statistics in Table 6, Parts A and B, it can be seen that girls and boys in the research sample differed significantly ($p<.05$) in the subareas of School Satisfaction and Confidence on both the pretest and posttest. A similar result is reported for the Norming sample in Part C. The significant differences in favor of girls in the area of School Satisfaction are in agreement with the literature which suggests girls tend to have more positive attitudes towards school in general.

Also from Table 6, it can be seen that the Research group differed in terms of gender from the Norming group, Part C. Significant differences ($p<.01$) in favor of girls were noted between girls and boys in the Norming sample in the subscale areas of School Satisfaction, Penmanship/Neatness, Reading/Spelling, and on the Full Scale of the SPAS. However, this wasn't the case for the Research sample. Instead, gender difference was significant on the Confidence scale in the Research sample which wasn't the case for the Norming sample.

Observed differences between the present Research sample and the Norming sample are found in the areas of Reading/Spelling, Penmanship/Neatness, and in Full Scale scores. In the Norming sample these three areas differed significantly ($p<.01$) between boys and girls.

Reliability Analysis

Estimates of internal consistency of the SPAS were determined by Cronbach's alpha for the Research sample of 185

Table 6

Descriptive Statistics for Full and Subscale SPAS Scores for Research Sample and Norming Sample

			Boys		Girls			
			Mean	S.D.	Mean	S.D.	t Value	
			(n=89)		(n=96)			
		Full Scale	41.63	13.40	43.07	10.98	-0.80	
		General Ability	7.50	2.95	7.05	3.10	1.02	
	Research	Arithmetic	7.39	3.48	8.06	3.07	-1.39	
A	Sample	School Satisfaction	6.32	3.17	7.19	2.58	-2.03*	A
	Pretest	Reading/Spelling	8.52	3.35	8.91	3.16	-0.81	
		Penmanshp/Neatness	7.65	2.95	8.37	2.52	-1.80	
		Confidence	4.24	2.18	3.49	1.74	2.58*	
		Full Scale	43.19	13.40	44.62	11.07	-0.80	
		General Ability	7.45	2.86	7.00	3.25	0.99	
	Research	Arithmetic	8.75	3.45	9.26	2.96	-1.08	
B	Sample	School Satisfaction	6.35	3.22	7.33	2.74	-2.25*	B
	Posttest	Reading/Spelling	8.64	3.33	8.89	3.17	-0.53	
		Penmanship/Neatness	7.74	3.02	8.52	2.46	-1.93	
		Confidence	4.26	2.13	3.61	1.79	2.23*	
			(n=84)		(n=77)			
		Full Scale	41.91	12.75	49.03	11.45	3.82**	
		General Ability	7.07	3.20	7.91	3.09	1.73	
		Arithmetic	8.34	3.43	9.26	3.81	1.92	
C	Norming	School Satisfaction	7.72	3.09	9.13	2.35	3.37**	C
	Sample	Reading/Spelling	8.32	3.42	9.38	3.04	2.13**	
		Penmanship/Neatness	6.54	3.10	9.40	2.38	6.54**	
		Confidence	3.84	2.13	4.21	2.29	1.08	

* P < .05
** P < .01

subjects. Table 7 presents the Reliability Estimates for the pretest and posttest of the Research sample as well as the Norming sample for comparison.

Table 7

Reliability Estimates* for Research Sample and Norming Sample

	Number of Items	Research Pretest (n=185)	Research Posttest (n=185)	Norming Sample (n=642)
Full Scale	70	.917	.920	.915
General Ability	12	.769	.777	.785
Arithmetic	**12**	**.838**	**.861**	**.837**
School Satisfaction	12	.733	.760	.741
Reading/Spelling	12	.850	.851	.855
Penmanship/Neatness	12	.770	.779	.822
Confidence	10	.622	.613	.686

* Cronbach's Alpha

It can be seen from Table 8 that the pretest and posttest of the Research sample compare very well with each other and also compare very well with the Norming sample of 642 subjects. It can be observed from these comparisons that the SPAS has sound psychometric properties for each Subscale, particularly Arithmetic, a dependent variable in this study, as well as for the Full Scale.

Test-retest reliability data in the present study were collected over a 21-day interval. Test-retest coefficients for Full and Subscale scores are presented by group in Table 8.

Table 8

Test-Retest Reliability Coefficients by Group

	Group 1 Precision Teaching at School and Home. n=48	Group 2 Experimenter in Classroom but No Precision Teaching. n=51	Group 3 Precision Teaching at School Only. n=50	Group 4 Experimenter in Class for Pre and Post-test Only. n=36
Full Scale	.924	.979	.962	.982
General Ability	.929	.954	.917	.961
Arithmetic	**.312**	**.968**	**.788**	**.971**
School Satisfaction	.975	.918	.947	.956
Reading/Spelling	.965	.965	.987	.904
Penmanship/Neatness	.926	.974	.936	.933
Confidence	.906	.869	.887	.919

Table 8 reveals that excluding the subscale Arithmetic for the Precision Teaching at School and Home group, all coefficients are very high. Due to the nature of the experimental intervention in arithmetic with this group, it is within expectations that this subscale coefficient would be relatively low.

In summary, the decriptive statistics and reliability analysis of the SPAS showed that the Student's Perception of Ability Scale yielded reliable data in this study.

B. TEST OF THE HYPOTHESES

Although the research hypotheses were presented in Chapter Three, they are repeated here for ease of reference. Also, notwithstanding the research hypotheses were directional, they were cast into the null form for statistical testing. The criterion for rejection of the two main effects of the null hypotheses on each set of data (arithmetic subscale and fullscale) was alpha .05. However, where required, alpha was adjusted by Bonferroni procedure to guard against experimentwise error.

Null Hypothesis 1 stated that arithmetic self-concept would not be enhanced by daily feedback, charting of results, and daily parental reinforcement. Null Hypothesis 2 stated that there would not be differences between males and females in arithmetic self-concept at the grade four level.

There is no one prescribed way to evaluate the hypotheses due to the quasi-experimental nature of the study and it is recommended that different methods be used simultaneously (Cook & Campbell, 1979). Consequently, three statistical procedures were used. These procedures were:

(a) - ANOVA on pretet and posttest

(b) - ANCOVA with pretest as covariate, and

(c) - Repeated measures ANOVA.

These procedures were applied independently so they do not have a bearing on experiment-wise error rate. The purpose was to see if the findings matched. As previously noted in Chapter Three, due to the nature of the experimental setting, it was not possible to assign subjects randomly into groups at the onset of the intervention. As a result, intact class groups of students were randomly assigned to experimental or control conditions. As a consequence of this deviation from true experimental procedures it was essential to investigate the statistical equivalence between groups on the pretest before looking at any intervention effect. This was done by investigating both the global aspect of the measure as well as the specific area of arithmetic self-concept.

1. <u>Global Academic Full Scale Results</u>

To investigate statistical equivalence between groups on the pretest, a 2 x 4 (gender by groups) factorial fixed effects ANOVA was conducted on the full scale of the SPAS measure. Table 9 contains the descriptive statistics from this analysis.

The results of the ANOVA revealed that there were no significant differences, neither between the groups $F(3,177)=1.82$, $p=.15$, nor between gender $F(1,177)=.79$, $p=.38$, on the full scale pretest. Also, the interaction effect was not significant, $F(3,177)=.20$, $p=.90$.

Table 9

Full Scale Pretest Cell and Marginal Means and Standard Deviations*

Total Sample Mean

n=185
42.38

Group Means

Group 1 (n=48)	**Group 2** (n=51)	**Group 3** (n=50)	**Group 4** (n=36)
Precision Teaching at School and Home	Experimenter in Classroom but No Precision Teaching	Precision Teaching at School Only	Pretest and Posttest Only
44.85 (11.15)	**41.25** (13.02)	**39.86** (13.16)	**44.17** (10.35)

Gender Means

Boys (n=89)	**Girls** (n=96)
41.63 (13.40)	**43.07** (10.98)

	Group 1	**Group 2**	**Group 3**	**Group 4**
Boys	(n=26)	(n=26)	(n=22)	(n=15)
	43.50 (10.34)	**41.08** (15.73)	**38.27** (13.91)	**44.27** (13.17)
Girls	(n=22)	(n=25)	(n=28)	(n=21)
	46.45 (12.08)	**41.44** (9.76)	**41.11** (12.66)	**44.10** (8.14)

* Standard Deviations in parentheses

As no significant differences were found between groups on the pretest, ANOVA was subsequently conducted on the posttest. Table 10 reports the posttest cell means and standard deviations for groups and gender.

The results of the ANOVA on the Full Scale Posttest revealed that there were significant differences between groups F(3,177) = 3.52, p = 0.02, but the difference between gender was not statistically significant, F(1,177) =.92, p =.34. The interaction was not significant as well, F(3,177) =.31, p =.82.

As noted previously, the second analysis approach used with the full scale data was a 2 x 4 (sex by groups) ANCOVA using the pretest as the covariate. This analysis revealed similar results to the ANOVA in that a significant statistical difference was found between groups F(3,177) = 13.01, p =.00, but not between gender F(1,176) =.15, p =.70. Again, the interaction F(1,176) =.65, p =.59 was not significant.

A 4 x 2 x 2 (group by sex by test) repeated measures ANOVA approach likewise yielded parallel findings. Once again there were significant statistical differences between groups F(3,177) = 2.41, p =.05 but not between gender F(1,177) =.71, p =.40. There was a significant difference between pre- to posttest F(1,177) = 3.35, p =.001 and also a significant interaction between test and group F(3,177) = 11.36, p =.001. Test and gender interaction was not significant F(1,177) = 0, p = .99 nor was the three-way interaction between group, gender, and test F(3,177) = 0.61, p =.61.

Table 10

Full Scale Posttest Cell and Marginal Means and Standard Deviations*

Total Sample Mean

n=185
43.94

Total Group Mean

Group 1 (n=48)	**Group 2** (n=51)	**Group 3** (n=50)	**Group 4** (n=36)
Precision Teaching at School and Home	Experimenter in Classroom but No Precision Teaching	Precision Teaching at School Only	Pretest and Posttest Only
48.42 (10.48)	**41.29** (12.92)	**42.08** (13.12)	**44.28** (10.81)

Gender Means

Boys (n-89)	**Girls** (n=96)
43.19 (13.40)	**44.63** (11.07)

	Group 1	**Group 2**	**Group 3**	**Group 4**
Boys	(n=26)	(n=26)	(n=22)	(n=15)
	47.23 (9.13)	**40.88** (15.48)	**40.00** (14.22)	**44.87** (13.76)
Girls	(n=22)	(n=25)	(n=28)	(n=21)
	49.82 (11.95)	**41.72** (9.89)	**43.71** (12.20)	**43.86** (8.45)

In summary, it can be seen that when analyzing the full scale data of the SPAS measure, the three types of analyses converged on results revealing significant statistical differences between groups on the posttest but not on the pretest. No significant statistical differences were found between gender on pretest or posttest using these analyses. Also, no interaction between gender and groups or experimental conditions was found.

To determine exactly which groups differed on the posttest, three contrasts were conducted. The contrasts were interpreted at alpha .016 after Bonferroni adjustment to guard against experiment-wise error. As can be seen from Table 11, when using the full scale posttest SPAS scores, the contrast between the Precision Teaching at School and Home group and the Precision Teaching at School Only group was significant. The mean for the Precision Teaching at School and Home group was 48.45; whereas, the mean for the Precision Teaching at School Only group was 42.08. The contrasts between the Experimenter in Classroom but No Precision Teaching group and the Precision Teaching at School Only group and the Pretest and Posttest Only group and the Precision Teaching at School and Home group were not significant.

Support for Hypotheses la which stated global academic self-concept as measured by the SPAS will be enhanced by the daily experimental intervention, Precision Teaching, was gleaned when significant differences were found (in favour of the Precision

Teaching at School and Home group) on the Full Scale between the Precision Teaching at School and Home group and the Precision Teaching at School Only group.

Table 11

Group Comparisons on Full Scale Academic Posttest

Contrast Coefficient Matrix

	Group 1 Precision Teaching at School and Home	Group 2 Experimenter in Classroom but No Precision Teaching	Group 3 Precision Teaching at School Only	Group 4 Experimenter in Class for Pre and Posttest Only
Contrast 1	0.0	1.0	-1.0	0.0
Contrast 2	1.0	0.0	-1.0	0.0
Contrast 3	1.0	0.0	0.0	-1.0

Pooled Variance Estimate

	Value	S.Error	T Value	DF	T Prob.
Contrast 1	-0.7859	2.3870	-0.329	181	0.742
Contrast 2	-6.3367	2.4236	-2.615	181	0.010*
Contrast 3	-4.1389	3.6444	-1.565	181	0.119

* $p < .016$

The three foregoing analyses were now repeated on the pretest and posttest of the subscale arithmetic to examine differences at this level between all four groups.

2. Arithmetic Subscale Results

Table 12 contains the marginal means and standard deviations for both gender and group which were used for the 2x4 (sex and group) factorial fixed effects ANOVA conducted using the pretest of the subscale arithmetic on the SPAS.

Like the full scale pretest results, no significant differences were found between groups on the pretest subscale arithmetic, $F(3,177) = .28$, $p = .84$, or between gender $F(1,177) = 1.78$, $p = .18$. The interaction effect was not significant $F(3,177) = .57$, $p = .69$. Analysis of variance was now conducted on the posttest subscale arithmetic.

Table 12

Arithmetic Subscale Pretest Cell and Marginal Means and Standard Deviations*

Total Sample Mean

n=185
7.74

Group Means

Group 1 (n=48)	**Group 2** (n=51)	**Group 3** (n=50)	**Group 4** (n=36)
Precision Teaching at School and Home	Experimenter in Classroom but No Precision Teaching	Precision Teaching at School Only	Experimenter in Class for Pretest and Posttest Only
7.75 (3.07)	**7.53** (3.52)	**7.62** (3.32)	**8.19** (3.23)

Gender Means

Boys (n=89)	**Girls** (n=96)
7.39 (3.48)	**8.06** (3.07)

	Group 1	**Group 2**	**Group 3**	**Group 4**
Boys	(n=26)	(n=26)	(n=22)	(n=15)
	7.38 (3.20)	**6.81** (3.85)	**7.41** (3.46)	**8.40** (3.40)
Girls	(n=22)	(n=25)	(n=28)	(n=21)
	8.18 (2.92)	**8.28** (3.05)	**7.79** (3.26)	**8.05** (3.19)

* Standard Deviations in parentheses

Table 13 contains the cell and marginal means and standard deviations for both gender and group which were used for the 2x4 (sex and group) factorial fixed effects ANOVA conducted using the posttest of the subscale arithmetic on the SPAS.

Table 13

Arithmetic Subscale Posttest Cell and Marginal Means and Standard Deviations*

Total Sample Population

(n=185)
9.03

Group 1 (n=48)	**Group 2** (n=51)	**Group 3** (n=50)	**Group 4** (n=36)
Precision Teaching at School and Home	Experimenter in Classroom but No Precision Teaching	Precision Teaching at School Only	Experimenter in Class for Pretest and Posttest Only
10.94 (1.87)	**7.53** (3.69)	**9.30** (2.70)	**8.17** (3.25)

Gender Means

Boys (n=89)	**Girls** (n=96)
8.75 (3.45)	**9.26** (2.96)

	Group 1	**Group 2**	**Group 3**	**Group 4**
Boys	(n=26)	(n=26)	(n=22)	(n=15)
	10.81 (1.98)	**6.85** (4.10)	**8.77** (2.79)	**8.47** (3.40)
Girls	(n=22)	(n=25)	(n=28)	(n=21)
	11.09 (1.77)	**8.24** (3.14)	**9.71** (2.61)	**7.95** (3.20)

* Standard Deviations in parentheses

The results of the 2 x 4 (sex by groups) ANOVA on the subscale arithmetic posttest revealed that there was a significant difference between the groups on the posttest, $F(3,177) = 12.52$, $p = .00$, but there were no significant statistical differences between sexes, $F(1,177) = 2.01$, $p = .16$. The interaction was not significant as well $F(3,177) = 0.83$, $p = .48$.

Results from a 2 x 4 (sex by group) ANCOVA using the pretest subscale arithmetic as covariate also revealed similar results. Once again a significant statistical difference was found between groups on the subscale arithmetic analysis $F(3,176) = 34.99$, $p = 0.00$, but not between sexes $F(1,176) = .33$, $p = .57$. The interaction effect in this analysis was not significant $F(3,176) = .82$, $p = .49$.

A 2 x 4 repeated measures ANOVA analysis revealed similar results as well. Significant differences on the arithmetic subscale using this approach with the data were also found between groups $F(3,177) = 2.88$, $p = .04$, but not between sexes $F(1,177) = 1.53$, $p = .22$. The pre-post test effect was significant $F(1,177) = 65.07$, $p = .001$. Also the test by group interaction was significant $F(3,177) = 26.32$, $p = .001$. The sex by test interaction was not significant $F(1,177) = .03$, $p = .88$ and similarly, the group by sex by test interaction was not significant $F(3,177) = 0.57$, $p = .63$.

The specific arithmetic academic self-concept results converged revealing significant statistical differences only between groups on the subscale arithmetic from pretest to posttest.

Null Hypotheses 1 stated that arithmetic self-concept would not be enhanced by daily feedback, charting of results, and daily parental reinforcement. As different groups received different treatments and preceding analysis revealed differences between groups, one-way ANOVA and planned contrasts were now carried out on posttest data. It should be reported here that since no gender effects were found in the preceding analyses, these further analyses dropped gender as a variable and used only groups (therefore, the one-way ANOVA). Also at this point, null Hypothesis 2, which stated there would be no differences between males and females in arithmetic self-concept at the grade four level, was retained when no sex differences were detected in any of the analyses performed.

The contrast coefficient matrix used in the following group comparisons is reported in Table 14.

Table 14

Group Comparisons on Subscale Arithmetic Posttest

Contrast Coefficient Matrix

	Group 1 Precision Teaching at School and Home	Group 2 Experimenter in Classroom but No Precision Teaching	Group 3 Precision Teaching at School Only	Group 4 Experimenter in Class for Pre and Post-test Only
Contrast 1	0.0	1.0	-1.0	0.0
Contrast 2	0.0	0.0	1.0	-1.0
Contrast 3	1.0	0.0	0.0	-1.0

Pooled Variance Estimate

	Value	S.Error	T Value	DF	T Prob.
Contrast 1	-1.7706	0.5867	-3.018	181	0.003*
Contrast 2	-1.6375	0.5957	-2.749	181	0.007*
Contrast 3	-2.7708	0.6500	-4.263	181	0.000*

* $p < .016$

The contrasts were interpreted at alpha .016 after Bonferroni adjustment to guard against experiment-wise error. Contrast 1 in the preceding analyses is the contrast between the

Experimenter in Classroom but No Precision Teaching group and the Precision Teaching at School Only group. The Experimenter in Classroom but No Precision Teaching group was visited by the experimenter daily for ten minutes of multiplication drill; however, no progress aims were set, no feedback was given, and parental reinforcement was not incorporated. In the Precision Teaching at School Only group, students received the Precision Teaching intervention minus parental involvement. Through this contrast, it was revealed that there was a significant difference in favour of the Precision Teaching group. The Experimenter in Classroom but No Precision Teaching group had a mean of 7.5; whereas, the Precision Teaching at School Only group had a mean of 9.3.

The second contrast revealed that there was a significant difference between the two groups receiving Precision Teaching at School and Home and Precision Teaching at School Only. The Precision Teaching at School and Home group had a higher mean of 10.94; whereas, the Precision Teaching at School Only group had a mean of 9.30.

The third contrast in this analysis revealed that there was a significant difference between the Precision Teaching at School and Home group and the Pretest and Posttest Only group. The Precision Teaching at School and Home group had a mean of 10.94; whereas, the Pretest and Posttest Only group had a mean of 8.16.

The null Hypothesis 1 which stated that arithmetic self-concept would not be enhanced by daily feedback, charting of results, and daily parental reinforcement was rejected given the results of the contrasts.

C. EXPLORATORY QUESTIONS AND ANALYSIS

The present study was concerned with two questions of exploratory interest. Both questions related to a social validation of the experimental intervention. The first question was concerned with the parents' response to the intervention. As the intervention relied on parents as active participants in the study, obtaining feedback on their role was relevant to the study. The second question was concerned with the response of the students involved in the experimental intervention. The analysis and results pertaining to these questions are presented below in two separate subsections.

1. Parental Feedback from Intervention

The impact of parents as reinforcers and shapers of self-concept has been well documented (Brookover & Erickson, 1969; Brookover et al., 1965). However, since the present study required parents to follow a novel procedure with their students which was explained to them by way of letters sent home, it was of interest to explore if parents could allot time daily to the charting task and subsequent reinforcement of their students.

The questionnaire sent home to parents contained six statements. The parents were asked to rate each of these six statements on a scale of 1 to 5, 1 being the low end of the scale and 5 being the top end of the scale. Table 15 contains the means, standard deviations, and t-values by question and class for the parent responses to the questionnaire.

As can be seen from Table 15, all means out of a scale of 5 are high except for statement 5. This statement was deliberately framed in a negative manner to discern if all the statements were being carefully scrutinized. As can be seen from Table 15 by the low mean scores of 2.00 and 2.31 for this statement, parents did carefully respond to the statements.

In Class 1, 70 percent of the parents responded to the questionnaire and in Class 2, 73 percent of the parents responded. T-tests revealed that there were no significant differences between parent groups on any of the questions.

Table 15

Means, Standard Deviations, and t-Values of Parental Questionnaire

	Number of Cases	Mean	Standard Deviation	Pooled t-Value
Statement 1	I liked knowing how my child did in arithmetic each day.			
Class 1	17	4.59	0.71	
Class 2	19	4.79	0.42	-1.05
Statement 2	I liked charting my child's results on a daily basis.			
Class 1	16	4.06	0.85	
Class 2	19	4.37	0.89	-1.03
Statement 3	I liked being involved with my child's progress.			
Class 1	17	4.76	0.43	
Class 2	19	4.84	0.50	0.49
Statement 4	I think this program was motivating for my child.			
Class 1	17	4.35	0.86	
Class 2	19	4.16	0.76	0.72
Statement 5	I found it difficult to find the time to chart with my child.			
Class 1	17	2.00	1.32	
Class 2	19	2.31	1.49	-0.67
Statement 6	I think my child feels better about arithmetic now.			
Class 1	17	4.41	0.79	
Class 2	18	4.11	0.90	1.04

2. Student Feedback from Intervention

The scale given to students in the Precision Teaching intervention at the end of the program was designed to gather information about the various components of the intervention. This scale consisted of 7 statements which were rated on a scale of 1 to 5. Table 16 contains the means, standard deviations, and t-values of the scale broken down by question and class.

As can be seen from Table 16, the means for all statements were consistently high; the lowest being Statement 7 which read, "I liked being timed in arithmetic." There were no statistical differences between experimental classes on any of the statements on the scale.

The response rate on the the Student Social Validation Scale was 100 percent. Two extra students who did not complete the SPAS measure but did partake in the daily school intervention also completed the Social Validation Scale. This accounts for the two extra cases.

Table 16

Student Means, Standard Deviations, and t-Values for Student Social Validation Scale

	Number of Cases	Mean	Standard Deviation	Pooled t-Value
Statement 1	I liked charting my results in arithmetic every day.			
Class 1	24	4.75	.61	
Class 2	26	4.54	.71	1.13
Statement 2	I liked knowing how I was doing in arithmetic every day.			
Class 1	24	4.67	.64	
Class 2	26	4.58	.76	0.45
Statement 3	This arithmetic program made me try harder.			
Class 1	24	4.67	.70	
Class 2	26	4.58	.50	0.52
Statement 4	I think I've gotten better in arithmetic in the last 3 weeks.			
Class 1	24	4.67	.70	
Class 2	26	4.69	.62	-0.14
Statement 5	My parents think I've gotten better in arithmetic in the last 3 weeks.			
Class 1	24	4.62	.65	
Class 2	26	4.50	.71	0.65
Statement 6	I like arithmetic more now.			
Class 1	24	4.62	.71	
Class 2	26	4.65	.85	-0.13
Statement 7	I liked being timed in arithmetic.			
Class 1	24	3.87	1.33	
Class 2	26	3.96	1.31	-0.23

Summary of Results

In summary, it was concluded that the null form of Hypothesis 1 could be rejected and that the research hypothesis that arithmetic self- concept would be enhanced by daily feed-back, charting of results, and daily parental reinforcement was retained.

Hypothesis 2 in the null form stated that there would not be a difference in arithmetic self-concept at the grade-four level between boys and girls. This hypotheses however could not be rejected. The research hypotheses that there will be a difference between males and females in their arithmetic self-concept at the grade four level was not tenable.

Null Hypotheses 1a, which stated: Global academic self-concept as measured by the SPAS will not be enhanced by the daily experimental intervention, was rejected when differences on the full scale academic self-concept scale between the Precision Teaching at School and Home and Precision Teaching at School Only groups were found.

Null Hypotheses 2a, which stated: There will not be differences between males and females in their global academic self-concept at the grade four level was retained when analysis revealed no significant differences between gender on this measure.

In exploratory analysis, it was found that both students and parents involved were capable of mastering the intervention and liked taking part in the intervention. These findings are discussed in the following chapter along with their implications.

V. DISCUSSION

The purpose of this final chapter is to provide a review of the findings and their interpretation in relation to the theories and research issues considered in the foregoing chapters. The first part (A) presents an interpretation of Hypothesis One in relation to the work of Shavelson et al. (1976) and the various contributors to the Precision Teaching body of knowledge. Part (B) gives an interpretation of the second hypothesis, followed by (C), a discussion of the exploratory results. A summary of the findings and conclusions are presented in part (D). Part (E), presents a discussion of the strengths and limitations of the study and is followed by (F), the implications of the study, and finally part (G) which outlines some directions for further research.

A. ARITHMETIC SELF-CONCEPT ENHANCEMENT AND PARENTAL REINFORCEMENT

It was speculated in the present study that arithmetic self-concept could be enhanced by a daily experimental intervention utilizing Precision Teaching with parental evaluation and reinforcement. The data supported the main effect of the intervention. The effect, however, of the intervention was stronger when it included the evaluative parental component of the intervention.

This finding is in agreement with the research of Brookover et al. (1965) and Brookover and Erickson (1964), whose studies investigating sources of influence on students' self-concept found that it was parents who succeeded in increasing students self-concept of ability and academic achievements. Similarly, this is in accord with G. H. Mead who posited that the labels applied to one's self are learned during interaction within one's network of social relationships and that for children first acquiring labels the most important social influences were those of parents (Mead, 1934).

However, notwithstanding that the Precision Teaching at School and Home group effect (those receiving the parental reinforcement intervention) was stronger than the Precision Teaching at School Only group (those experiencing only Precision Teaching intervention), both groups did experience significant effects in the study. The practical implications of this are addressed later in Section F; however, from the present data, it appears that the Precision Teaching intervention can be successfully used with or without the use of parents.

1. Arithmetic and Academic Self-Concept and Shavelson et al.'s (1976) Theory of Self-Concept

Returning to Shavelson et al.'s (1976) definition of self-concept, various theoretical points can be drawn from this definition for the interpretation of the effect of the intervention on arithmetic self-concept and academic self-concept.

Shavelson et al. (1976) propose that one of the critical features of general self-concept is that it is stable. This is in contrast, however, to the lower levels of the hierarchy where self-concept varies greatly with variation in specific situations. Shavelson et al. (1976) state: "as one descends the self-concept hierarchy, self-concept depends increasingly on specific situations and thus becomes less stable." (p. 414)

The findings of the present study support the above interpretation. Had the lower levels of the self-concept hierarchy been stable, it would seem unlikely that the intervention would have been able to effect measurable change. Since the intervention was applied and measured at the base of the hierarchy, change was able to be effected. In contrast, as pointed out by Shavelson et al. (1976), the higher levels of self-concept are more resistant to changes and changing general self-concept requires numerous situation-specific instances inconsistent with general self-concept.

The evaluative character of self-concept, also a feature of Shavelson et al.'s (1976) definition, is of theoretical importance in the present study. According to Shavelson et al. (1976), not only does the individual develop a description of himself in particular situations but also he or she forms evaluations of himself or herself in these situations. These self-evaluations can be formed against absolute "ideal" standards, relative standards, such as "peers," or perceived evaluations of "significant others."

If it can be assumed that "significant others" and the evaluation system of Precision Teaching influenced students self-description and hence self-evaluation in arithmetic, then the current findings are supportive of the evaluative character of self-concept. Paralleling this are the results of a study done by Ludwig and Maehr (1967) whose results were interpreted as supportive of the theory that self-concept change is a function of the reaction of significant others. Similarly, the results of the present study show self-concept can be influenced by specific experiences. In the words of Shavelson et al. (1976), "the more closely self-concept is linked with specific situations, the closer is the relationship between self-concept and behavior in the situation" (p. 415).

It has been suggested by some critics of education (e.g., Lovitt, 1977) that educational practices over the last decades have changed but that often these changes have not been brought about by educational research and theory. One aspect of the present study was concerned with the viability of using Shavelson et al.'s (1976) theory of the structure of self-concept practically to design an intervention to enhance self-concept. Most of the studies to date have not utilized the multidimensional and hierarchical structure of self-concept. This deficiency in the past research is due in part, as noted by Wylie (1961), to the difficulty and unreliability associated with measuring and defining self-concept. Consequently, the present study attempted to utilize the multidimensional and hierarchical interpretation of self-concept, to manipulate one dimension of the lowest level of the hierarchy and, subsequently, to measure at a higher level.

It was expected that arithmetic self-concept could be reliably measured by the SPAS and could be enhanced by the intervention. The results confirmed this expectation. It was also confirmed that one dimension of the self-concept hierarchy could be preselected and manipulated without seemingly altering any of the other dimensions of the hierarchy. To this end, the construct of self-concept as defined by Shavelson et al. was found to be a relevant and viable model to utilize when designing a practical intervention to enhance academic self-concept.

2. Enhancing Arithmetic Self-Concept and Precision Teaching

Valued goals of education include enhancement of students' self-concept and scholastic achievement (Shavelson & Bolus, 1982). Benefits of Precision Teaching have been well documented (Lovitt & Fantasia, 1983; Lovitt, 1984; White, 1986). Few studies to date, if any, have examined the effect of Precision Teaching on students' academic self-concept. The present study was designed to examine this effect.

As predicted, the results of the current study did confirm the expectation that arithmetic self-concept would be enhanced by the Precision Teaching intervention. Precision Teaching coupled with parental reinforcement or without reinforcement from parents did significantly affect the arithmetic self-concept of grade four students.

One possible explanation for this can be found in the self-efficacy studies by Schunk. Results of these studies (Schunk 1981, 1982, 1983, 1985) support the idea that self-efficacy is an important variable in understanding students' achievement behavior. According to Schunk (1983), there are several ways children develop a sense of efficacy. Observation of progress on a task and goal setting are two important sources of efficacy information. The anticipated satisfaction of attaining a goal helps to sustain efforts toward improvement and, at the same time, as students observe their progress toward the goal, they begin to develop a sense of efficacy (Schunk, 1983).

Two important aspects of the evaluation system of Precision Teaching are the setting of a goal or aim line and the daily recordings of progress toward this goal. The visual focus of Precision Teaching is the information conveyed on the standard behavior chart.* With little or no feedback on the accuracy of their work, students may be unsure of how competent they are. However, through daily recording of corrects and errors and the plotting of progress toward an attainable goal, students using the Precision Teaching evaluation system are daily given a

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* See Appendix A for copy of chart.

wealth of information. Collectively, this information can help produce changes in motivation and self-perceptions of competence and, subsequently, changes in self-concept on the task.

Further to goal setting and daily recording of progress, the present study utilized self-recording, another facet of Precision Teaching. There is evidence in the literature of a growing interest in the role of self-regulation as a means of initiating and maintaining behavioral change (Hallahan & Marshall & Lloyd, 1981; Kazdin, 1974; Schunk, 1983). According to Kanfer (1970), the self-regulation process is composed of three integral parts; self-monitoring, self-evaluation, and self-reinforcement. When employing Precision Teaching with self-charting as in the current study, all three of these components are brought into bearing. In a study done by Schunk (1983) to investigate the effects of progress self-monitoring on students' self-efficacy and achievement, it was found that self and external monitoring of progress led to significantly higher percepts of efficacy as compared with no monitoring. Self-recording also enables students to gain capability information on their own and hence foster a more personal sense of responsibility for mastering learning.

The present study's self-recording procedure included elements of recording and of reviewing progress. It is believed that this recording and reviewing of progress may be more important for young children who have short time frames of reference and who may not always be cognizant of what they have accomplished (Schunk, 1983). Similarly to goal setting, self-recording appears to be a practice highly effective in promoting percepts of efficacy and achievement and, subsequently, self-concept.

3. Enhancing Global Academic Self-Concept and Precision Teaching

The results of the current study gleaned only partial support for Hypothesis 1a which stated global academic self-concept as measured by the SPAS will be enhanced by the daily intervention of Precision Teaching. Of the three group comparisons performed using the Full Scale Academic Posttest, only one of the comparisons (that of the Precision Teaching at School and Home group with the Precision Teaching at School Only group) was significant. However, this contrast did follow the model in so far as it was significant in favour of the Precision Teaching at School and Home group. This result can be interpreted as supportive of the hypothesis of self-concept theory that self-concept change is a function of the reaction of significant others.

One feasible explanation for the inconsistent pattern of results found at the global level of academic self-concept is that the hierarchy is more complicated than originally anticipated. Perhaps academic self-concept is not just a single higher-order facet but rather made up of specific facets of academic self-concept. If this were the case then one intervention at one level would not be able to effect a change at an aggregate level of academic self-concept.

B. GENDER DIFFERENCES IN ARITHMETIC SELF-CONCEPT AT THE GRADE FOUR LEVEL

It was speculated that there would be differences between males and females in arithmetic self-concept at the grade four level. The data did not support a significant main effect of gender either on arithmetic self-concept or on general academic self-concept. As noted in Chapter Three, many researchers have used gender as a variable when examining mathematic achievement. According to Fennema (1980), all reviews published before 1974 concerned with sex-related differences in arithmetic achievement were in agreement that males were surpassing females in achievement by the time students were in upper elementary school. Also noted by the same author (Fennema, 1980) was that published reports after 1974 have not shown the same consensus.

However, the present study did not examine arithmetic achievement per se but rather arithmetic self-concept. When reviewing the psychometric characteristics and normative data of the measuring instrument used in the present study, it was noted that there were gender effects at grades three, four, and five with most of these occurring at the grade four level.* However, a detailed analysis of the grade four data as a function of individual classes and schools failed to reveal the source of these gender differences on the measure (Boersma & Chapman, 1977). It should be noted that the gender differences in the original norming sample in arithmetic were not significant.

Not withstanding the absence of consensus in the literature relating to gender differences in arithmetic achievement and arithmetic self-concept (Aiken, 1970; Fennema, 1980), the directionality of the present hypothesis was influenced by the feedback/reinforcement nature of the intervention used in the study. Studies done by Eagly and Whitehead (1972) and Feather and Simon (1971) both found females to be more sensitive to feedback on performance than males. Due to the predominant female/male ratio in the elementary schools, the hypothesis was directed toward differences in arithmetic self-concept. However, results from the present study show no significant gender differences in arithmetic self-concept before or after the intervention, and consequently do not allow the researcher to speculate on whether females are more sensitive to feedback on performance than males.

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* See page 63 for descriptive statistics for full and sub-scale SPAS scores as a function of gender and grade level.

C. FINDINGS FROM EXPLORATORY ANALYSIS

1. Parental Validation of the Experimental Intervention

As stated in the first chapter, one purpose of the present study was to examine the utility of a Precision Teaching intervention as a practical way to enhance the academic self-concept of grade four students in arithmetic. As noted by Lovitt (1977), it is the responsibility of educational researchers to insure that changes in educational practices be supported by research and to share and report their findings in such ways that can be effectively implemented.

In order to implement and examine thoroughly the present intervention which required the support and help of parents, it was necessary to gain a response from the parents involved. Of primary interest were: (1) Would parents be able to learn the charting convention from a printed explanation and, (2) Would parents chart with their children on a daily basis? It was assumed that before teachers will be willing to implement an intervention using parents as partners the practicality of conveying information to parents by letter would be necessary.

The feedback from parents in the present study revealed that parents did like charting with their children on a daily basis. Also, parents were able to learn the charting procedure from a written explanation.

These findings coupled with research documenting the impact of parents as reinforcers and shapers of self-concept (Bradshaw, 1982; Brookover & Erickson, 1969; Miller, 1981) suggest that educators should not be hesitant in involving parents in the educational practices of their children. However, in order to be effective in their reinforcement of their children, parents need precise and on-going data from the teacher. Precision Teaching practices as demonstrated in this study are one way of conveying this information. Notwithstanding that an important goal of education should be teaching students to produce their own feedback since this ability is at the core of learning how to learn (Van Houten, 1980); it is also essential that students experiencing difficulties learn to recognize their small successes or it is probable they will continue to maintain low self-concept of ability. Precision Teaching is a way of enabling students to recognize small successes.

2. Student Validation of the Experimental Intervention

As with parental feedback from the study, feedback from students on how they perceived the intervention was of utmost concern. Means for all statements on the Likert-type scale where high scores indicated a more favorable attitude were consistently high.* Furthermore, these results revealed that students liked charting their results daily and reported they

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* See Table 15.

thought their parents perceived improvement in their arithmetic ability and that they liked arithmetic more since the intervention.

Many educators tend to assume that the time involved to administer and begin an intervention, such as used in the present study, would be far too great given their daily schedule. However, the present study shows that this need not be the case. With students self-graphing and self-correcting in the classroom, the time required daily for the intervention averaged six minutes.

D. SUMMARY OF THE FINDINGS AND CONCLUSIONS

The investigation began with the primary objective of examining the effect of a Precision Teaching intervention that incorporated reinforcement and evaluation on arithmetic and academic self-concept. Theoretically and practically the study utilized the hierarchical and multidimensional model of self-concept as proposed by Shavelson et al. (1976). Specifically, the study was designed to apply the intervention to the situational level of multiplication in arithmetic. The effects of this intervention were subsequently measured at the ascending levels of arithmetic self-concept and academic self-concept. Differences between males and females on arithmetic self-concept were also examined before and after the intervention. Exploratory questions were directed toward a social validation of the intervention by students and parents involved. The findings and conclusions that can be drawn from these findings are as follows.

1. There were no significant differences between males and females at the grade four level in arithmetic self-concept or global academic self-concept on either the pretest or the posttest. These findings suggest that at the grade four level girls and boys have not been affected by any measurable pattern of differing arithmetic self-concept or academic self-concept. Similarily as there were no measurable differences between males and females after the intervention in arithmetic self-concept, these findings suggest that performance feedback likewise did not affect one sex more than another.

2. The Precision Teaching intervention had a significant impact on enhancing the arithmetic self-concept of both the Precision Teaching at School and Home group as well as the Precision Teaching at School Only group. These findings suggest that it is possible to significantly enhance arithmetic self-concept of grade four students with or without utilizing reinforcement and evaluation from students' parents.

3. Precision Teaching combined with reinforcement and evaluation by parents produces a stronger enhancement of arith-

metic self-concept than just the utilization of Precision Teaching alone. This pattern of self-concept enhancement suggests that, for the grade four student, perceptions of self are influenced by both attributions for one's own behavior as well as reinforcement and evaluation by significant others.

4. The evaluation system of Precision Teaching is one that both grade four students and their parents can master and enjoy taking part in.

5. The reliability of the Students' Perception Ability Scale (Boersma & Chapman, 1977) as a measure of arithmetic self-concept and academic self-concept was endorsed. Also the present study confirms that SPAS scores are sensitive to increases in academic self-concept as a function of remediation and intervention.

In most studies there are strengths and limitations and it is in this light the preceding conclusions should be entertained. The strengths and limitations of the present study are discussed in the following section.

E. LIMITATIONS AND STRENGTHS OF THE STUDY

One of the limitations of the present study was the fact that it had to be conducted using a quasi-experimental design. Unfortunately, most educational research conducted in a naturalistic school setting suffers from this limitation. When dealing with already assembled intact classes, it is an impossibility to randomly assign subjects from a common population to experimental or control groups. Consequently, when confronted with this situation, the experimenter is forced to make do with a quasi-experimental design rather than a true experimental design and its accompanying superior internal validity. However, as pointed out by Campbell and Stanley (1966), where more efficient designs are unavailable, utilization of quasi-experimental designs are justified and well worth using.

One of the strengths of the Nonequivalent Control Group Design which the present study employed is that its utilization of control groups reduces equivocality of interpretation of results. Also the more similar the experimental and control groups are in their recruitment and the more the similarity is confirmed by the scores on the pretest, the more effective this control becomes (Campbell & Stanley, 1966). In the present study, it was revealed through statistical analysis that there were no statistical differences between experimental and control groups on the pretest. Thus in the present study, the design can be regarded as controlling the main effects of history, maturation, testing, and instrumentation.

One of the strengths of the present study resides in the external validity of results. The study was not conducted in a controlled laboratory setting but rather in preassembled classrooms throughout an average suburban school district.

One of the main criticisms of self-concept research has been the validity of the self-report measures. As with any self-report measure of a personality variable, the interpretation may be challenged on the grounds that students will select responses they know to be socially desirable rather than responses that are self-descriptive. As this is a legitimate concern, the present study attempted to create an environment where the chance of eliciting an honest response was maximized. Students were assured by the experimenter that teachers and parents would not see their answers and confidentiality of responses was assured.

For some educators, the integrity of the Precision Teaching charts or the fact that students self-corrected their daily probes may be an issue. However, much of the data collected to date indicate that students are generally accurate at self-scoring provided there are no punitive consequences for low scores (Van Houten, 1980). In this respect, Precision Teaching as an evaluation system serves to assist reliable self-scoring as feedback is never pegged to absolute levels. Student goals in the present study were individualized and the major emphasis was on improvement rather than some absolute group level of achievement.

The confidence in the results of any study depends in part on the reliability of the measuring instrument used to collect the data. The reliabilities of the measure used in the current study as reported in Chapter Four were high.

F. IMPLICATIONS

According to some educators; e.g., Lovitt (1977), it is the responsibility of educational researchers to seek out educational truths, to unearth the basic fundamentals of education, and to then explain these basics to teachers and learners in terms that are understandable and implementable. Bearing this in mind, the primary goal of the present researcher has not been to settle the argument between the self-enhancement theorists who believe initial time and effort should be spent trying to increase the general self-concept of children in an educational program or the skill development theorists who believe that self-concept variables are primarily consequences of academic achievement.

Instead, realizing that the two most important roles played by the elementary schools are the development of basic academic skills and the enhancement of students' self-concept, the present study was conceived to research a practical intervention that could enhance academic skills and self-concept simultaneously.

Prior to the present research many studies have confirmed that Precision Teaching can be used successfully to facilitate learning (Lovitt & Fantasia, 1983; White, 1986). However, even though researchers suspected and noted in their studies other outcomes such as increased motivation as a result of the use of

Precision Teaching, there was an absence of studies that had specifically investigated the effect of Precision Teaching on academic self-concept.

The findings of the present study have several implications. These implications relate to the theoretical points of view that guided the study, relate to practices that are effective in enhancing the academic self-concept of elementary school students, and relate to certain issues regarding the role of parents and schools in developing students' academic self-concept.

On a theoretical level the findings of this study support the various other researchers who posited that the self-concept is an organized, multifaceted, and hierarchical construct. (Byrne & Shavelson, 1986; Shavelson & Bolus, 1982). The present results indicate that the situation specific sublevels of academic self-concept influence the ascending levels of the hierarchy. These findings have implications for evaluating change in perception of ability over time, and particularly, following remediation. Although there are a multiplicity of self-concept measuring instruments it seems pertinent to employ an instrument capable of detecting change at ascending levels of the self-concept hierarchy rather than at the global level.

The success of Precision Teaching as a successful facilitator of progress in a wide range of learners has been well documented (Lovitt & Fantasia, 1983; White, 1986). Further, Schunk

(1985) found that certain educational practices effect judgments of performance capabilities by clearly conveying information that students are acquiring skills. The results of the present research similarly show that educational practices are an important contextual influence on students' academic self-concept. Students who kept data and focused on this data experienced significant enhancement of academic self-concept whether their parents simultaneously charted with them or not. The results of this study support Precision Teaching as an educational practice that influences students' academic self-concept. There are many teaching practices that result in the daily progress of students; however, unless these small improvements are readily apparent and visually available to the student, the effects of these practices may not be effective in academic self-concept enhancement. As observed in the Experimenter in Classroom but No Precision Teaching group of this study, academic self-concept was not aided when students were unable to sense they were making progress.

An essential aspect of the evaluation system of Precision Teaching is goal setting and progress toward this goal. In the present study, students working toward specific goals experienced enhancement of academic self-concept. This is in confirmation with the research of Schunk (1985) who found that specific goals raise self-efficacy more than do general goals because progress toward an explicit goal is easier to gauge. The information conveyed to students, when utilizing Precision

Teaching, conveys nothing about others' accomplishments and subsequently students are more able to focus on their present performance and progress toward their personal goals. This benefit of Precision Teaching becomes significant when working with classrooms of students with differing levels of achievement, for as noted by Ruble, Boggiano, Feldman and Loebl (1980), children show an increasing interest in social comparison during the early elementary school years, and, by the fourth grade, use this information to help form self-evaluations of competence.

As noted in the introduction of the study, the development of a positive self-concept is an objective of almost all educational programs from kindergarten to high school; however, teachers are seldom given any practical, let alone researched, methods for practically achieving this important goal. The patterns of information found in the present study address this problem. Precision Teaching offers a viable and useful educational practice for enhancing academic self-concept.

Precision Teaching also offers a method of advantageously incorporating parents involvement academically with their children. As noted in the present study, the academic self-enhancement factor was greater when students charted with parents at home. This is in agreement with the results of Brookover, Paterson, & Thomas (1962), who found students' self-concept of ability was positively related to the image he or she perceived parents held of him or her. The primary implication to be drawn from this being that in order to be maximally efficient, strategies to enhance academic self-concept with elementary school students need to involve parents or significant others.

As observed by some education critics (e.g., Lovitt, 1977), there has been a movement to discourage parents from working with their own children. Lovitt states:

> In this respect, the business of education is deserving of the same criticism Ivan Illich levelled at the business of medicine in 1970 when he said that it had done everything possible to hide the simplicity of its basic procedures from the public. (p. 8)

It is perhaps this separation of school and family that is partially responsible for the recent charge voiced by Vancouver's elementary school administrators (Vancouver Sun, 1988) who state that society now expects the school to be a "super parent" and added, "The school is no longer just supporting the family, but is dangerously close in some areas of supplanting it altogether." In light of this vision, it seems pertinent for schools and teachers to incorporate strategies to re-involve parents with the schools and with the daily progress of their children. Precision Teaching offers an opportunity to do this by conveying continuous performance feedback to parents, students, and teachers alike, thus consolidating the goals of student achievement.

A further implication of the present research is the necessity to acquaint classroom teachers with the findings. As posited by Lovitt (1977), the majority of classroom teachers do not read the journals used by educational researchers to document their findings. This would be especially true for research theses, and, although research theses are written so that replication of the research can be conducted from the methodological details, it would be naive to assume that classroom teachers are busy replicating these studies.

It seems apparent from this dilemma, however, that there are several options open for channeling research outcomes to the classroom teacher. Educational researchers can make their findings available to practitioners and districts within which they did their research, and institutions which train and acquaint prospective teachers with pedagogy can assume responsibility for sharing these findings. Ultimately, however, the likelihood of researched educational practices being successfully implemented depends in part on whether they are perceived as consistent with existing values. Further, it seems likely that unless educators accept and understand the importance of fostering a positive academic self-concept, classroom teachers will not attempt to conduct procedures that will ultimately enhance academic self-concept. Similarly, unless teachers understand and are proficient in Precision Teaching conventions, they will not attempt to implement these techniques regardless of their benefit. Deno (1985) cautions that teachers must be carefully trained to be maximally efficient in assessment lest they become increasingly inefficient to the point where the commonly held reservation that direct and frequent measurement takes too much time.

Although the area of interest for the researcher has been what may be called Special Education practices, the present research was designed for and conducted in the regular classroom setting. Given the current and timely trend of merging Special Education and regular education students, Precision Teaching practices offer a way to respond to the wide range of individual differences found in the classroom. As stated by Shepard (1987), teachers in training are presently taught the referral model when dealing with exceptional students. However, given the current philosophical and theoretical trends in education, it seems expedient to teach regular teachers a repertoire of practical researched technologies rather than the notion that classroom problems can only be solved by external resources.

The present study drew on self-concept theories, self-efficacy research and evaluation systems research. The results confirmed certain hypothesized relationships. The results from this study indicate that an attempt to understand students' academic self-concept, particularly the influence of an evaluation system coupled with parental reinforcement, is a potentially fruitful path to proceed upon to understand some of the causes of self-concept problems in the school and the family.

As in any research, the findings and the implications which have been drawn from the findings suggest additional inquiry. Some areas stemming from the present research are discussed in the following section.

G. DIRECTIONS FOR FURTHER RESEARCH

Given the general consensus that positive attitudes toward a subject influence the outcome of accomplishment in that subject, there has only been a small amount of research done to examine techniques for developing positive attitudes and modifying negative attitudes toward different subjects. It is clear that there is a need for more research concerned with the modifying of academic self-concept in the early school years. In regard to both the development and the modification of attitudes is the question: How can this best be achieved? New practices may be initially motivating and contribute toward enhancement of academic self-concept; however, it is doubtful their effects will last unless teachers are educated in self-concept enhancement techniques, parents remain sympathetic, and the students are successful in mastering the subject.

This is perhaps the first study to use Precision Teaching as an intervention to modify academic self-concept per se. As the present study only attempted to enhance arithmetic self-concept, an obvious next step would be to replicate the findings using other facets of academic self-concept as described by Shavelson et al. (1976).

As noted in Chapter Three, the present study was conducted in an average middle-class district using predominantly white students. As it is not known whether similar results would be attained using a less homogeneous group of students and parents, further research in this direction would be of benefit. Furthermore, as school social climate variables explain more of the differences in mean self-concept of academic ability than do the student body composition (Brookover, 1979), it would be of interest to investigate variance between schools mean self-concept of academic ability and teacher/principal attitudes toward Precision Teaching.

Although gender differences were not observed in the present study, directions for further research could include differences in sensitivity to performance feedback between males and females as noted by Eagly & Whitehead (1972). Also since research on the development of self-concept suggests that boys self-concept is closely associated with the relationship with the father, but not with the mother, and conversely, girls' self-concept is closely associated with the relationship with the mother, but not with the father (Dickstein & Posner, 1978), it would be prudent to continue to explore gender differences in relationship to feedback and reinforcement from parents.

In conclusion, if enhancement of student self-concept in general or academic self-concept in particular are going to be objectives of the school system, then it seems wise to expand our knowledge on methods of teaching that facilitate the enhancement of self-concept. Further the findings of this study speak to the need of incorporating parents and their indispensable support back into the education system. One way of accomplishing this as confirmed by the present study is through the sharing of skill acquisition information with parents on a daily basis. In the final analysis, educational practices can be seen as an important contextual infuence on students' academic self-concept.

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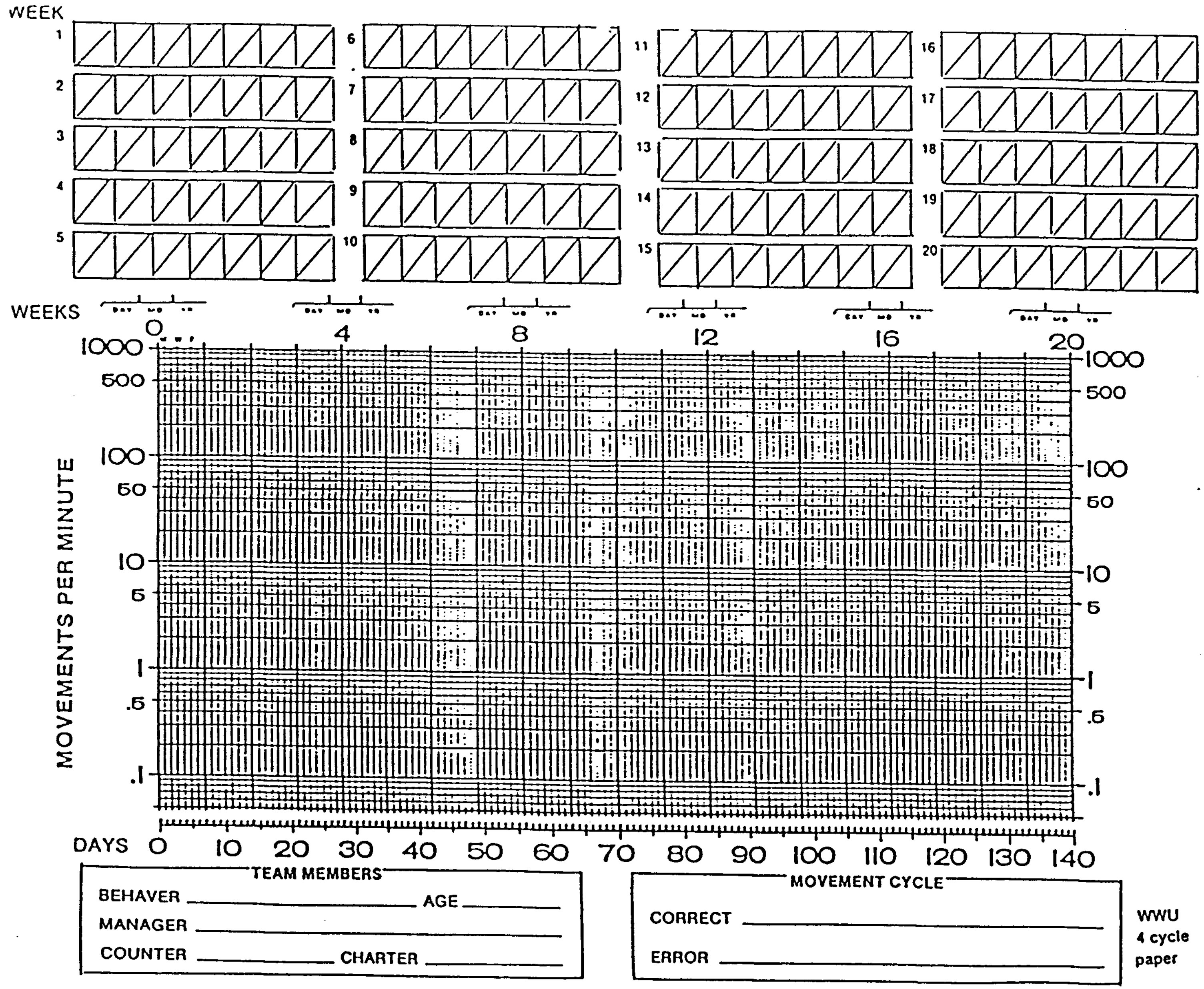
A. STANDARD BEHAVIOR CHART



B. SPAS SUBSCALE FOR ARITHMETIC STATEMENTS

(5) I think my school work is really good.	yes o	no o
(9) I usually finish my school work.	yes o	no o
(20) I am poor at subtraction.	yes o	no o
(27) I am good with my times tables.	yes o	no o
(34) I have difficulty getting my arithmetic finished on time.	yes o	no o
(35) I have difficulty working with numbers.	yes o	no o
(37) I like arithmetic.	yes o	no o
(45) My teacher thinks I am dumb in arithmetic.	yes o	no o
(51) I am unhappy with how I do arithmetic.	yes o	no o
(55) I usually get my arithmetic right.	yes o	no o
(66) I am good at arithmetic.	yes o	no o
(69) I find multiplication fun.	yes o	no o

(Numbers in parentheses correspond to numbers in SPAS measure.)

subscale items n=12

SPAS total items n=70

C. STUDENT'S PERCEPTION OF ABILITY SCALE

Name ______________________ Birth Date ______________

Boy _____ Girl _____ Grade _____ School ______________

IMPORTANT DIRECTIONS FOR MARKING ANSWERS

Use black soft lead pencil only.
Make heavy black marks that fill the circle completely.
Erase clearly any answer you wish to change.
Make no stray marks on this answer sheet.
Answer each item Yes or No.

RIGHT					
YES	NO	YES	NO	YES	NO
WRONG					
YES	NO	YES	NO	YES	NO

Psi Can Consulting Ltd.
8910 117 Street
Edmonton, Alberta
Canada T6G 1R7

Psi Can consulting ltd

07339

DO NOT MARK HERE

SEX
Male
Female

STUDENT I.D.

0 1 2 3 4 5 6 7 8 9

STUDENT NAME

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

GRADE
2 3 4 5 6 7 8

BIRTH DATE

MONTH
Jan. Feb. Mar. April May June
July Aug. Sept. Oct. Nov. Dec.

YEAR
Last 2 Digits

0 1 2 3 4 5 6 7 8 9

SPECIAL CODE

0 1 2 3 4 5 6 7 8 9

DIRECTIONS

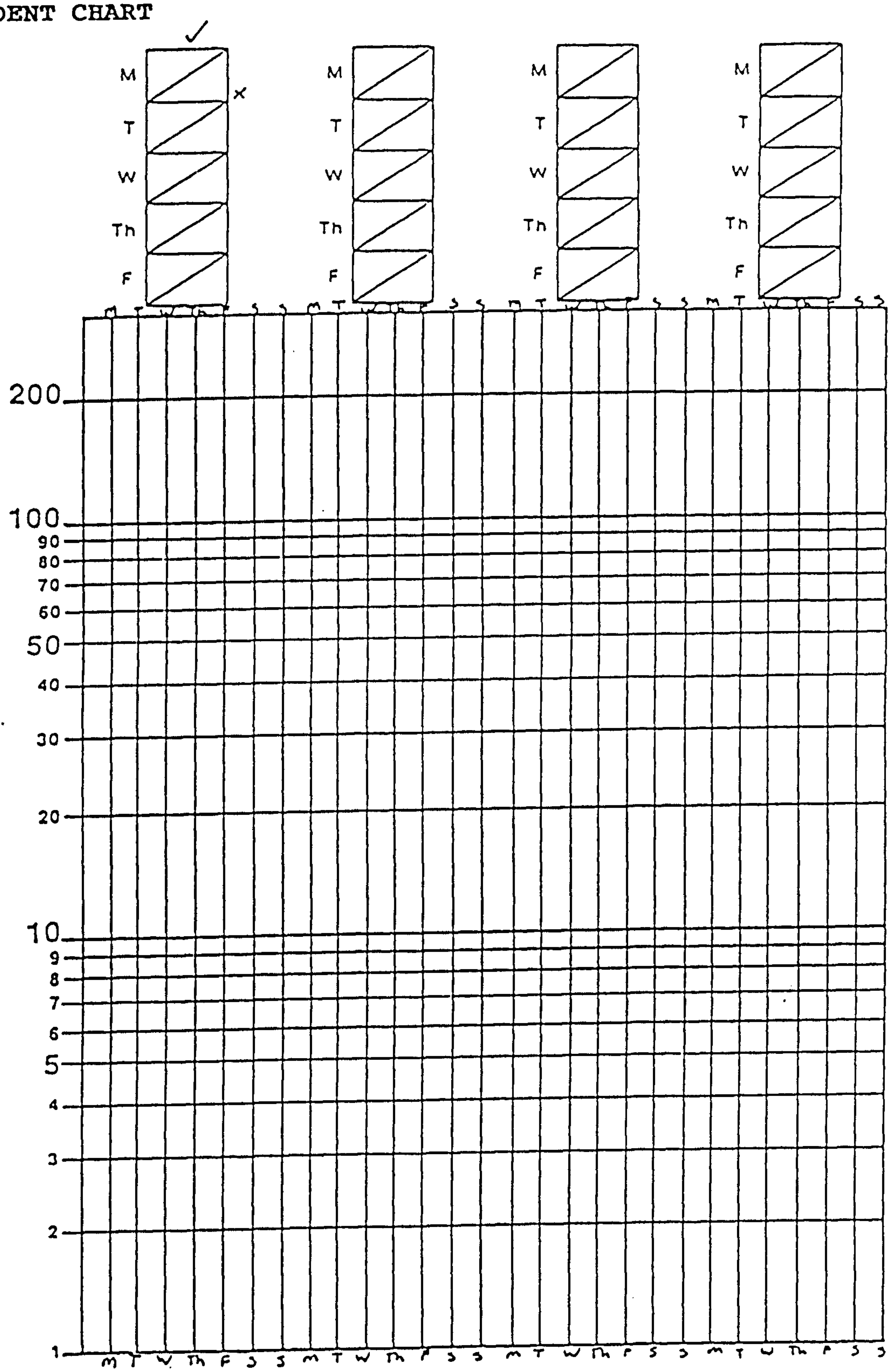
This booklet has a list of statements about how you feel about school. Some of these are true and some are not. Fill in the circle [O] below the YES if the statement is usually true of you. Fill in the circle [O] below the NO if the statement is not usually true of you. Read each question carefully and answer every item, even if it is hard to decide which answer is most like you. Do not fill in both circles. Just fill in one circle for each statement. This is not a test so there are no right or wrong answers. Please mark exactly how you really feel inside about school.

	YES	NO
1. I always understand everything I read	O	O
2. My school work is usually untidy	O	O
3. All new words are easy for me to spell	O	O
4. I find it hard to understand what I have to do	O	O
5. I think my school work is really good	O	O
6. I usually have problems understanding what I read	O	O
7. I am one of the smartest kids in the class	O	O
8. I have neat printing	O	O
9. I usually finish my schoolwork	O	O
10. I am unhappy with how I read	O	O
11. I like reading	O	O
12. My printing is perfect	O	O
13. I am good at spelling	O	O
14. I make many mistakes in school	O	O
15. I have problems in spelling	O	O
16. I like to read to my parents	O	O
17. I am happy with the way I spell	O	O
18. I like making up endings to stories	O	O
19. My teacher thinks I write poor stories	O	O
20. I am poor at subtraction	O	O

	YES	NO
21. I like to answer questions	O	O
22. Working with my hands is hard	O	O
23. I like doing printing	O	O
24. I have trouble drawing pictures	O	O
25. I am poor at silent reading	O	O
26. I have problems printing neatly	O	O
27. I am good with my times tables	O	O
28. I am good at drawing	O	O
29. When school gets tough I give up	O	O
30. I like to do story problems	O	O
31. My friends read better than I do	O	O
32. I am good at printing	O	O
33. I always do neat work	O	O
34. I have difficulty getting my arithmetic finished on time	O	O
35. I have difficulty working with numbers	O	O
36. I like spelling	O	O
37. I like arithmetic	O	O
38. I am a messy writer	O	O
39. Tests are easy for me to take	O	O
40. I like to sound out words	O	O
41. My teacher often makes me write my work again	O	O
42. I have difficulty looking up words in the dictionary	O	O
43. I like to use big words when I talk	O	O
44. I like telling my friends about school work	O	O
45. My teacher thinks I am dumb in arithmetic	O	O

	YES	NO
46. I like going to school	O	O
47. I like playing spelling games	O	O
48. I have difficulty thinking up good stories	O	O
49. My spelling is always right	O	O
50. Saying new words is hard for me	O	O
51. I am unhappy with how I do arithmetic	O	O
52. I am a smart kid	O	O
53. I have difficulty doing what my teacher says	O	O
54. I find spelling hard	O	O
55. I usually get my arithmetic right	O	O
56. I find reading hard	O	O
57. I am unhappy with my printing	O	O
58. I am a good reader	O	O
59. I am slow at spelling	O	O
60. I am a slow reader	O	O
61. In school I find new things difficult to learn	O	O
62. I usually spell words right	O	O
63. My teacher thinks I am good at printing	O	O
64. All new words are hard for me to understand	O	O
65. I have trouble telling others what I mean	O	O
66. I am good at arithmetic	O	O
67. I like to tell stories in class	O	O
68. I feel I often say the wrong things	O	O
69. I find multiplication fun	O	O
70. I always get everything in arithmetic right	O	O

D. STUDENT CHART



NAME: ______________________ PROBE #: __________

E. PARENT INFORMATION

Dear Parent or Guardian,

Thank you for supporting me in this academic self-concept study. I feel optimistic that the study will be able to contribute further information toward enabling students to feel better about themselves academically.

Enclosed you will find three charts labeled Parent Chart. One chart has several notes explaining how to chart and the other two are for your use in charting. Please affix one chart to your fridge or some other easy-to-see spot.

On the first day of the school intervention, Wednesday, March 2, your child will bring home from school the results from his or her first timing. These results will consist of so many corrects and so many errors on a one-minute timing on arithmetic facts. Your child will also tell you where to place the aim line or number to which your child is working toward. It is important that you draw this line across the chart as illustrated on your sample chart. Use a crayon or brightly coloured pen. Also place corrects and errors in the Wednesday box at the top of the chart and on the Wednesday line of the graph. Use a dot for corrects and an x for errors.

Of utmost importance to this study is that you praise your child for daily improvement. Praise from parents is the most powerful reinforcer that a child can get.

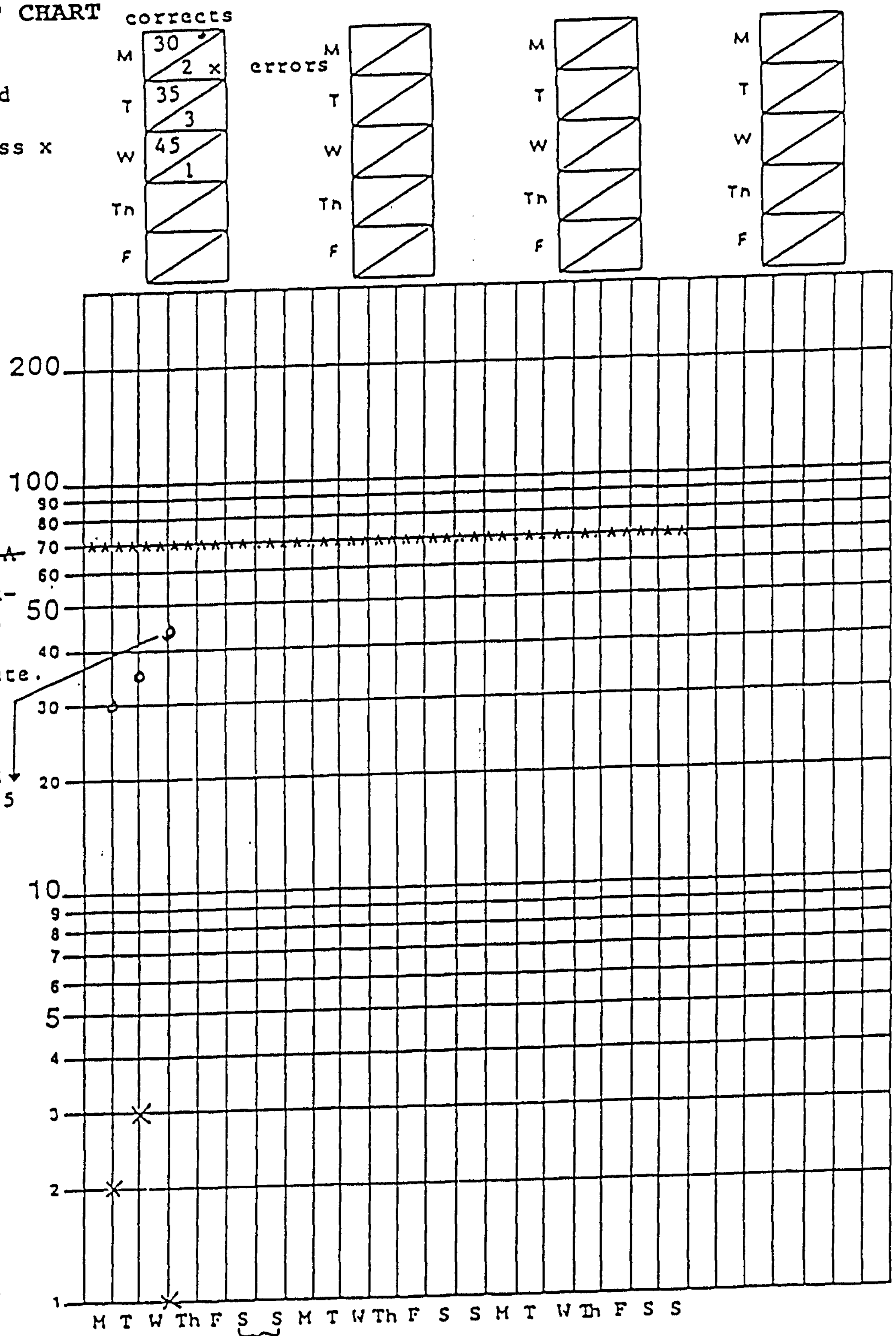
When your child reaches his or her aim for a certain worksheet number, he or she will start at the next level worksheet. At this time the corrects and errors will change. To show on your chart that a change in worksheet has occurred, just use a different coloured pen/pencil or marker and start graphing again. Your child will inform you when this happens as he or she is also keeping a chart at school.

If you have any questions that your child cannot answer about the study, please feel free to call me in the evening. Once again, I appreciate your participation in this study.

Sincerely,

F. PARENT CHART

Corrects charted as a dot .
Errors as a cross x



AIM LINE —A—

*Student is working toward this many correct digits per minute.

Approximate numbers in between printed numbers - eg. 45

On Saturday and Sunday, leave blank.

NAME: ______________________ PROBE #: ________

G. PARENT SOCIAL VALIDATION FORM

Dear Parent:

The purpose of this questionnaire is to get your response to the three-week arithmetic program your child has just completed. Your comments and response are a valuable source of information in assessing the benefits of the program. Thank you for your help and participation.

Gender of parent who charted with student: M/F

Gender of student: M/F

Please circle the number closest to your feelings on the following statements.

1. I liked knowing how my child did in arithmetic each day.

(not at all) 1 2 3 4 5 (very much)

2. I liked charting my child's results on a daily basis.

1 2 3 4 5

3. I liked being involved with my child's progress.

1 2 3 4 5

4. I think this program was motivating for my child.

1 2 3 4 5

5. I found it difficult to find the time to chart with my child.

1 2 3 4 5

6. I think my child feels better about arithmetic now.

1 2 3 4 5

H. STUDENT SOCIAL VALIDATION SCALE

School: ______________________________

Name: ______________________________

Age: __________ Male/Female: __________

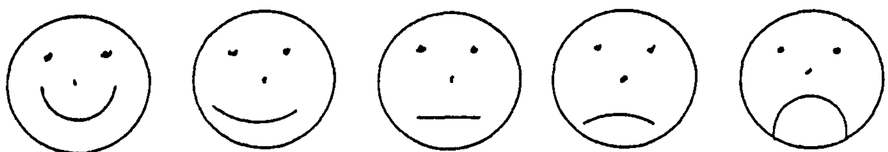
Please pick the face that best describes your feelings about the following statements.

1. I liked charting my results in arithmetic every day.

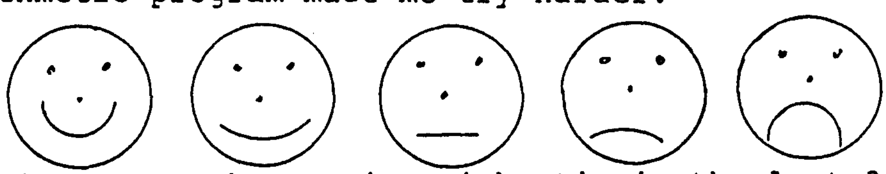
(really a lot)

(not at all)

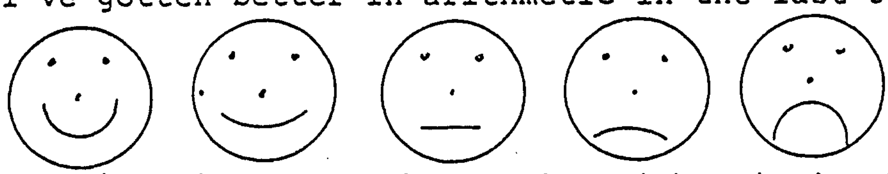
2. I liked knowing how I was doing in arithmetic every day.



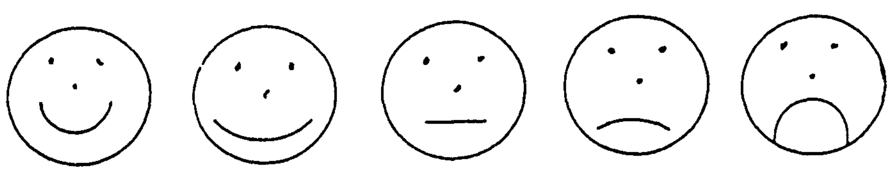
3. This arithmetic program made me try harder.



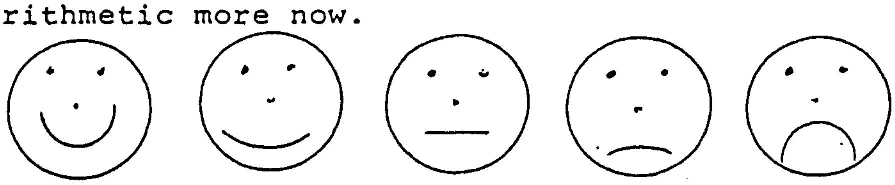
4. I think I've gotten better in arithmetic in the last 3 weeks.



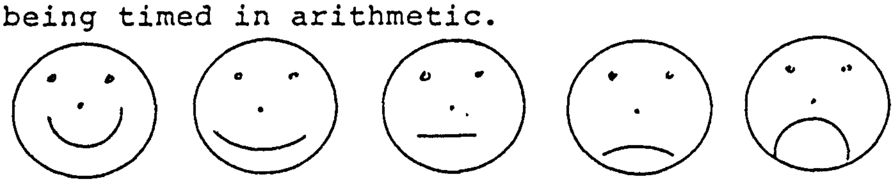
5. My parents think I've gotten better in arithmetic in the last 3 weeks.



6. I like arithmetic more now.



7. I liked being timed in arithmetic.



I. PROBES

Appendix I contains a copy of all the probes used with the Precision Teaching Intervention.

NAME______________________ DATE______________________ COUNT: CORRECT______ ERROR______

SEE TO WRITE: Multiplication Facts - x1

0	1	2	3	4	5	6	7	8	0
x1	x1	x1	x1	x1	x1	x1	x1	x1	x1
0	1	2	3	4	5	6	7	8	9

0	1	2	3	4	5	6	7	8	9	8	2	7	5	
x1	x1	x1	x1	x1	x1	x1	x1	x1	x1	x1	x1	x1	x1	(14)
2	3	6	0	9	3	4	7	5	1	6	8	9	2	
x1	x1	x1	x1	x1	x1	x1	x1	x1	x1	x1	x1	x1	x1	(28)
5	4	8	3	6	1	2	7	9	0	4	3	8	5	
x1	x1	x1	x1	x1	x1	x1	x1	x1	x1	x1	x1	x1	x1	(42)
0	2	9	7	4	8	1	3	5	6	2	0	3	7	
x1	x1	x1	x1	x1	x1	x1	x1	x1	x1	x1	x1	x1	x1	(56)
9	4	5	8	0	6	3	2	7	1	9	4	5	8	
x1	x1	x1	x1	x1	x1	x1	x1	x1	x1	x1	x1	x1	x1	(70)
2	6	3	1	9	7	4	0	8	5	3	2	6	1	
x1	x1	x1	x1	x1	x1	x1	x1	x1	x1	x1	x1	x1	x1	(84)

NAME______________________ DATE______________________ COUNT: CORRECT_____ ERROR_____

SEE TO WRITE: Multiplication Facts - x2

0	1	2	3	4	5	6	7	8	9
x2	x2	x2	x2	x2	x2	x2	x2	x2	x2
0	2	4	6	8	10	12	14	16	18

0	1	2	3	4	5	6	7	8	9	8	2	7	5	
x2	x2	x2	x2	x2	x2	x2	x2	x2	x2	x2	x2	x2	x2	(22)
2	3	6	0	9	3	4	7	5	1	6	8	9	2	
x2	x2	x2	x2	x2	x2	x2	x2	x2	x2	x2	x2	x2	x2	(43)
5	4	8	3	6	1	2	7	9	0	4	3	8	5	
x2	x2	x2	x2	x2	x2	x2	x2	x2	x2	x2	x2	x2	x2	(64)
0	2	9	7	4	8	1	3	5	6	2	0	7	3	
x2	x2	x2	x2	x2	x2	x2	x2	x2	x2	x2	x2	x2	x2	(84)
9	5	4	8	0	6	3	2	7	1	9	4	5	8	
x2	x2	x2	x2	x2	x2	x2	x2	x2	x2	x2	x2	x2	x2	(106)
2	6	3	1	9	7	4	0	8	5	3	2	6	1	
x2	x2	x2	x2	x2	x2	x2	x2	x2	x2	x2	x2	x2	x2	(126)

NAME______________________ DATE______________________ COUNT: CORRECT_____ ERROR_____

SEE TO WRITE: Multiplication Facts - x3

0	1	2	3	4	5	6	7	8	9
x3	x3	x3	x3	x3	x3	x3	x3	x3	x3
0	3	6	9	12	15	18	21	24	27

0 x3	1 x3	2 x3	3 x3	4 x3	5 x3	6 x3	7 x3	8 x3	9 x3	8 x3	2 x3	7 x3	5 x3	(23)
2 x3	3 x3	6 x3	0 x3	9 x3	3 x3	4 x3	7 x3	5 x3	1 x3	6 x3	8 x3	9 x3	2 x3	(45)
5 x3	4 x3	8 x3	3 x3	6 x3	1 x3	2 x3	7 x3	9 x3	0 x3	4 x3	3 x3	8 x3	5 x3	(68)
0 x3	2 x3	9 x3	7 x3	4 x3	8 x3	1 x3	3 x3	5 x3	6 x3	2 x3	0 x3	7 x3	3 x3	(89)
9 x3	5 x3	4 x3	8 x3	0 x3	6 x3	3 x3	2 x3	7 x3	1 x3	9 x3	4 x3	5 x3	8 x3	(113)
2 x3	6 x3	3 x3	1 x3	9 x3	7 x3	4 x3	0 x3	8 x3	5 x3	3 x3	2 x3	6 x3	1 x3	(134)

NAME____________________ DATE____________________ COUNT: CORRECT_____ ERROR_____

SEE TO WRITE: Multiplication Facts - x4

0	1	2	3	4	5	6	7	8	9
x4	x4	x4	x4	x4	x4	x4	x4	x4	x4
0	4	8	12	16	20	24	28	32	36

0	1	2	3	4	5	6	7	8	9	8	2	7	5	
x4	x4	x4	x4	x4	x4	x4	x4	x4	x4	x4	x4	x4	x4	(24)
2	3	6	0	9	3	4	7	5	1	6	8	9	2	
x4	x4	x4	x4	x4	x4	x4	x4	x4	x4	x4	x4	x4	x4	(48)
5	4	8	3	6	1	2	7	9	0	4	3	8	5	
x4	x4	x4	x4	x4	x4	x4	x4	x4	x4	x4	x4	x4	x4	(73)
0	2	9	7	4	8	1	3	5	6	2	0	7	3	
x4	x4	x4	x4	x4	x4	x4	x4	x4	x4	x4	x4	x4	x4	(96)
9	5	4	8	0	6	3	2	7	1	9	4	5	8	
x4	x4	x4	x4	x4	x4	x4	x4	x4	x4	x4	x4	x4	x4	(121)
2	6	3	1	9	7	4	0	8	5	3	2	6	1	
x4	x4	x4	x4	x4	x4	x4	x4	x4	x4	x4	x4	x4	x4	(144)

NAME______________________________ DATE____________________________ COUNT: CORRECT_____ ERROR_____

SEE TO WRITE: Multiplication Facts - x5

0	1	2	3	4	5	6	7	8	9
x5	x5	x5	x5	x5	x5	x5	x5	x5	x5
0	5	10	15	20	25	30	35	40	45

0	1	2	3	4	5	6	7	8	9	8	2	7	5	
x5	x5	x5	x5	x5	x5	x5	x5	x5	x5	x5	x5	x5	x5	(26)
2	3	6	0	9	3	4	7	5	1	6	8	9	2	
x5	x5	x5	x5	x5	x5	x5	x5	x5	x5	x5	x5	x5	x5	(52)
5	4	8	3	6	1	2	7	9	0	4	3	8	5	
x5	x5	x5	x5	x5	x5	x5	x5	x5	x5	x5	x5	x5	x5	(78)
0	2	9	7	4	8	1	3	5	6	2	0	7	3	
x5	x5	x5	x5	x5	x5	x5	x5	x5	x5	x5	x5	x5	x5	(103)
9	5	4	8	0	6	3	2	7	1	9	4	5	8	
x5	x5	x5	x5	x5	x5	x5	x5	x5	x5	x5	x5	x5	x5	(129)
2	6	3	1	9	7	4	0	8	5	3	2	6	1	
x5	x5	x5	x5	x5	x5	x5	x5	x5	x5	x5	x5	x5	x5	(154)

NAME____________________ DATE____________________ COUNT: CORRECT_____ ERROR_____

SEE TO WRITE: Multiplication - x0-x5

0	3	1	1	2	0	5	3	2	3	5	0	4	1	
x5	x4	x3	x1	x2	x4	x2	x1	x5	x3	x1	x2	x4	x5	(18)
4	5	5	3	0	5	1	4	3	2	1	0	4	2	
x1	x3	x4	x2	x1	x5	x2	x3	x5	x1	x4	x3	x2	x4	(37)
2	1	4	0	5	3	2	3	5	0	2	1	1	3	
x3	x5	x4	x2	x1	x3	x5	x1	x2	x4	x2	x1	x3	x4	(55)
4	2	4	0	1	2	3	4	1	5	0	3	5	5	
x5	x4	x2	x3	x4	x1	x5	x3	x2	x5	x1	x2	x4	x3	(75)
3	5	0	2	1	1	3	0	2	1	4	0	5	3	
x1	x2	x4	x2	x1	x3	x4	x5	x3	x5	x4	x2	x1	x3	(90)
4	1	5	0	3	5	5	4	4	2	4	0	1	2	
x3	x2	x5	x1	x2	x4	x3	x1	x5	x4	x2	x3	x4	x1	(109)

NAME________________ DATE________________ COUNT: CORRECT______ ERROR______

SEE TO WRITE: Multiplication Facts - x6

0 x6 = 0	1 x6 = 6	2 x6 = 12	3 x6 = 18	4 x6 = 24	5 x6 = 30	6 x6 = 36	7 x6 = 42	8 x6 = 48	9 x6 = 54

0 x6	1 x6	2 x6	3 x6	4 x6	5 x6	6 x6	7 x6	8 x6	9 x6	8 x6	2 x6	7 x6	5 x6	(26)
2 x6	3 x6	6 x6	0 x6	9 x6	3 x6	4 x6	7 x6	5 x6	1 x6	6 x6	8 x6	9 x6	2 x6	(52)
5 x6	4 x6	8 x6	3 x6	6 x6	1 x6	2 x6	7 x6	9 x6	0 x6	4 x6	3 x6	8 x6	5 x6	(78)
0 x6	2 x6	9 x6	7 x6	4 x6	8 x6	1 x6	3 x6	5 x6	6 x6	2 x6	0 x6	7 x6	3 x6	(103)
9 x6	5 x6	4 x6	8 x6	0 x6	6 x6	3 x6	2 x6	7 x6	1 x6	9 x6	4 x6	5 x6	8 x6	(129)
2 x6	6 x6	3 x6	1 x6	9 x6	7 x6	4 x6	0 x6	8 x6	5 x6	3 x6	2 x6	6 x6	1 x6	(154)

NAME________________________ DATE________________________ COUNT: CORRECT_____ ERROR_____

SEE TO WRITE: Multiplication Facts - x7

0	1	2	3	4	5	6	7	8	9
x7	x7	x7	x7	x7	x7	x7	x7	x7	x7
0	7	14	21	28	35	42	49	56	63

0	1	2	3	4	5	6	7	8	9	8	2	7	5	
x7	x7	x7	x7	x7	x7	x7	x7	x7	x7	x7	x7	x7	x7	(26)
2	3	6	0	9	3	4	7	5	1	6	8	9	2	
x7	x7	x7	x7	x7	x7	x7	x7	x7	x7	x7	x7	x7	x7	(52)
5	4	8	3	6	1	2	7	9	0	4	3	8	5	
x7	x7	x7	x7	x7	x7	x7	x7	x7	x7	x7	x7	x7	x7	(78)
0	2	9	7	4	8	1	3	5	6	2	0	7	3	
x7	x7	x7	x7	x7	x7	x7	x7	x7	x7	x7	x7	x7	x7	(103)
9	5	4	7	8	0	6	3	5	2	7	1	9	4	
x7	x7	x7	x7	x7	x7	x7	x7	x7	x7	x7	x7	x7	x7	(129)
2	6	3	1	9	7	4	0	8	5	3	2	6	1	
x7	x7	x7	x7	x7	x7	x7	x7	x7	x7	x7	x7	x7	x7	(154)

NAME______________________ DATE______________________ COUNT: CORRECT______ ERROR______

SEE TO WRITE: Multiplication Facts - x8

0	1	2	3	4	5	6	7	8	9
x8	x8	x8	x8	x8	x8	x8	x8	x8	x8
0	8	16	24	32	40	48	56	64	72

0	1	2	3	4	5	6	7	8	9	8	2	7	5	
x8	x8	x8	x8	x8	x8	x8	x8	x8	x8	x8	x8	x8	x8	(26)
2	3	6	0	9	3	4	7	5	1	6	8	9	2	
x8	x8	x8	x8	x8	x8	x8	x8	x8	x8	x8	x8	x8	x8	(52)
5	4	8	3	6	1	2	7	9	0	4	3	8	5	
x8	x8	x8	x8	x8	x8	x8	x8	x8	x8	x8	x8	x8	x8	(78)
0	2	9	7	4	8	1	3	5	6	3	0	2	7	
x8	x8	x8	x8	x8	x8	x8	x8	x8	x8	x8	x8	x8	x8	(103)
9	4	5	8	0	6	3	2	7	1	9	4	5	8	
x8	x8	x8	x8	x8	x8	x8	x8	x8	x8	x8	x8	x8	x8	(129)
2	6	3	1	9	7	4	0	8	5	3	2	6	1	
x8	x8	x8	x8	x8	x8	x8	x8	x8	x8	x8	x8	x8	x8	(154)

NAME______________________DATE______________________COUNT: CORRECT______ERROR______

SEE TO WRITE: Multiplication Facts - x9

0	1	2	3	4	5	6	7	8	9
x9	x9	x9	x9	x9	x9	x9	x9	x9	x9
0	9	18	27	36	45	54	63	72	81

0	1	2	3	4	5	6	7	8	9	8	2	7	5	
x9	x9	x9	x9	x9	x9	x9	x9	x9	x9	x9	x9	x9	x9	(26)
2	3	6	0	9	3	4	7	5	1	6	8	9	2	
x9	x9	x9	x9	x9	x9	x9	x9	x9	x9	x9	x9	x9	x9	(52)
5	4	8	3	6	1	2	7	9	0	4	3	8	5	
x9	x9	x9	x9	x9	x9	x9	x9	x9	x9	x9	x9	x9	x9	(78)
0	2	9	7	4	8	1	3	5	6	3	0	2	7	
x9	x9	x9	x9	x9	x9	x9	x9	x9	x9	x9	x9	x9	x9	(103)
9	4	5	8	0	6	3	2	7	1	9	4	5	8	
x9	x9	x9	x9	x9	x9	x9	x9	x9	x9	x9	x9	x9	x9	(129)
2	6	3	1	9	7	4	0	8	5	3	2	6	1	
x9	x9	x9	x9	x9	x9	x9	x9	x9	x9	x9	x9	x9	x9	(154)

NAME________________________ DATE____________________ COUNT: CORRECT______ ERROR______

SEE TO WRITE: Multiplication Facts - x10

10	10	10	10	10	10	10	10	10	10	10
x0	x1	x2	x3	x4	x5	x6	x7	x8	x9	x10
0	10	20	30	40	50	60	70	80	90	100

10	10	10	10	10	10	10	10	10	10	10	10	10	10	
x0	x1	x2	x3	x4	x5	x6	x7	x8	x9	x10	x8	x2	x7	(28)
10	10	10	10	10	10	10	10	10	10	10	10	10	10	
x1	x1	x2	x3	x6	x0	x9	x3	x4	x7	x5	x4	x6	x8	(55)
10	10	10	10	10	10	10	10	10	10	10	10	10	10	
x5	x4	x8	x3	x6	x1	x3	x7	x9	x0	x4	x3	x8	x5	(82)
10	10	10	10	10	10	10	10	10	10	10	10	10	10	
x0	x2	x9	x7	x4	x8	x1	x3	x5	x6	x3	x0	x2	x7	(108)
10	10	10	10	10	10	10	10	10	10	10	10	10	10	
x9	x4	x5	x8	x0	x6	x3	x2	x7	x1	x9	x4	x5	x8	(135)
10	10	10	10	10	10	10	10	10	10	10	10	10	10	
x10	x2	x6	x3	x10	x7	x4	x0	x8	x5	x3	x2	x6	x1	(164)

NAME______________________ DATE______________________ COUNT: CORRECT_____ ERROR_____

SEE TO WRITE: Multiplication Facts - x11

11 x0 = 0	11 x1 = 11	11 x2 = 22	11 x3 = 33	11 x4 = 44	11 x5 = 55	11 x6 = 66	11 x7 = 77	11 x8 = 88	11 x9 = 99	11 x10 = 110	11 x11 = 121

11 x0	11 x1	11 x2	11 x3	11 x4	11 x5	11 x6	11 x7	11 x8	11 x9	11 x10	11 x11	11 x8	11 x7	(29)
11 x1	11 x4	11 x2	11 x3	11 x6	11 x0	11 x9	11 x3	11 x7	11 x10	11 x4	11 x6	11 x8	11 x11	(58)
11 x11	11 x5	11 x4	11 x8	11 x3	11 x6	11 x1	11 x10	11 x7	11 x4	11 x3	11 x8	11 x11	11 x5	(89)
11 x0	11 x2	11 x9	11 x7	11 x4	11 x8	11 x2	11 x3	11 x5	11 x6	11 x3	11 x0	11 x10	11 x7	(116)
11 x10	11 x4	11 x11	11 x8	11 x1	11 x5	11 x6	11 x3	11 x2	11 x4	11 x8	11 x1	11 x0	11 x7	(145)
11 x9	11 x4	11 x5	11 x9	11 x11	11 x3	11 x7	11 x1	11 x10	11 x6	11 x8	11 x7	11 x4	11 x3	(175)

NAME____________________ DATE________________ COUNT: CORRECT_____ ERROR_____

SEE TO WRITE: Multiplication Facts - x12

12	12	12	12	12	12	12	12	12	12	12	12	12
x0	x1	x2	x3	x4	x5	x6	x7	x8	x9	x10	x11	x12
0	12	24	36	48	60	72	84	96	108	120	132	144

12	12	12	12	12	12	12	12	12	12	12	12	12	12	
x1	x2	x3	x4	x5	x6	x7	x8	x9	x10	x11	x12	x0	x8	(31)
12	12	12	12	12	12	12	12	12	12	12	12	12	12	
x11	x9	x7	x4	x2	x1	x12	x9	x3	x5	x7	x10	x3	x12	(75)
12	12	12	12	12	12	12	12	12	12	12	12	12	12	
x5	x8	x3	x10	x9	x12	x3	x4	x11	x6	x3	x2	x0	x1	(106)
12	12	12	12	12	12	12	12	12	12	12	12	12	12	
x7	x8	x12	x11	x10	x9	x8	x7	x6	x5	x4	x3	x2	x1	(138)
12	12	12	12	12	12	12	12	12	12	12	12	12	12	
x6	x12	x3	x10	x7	x5	x3	x9	x3	x1	x2	x4	x7	x9	(170)
12	12	12	12	12	12	12	12	12	12	12	12	12	12	
x12	x1	x0	x3	x3	x6	x2	x4	x11	x4	x3	x12	x9	x10	(202)