Order Number 9000705

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A COMPARISON OF STUDENTS' MATHEMATICAL LEARNING STYLE ORIENTATIONS, GENERAL LEARNING STYLE ORIENTATIONS, SCHOLASTIC APTITUDE TEST SCORES, AND GRADE POINT AVERAGES

by

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A dissertation submitted to the Graduate Faculty in Educational Psychology in partial fulfillment of the requirements for the degree of Doctor of Philosophy, The City University of New York

1989

This manuscript has been read and accepted for the Graduate Faculty in Educational Psychology in satisfaction of the dissertation requirement for the degree of Doctor of Philosophy

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ABSTRACT

A Comparison of Students' Mathematical Learning Style Orientations, General Learning Style Orientations, Scholastic Aptitude Test Scores, and Grade Point Averages

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The purpose of this study was to explore students' approaches to learning mathematics. This research extended previous studies, which characterized students' general learning style orientations (Entwistle, 1981, Entwistle & Kozeki, 1985), by restricting the inquiry to the domain of mathematics. The study involved first corroborating the original classifications of learning style orientations and then comparing these constructs to the proposed mathematical learning style orientations.

Four hundred twenty seniors from five high schools in the New York City area completed two inventories, during one session. One inventory pertained to students' general learning style orientations. This scale had been previously developed and tested by Entwistle and colleagues. The other inventory, an adaptation of the original, dealt with students' math learning style orientations.

Every student completed both inventories. In addition, the students reported their SAT scores, and general and math grade point averages. Forty-six of the

students repeated the session three weeks later, allowing for a reliability measure.

As expected, for the original inventory, the students delineated the three learning style orientations identified by Entwistle. Further, students responded differently to the inventory adapted for math. When answering questions about how they learn math, students reported two main mathematical learning style orientations.

All students reported a higher reproducing orientation for math than when no subject matter was specified. Other variations in the students' responses were associated, in part, with gender and the schools that they attended.

Overall GPA was predicted by the general Reproducing and Achieving Orientations. Math GPA was predicted by the Math Reproducing and Achieving Orientations. Verbal SAT scores were predicted by school, and the Meaning and Reproducing Orientations. Math SAT scores were predicted by school, the Math Meaning and Reproducing Orientations, and gender.

Comparing the responses of the students across the two inventories allowed for the detection of differences between students' general approaches to learning and their approaches towards learning mathematics. The educational implications of this study and suggestions for additional research are discussed.

ACKNOWLEDGEMENTS

Several people deserve special thanks for helping me earn this degree.

First, a special thanks to my mentor and friend Carol Kehr Tittle. Her high standards and zest for learning have inspired me. Her willingness to help has allowed me to understand and learn. Her vision for the future has challenged me.

I am grateful to Sam Messick, whose scholarship helped me develop this study, to Alan Gross and Zita Cantwell for the time and effort they contributed throughout the dissertation process, and to Nick Anastasiow and Sherry Graves for their helpful suggestions. I also owe a special thanks to Dr. Saad who long ago showed me that I could make a difference.

For my family, friends and colleagues, who were always there to offer their support and encouragement, I express my gratefulness. Thanks especially to Joanne Sacks for leading the way, and to Rose Caporrimo and Ines Solomon for their camaraderie.

Finally, eternal gratitude and love goes to my husband, Bill. He continuously offered loving support, a steadfast belief in me, and of course, a sense of humor. I dedicate this dissertation to Bill in acknowledgement of his wisdom and in appreciation for his partnership.

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I. Introduction

Differences in students' approaches to learning and studying have been the focus of much research in recent years. These "learning styles" represent an expression, in an academic context, of more fundamental and relatively stable components of cognitive style and personality (Entwistle, 1981; Messick, 1985). Several studies, conducted with differing cultural populations, have reported remarkably similar learning style dimensions (Biggs, 1988; Entwistle, 1981, 1987). While the studies in these areas have taken different approaches to the identification and illustration of learning styles, each has independently characterized similar profiles of students' learning and studying behaviors. Specifically, all have defined three approaches to learning. They are: (1) a deep approach to the task, focusing on the meaning, intending to comprehend and understand, (2) a shallow approach, focusing on the surface level, attending to the facts and details, and (3) a versatile approach, focusing either on the deep or surface level depending on the demands of the task.

Research in this area has typically concentrated on identifying the characteristics of the person, without variation in the context in which the learning style is displayed. Context is defined here as the environment created by the subject matter, the institutional practices, the assessment methods, and the skills and attitudes of the faculty. The majority of studies conducted to identify learning styles have used reading comprehension or verbally laden tasks; none have used a mathematical task, that is, a different context. However, there are reasons to propose that learning styles may vary according to the subject matter.

Corno & Snow (1985) have stated that an individual's performance is a mixture of the predisposition the individual brings to that performance in interaction with the demands of the educational task and situation. Similarly, Shulman (1985) noted that learning can be viewed as a student making sense of what is happening around her/him rather than just a change in behavior. Context influences learning. Accordingly, context may indeed affect a student's approach to learning. While Entwistle and others have discussed the importance of context in their discussions of learning styles, they have generally questioned students about the ways that they learn and study without reference to context or, more specifically, subject.

In contrast to the researchers examining learning styles, who have taken a relatively context-free approach, researchers in math education have taken a rather context-specific approach. Research in mathematics education has primarily focused on students' problem solving behaviors. They have examined the role of individual differences either by concentrating on the problem solvers' actions or by identifying the general aptitudes which interact with problem solving activity (Fennema & Behr, 1980; Threadgill-Sowder, 1985).

Studies concentrating on the problem solvers' behaviors have contrasted the characteristic approaches of good and poor problem solvers, experts and novices (Lesh, 1985, Lester, 1985; Schoenfeld, 1985, 1987). Studies identifying student aptitudes have looked at specific skills in relation to specific types of problems (Silver, 1985). Few areas of mathematics research, with the exception of math anxiety (Tobias, 1979) and gender differences (Fennema & Sherman, 1978), have examined the influence students' perceptions have on the approaches they take when learning mathematics.

The research dealing with learning styles and math learning have developed independently. The math education researchers have recognized the importance of identifying the influence of person variables

(Kulm, 1984) on learning behavior. The learning style researchers have acknowledged the important influence of context on students' learning behavior (Ramsden, 1988). However little overlap between these areas of research exists.

This investigation was an initial step in relating students' learning styles to the context of mathematics. Specifically, this research examined: (1) how students' mathematical learning style orientations compared to their general learning style orientations, (2) how both types of learning style orientations relate to students' academic performance (as measured by GPA and SAT scores), and (3) the differences, by gender and school, if any, in students' self-reported learning styles.

II. Review of the Literature

This chapter is divided into four parts. They are: (1) learning styles, and learning strategies, (2) students' learning styles and academic context, (3) mathematical learning, and (4) the summary of the literature review.

Part One, Learning Styles and Strategies, describes the research done to characterize and measure learning styles, learning strategies, and learning style orientations. More specifically, this section discusses: (1) the theoretical framework for learning styles and the related motivational constructs, (2) the research which identified the various learning styles and strategies, and (3) studies which developed inventories to delineate students' learning styles and learning strategies. In this section, the tasks designed to allow students to demonstrate their learning styles are discussed, and the various Learning Style Inventories are compared. The implications of this research on students' approaches to learning are considered.

Part Two, Learning Styles and Academic Context, describes the research which has examined the relationship between context and students' learning styles and strategies. This part of the review focuses on research aimed at examining the contextual limits of students' learning styles. Students' perceptions of contextual demands are also discussed.

Part Three, Mathematical Learning describes the research done to investigate students' approaches to mathematics. This section of the review is divided into three subsections. They are: (1) processes in math learning, (2) students' approaches to mathematics, and (3) gender differences in mathematical attitude. The research reviewed in this section includes studies identifying the processes that students use when doing mathematics, studies that explored how students represent and think about mathematics, and studies that investigated gender differences in math learning. The importance of considering affective and conative variables when assessing students' mathematical performance is discussed.

Part Four, Summary of the Literature Review, summarizes the research and theoretical literature which serves as the foundation for the present study. The definitions of the terms used in this study are provided at the end of this chapter.

Learning Styles and Learning Strategies

Theoretical Framework

Learning styles. Researchers interested in students' learning and studying behaviors have identified patterns or approaches in how students deal with information across limited content areas. Approaches or "Learning styles" can be described as self-consistent regularities in the manner or form of learning and studying activities (Messick, 1985). Learning styles are concerned with how a person learns, whereas intellectual abilities refer to the content of cognition or what a person can learn. Intellectual abilities "implies the measurement of capacities in terms of maximal performance, with the emphasis on the level of accomplishment" (Messick, 1976, p. 7). In contrast styles "... cut across domains. They appear to serve as high-level heuristics that organize lower-level strategies, operations and propensities - often including abilities - in such complex sequential processes as problem solving and learning" (Messick, 1976, p. 9). People do differ in how they learn and individuals can use varying approaches to arrive at the same learning outcome.

Other definitions of learning styles exist that are beyond the scope of this review. In order to differentiate among the different learning style constructs, Marshall's (1987) learning style topology serves as a useful way to characterize the learning style research. Three levels of learning styles are illustrated within Marshalls' learning style topology. The three levels are:

(1) Environmental level. Learning style research at this level focuses on defining the ways individuals interact directly with their environment (Berger, 1988; Dunn & Dunn, 1978; Renzulli & Smith, 1978; Smith & Holliday, 1987).

(2) Information processing level. These learning style variables identify the ways that individuals assimilate information independent of the actual learning environment (Hunt, 1979; Kolb, 1984).

(3) Cognitive-personality level. Learning style research at this level seeks to identify the individual's approach to adapting information as it has been assimilated through her/his information processing style.

The learning styles at the cognitive-personality level focus on the person variables (Flavell, 1976) which include both enduring properties that change little over time and temporary properties. They reflect a task-oriented behavior which is constrained by one's enabling competence (intellectual ability) and one's enduring disposition (Messick, 1985). These learning styles function to voluntarily oversee and control particular learning activities (Corno & Snow, 1985).

This thesis deals with learning styles at the cognitive-personality level, rather than at the information processing or environmental levels. However, in order to clearly differentiate learning styles and learning strategies, Schmeck's (1983) "Inventory of Learning Processes "(ILP) and Weinstein's (1988) "Learning and Studying Strategies Inventory" (LASSI) are also reviewed (in a later section). These inventories straddle the two deepest levels of Marshall's topology.

Motivation. Motivation is a major part of Biggs and Entwistle's learning style models. These models extend the concept of learning styles by including motivational constructs with learning approaches and strategies. Motivation is the process of initiating, sustaining, and directing activity (Wittrock, 1985). It is defined in terms of the many factors that incite and direct behavior, including personal attributions and goals, past experiences, and environmental influences.

Theories of achievement motivation seek to explain and predict behavior in achievement situations (Stipek, 1988). A person who is intrinsically motivated behaves as a result of internal causes rather than external pressures (Deci, 1975). Students who are intrinsically motivated achieve for the satisfaction of accomplishment and/or the enjoyment of the experience (Harter, 1982). Extrinsic motivation depends on the environmental factors that a person values. Students who are extrinsically motivated achieve either to earn a reward or for the recognition of others. Achievement motivation also addresses students' hope for success and/or fear of failure. Both of these can act as a motivator for some students.

Achievement motivation research has focused on identifying students' goal orientations, the motivational processes associated with these goals, and the conditions that elicit them (Ames & Archer, 1988). Schunk (1985) identified goals as a factor in educational practices. These goals play a role in a student's perceived self-efficacy and influence a student's motivation, choice of activity, and level of skillful performance. Dweck (1986) also described the achievement situation as affording a choice of goals. The goals that students preferentially adopt predict the achievement patterns that they will display. A student choosing a learning goal seeks to increase competencies, understanding and/or mastery. A student adopting a performance goal seeks to gain favorable judgments or to avoid negative judgments of her/his competency. These goals are similar to the intrinsic and extrinsic motivational constructs included in Entwistle's learning style orientations.

Eccles & Wigfield (1985) suggested that individual differences in motivational constructs may be attributable to the students' interpretations of their own achievement experiences. Individual's beliefs about the outcomes they experience influence both present behavior and future expectancies. Ames & Archer (1988) found that junior high school students' perceptions of the classroom environment were related to how they approached, engaged in, and responded to learning tasks. They used Weinstein's LASSI (see description in a later section), Dweck's goal orientation model, and a measure of task preference (easy vs. challenging), to examine the relationship among students' perceived ability, use of learning strategies, task preference, and goal orientation.

Ames & Archer determined it was the goal orientation and not ability that made the difference in the students' use of learning strategies, their task preference, and attitudes. High mastery goal orientation scores were correlated with effective learning strategies (.49), preference for challenging tasks (.34), and a positive attitude towards learning (.63). The performance goal orientation scores were not correlated with any of the measures (correlations ranged from -.14 to .12), nor were they correlated with mastery goal orientation (-.03).

These results suggest that the goals students value, and schools emphasize, may make a difference in how students approach academic tasks. In other words, the context may affect the students' learning orientation. Students encouraged to master a task will learn and study differently than students who are rewarded for performance. This affirms the findings of Ramsden (1983), Laurillard (1979) and others that will be discussed in a later section. These results also indicate that the context may affect the students' learning orientation.

Identifying Learning Styles and Strategies

Marton and Saljo (1976) sought to describe the qualitative differences in how people comprehend the text they read. In a series of studies they interviewed first-year college students in Gothenberg, Sweden, about what they remembered about the text they had just read. Their objectives were to identify the different ways that students' comprehended (levels of outcome) and processed (levels of processing) what they read. From the response patterns of the subjects, based on the summary questions and the students' free recall of the article, they concluded that two approaches to learning could be identified. Students using different approaches to learning undertook the tasks with different intentions. Specifically, one group of participants took a deep approach, relating the passage to previous knowledge and personal experiences with the intention of understanding the meaning of the text. The other group chose a surface approach, attending to specific facts or information, with the goal of memorizing the parts of the article they anticipated would be important to the questioner.

In another study, similar to Marton & Saljo's research, Wenestam (cited in Marton, 1988) asked six female and nine male adults to explain what they had just read. The adults offered two qualitatively different outcomes of learning. One group focused on the meaning of the story and the other on the structure, the facts offered in the passage. These studies showed that individuals can be distinguished by what they focus on when learning. In each case, one group focused on the overall meaning of the passage while the other focused on the most obvious meaning of each part of the passage and the details specified (Marton, 1988). These findings, and their own, led Marton and colleagues to conclude that learning should be described in terms of the variety of ways that a subject is comprehended by the learner. However, although recognizing the importance of the subject matter, the content they examined was limited to readings in educational psychology.

To determine whether deep and surface approaches to learning existed across a broader range of academic tasks, Entwistle and Ramsden (1983) also conducted interviews. These protocols were the first part of a five year study begun in 1976 in Lancaster, England, to examine the learning styles of college students across various majors (English, history, physics, psychology, economics, and engineering). The students' responses both confirmed the two main approaches identified by Marton and Saljo and helped identify a third learning style category, the strategic approach. This approach, as well as the variations of the students' responses, will be discussed in later sections.

While Marton and Entwistle and colleagues arrived at the approaches to learning through individual interviews, Pask (1976) arrived at similar styles of learning through a series of experiments. In the first experiment (Pask & Scott, 1972) 26 Dutch college students completed a learning task in which they were required to learn the biological taxonomies of two types of imaginary Martian animals under free learning conditions. The taxonomies were displayed on 40 data cards featuring 10 types of subspecies and 5 separate categories of descriptive information (physical characteristics, habitat, pictorial representations, etc.). Students were required to choose one card at a time, explaining their choice as they did. When the students considered themselves proficient in the task they completed a 30 item questionnaire about the "Clobbits" and "Gandlemullers." Ten of the subjects also participated in a "teachback" task. These students explained what they had learned by teaching the taxonomy back to another person.

Two learning styles emerged: a holist style and a serialist style. The students who employed a holist style used a global approach to problem solving. They had a wide focus of attention, trying to construct the whole picture from the start. They looked farther ahead when working through the hierarchy of subtopics towards understanding, fitting details in afterwards. On the other hand, the serialist used a step-by-step approach, working through each category separately, and integrating them only when necessary for overall understanding. They put more emphasis on the separate topics and logical sequencing of the data, forming the whole picture late in the process. Pask's work expanded the concept of approaches to learning by detailing the processes students actually engaged in while learning, and by characterizing the learning pathologies of those students who showed extreme reliance on either approach. The pathologies identified were "globetrotting" and "improvidence." Globetrotting is the tendency for a holist to overgeneralize and improvidence is the failure of serialists to see useful analogies.

In subsequent studies Pask (1979) replicated these findings and extended the experiment in several ways. He designed teaching programs with either a serialist or a holist progression and compared matched and mismatched learning conditions. He compared the consistency of students' approaches across certain topics (the operon cycle, the menstrual cycle), and an inductive inference task.

He presented the variety of tasks to 62 students in a counterbalanced order and found results similar to those of the first studies. Holists selected a large number of data cards, showing the intention to test a large predicate or relational hypothesis. Serialists selected a smaller number of data cards, searching for specific details. Matched performances, that is, holists with holist type tasks and serialists with serialist type tasks, were better than mismatched ones. All these approaches persisted across the different tasks.

As a result of this work, Pask concluded that stylistic consistency outweighed contextual demands as a determiner of the students' choice of approach. Even when the task was structured to facilitate one approach instead of another, some individuals did not vary their approach. This led Pask to conclude that some individuals have a general tendency to adopt a particular learning style in a variety of situations.

Students who consistently used a holist approach were identified as comprehension learners. Those who habitually used a serialist approach were classified as operation learners. Pask also recognized that some individuals can adopt either approach rather than always relying on one approach or the other. These individuals are designated versatile learners. They are the most efficient learners, using the approach that is most appropriate for the required task. Pask's findings of style outweighing context have not been consistently demonstrated. Laurillard's (1984) work, described in a later section, offers an alternative view.

In summary, the work of Pask and Marton and colleagues illustrated qualitatively the different approaches people employed when comprehending and learning. A person utilizing a deep approach will strive to understand and comprehend the material, extending the current information beyond the facts being reported. A person taking a surface approach will concentrate primarily on the actual information, seeking to remember the facts as stated without necessarily developing an overall sense of meaning. Persons varying their approach depending on the context are versatile learners. Overuse of either approach results in learning pathologies.

Delineating Learning Styles and Strategies

Learning Style Inventories. In an effort to operationalize the findings of Marton and Pask, Entwistle and his colleagues developed and refined a series of inventories designed to identify students' learning style orientations (Entwistle, 1981, 1988;

Entwistle & Kozeki, 1985; Entwistle and Ramsden, 1983; Entwistle & Wilson, 1970). Entwistle's learning style orientations extended the concept of learning styles by including motivational constructs with the pre-defined learning approaches and strategies.

The initial study (Entwistle & Wilson, 1970) questioned 767 first year university students, trying to identify the students' personality and motivational differences that would predict academic performance. They administered a questionnaire containing 15 subscales designed to examine the patterns of relationship between approaches and outcomes identified by Marton and Pask. A factor analysis identified three factors. Factor I was labeled the deep approach and included loadings on intrinsic motivation, comprehension learning, internality, and openness, and negative loading for syllabus-boundedness. Factor II was labeled the surface approach and included loadings on operation learning, extrinsic motivation, syllabus-boundedness, the strategic approach, and, to a lesser extent, fear of failure, and achievement motivation. Factor III related organized study methods, positive attitudes toward studying and to some degree achievement and the deep approach. From these findings, three major learning style orientations (LSO) were derived, each involving a different source of motivation and each describing students likely to adopt a certain approach to studying. The Learning Style Orientations are:

(1) meaning orientation, whereby a student adopts a deep level approach or a holist style and is intrinsically motivated;

(2) reproducing orientation, whereby the individual adopts a surface-level approach or a serialist style and is externally motivated; and

(3) achieving orientation whereby an individual will do whatever is necessary to earn high grades, manifesting high achievement motivation or fear of failure, adopting either a deep or surface level approach. The achieving orientation may imply versatility for some students and a different motivational orientation for others.

Based on these and other studies, the Approach to Studying Inventory (ASI) was developed (Entwistle & Ramsden 1983). The original ASI[1] contained 64 items grouped into 4 domains representing the three approaches to learning and Pask's styles and

[1]The study surveyed 2200 British college students: 491 art students, 852 social science students, and 865 pure or applied science students from english, economics, engineering, history, psychology, and physics departments.

pathologies. Internal reliabilities were .79 for the deep approach, .73 for the surface approach, .70 for the strategic approach and .59 for Pask's styles and pathologies (Entwistle, 1986). The factor analysis for this study produced four related factors. The first three factors identified were similar to those of the earlier study. The fourth factor related disorganized study with negative attitudes and globetrotting. This last dimension was later explained by Entwistle as also related to the strategic approach, picking up on organized study and effective use of time and effort (Entwistle, 1986).

Two other studies have replicated Entwistle's previous findings with different student populations. Diaz (cited in Entwistle, 1988) administered a translated version (Spanish) to 534 Venezuelan university students. Entwistle & Kozeki (1985) compared the responses of British and Hungarian secondary school students (ages 13-17) on a revised inventory. Item analysis was used along with the factor analyses to confirm the ASI dimensions.

The factor analyses of these studies showed results similar to the others. Meaning orientation was characterized by a deep approach, intrinsic motivation, and a holist style. Reproducing orientation was characterized by a surface approach, instrumental motivation, fear of failure, and a serialist style. The achieving orientation related the strategic approach, conscientiousness, the deep approach, intrinsic motivation, hope for success, and the serialist style (British sample only). This loading shows factors from each of the other orientations related to the achieving orientation. This could be construed as an indicator of Pask's versatility style but only where the individual shows a facility with both meaning and reproducing.

Biggs (1979) constructed a learning style inventory similar to Entwistle's. His Study Process Questionnaire was developed in Australia, without knowledge of Marton, Pask or Entwistle's work, to explore the learning processes that occur as a result of one's personal characteristics and perceptions of an academic task. It was initially designed to identify the cognitive and motivational components of learning processes. Using this questionnaire, Biggs identified three factors: internalizing, utilizing, and achieving. The "internalizing" factor combined the cognitive component of meaning assimilation and intrinsic motivation. The "utilizing" factor associated fact-rote learning with extrinsic motivation. The "achieving" factor connected study skills and organization with fear of failure and need for achievement. He later changed the labels of the categories to deep, shallow, and achieving, due to the similarity of the first two factors to Marton et al's work. Biggs' work, together with the studies in Sweden and Lancaster, served to reinforce both the construct of deep and surface approaches to learning and the importance of a student's intention in determining approach.

In summary, the factors identified in Biggs and Entwistle's learning style inventories have characterized persons' approaches to studying and intentions similarly. In each theory the first type of learning style (meaning/ internalizing) represents a deep-level processing, holistic approach. Students manifesting this kind of learning style search for personal understanding, and are internally motivated to learn. They seek to build an overall description of the content area. They reorganize incoming information to relate to previous knowledge or experience, with the purpose of establishing personal meaning.

The second category of learning style (reproducing/ utilizing) is characterized by a reliance on memorization. They perform tasks in a surface-level, serialist approach. They are externally motivated. They learn by memorizing or overlearning, maintaining a critical, objective stance, paying attention to the details and the steps of the argument. They achieve a surface level of understanding.

Students demonstrating the third learning style (achieving) fall into two groups. One group includes students who will do whatever is needed to get high grades. They have a high need for achievement, stress study skills and organization, and usually take a surface-approach to a task. They can achieve high grades without understanding. The other group of students manifesting an achieving learning style orientation can take a deep-level approach when that is what is rewarded (Entwistle, 1981). They learn in whatever way is perceived as appropriate according to the task demands and criteria for assessment. They can achieve high grades with or without understanding.

<u>Learning Strategies Inventories</u>. The inventories created by Biggs and Entwistle and colleagues have focused primarily on the relatively stable components of style and personality that affect learning.

Other inventories have been designed to measure students' learning strategies (Schmeck, 1983;

Weinstein, 1985, 1988) rather than learning styles. These scales have focused on the information processing components students use when learning rather than on the students' perceptions and motivations. If we think in terms of the learning style topology portrayed earlier (Marshall, 1987) we can see that Schmeck's (1983) Inventory of Learning Processes (ILP) and Weinstein's (1988) Learning and Studying Strategies Inventory (LASSI) straddle the two deepest levels.

Schmeck's ILP was designed to identify four scales: deep processing, elaborative processing, fact retention, and methodical study. Weinstein focused on the "behaviors or thoughts that facilitate encoding in such a way that knowledge integration and retrieval are enhanced" (p. 291). The LASSI was originally designed to diagnose and facilitate the design of remedial learning strategy instruction for college students. Schmeck's ILP emphasizes the cognitive processes and learning behavior characteristics of college students, rather than their perceptions and intentions. While concerned with approaches to learning, the real focus is on assimilating information rather than adapting information. For example, Schmeck defines "deep processing" as an information processing of verbal classifications and categorical comparisons. This conception does not include the resulting approaches to learning. Moreover, he has divided understanding and personalization of knowledge into separate, though related (r=.45), learning strategies, the former being classified as deep processing and the later as "elaborative processing." Entwistle and Biggs do not separate these components within the meaning category.

Elaborative processing is the extent to which a student personalizes the situation, translating new information into her/his own terminology. This scale has been correlated with writing performance and use of mental imagery (Schmeck, 1983). In comparison, the deep processing scale has been correlated with items like critical thinking ability and reading comprehension.

The other two scales included in Schmeck's ILP are methodical study and fact retention. Fact retention is similar to Pask's operation learning. A student who scores high on the fact retention scale tends to do well on tests of recall since they attend to details and specifics when processing new information. Students who report studying more often and carefully, employing classic "how to study" techniques score high on the methodical study scale.

This scale appears to be similar to Entwistle and Biggs achieving orientations.

Schmeck and his colleagues have conducted several validity studies as well as the factor analysis and intercorrelations of the four ILP scales. One study (Schmeck, Ribich, & Ramanaiah, 1977) compared students' responses on a 30 item test of knowledge and comprehension to their ILP scores. The students were tested after watching a videotaped lecture in an introductory psychology class. Students were not apprised of the post-test until after they had watched the tape, although the tape was viewed during a class period. Both deep processing and elaborative processing were significantly and positively correlated to performance on the test ($r=.42$ and $r=.51$ respectively), somewhat less with the comprehension questions than with the knowledge questions.

In a related study where students' recall of word lists was tested (Schmeck et al., 1977), deep processing and elaborative processing were again significantly correlated with performance ($r=.50$ and $r=.35$), especially in conditions where students were not specifically told to learn the lists. In the condition where students were told to learn the word lists, recall was related to methodical study, possibly because instructions elicited intense study behavior.

Schmeck & Ribich (1978) compared the scales of the ILP to other measures of individual differences. They found critical thinking ability was related positively to deep processing and negatively to methodical study. Both deep and elaborative processing related positively to curiosity, but only the elaborative scale was correlated with mental imagery ability. Both fact retention and deep processing were negatively correlated with anxiety. These findings served to further identify the four dimensions identified by the ILP. Other studies relating Schmeck's ILP to academic performance will be discussed in the next section.

Clearly Schmeck's learning strategy inventory and Entwistle's learning style inventory are related, although each was established from a different theoretical base. Entwistle and Waterson (cited in Entwistle, 1988) compared shortened versions of the two inventories and found correlations between them. Entwistle's deep approach was correlated with Schmeck's elaborative processing (.36), but Entwistle's strategic approach was not related to Schmeck's fact retention (.05). The surface approach negatively related to deep processing (-.39) and methodical study correlated negatively with disorganized study (-.49). A factor analysis linked the two inventories in expected ways.

The correlation between the scales affirmed the connection between learning styles and learning strategies. Indisputably the learning strategy that one chooses to employ when involved in an academic task is related to one's learning style orientation, and vice versa. Both learning style and learning strategy inventories give us some insight into the learning processes. However, each is limited by its lack of context. Research has shown us that context affects students' perceptions.

Learning Styles and Academic Context

While the research reported previously has concentrated on identifying the similarities among students' approaches to learning, other researchers have looked at the relationship of students' learning styles to academic achievement and self-concept, and at the boundaries of students' learning styles across some academic domains. Although seemingly paradoxical, students approaches to learning can be both consistent across situations and varying to meet the demands of the task. Students strive to adapt to context (Ramsden, 1988) and seek to maintain a self-perception of competence (McCombs, 1987). Specifically, many students, when not given explicit directions, will use the approach most consistent with their perceptions of the situation, but when instructed to use a specific approach (i.e., memorization or comprehension), will do so. This variation in approach can be viewed as the interaction of the student and the context. When the context is made explicit and the required approach is identified most students behave accordingly. When the context is open to students' perceptions and interpretation, and no specific approach is specified, students rely on the approach that has most consistently worked in similar past situations. Ramsden (1984) has identified three conceptual domains that influence students' perceptions and approaches to learning: teaching, assessment, and the curriculum (the content as well as the form and structure). These factors within the natural setting of academic departments may influence how students learn.

In order to investigate the influence of various academic domains, Ramsden (1984, 1988; Ramsden & Entwistle, 1981, 1983) administered the Course Perceptions Questionnaire along with the ASI to college students from various departments (detailed above - see footnote 1). Ramsden looked at the effect the academic departments had on students' perceptions and approaches to studying some university subjects. Using the students' overall perceptions of their college department (mean scores of these contextual variables) as the independent variable and students' ASI scores as the dependent variables, Ramsden compared the responses of arts and science students. He concluded that students' perceptions of the learning context was an integral part of the experience of learning. The students' responses, although reflecting Pask's style of learning (comprehension and operation), were stereotypical. Science courses were perceived to be hierarchical, logical, heterogeneous, and rule and procedure governed. Art and social science courses were perceived to be interpretative, comparative, more self-governed and easier. When these profiles were compared to the students' perceptions of teaching and assessment across the departments, definitions for deep and surface approaches to studying emerged.

The deep approach was strongly related to good teaching, positive attitude, and freedom in learning. The surface approach was related to heavy workload and lack of freedom in learning. There was no relationship identified for achievement motivation or organized study. Results also indicated that how students felt about the assessment situation affected their approach to learning. For example, some students exploited the opportunities offered by the assessment method, typifying the achieving or strategic approach.

Students' perceptions of the work load, teaching expertise, course requirements of the various departments, and methods of assessment may differentially influence students' approaches to learning. Their responses may suggest that students' perceptions influence their course selections, and the learning styles they employ within each academic area. However this relationship is reflexive since students' perceptions of the quality of their courses is functionally related to their attitudes toward studying and learning.

Laurillard (1984) found similar contextual influences when she conducted studies comparing students learning styles to their problem solving performance. Students were questioned individually after they had carried out problem-solving tasks for their microelectronics course. The students were asked about the way(s) they decided on their solutions, their strategic decisions, and the difficulties they encountered. What emerged was that students focused not on the task parameters but on the educational context. That is, they made strategic decisions and rated their final work based on how it would be evaluated, what the teacher required.

The predominant style of learning exhibited in the students' protocols matched the requirements of the tasks, as characterized by both the students' intentions and their approach to the tasks. The focus of the students' attention was the key to the students' approaches. When they were learning for meaning they used a deep approach, fully focused on the subject matter. When they were fulfilling the specified requirements they focused only on the elements of the tasks, using a surface approach. Holists preserved structure and related the meaning of each part to the whole, while solving the problems. Serialists distorted the structure, concentrating only on joining elements together until they derived a solution.

Laurillard also found that students' intentions changed students' approaches. Rather than being a stable characteristic across various situations, deep and surface approaches to learning described a relationship between the students' perceptions of the educational context and the approach used. Nineteen of the 31 students interviewed employed both deep and surface approaches. These findings clearly showed that students' perceptions of the academic context can influence how students learn within those domains.

While both Laurillard and Ramsden considered the important influence of context in different ways, both showed that the perceived conditions were associated with approaches to learning. Context constrained learning styles directly through the nature of the tasks themselves, and indirectly through the students' perceptions of the requirements of the tasks (Ramsden, 1988). Both these constraints needed to be considered when evaluating students' learning performance.

Similarly, Fransson (1977) showed that interest in the material being learned was related to deep approach, whereas lack of interest, or a failure to perceive relevance, was associated with a surface approach. In this study education and sociology majors were selected to represent high and low interest and were classified as high or low test anxious (based on 4 questions). The education majors were considered to be the high intrinsic motivation group since the material was a reading relating to education. The sociology majors had not taken any education courses. Fransson seemingly equated familiarity with the material with high intrinsic motivation.

The students were put into groups of three to five and randomly assigned to high or low extrinsic motivational conditions. Fransson's purported purpose was to create a learning condition where reasons for the learning effort had nothing to do with the content of the material. Students in the high extrinsic motivation condition were told, with a tape recorder prominently displayed, that one of them would have to report what she (the 81 subjects were all women) had "gathered" (sic) from the reading. Students in the low extrinsic motivation condition were simply told to write down what they recalled after reading. After the reading task <u>all</u> students wrote summaries of the most important information, completed a 15-item short-answer test of facts, and were interviewed.

Based on this information Fransson found both deep and surface processing and two levels of attention (high/low). Students high in attention who employed deep processing, tried to go beyond the information given. Students high in attention who employed surface processing, tried to form a general impression of the material. Students employing deep processing with low attention tried to press the text into their minds. Low attention, surface processors reported a lazy reading, hoping some information would slip into memory. The students in the high extrinsic motivation condition showed a greater tendency to choose the surface approach. However the high intrinsic motivation students did not necessarily choose the deep approach. Fransson hypothesized that this was partly due to test anxiety, the perceived threat of the condition evoking a surface approach. A second analysis based on students' responses to how they perceived the task and how interesting they found the task to be highlighted the relationship between interest and task demands. Lack of interest, high test anxiety, and efforts to adapt to the test demands all increased the students' proclivity towards the surface approach. Fransson concluded that testing was indeed related to approach and that if deep processing is valued, threatening conditions must be avoided.

In order to identify the learning styles associated with high academic performance in college, Miller, Alway & McKinley (1987) compared students' learning style scores with their grade point average

(GPA) and their American College Testing Program (ACT) scores. Students' learning style scores were measured by Schmeck's ILP. Several of the included scales were positively correlated: deep processing and fact retention (.56), deep processing and elaborative processing (.44), deep processing and the ACT (.45). The methodical study score had the lowest correlations: .24 with deep processing, and -.19 with the ACT. These correlations suggested links between the learning process and academic achievement. When students were grouped by their GPAs - high (3.0-4.0), average (2.0-2.99), low (below 2.0), an examination of their scores showed that students with a high GPA had higher deep processing and ACT scores than students with average or low GPAs. There were no significant differences for students with average and low GPAs on any of the five variables.

A stepwise multiple regression was used to examine the amount of variance in the students' GPA accounted for by learning style scores and ACT scores. Deep processing accounted for the most variance (14.4%), the ACT score added 3.7% and the methodical study added 3.1%. Deep processing and ACT scores were the variables that discriminated best among students with high, average, and low GPAs. These two scores together accounted for more of the variance of students' GPA (18.1%) than the ACT alone (11.56%). These comparisons serve to reinforce the findings previously reported. Specifically, students with higher grades reported more use of deep and elaborative processing, whereas students with average or below average grades indicated a tendency to reproduce information, focusing on facts and details more than meaning.

Gadzella, Ginther and Williamson (1986) used a section of Schmeck's ILP to investigate whether deep and shallow processors differed in self-concept. Self-concept was measured by the Tennessee Self-Concept Scale (TSCS) which contains eight subscores. A group of 143 college students volunteered to be included. These students were identified as deep processors or shallow processors based on their ILP deep processing scores. The students' TSCS subscores were then compared across groups. The results showed that the deep processors scored higher than the shallow processors on the following TSCS subscores: identity, self-satisfaction, behavior, moral self, personal self, social self, and total self-concept. There were no differences for the physical self or family self subscores. These findings seemed to indicate that a students' self-concept may be associated with how a student perceives and processes information.

One way to summarize all the findings of learning style variations reported in this section is to relate students' approaches to learning and studying to McCombs (1987) conceptualization of self-evaluation. Self-evaluation relates to a person's judgments, in both general and specific situations, of personal control and competence. Self-evaluation involves a student's understanding of: (1) the self and the task, (2) the learning outcome, (3) one's own and others' expectations, (4) the importance of the task, and (5) the cost or effort required. This framework facilitates the characterization of the research findings. The contextual variability discerned by Ramsden, Laurillard, and Fransson may be related to these five categories. Perceived teacher, assessment, or curricular demands may emphasize or diminish one category more than the others, thereby leading students to also emphasize or diminish the corresponding style or approach.

Mathematics Learning

Mathematics has always required attention to the processes used when solving mathematics problems, as Polya's (1957) problem solving principles illustrated. However, it is only within recent years that the processes have been defined within a cognitive and metacognitive framework (Garafalo & Lester, 1985). By addressing the psychological factors of mathematical behavior, the research has shifted its focus to the analyses of learning, for both the domain of mathematics and the processes of doing math (Romberg & Carpenter, 1986).

The research pertaining to math learning, that relates to students' learning styles, comes from three main areas. They are: (1) processes in math learning, (2) students' approaches to mathematics, and (3) gender differences in mathematical attitude.

<u>Processes in Math Learning</u>

Research in this area has focused on gaining insight into how students learn mathematical concepts and skills (Peterson, 1988). These studies attempted to identify the range of individual differences in the processes that students use when doing mathematics. They have tried to discern the strengths and weaknesses in how students process information.

Studies concentrating on the problem solvers' behaviors have contrasted the characteristic approaches of experts and novices problem solvers (Carpenter, 1985; Lesh, 1985; Silver, 1985). These studies have shown that there are qualitative as well as quantitative differences between the performance of expert and novice problem solvers.

For example, Carpenter & Moser (1983) reported that expert problem solvers take advantage of the structure in learning mathematics - novice problem solvers do not. Novices tend to store knowledge in isolated bits or on the basis of superficial characteristics that had no mathematical significance. This requires them to learn many more math rules and discrete pieces of information.

Expert problems solvers focused on the mathematical structure of the problems and ignored the superfluous information. They simplified the tasks of learning math by regarding a problem as a specific case of a general class of problems, with similar mathematical structure. Other researchers have reported similar findings (Chi, Glaser, & Rees, 1982; Silver, 1979).

These studies looked at students as information processors. Consequently, the kinds of task(s) being performed were important. Doyle (1983) defined task as a goal and a set of operations required to meet the goal.

Blumenfeld, Mergendoller, & Swarthout (1988) found that students generally focused on the tasks rather than the content goals when they thought about and worked at mathematics. The task influenced learners by directing their attention to particular aspects of content and by specifying ways of processing information. The task also influenced perceptions of success, motivation, interest, persistance, and the standards by which students conduct self-evaluations.

For example, Swing & Peterson (1988) compared the memory and understanding of fifth graders receiving different instructional worksheets. Two treatment groups and a control group were formed. One treatment group got "cognitive-processes" seatwork. These students got worksheets with "pre-questions" to help analyze, compare, and define problems before answering computational and conceptual questions. This treatment was hypothesized to promote integration, analysis and comparison, not just facts. The prediction was that the students in this treatment group would have higher post-test understanding scores. The second treatment group were given "fact worksheets" that paralleled the cognitive "pre-question" sheets. The control group worked the problems without any instructional lead.

Memory was assessed by the number of

computation, concept, and definition/formula questions answered correctly on a post-test (the STEP achievement test). Understanding was judged by the number of story problems and generalization questions answered correctly.

Although Swing & Peterson expected the cognitive-processes condition to gain higher understanding scores than the others, this was not the case. In fact only ability predicted achievement test scores. In addition, although not significant, the cognitive-processes condition was more related to memory scores than to understanding scores. Swing & Peterson originally defined the task in terms of the mathematical content - not the students' goals. Students' interview responses revealed that all students perceived the worksheets as tasks to be processed and remembered. In other words, the students approach to the task was a more important influence on their performance than the treatment the researchers thought students were being given. This finding fits with Doyle's (1983) definition of task.

Students' Approaches to Mathematics

This area of research includes studies that explored how students construct and interpret knowledge, and represent mathematics. Students' interpretations of a given task are influenced as much by internal representations as by external task variables (Lesh, 1985). The particular knowledge a person brings to a situation is a function of both the person's past experience and the problem context.

Beliefs about mathematics, held consciously or not, govern the approach one takes to a problem, the techniques one chooses or avoids, and the effort one expends (Schoenfeld, 1985, 1987). Schoenfeld acknowledged the importance of mathematical belief systems in establishing the context within which the solution attempt takes place.

Similarly, some developmental researchers have suggested that thinking abilities are not simply added on top of existing domain-specific competencies but that competencies in a domain, and the ability to think about that domain, develop hand in hand (Baroody, 1987; Bransford, Sherwood, Vye & Rieser, 1986; Davis, 1985). Evidence of this can be seen in studies like those of Cobb (1985) and Kaplan (1986). Students' beliefs about the nature of mathematics influenced the resulting approach(es) the students took.

Cobb's (1985) analysis of the mathematical development of two children illustrates the important role mathematical beliefs play. He examined the anticipations and expectations of the children over the first two years of school. Cobb found that the beliefs the children held defined their expectations and profoundly influenced their motivation. This, in turn, affected their selection and application of strategies.

One student believed that doing math involved constructing relationships between numbers and concepts, thereby actively searching for opportunities to use the known to solve the unknown. This child looked for connections between problems, related concepts rather than words when solving problems, and generally displayed a belief that there is an underlying structure to mathematics that is more important than the surface details.

The second child relied on fixed algorithms and previously-learned facts and sequences, seldom modifying them in the case of difficulty or inappropriate context. This child often focused on the superficial features of the problem. Similar tasks were solved independently and the criterion for completion was any answer the teacher would accept.

The students characterized in Cobb's study employed different approaches to learning. Their approaches could be viewed as representing different mathematical learning style orientations. One student focused on meaning, the other focused on reproducing facts and procedures.

Kaplan (1987) found similar evidence of these mathematical styles in young children. Videotapes of preschoolers engaged in solving math problems showed a clear distinction between types of task-oriented information processing. One group of children could mentally manipulate and recombine numbers without explicit instruction. They could make explicit in words or pictures how they were thinking about a problem, and could make connections between known problems and novel problems based on the structure of the new problem. These children persisted with challenging or difficult problems and took pleasure in spontaneously describing their solution strategies. They initiated action without direction, spontaneously reworked problems, tried alternatives when faced with errors, and exhibited focused concentration.

The other group of children remained at a fixed level of mathematical thinking, rigidly applying the same strategies to all kinds of problems. These children maintained multiple sets of math principles as discrete and unrelated units, and seemed unable to describe their solution processes. They gave up easily in the face of errors, frustration, difficulty or challenging problems. They took a surface approach to task solutions, and were satisfied with perfunctory answers. These children waited for instructions and judgments by others before completing or evaluating a task. They spent most of their energy avoiding tasks. Studies like Kaplan's and Cobb's further illustrate the impact students' beliefs, perceptions, and attitudes, have on students' mathematical problem solving.

Gender Differences

Researchers examining gender differences have compared the attitudes of females and males towards mathematics and what influences these attitudes. Many studies have been conducted to assess the affective variables of mathematical development. These studies have examined the relationship of girls' and boys' perceptions to math achievement, the importance of school and parental models, and the perceived relevance of math in future plans.

A national survey conducted by Armstrong (1982) asked 1788 high school seniors from 71 different schools a series of questions designed to identify the relative importance of the many factors that affect women's participation in mathematics. Armstrong concluded that the three most important factors contributing to both female and male participation in math were: a positive attitude towards math, the perceived usefulness of math for educational and career goals, and the positive influences of parents, teachers, counselors, and peers.

Similarly, Aiken (1972) investigated the variables related to students' attitudes towards math. By questioning graduate students, college freshman and eighth grade students he found that students linked math attitudes to success in math, school grades in general, and their perception of math teachers. In addition, students' attitude towards computation, symbols, word problems, and problems solving tasks were related to students' general attitude towards mathematics. An inverse relationship was established between interest in language arts, and other verbal subjects, and interest in math.

Sherman (1983) used the Fennema-Sherman Mathematical Attitudes Scale to measure changes from the eighth grade to the twelfth grade for females and males. She reported that both females and males rated confidence in learning math, vocabulary, attitudes toward success in math, effectance motivation in math, mathematical concepts, spatial visualization, and usefulness of math as important factors in deciding to continue to study math. This study also confirmed past findings that males were more confident, even if their measured performance was lower, and that they tend to overestimate their mathematical skills while females underestimate theirs.

Summary of the Literature

The literature reviewed in this chapter has focused on areas of research that explored the connections between students' perceptions, beliefs and attitudes, and their academic performance. One area of research has focused on identifying the learning styles that students manifest when involved in academic work. This literature has repeatedly classified different approaches to studying and learning. The creation of learning style inventories like Entwistle's allows students to report how they approach learning and studying. This can offer some insight into students' cognitive and metacognitive processes.

Entwistle's inventory is limited, however, by its lack of content-specific information. Shavelson's (Marsh, 1986) model has shown that students have varying self-concepts. They maintain a general self-concept, and an academic self-concept, but also a math self-concept and a verbal self-concept. If students reportedly see themselves differently, depending on the context, then perhaps their approaches to learning in different contexts may also differ. Laurillard (1979) and others have demonstrated the effects of content on students approaches to learning. Schoenfeld (1985) and others have identified the impact of students' belief systems on their mathematical problem solving performance. Sherman (1979) and others have reported the attitudinal factors students delineate.

The present study is a first step in linking some of the findings elucidated in the review of the literature. If students' learning style orientations differ from their general learning style orientations, in the same way as Shavelson's (Marsh, 1986) model of self-concepts, then a revised learning style inventory may better detect students' approaches to mathematics.

Specifically, this study asked students about both their general and mathematical learning style orientations. Comparing the responses of the students across the two inventories allowed for the detection of any differences between students' general approaches to learning and their approaches towards learning mathematics. Administering both inventories also allowed for a comparison of females' and males' responses.

The results of this study provide a way to assess students' mathematical learning style orientation. This may allow us to consider the factors that students focus on when solving math problems and the components of students' belief systems that influence the ways they learn math.

Definition of Terms

The following operational definitions were used:

Aptitude

Aptitude is defined as any characteristics of an individual that increases (or impairs) the probability of success in learning (Cronbach & Snow, 1977).

Belief Systems

One's perspective regarding the nature of a task within the context of both the person's experience and the problem context (Schoenfeld, 1985).

Cognitive Style

Cognitive styles are the stable individual differences in ways of organizing and processing information and experience (Messick, 1985).

Conscientiousness

Effort that is directed towards self-satisfaction.

Context

The environment created by the subject matter, the institutional practices, the assessment methods, and the skills and attitudes of the faculty.

Deep Approach

The intention to understand through vigorous interaction and the attempt to relate present information to previous knowledge.

Extrinsic Motivation

Behavior which is motivated by external reinforcements, rewards and/or praise.

Fear of Failure

Effort that is derived from anxiety about assessment.

Holist Style

The preference for learning by seeing the overview, using analogies and relating to experience.

Hope for Success

Effort based on competition and self-confidence.

Intrinsic Motivation

Intrinsic motivation is the self-motivated behavior which is impelled by the pleasure from mastery and/or the enjoyment of the learning process (Harter, 1982).

Instrumental Motivation

Effort directed from anxiety towards obtaining qualifications.

Learning

An internally mediated, active, generative and constructive process of attending, processing and transforming information into both relatively stable and dynamic knowledge structures (McCombs, 1987).

Learning Strategy

A sequence of procedures for accomplishing learning. A combination of cognitive skills implemented when a situation is perceived as one demanding learning (Schmeck, 1988).

Learning Style

An expression, in academic context, of more fundamental and relatively stable components of cognitive style and personality (Entwistle, 1981; Messick, 1985).

Learning Style Orientation

A style-like consistency in approach to a task which is predominantly the result of a person's perception of the situation, mediated by her or his motives (Entwistle, 1988).

Mathematical Ability

Mathematical Ability is that ability which is inferred from a person's performance on a math task (Kilpatrick, 1987).

Motivation

The process of initiating, sustaining, and directing activity (Wittrock, 1985).

Perception

Perception involves an act of classification in which a situation is matched to a pattern or prototype that evolved from past experience (Schmeck, 1988).

Personality

The integration of differentiated psychological subsystems as distinctly manifested in each individual (Messick, 1985).

Serialist Style

The preference for step-by-step, tightly structured learning, concentrating on details and logic.

Strategic Approach

The intention to obtain the highest possible grades by whatever means or learning process available.

Surface Approach

The intention to carry out the teachers' instructions without personal involvement by memorizing.

III. Statement of the Problem

The purpose of this study was to compare students' mathematical learning style orientations to their general learning style orientations. Additionally, both learning style orientations were compared to students' grade point averages, math grade point averages, and verbal and math SAT scores. If students' learning style orientations towards mathematics differ from their general learning style orientations, in the same way as Shavelson's (Marsh, 1986) model of self-concepts, than a revised learning style inventory may better detect students' approaches to mathematics.

Specifically, this study investigated both the general and the mathematical learning style orientations of high school students. Comparing the responses of the students across the two inventories illustrated the differences between students' general approaches to learning and their approaches towards learning mathematics. Administering both inventories also allowed for between school comparisons, and for a comparison of female and male response differences.

Hypotheses

Several hypotheses were tested in this study. It was expected that:

1. Students' would report learning style orientations that were similar to those of other populations.

This was determined by comparing the factors formed by the responses of the NYC group to the factors of the British and Hungarian populations (Entwistle & Kozeki, 1985) on the "Approaches to Studying Inventory" (ASI). This hypothesis was based on the prior research which documents similar response patterns on the ASI for British, Hungarian, and Venezuelan populations.

2. Students' responses on the Approaches to Studying Mathematics Inventory (ASMI) would form factor clusters similar to those identified by the Approaches to Studying Inventory.

This hypothesis was based on prior research which showed that even when context and outcome did influence individuals' responses, the patterns of the responses were still within the dimensions of the learning style orientations.

3. Females and males would report different mathematical learning style orientations, determined by a comparison of the mean scores on the meaning, achieving, and reproducing orientation subscores of the ASMI and the ASI for females and males.

This hypothesis was based on the research which documents differences in how females tend, on the average, to perceive themselves as math learners.

4. Students from the different schools would report different mathematical learning style orientations, determined by a comparison of the mean scores, by school, on the meaning, achieving, and reproducing orientation subscores of the ASMI and the ASI.

This hypothesis was based on the research which documents the relationship between students' course of study and their self-perceptions.

5. Students' overall grade point average (GPA), math grade point average (MGPA), verbal Scholastic Aptitude Test score (VSAT) and math Scholastic Aptitude Test score (MSAT) would be predicted by the learning style orientation constructs included in the ASI and ASMI.

Specifically:

(1) GPA would be directly related to the reproducing orientation subscore on the ASI,

(2) MGPA would be directly related to the reproducing orientation subscore on the ASMI,

(3) VSAT would be predicted by a combination of meaning orientation and achieving orientation subscores on the ASI,

(4) MSAT would be predicted by a combination of meaning orientation and achieving orientation subscores on the ASMI.

Hypotheses 5(1), 5(2), 5(3), and 5(4) were tested using a series of regression equations which used the subscores of the ASI and ASMI to predict the students' GPA, MGPA, VSAT, AND MSAT. These hypotheses were based on research which has demonstrated that students' mathematical belief systems affect their perceptions of, and performance in mathematics.

IV. Methods

Subjects

A total of 420 high school seniors participated in this study; 210 females and 210 males. Table 1 shows the percentage of students participating in the study, by school. The percentage of students with SAT scores, with math Achievement Test scores, and who have received SAT coaching are also included in Table 1. The students' mean GPAs, SAT scores, and math Achievement Test scores are given in Table 2.

The students in this study were recruited from one parochial and four public high schools in the New York City area. Three of the public schools were specialized New York City high schools. Students at two of these schools are admitted based on academic excellence. Students at the other specialized high school are admitted based on their performing arts talents.

The fourth public school was a middle-income suburban New York City public school, similar in composition and location to the participating parochial school. Neither of these schools set criterion for admissions. Consequently, these schools provided a student population that was different from the other three high schools.

Table 1

Subject data by school. Percentages of school population included in the study and the corresponding percentages for SAT, Math Achievement Test, and SAT preparation courses.

	No. of Students Participating (F)	(M)	% of Entire Senior Class	% of Sr. Class who take SATs	% of Subjects with SAT Scores	% of Subjects with Math Ach Test Scores I	II	% of Subjects who took SAT Prep Course
School 1	41	37	16%	90%	96%	9%	4%	36%
School 2	71	58	28%	74%	86%	0%	0%	14%
School 3	27	39	9%	100%	96%	69%	27%	21%
School 4	40	45	13%	72%	91%	18%	3%	53%
School 5	31	31	31%	100%	97%	60%	37%	40%

Table 2
Mean SAT and College Board Mathematics Achievement Test (Levels I and II) scores, and grade point averages for students included in the study.

	Mean SAT of Entire Senior Class	Mean SAT of Subjects (V)	Mean SAT of Subjects (M)	Mean GPAs of Subject (Gen)	Mean GPAs of Subject (Math)	Mean No. of Math Courses Taken	Mean Math Ach. Test I	Mean Math Ach. Test II
School 1	900	431	476	83	71	3	601	637
School 2	800	397	418	86	80	3	-	-
School 3	1250	601	682	91	88	5	659	760
School 4	910	446	513	81	75	4	566	606
School 5	1200	683	694	90	86	4	646	725

This student population was not intended to be representative of the entire New York City high school population, rather it was selected to provide a broad range of schooling experiences. As demonstrated in Table 1 and Table 2, the students from the participating schools varied in the number of mathematics courses taken, SAT scores, and Math Achievement Test experience. Further, students from the participating schools had different college expectations.

For example, the students in School 3 had above average math SAT and Math Achievement Test scores, and had taken an average of five mathematics courses during their high school tenure. Many of these students will attend highly competitive colleges, electing math related majors. In contrast, the students from School 1 mostly preferred humanities courses, and had verbal SAT scores that were higher than their math SAT scores. These students are training for careers in the performing arts. Finally, many of the students from Schools 2 and 4 had average or below average SAT scores, and were undecided about college plans. About half of these students will attend local colleges.

Instrument

Students were presented with several scales in a single booklet labeled the "School and School Work questionnaire. This questionnaire contained four sections: the Approach to Studying Inventory (ASI); the Approach to Studying Mathematics Inventory (ASMI); questions pertaining to students' views of the SAT; and questions concerning students' school grades and courses taken (see Appendix A).

One section (either section 1 or section 2 depending on the counterbalancing) contained the ASI (see Appendix A, Section 1). This section included 60 items, each presented in a 5-response Likert scale. The five possible answer choices were: strongly agree, agree, not sure/don't know/can't answer, disagree, and strongly disagree. These choices were rated from 4 for strongly agree to 0 for strongly disagree.

Commensurate with the previous research that used the ASI (Entwistle & Kozeki, 1985), groups of six items were combined to form ten variables: Deep Approach, Holist Style, Intrinsic Motivation, Surface Approach, Serialist Style, Fear of Failure, Instrumental Motivation, Strategic Approach, Hope for Success, and Conscientiousness (see Appendix B for the items that were combined to form each variable).

The highest possible score for each variable was 24 and the lowest was 0.

The ten variables from the ASI subsequently formed the three general Learning Style Orientations: Meaning Orientation, Reproducing Orientation, Achieving Orientation. The highest possible score for the Meaning Orientation was 72. The highest possible score for the Reproducing Orientation was 96. The highest possible score for the Achieving Orientation was 72. The lowest for all LSOs was 0.

The form of the ASI[2] used was one from a prior study (Entwistle & Kozeki, 1985) which was administered to 614 British students and to 579 Hungarian high school pupils. The Cronbach alpha measure of internal consistency for the test scores in that study ranged from .45 to .79, with a median value of .59. Entwistle & Kozeki, using a test-retest format over a three week interval, reported a reliability of .63 to .77, with median value of .73.

Another section of the questionnaire contained the Approaches to Studying Mathematics Inventory (ASMI) (see Appendix A, Section 2). The ASMI, developed by rewriting the items from the ASI, asked students specifically about their approaches to learning mathematics. For example, whereas the ASI

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[2]Adapted with permission of N. Entwistle.

item said "I find some subjects so interesting that I would like to go on with them after I leave school," the ASMI said "I find math so interesting that I would like to go on with it after I leave school."

A pilot study, using an earlier version of the ASI, was conducted to test the modified items. Correlations between the general and math items ranged from .15 to .64. A split-half reliability test for the two inventories provided a reliability estimate of .74.

The final sixty ASMI items were presented in a 5-response Likert scale, with the same five options as the ASI (strongly agree to strongly disagree). The ASMI incorporated the same ten scales as the ASI. These ten variables are: Math Deep Approach, Math Holist Style, Math Intrinsic Motivation, Math Surface Approach, Math Serialist Style, Math Fear of Failure, Math Instrumental Motivation, Math Strategic Approach, Math Hope for Success, and Math Conscientiousness (see Appendix B for the items included in each variable). The highest possible score for each variable was 24 and the lowest was 0.

These ten variables subsequently formed the three Math Learning Style Orientations: Math Meaning Orientation, Math Reproducing Orientation, and Math Achieving Orientation. The highest possible score for the Math Meaning Orientation was 72. The highest possible score for the Math Reproducing Orientation was 96. The highest possible score for the Math Achieving Orientation was 72. The lowest for all LSOs was 0.

The questions in the third section asked students about their approach(es) to the SAT (see Appendix A, Section 3). The purpose of these ten questions was to elicit students' perceptions of the SAT and the factors that influenced their test performance. For example, one of the items said "To get a high score on the math SAT I need to know a lot of mathematical formulas." The ten items were presented in the same 5-response Likert scale as sections one and two. These exploratory items were included to provide some additional student information, if needed.

The fourth section asked students to report their overall high school grade point average, the mathematics courses they had completed, and what final grade they earned in each course. The final questions asked for the students' PSAT and SAT math and verbal scores, on the Mathematics Achievement Tests (Levels 1 and/or 2) if any, and if they participated in any test preparation programs for the SAT (see Appendix A, Section 4).

Procedure

In order to include a broad sample of students for this study, several public, private, and parochial school administrators (principals and/or assistant principals) were contacted. Some of these school personnel gave their approval and arranged meetings with teachers. The teachers agreed to solicit students to participate in the study. The teachers arranged for consenting students to complete the School and Schoolwork questionnaire during a class period.

Students were told that their cooperation was being requested for a study concerning how students learn and study. The students were informed that participation was voluntary and that all answers were confidential. Students not completing the questionnaire were either excused from class or allowed to work independently.

During one class period, the participating students completed the School and Schoolwork questionnaire. This inventory contained the four sections detailed earlier. They were: (1) the Approaches to Studying Inventory (ASI) (Entwistle & Kozeki, 1985), (2) the Approaches to Studying Mathematics Inventory (ASMI), (3) a questionnaire which asks students about their perceptions of the

SAT, and (4) a grader/score information questionnaire.

The presentation of the inventories were balanced, half of the students completed the ASI first and then the ASMI, and the other half completed the ASMI first and then the ASI, to control for order effects.

Forty-six students from School 2 participated in a second session, held three weeks after the first. These students were asked to repeat the procedure of the first session. The retesting of these students allowed for a measure of the reliability of the students' responses over time.

The accuracy of the students' self-reported SAT scores was also checked at School 2. Of the 101 students reporting SAT scores, 8 of the students (8%) reported inaccurate scores. These students reported scores slightly higher than their actual ones (an average of 36 points on the combined score).

All students were thoroughly debriefed after completing the questionnaire. The purpose and goals of this research were explained to all students.

V. Results

This chapter is divided into four parts. They are: (1) analysis of students' responses, (2) group comparisons, (3) predictive measures, and (4) summary of the results.

Part One, Analysis of Students' Responses, consists of a summary of the students' responses for both inventories and the factorial relationship of these responses. This includes the mean and standard deviation for the 20 variables in the Approaches to Studying Inventory (ASI) and the Approaches to Studying Mathematics Inventory (ASMI), and a description of the factor analyses performed. Also included in this section are the inter-item correlations, and the reliability data. This part of the results chapter addresses hypotheses 1 and 2.

Part Two, Group Comparisons, reports the variations in the ASI and ASMI, for females and males, across the five schools included in the study. Specifically, the results of the repeated measure Analysis of Variance are described. Hypotheses 3 and 4 are addressed in this part of the chapter.

Part Three, Predictive Measures, describes the results of the regression analyses. Specifically, this section identifies the variables that predicted

GPA, math GPA, verbal SAT scores, and math SAT scores. This part of the results section deals with hypothesis 5.

The last part, Summary of the Findings, recapitulates the major findings from the first three sections. The relationship among the findings are also discussed.

Analysis of Students' Responses

Means and Standard Deviations

The mean scores and standard deviations for the 10 variables included in the ASI and the 10 variables included in the ASMI are given in Tables 3 and 4.

Table 3 shows the means and standard deviations for all students at each of the five school. The means for the ASI variables ranged from 5.96 to 18.35 with an overall mean of 13.54. The standard deviations for the ASI variables ranged from 2.70 to 4.92. The means for the ASMI variables ranged from 7.96 to 15.51 with an overall mean of 12.21. The standard deviations for the ASMI variables ranged from 2.91 to 5.44.

Table 4 gives the means and standard deviations for the females and males in each of the five schools. The means for the ASI variables ranged from 8.38 to 19.22 with an overall mean of 13.54. The standard deviations for the ASI variables ranged from 2.21 to 5.69. The means for the ASMI variables ranged from 6.96 to 15.62 with an overall mean of 12.21. The standard deviations for the ASMI variables ranged from 2.21 to 5.85. The mean differences for gender and school will be discussed in part 3.

Table 3

Means (M) and standard deviations (SD), by school, for the 10 variables included in the Approaches to Studying Inventory (ASI) and the 10 variables included in the Approaches to Studying Mathematics Inventory (ASMI)

		School					
		1	2	3	4	5	All
Approaches to Studying Inventory							
Deep Approach	M	16.93	15.17	16.63	16.02	18.35	16.37
	SD	(3.48)	(3.46)	(3.78)	(3.69)	(2.96)	
Holist Style	M	18.32	16.37	17.54	17.00	18.33	17.33
	SD	(2.74)	(2.96)	(2.96)	(3.58)	(2.70)	
Intrinsic Motivation	M	14.57	13.72	15.75	13.98	18.06	14.89
	SD	(4.23)	(4.38)	(4.45)	(4.67)	(4.40)	
Surface Approach	M	11.23	12.20	10.45	12.28	8.64	11.23
	SD	(3.74)	(3.64)	(3.39)	(3.56)	(3.19)	
Serialist Style	M	14.08	14.58	13.72	15.28	11.33	14.01
	SD	(3.13)	(3.25)	(3.21)	(4.42)	(3.01)	
Fear of Failure	M	10.43	11.51	9.04	12.30	5.96	10.26
	SD	(3.73)	(3.88)	(3.90)	(3.54)	(3.27)	
Instrumental Motivation	M	12.11	11.83	11.62	12.03	9.74	11.58
	SD	(4.70)	(4.57)	(4.92)	(4.68)	(4.64)	
Strategic Approach	M	12.78	13.35	11.48	13.35	11.54	12.68
	SD	(3.91)	(3.63)	(3.96)	(4.23)	(4.40)	
Hope for Success	M	12.60	13.59	12.72	13.22	11.62	12.90
	SD	(3.69)	(3.85)	(3.76)	(3.77)	(4.13)	
Conscientiousness	M	14.15	14.99	14.15	14.34	12.40	14.19
	SD	(4.71)	(3.68)	(4.29)	(4.21)	(4.79)	
Approaches to Studying Mathematics Inventory							
Math Deep Approach	M	12.69	13.41	15.09	13.45	14.48	13.71
	SD	(3.99)	(3.53)	(3.69)	(4.00)	(3.91)	
Math Holist Style	M	12.12	13.03	13.77	13.09	12.91	12.97
	SD	(3.49)	(3.51)	(3.61)	(4.40)	(4.23)	
Math Intrinsic Motivation	M	8.57	9.56	11.87	9.20	8.90	9.57
	SD	(5.33)	(4.47)	(4.87)	(5.27)	(5.36)	
Math Surface Approach	M	14.42	13.13	11.54	13.56	11.95	13.03
	SD	(4.12)	(3.17)	(3.49)	(3.98)	(4.28)	
Math Serialist Style	M	15.51	15.14	14.13	14.87	12.98	14.68
	SD	(3.24)	(2.91)	(3.24)	(3.77)	(3.56)	
Math Fear of Failure	M	11.35	11.14	7.96	11.23	8.85	10.36
	SD	(4.05)	(3.96)	(4.45)	(3.54)	(4.53)	
Math Instrumental Motivation	M	12.41	11.80	10.80	12.10	10.08	11.56
	SD	(4.79)	(4.98)	(5.02)	(4.70)	(5.44)	
Math Strategic Approach	M	12.52	13.31	12.71	12.44	10.85	12.53
	SD	(5.44)	(3.68)	(3.80)	(4.04)	(3.32)	
Math Hope for Success	M	10.39	12.16	11.74	10.91	9.01	11.05
	SD	(4.65)	(3.65)	(3.93)	(4.08)	(4.22)	
Math Conscientiousness	M	12.20	13.55	13.57	12.54	10.20	12.60
	SD	(5.38)	(4.17)	(4.93)	(4.60)	(4.46)	
Number of Students		77	129	66	85	62	420

Table 4

Means (M) and Standard Deviations (SD), by school and gender, for the 10 variables included in the ASI and the 10 variables in the ASMI.

		School 1		School 2		School 3		School 4		School 5	
		Female	Male	Female	Male	Female	Male	Female	Male	Female	Male
Approaches to Studying Inventory											
Deep Approach	M	16.85	17.02	15.77	14.44	18.66	15.23	16.62	15.48	19.22	17.48
	SD	(3.71)	(3.27)	(3.06)	(3.78)	(2.44)	(3.93)	(3.28)	(3.98)	(2.91)	(2.79)
Holist Style	M	18.09	18.56	16.61	16.06	18.25	17.05	17.67	16.40	18.12	18.54
	SD	(2.70)	(2.81)	(2.78)	(3.16)	(2.91)	(2.93)	(2.79)	(4.09)	(2.21)	(3.15)
Intrinsic Motivation	M	14.48	14.67	14.54	12.70	16.62	15.15	14.22	13.77	18.96	17.16
	SD	(4.28)	(4.22)	(4.40)	(4.17)	(3.10)	(5.14)	(4.39)	(4.95)	(3.37)	(5.13)
Surface Approach	M	11.07	11.40	11.53	13.01	9.70	10.97	12.10	12.44	8.38	8.90
	SD	(3.54)	(3.98)	(3.42)	(3.77)	(3.14)	(3.49)	(3.32)	(3.79)	(2.99)	(3.40)
Serialist Style	M	14.82	13.27	14.61	14.53	14.37	13.28	16.47	14.22	12.12	10.54
	SD	(3.14)	(2.94)	(3.02)	(3.54)	(3.21)	(3.18)	(5.17)	(3.33)	(2.88)	(2.97)
Fear of Failure	M	11.00	9.81	10.88	12.27	8.14	9.66	12.47	12.15	5.61	6.32
	SD	(3.66)	(3.76)	(3.80)	(3.88)	(4.23)	(3.58)	(3.63)	(3.49)	(2.89)	(3.63)
Instrumental Motivation	M	13.07	11.05	12.40	11.13	12.14	11.25	12.60	11.53	10.35	9.12
	SD	(4.51)	(4.73)	(4.43)	(4.68)	(5.69)	(4.35)	(4.47)	(4.85)	(4.47)	(4.79)
Strategic Approach	M	13.88	11.64	13.95	12.62	12.88	10.51	14.65	12.20	13.12	9.96
	SD	(3.37)	(4.19)	(3.29)	(3.90)	(4.22)	(3.50)	(4.13)	(4.02)	(4.38)	(3.86)
Hope for Success	M	13.04	12.10	12.91	14.43	11.55	13.53	12.52	13.84	12.06	11.19
	SD	(4.16)	(3.88)	(3.58)	(4.03)	(4.03)	(3.37)	(3.50)	(3.93)	(4.15)	(4.13)
Conscientiousness	M	15.24	12.94	16.15	13.56	15.70	13.07	15.72	13.11	13.51	11.29
	SD	(4.56)	(4.64)	(3.60)	(3.27)	(4.28)	(4.00)	(3.58)	(4.38)	(4:47)	(4.92)
Approaches to Studying Mathematics Inventory											
Math Deep Approach	M	13.68	11.59	13.74	13.01	15.11	15.07	13.60	13.33	14.58	14.38
	SD	(3.72)	(4.04)	(3.40)	(3.68)	(3.33)	(3.96)	(4.16)	(3.89)	(3.64)	(4.23)
Math Holist Style	M	11.53	12.78	13.11	12.93	12.70	14.51	12.47	13.64	11.51	14.32
	SD	(3.42)	(3.50)	(3.47)	(3.59)	(3.66)	(3.42)	(4.39)	(4.39)	(3.66)	(4.34)
Math Intrinsic Motivation	M	8.78	8.35	9.63	9.48	11.77	11.94	8.07	10.20	6.96	10.83
	SD	(5.14)	(5.59)	(4.83)	(4.04)	(4.58)	(5.11)	(5.67)	(4.74)	(4.58)	(5.45)
Math Surface Approach	M	14.36	14.48	12.98	13.32	11.88	11.30	14.05	13.13	12.83	11.06
	SD	(4.64)	(3.51)	(3.51)	(2.71)	(2.96)	(3.83)	(3.77)	(4.14)	(3.46)	(4.87)
Math Serialist Style	M	16.00	14.97	15.11	15.18	14.74	13.71	15.62	14.20	13.70	12.25
	SD	(3.34)	(3.08)	(2.91)	(2.94)	(3.38)	(3.11)	(3.53)	(3.89)	(3.43)	(3.59)
Math Fear of Failure	M	11.51	11.18	10.63	11.77	7.37	8.38	11.50	11.00	9.77	7.93
	SD	(4.62)	(3.36)	(3.98)	(3.88)	(4.53)	(4.41)	(3.82)	(3.30)	(4.76)	(4.17)
Math Instrumental Motivation	M	13.12	11.62	12.23	11.27	12.77	9.43	13.27	11.06	11.22	8.93
	SD	(5.14)	(4.29)	(4.80)	(5.19)	(5.85)	(3.87)	(4.45)	(4.72)	(5.76)	(4.92)
Math Strategic Approach	M	13.75	11.16	14.11	12.34	13.44	12.20	12.87	12.06	11.41	10.29
	SD	(6.31)	(3.91)	(3.28)	(3.93)	(3.86)	(3.73)	(4.42)	(3.67)	(3.25)	(3.34)
Math Hope for Success	M	11.09	9.62	11.59	12.86	10.40	12.66	9.57	12.11	8.74	9.29
	SD	(5.12)	(4.00)	(3.44)	(3.79)	(3.55)	(3.96)	(3.81)	(3.97)	(4.29)	(4.21)
Math Conscientiousness	M	13.43	10.83	14.61	12.25	14.70	12.79	12.50	12.57	9.90	10.51
	SD	(5.83)	(4.53)	(3.99)	(4.04)	(4.39)	(5.18)	(4.00)	(4.46)	(4.57)	(4.39)
Number of Students		41	37	71	58	27	39	40	45	31	31

The means and standard deviations for the three general LSOs and the three math LSOs, for all students and for the females and males in the five schools, are presented in Tables 5 and 6. The highest possible score for the Meaning and Math Meaning LSO was 72. The highest possible score for the Reproducing and Math Reproducing LSO was 96. The highest possible score for the Achieving and Math Achieving LSO was 72. The lowest for all LSOs was 0.

The general LSO means ranged from 32.45 to 56.32 (Table 5), and from 35.58 to 54.75 (Table 6). The standard deviations ranged from 6.76 to 12.11 (Table 5), and from 8.31 to 10.35 (Table 6). The Math LSO means ranged from 32.72 to 41.53 (Table 5) and from 30.06 to 53.55 (Table 6). The standard deviations ranged from 9.04 to 12.48 (Table 5) and from 8.92 to 13.82 (Table 6).

Inter-Item Correlations

In order to assess the correlations between the two inventories, an inter-item correlation was performed. The comparison of the items from the original inventory, the ASI, and the math inventory, the ASMI, is presented in Table 7. A one-tailed product moment correlation revealed that seventy-five percent of the items were correlated. Most of

Table 5

Means (M) and standard deviations (SD), by school and gender, for the three variables derived from the ASI and the three variables derived from the ASMI.

		School 1		School 2		School 3		School 4		School 5	
		Female	Male	Female	Male	Female	Male	Female	Male	Female	Male
Approaches to Studying Inventory											
Meaning LSO	M	49.43	50.27	46.94	43.22	53.55	47.43	48.52	45.66	56.32	53.19
	SD	(8.64)	(8.26)	(8.81)	(9.01)	(6.76)	(10.25)	(8.83)	(11.64)	(7.10)	(9.22)
Reproducing LSO	M	49.97	45.54	49.45	50.96	44.37	45.17	53.65	50.35	36.48	34.90
	SD	(10.15)	(9.22)	(10.09)	(10.78)	(12.11)	(11.32)	(10.05)	(11.24)	(8.89)	(10.76)
Achieving LSO	M	42.09	36.70	43.02	40.62	40.14	37.12	42.90	39.15	38.70	32.45
	SD	(9.31)	(8.92)	(7.96)	(7.72)	(8.59)	(8.31)	(8.45)	(9.69)	(10.73)	(10.09)
Approaches to Studying Mathematics Inventory											
Math Meaning LSO	M	34.00	32.72	36.49	35.43	39.59	41.53	34.15	37.17	33.06	39.54
	SD	(10.19)	(10.79)	(9.69)	(9.04)	(9.35)	(10.90)	(12.16)	(11.40)	(10.23)	(12.48)
Math Reproducing LSO	M	55.00	52.27	50.97	51.56	46.77	42.84	54.45	49.40	47.54	40.19
	SD	(14.38)	(9.24)	(11.42)	(9.56)	(11.95)	(11.81)	(10.39)	(12.35)	(14.03)	(12.80)
Math Achieving LSO	M	38.29	31.62	40.32	37.46	38.55	37.66	34.95	36.75	30.06	30.09
	SD	(14.43)	(11.14)	(8.79)	(9.05)	(8.26)	(11.09)	(10.94)	(10.55)	(9.57)	(9.35)
No. of Students		78		129		66		85		62	

Table 6
Means (M) and standard deviations (SD) of the five schools for the three general Learning Style Orientations (LSO) variables and the three math LSO variables.

		School					
		1	2	3	4	5	All
Approaches to Studying Inventory							
Meaning LSO	M	49.93	45.27	49.93	47.01	54.75	48.62
	SD	(8.42)	(9.06)	(9.43)	(10.45)	(8.31)	
Reproducing LSO	M	47.70	50.13	44.84	51.90	35.69	47.07
	SD	(9.86)	(10.39)	(11.56)	(10.76)	(9.82)	
Achieving LSO	M	39.68	41.94	38.36	40.91	35.58	39.81
	SD	(9.43)	(7.92)	(8.49)	(9.27)	(10.80)	
Approaches to Studying Mathematics Inventory							
Math Meaning LSO	M	33.48	36.01	40.74	35.75	36.30	36.28
	SD	(10.47)	(9.38)	(10.26)	(11.79)	(11.78)	
Math Reproducing LSO	M	53.55	51.24	44.45	51.77	43.87	49.61
	SD	(12.22)	(10.59)	(11.93)	(11.68)	(13.82)	
Math Achieving LSO	M	35.23	39.00	38.03	35.87	30.06	36.20
	SD	(13.39)	(8.92)	(9.97)	(10.71)	(9.40)	
No. of Students		78	129	66	85	62	420

Table 7
Correlation between the parallel items on the ASI and the ASMI.

ASI Items	ASMI Items	Correlation	ASI Items	ASMI Items	Correlation
1	1	.05	31	31	.18
2	2	-.28	32	32	.16
3	3	-.15	33	33	.04
4	4	-.14	34	34	.26
5	5	.29	35	35	.30
6	6	.22	36	36	.41
7	7	.30	37	37	.32
8	8	.31	38	38	.26
9	9	.27	39	39	-.05
10	10	.17	40	40	.26
11	11	.24	41	41	.31
12	12	.00	42	42	.19
13	13	.15	43	43	.10
14	14	.06	44	44	.34
15	15	.19	45	45	.28
16	16	.30	46	46	.11
17	17	.28	47	47	.26
18	18	.08	48	48	.31
19	19	.28	49	49	.37
20	20	.32	50	50	.36
21	21	.01	51	51	.03
22	22	-.03	52	52	.06
23	23	.27	53	53	-.01
24	24	.11	54	54	-.00
25	25	.25	55	55	.17
26	26	.19	56	56	.29
27	27	.25	57	57	.32
28	28	.31	58	58	.25
29	29	.33	59	59	.24
30	30	.26	60	60	.31

Note. $r = .14$ significant at the $p < .05$ level.
$r = .15$ significant at the $p < .01$ level.
$r > .16$ significant at the $p < .001$ level.
$N = 420$.

these items were positively correlated at the $p < .001$ level of significance. Only three of the items were negatively correlated (items 2, 3, and 4). Fifteen of the items were not significantly correlated ($p > .05$). The correlations ranged from -.28 to .41.

These correlations indicate some parallelism between the items on the original and the math scales. For example, items 1-50 and 2-50 (see Appendix A) were positively correlated ($r = .36$, $p < .001$). Item 1-50 says "I take my work seriously, no matter what." Item 2-50 says "I take my math work seriously, no matter what." These items are closely related regardless of whether or not content is specified.

On the other hand, items 1-2 and 2-2 (see Appendix A) were negatively correlated ($r = -.28$, $p < .001$). Item 1-2 says "When I'm reading, the ideas sometimes provide vivid images in my mind." Item 2-2 says "When I'm doing math, the ideas sometimes provide vivid images in my mind." These items are parallel in phrasing. However, the negative correlation suggests, understandably, that items 1-2 and 2-2 have diverse meanings for students across the two inventories.

The correlation matrices for the ASI (Section 1), the ASMI (Section 2), Sections 3 and 4 are displayed in Appendix C. These matrices show the correlations within each of the two inventories and for the other parts of the School and Schoolwork questionnaire.

Test-Retest Reliability

Forty-six of the students from School 2 were asked to complete the inventory a second time. The second session took place three weeks after the first one. The participating students received the alternate version of the questionnaire from the one taken in the regular administration (i.e., either ASI or ASMI first).

The test-retest reliability measure for the 46 students who completed the questionnaire denoted a high probability of reliability. The reliability coefficient was .89.

Factor Analyses

General Learning Style Orientations. In order to examine the relationship of the current student responses for the ASI to other populations, a factor analysis was done using the LSO sub-scale scores of the ASI. Hypothesis 1 tested whether the students in the current study would report LSOs similar to those in other populations. The hypothesis was tested by examining the comparability of the factor structure of the variables.

The factor analysis utilized a principal axes analysis with an oblique rotation to extract the factors. Table 8 contains the correlations of the variables with the factors (the structure matrix). The factors were nearly uncorrelated. The procedure identified three factors with eigenvalues greater than 1. These factors were similar to the ones identified by Entwistle and Kozeki (1985).

For the present population, Factor I clustered the three variables from Entwistle's Achieving Orientation with Deep Approach, Intrinsic Motivation, and Serialist Style. As seen in Table 8, both Deep Approach and Intrinsic Motivation correlated with Factor I for all of the student populations. In fact the variables included in Factor I for the present populations' responses are exactly the same as those of the British sample. Only the magnitude of loadings were different. While Hope for Success and the Strategic Approach had the highest loadings within the British sample, the highest loadings for the New York City sample were the Strategic Approach and Conscientiousness.

Factor II grouped the four variables included in Entwistle's Reproducing Orientation. These variables

Table 8

Factor Analysis for the Approaches to Studying Inventory for all populations being compared

	British Schools[a]			Hungarian Schools[b]			N.Y.C. Schools[c]		
Sub-scales/Factors	I	II	III	I	II	III	I	II	III
Meaning Orientation									
Deep Approach	53		75	54		87	32		81
Holist Style			62			57			74
Intrinsic Motivation	53		61	53		62	35		73
Reproducing Orientation									
Surface Approach		71			81			58	-41
Serialist Style	47	46			55		43	50	
Fear of Failure		61			58			81	
Instrumental Motivation		45			62			50	
Achieving Orientation									
Strategic Approach	71		34	70		36	77		
Conscientiousness	35		32		30		74		41
Hope for Success	85		43	88		38	30	32	

Note. Decimal points and correlations below .30 omitted.

[a] N = 614. Percentage of variance extracted = 60.2.

[b] N = 579. Percentage of variance extracted = 63.7.

[c] N = 420. Percentage of variance extracted = 49.9.

were: Surface Approach, Serialist Style, Fear of Failure, and Instrumental Motivation. Hope for Success was the other variable that loaded positively within this factor for the New York City schools. This factor pattern is also closely related to both the British and the Hungarian population; only Hope for Success loaded differently.

Four variables loaded positively and one variable loaded negatively for Factor III for the New York City sample. The first three variables, Deep Approach, Holist Style, and Intrinsic Motivation, comprise Entwistle's Meaning Orientation. Conscientiousness was the fourth variable that loaded positively for this factor. Surface Approach loaded negatively. This loading is also similar to the British and Hungarian factor analyses.

In comparison to the other populations reported in Table 8, the present analysis displayed a similar factor structure but less overlap with the variables included in Entwistle's other LSOs. In the main, these results replicate Entwistle et al.'s findings. The same three learning style orientations identified by the British and Hungarian students, each with the similar subscales, were identified in the present New York City population. Therefore hypothesis 1 was supported.

Mathematical Learning Style Orientations. A second series of factor analyses were performed with the variables included in the Approaches to Learning Mathematics Inventory (ASMI). These analyses provided a comparison of the factor structure across the two inventories. Hypotheses 2 stated that the factor structure of the ASI and the ASMI would be the same. This hypothesis was not supported, although the factor structures were somewhat similar.

The initial factor analysis utilized a principal axes analysis with an oblique rotation to extract the factors. The procedure identified two factors with eigenvalues greater than 1 (see Table 9).

Factor II was the same as the second factor identified for the ASI. Surface Approach, Serialist Style, Fear of Failure, and Instrumental Motivation all loaded positively within this factor. This factor is analogous to Entwistle's Reproducing Orientation.

Six variables loaded positively within Factor I. They included all of the Meaning Orientation and all of the Achieving Orientation variables. Instead of forming two separate factors like Entwistle et al.'s factor analyses, the present final analysis combined them. This grouping warranted further examination.

In order to compare the factor structure of the ASI and the ASMI, an additional factor analysis

Table 9

Factor Analysis of the Math Learning Style Orientation variables (MLSO) for the Approaches to Studying Mathematics Inventory, for New York City population

Sub-scales/Factors	NYC Schools[a] I	II
Math Meaning Orientation		
Deep Approach	71	
Holist Style	62	
Intrinsic Motivation	74	
Math Reproducing Orientation		
Surface Approach	-37	74
Serialist Style		55
Fear of Failure		68
Instrumental Motivation		61
Math Achieving Orientation		
Strategic Approach	59	
Conscientiousness	80	
Hope for Success	67	

Note. Decimal points and correlations below .30 omitted. N = 420.

[a] Percentage of variance extracted = 49.1. Principal Axes Analysis.

was performed including all of the general LSO variables and all of the mathematical LSO variables. This factor analysis also utilized a principal axes analysis with an oblique rotation to extract the factors. The procedure identified five factors with eigenvalues greater than 1 (see Table 10).

This factor analysis clearly shows that the Math Meaning Learning Style Orientation factor and the general meaning Learning Style Orientation factors are different. Factor I clustered math deep approach, math holist style, math intrinsic motivation, math conscientiousness, and math hope for success. This factor loading is similar to the loading of the first factor from the math LSO factor analysis (Table 9). By contrast, the general LSO variables: deep approach, holist style, and intrinsic motivation, formed Factor III. The correlation between Factors I and III was .23. Apparently students assessed learning math for meaning differently from learning for meaning in general. The implications of this will be discussed in the next chapter.

The other factor loadings indicated that students judged the other general and math LSO variables similarly. For example, Factor IV included the general and math serialist style variables, the general and math strategic approach variables, and the general and math

Table 10
Factor Analysis for the 10 variables included in the Approaches to Studying Inventory (ASI) and the 10 variables included in the Approaches to Studying Mathematics Inventory (ASMI).

Sub-scales/Factors	I	II	III	IV	V
Meaning Orientation					
Deep Approach			80		
Holist Style			68		
Intrinsic Motivation			73		
Reproducing Orientation					
Surface Approach					
Serialist Style		30		46	
Fear of Failure		38			47
Instrumental Motivation		76			
Achieving Orientation					
Strategic Approach				75	
Conscientiousness				62	
Hope for Success					78
Math Meaning Orientation					
Deep Approach	65				
Holist Style	68				
Intrinsic Motivation	79				
Math Reproducing Orientation					
Surface Approach		49			
Serialist Style		37		50	
Fear of Failure		46			33
Instrumental Motivation		84			
Math Achieving Orientation					
Strategic Approach				70	
Conscientiousness	54			54	
Hope for Success	53				60

Note. Decimal points and correlations below .30 omitted.
[a] N = 420. Percentage of variance extracted = 58.1.

conscientiousness variables, with loadings that were approximately the same. Factor V loaded both ASI and ASMI fear of failure, and both hope for success variables. Finally, Factor II included all of the general and math Reproducing LSO variables, with the exception of the general surface approach.

In summary, the factors identified by the analysis of all the ASI and ASMI variables together, showed enough similarities with Entwistle's Learning Style Orientation constructs to retain the three LSO categories for the ASMI. However, some differences existed in the factorial relationship of the meaning LSO constructs. Each of the LSO variables will be investigated further in the next sections.

Group Comparisons

In order to evaluate the patterns of responses for females and males from the different schools, a repeated-measure Analysis of Variance was performed (see Table 11). This allowed for a comparison of the general and math LSOs for the different students within the present population. Hypotheses 3 stated females and males would report different mathematical LSOs. Hypotheses 4 stated students from the various schools would report different mathematical LSOs. These hypotheses were supported.

Table 11

The results of the repeated-measure ANOVA with school, gender, and inventory as independent measure, and learning style orientation (LSO) as the repeated measure

	SUM OF SQUARES	D.F.	MEAN SQUARES	F
School	5897.81	4	1474.45	6.80**
Gender	2390.34	1	2390.34	11.02*
School * Gender	290.80	4	72.70	0.34
1 ERROR	88957.22	410	216.96	
Inventory[a]	12315.41	1	12315.41	247.80**
Inventory * School	462.96	4	115.74	2.33
Inventory * Gender	401.25	1	401.25	8.07**
Inventory * Sch * Gen	357.18	4	89.29	1.80
2 ERROR	20376.72	410	49.69	
LSO[b]	40210.12	2	20105.06	152.86**
LSO * School	17869.49	8	2233.68	16.98*
LSO * Gender	617.71	2	308.85	2.35
LSO * School * Gen	1820.39	8	227.54	1.73
3 ERROR	107851.70	820	131.52	
Inv * LSO	25426.10	2	12713.05	258.96**
Inv * LSO * Sch	4861.07	8	607.63	12.38**
Inv * LSO * Gen	1277.82	2	638.91	13.01**
Inv * LSO * Sch * Gen	1242.05	8	155.25	3.16
4 ERROR	40255.72	820	49.09	

Note. ** = $p < .0001$ * = $p < .001$ N = 420.

[a] = Inventory (Inv) indicates the ASI as compared to the ASMI.
[b] = LSO indicates the 3 LSOs contained in the ASI and the 3 contained in the ASMI.

The repeated-measure ANOVA employed a 2 (Inventory) by 2 (Gender) by 5 (School) design. The LSOs were the repeated measure. All main effects were significant. Specifically, significant differences existed for the inventories, gender, and schools.

Inventory and Learning Style Orientation Differences

Main effects. The ANOVA results delineated a difference in the students' responses between the two inventories ($F(1,410) = 247.8$, $p < .0001$), as well as for the particular LSOs within each of the inventories ($F(2,820) = 152.86$, $p < .0001$).

The main effect for Inventory can be seen by comparing the overall mean for the ASI (45.2) to the overall mean for the ASMI (41.7) (see Table 12). These means indicate that students' responses to the questions about how they learn math differed from their responses to the questions about how they learn in general.

Table 12

Means of the learning style orientation (LSO) variables for the two inventories

	ASI	ASMI	
Meaning LSO	48.6	39.3	43.9
Reproducing LSO	47.1	49.7	48.4
Achieving LSO	39.8	36.2	38.0
	45.2	41.7	

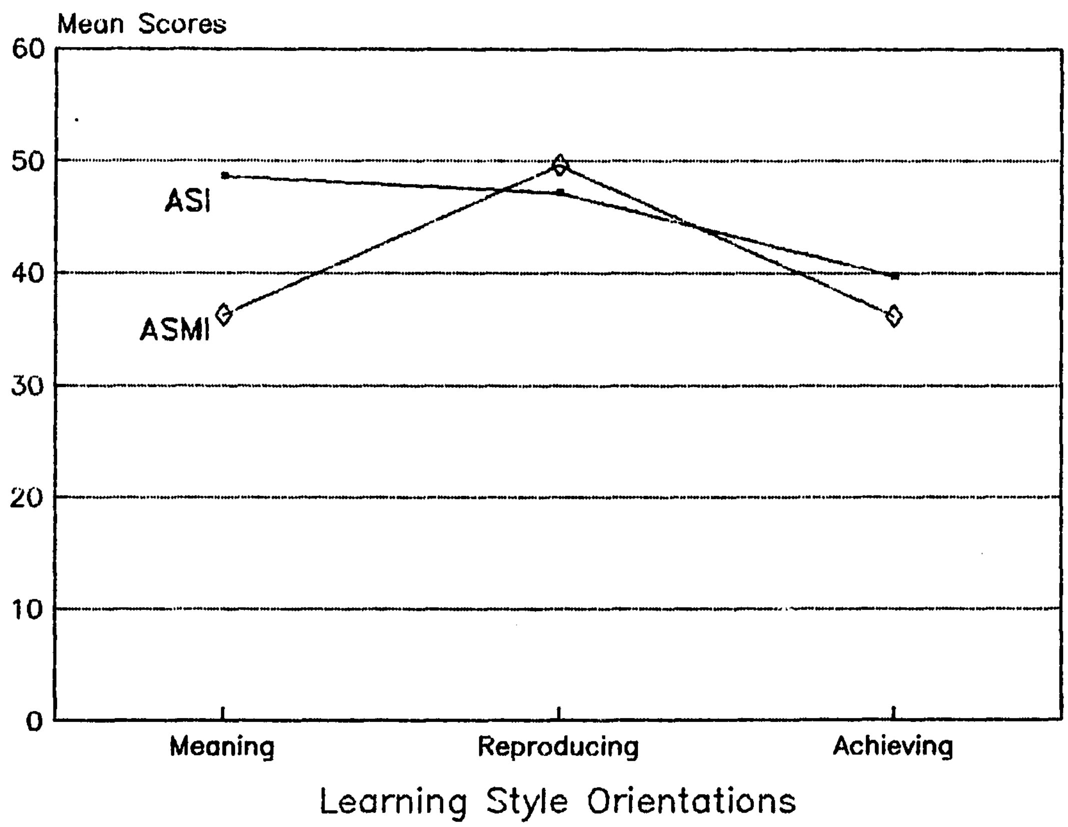
There were three general and three math LSO subscales within the two inventories. The ANOVA showed that the LSO main effect was significant (see Table 12). Specifically, the mean scores were 43.9 for the Meaning LSO, 48.4 for the Reproducing LSO, and 38.0 for the Achieving LSO.

Interaction effects. Examining these means also provided an explanation for the significant interaction between the inventories and the LSO sub-scales (see Table 12).

The two-way interaction (Inventory by LSO) was significant, $F(2, 820) = 258.96$, $p < .0001$. This interaction is illustrated by Figure 1. Specifically, the mean scores for the general Meaning Orientation subscale (48.6) was significantly higher than the mean score for the Math Meaning Orientation subscale (39.3). Similarly, the mean score for the general Achieving Orientation sub-scale (39.8) was significantly higher than the mean score for the Math Achieving Orientation subscale (36.2). The opposite relationship held true for the Reproducing Orientation, with the math mean (49.7) significantly higher than the general mean (47.1). In other words, the direction of the students' responses was different only for the Reproducing Orientation across the ASI and the ASMI.

Figure 1

<u>The means for the Learning Style Orientation (LSO) variables contained in the Approaches to Studying Inventory (ASI) and Approaches to Studying Mathematics Inventory (ASMI)</u>



Gender Differences

Main effect. A main effect for gender was significant, $F(1,410) = 6.80$, $p < .001$. In other words, females had scores that were different from the males. The overall means were 44.3 for the females and 42.4 for the males (see Table 13).

Table 13

Means for females and males for the ASI and ASMI

	ASI	ASMI	
Females	46.4	42.3	44.3
Males	43.5	41.2	42.4
	45.2	41.7	

Interaction effects. There were two significant interactions, Inventory by Gender ($F(1, 410) = 8.07$, $p < .0001$) and Inventory by LSO by Gender ($F(2,820) = 12.38$, $p < .0001$). The other interactions, School by Gender, and LSO by Gender, were not significant.

Table 13 shows the Inventory by Gender interaction. The overall means for the ASI were 46.4 for the females and 43.5 for the males. The overall means for the ASMI were 42.3 for the females and 41.2 for the males. This shows that the females responded more positively than the males to the statements within the ASI, but not to the statements within the ASMI.

Figure 2 shows the three-way interaction (Inventory by LSO by Gender). The means for the females and males for the three general and three math LSO variables are given in Table 14. The data shows that the mean scores of females and males, collapsed over schools for the ASI and the ASMI, interacted only for the Math Meaning Orientation variable.

Table 14

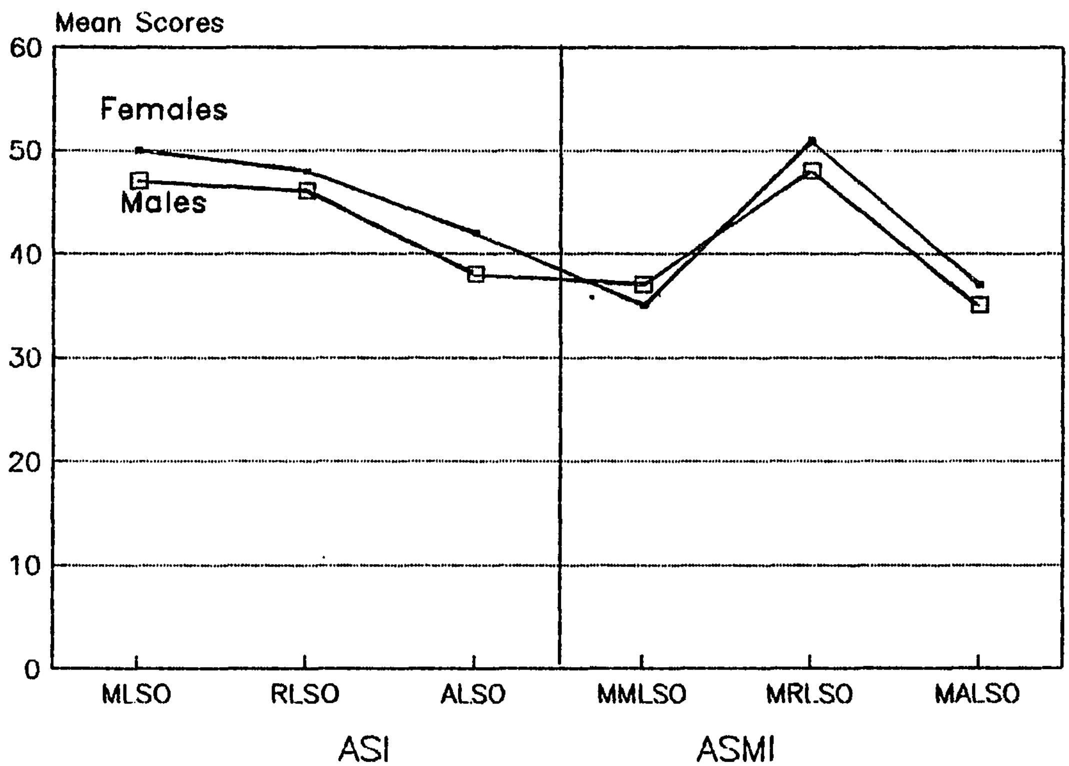
The means for females and males for the three general and the three math LSO contained in the ASI and ASMI

	ASI			ASMI			
	MLSO	RLSO	ALSO	MMLSO	MRLSO	MALSO	
Females	50.9	46.8	41.4	35.8	50.9	36.4	43.7
Males	47.9	45.4	37.2	37.3	47.3	34.7	41.7
	49.4	46.1	39.3	36.5	49.1	35.6	

The Inventory by LSO by Gender interaction resulted from the combination of the females' higher mean scores for all LSOs except MMLSO, the differences in the mean responses across the ASI and the ASMI, and the reversal in Math Meaning Orientation (males had higher mean scores for the MMLSO than females). In other words, with the exception of Math Meaning Orientation, the girls' mean scores were higher than the boys. This means that the females tended to agree more strongly

Figure 2

The means, for females and males, for the Learning Style Orientation (LSO) variables contained in the two inventories



with most of the statements contained in the ASI and the ASMI. The implications of these interactions will be discussed in the next chapter.

School Differences

Main effects. The students' responses varied significantly by school, F (4,410) = 6.80, p <.0001. This main effect connoted a difference in responses across the five schools (see Table 15).

Table 15

The mean scores of the five schools for the two inventories

	Schools 1	2	3	4	5	
ASI	45.8	45.8	44.4	46.6	42.0	45.2
ASMI	40.8	42.1	41.1	41.1	36.7	41.7
	43.3	44.0	42.8	43.9	39.4	

Interaction effects. Two interactions involving the responses across the schools were also significant. The School by LSO interaction was significant (F(8,820) = 16.98, p < .0001), as was the Inventory by LSO by School interaction (F(8,820) = 12.38, p < .0001). These interactions illustrate the differences across the two inventories for the five schools. The interaction for Inventory by School was not significant.

The School by LSO interaction is illustrated by Figure 3. The means for the LSO variables for the five schools are shown in Table 16. This interaction indicates that students at the various schools differed in the learning style orientations they preferentially adopted. It should be noted that this interaction collapsed the Meaning, Reproducing and Achieving Orientations across the inventories.

Table 16

Means for the LSO variables for the five schools

	School 1	School 2	School 3	School 4	School 5	
Meaning LSO	41.7	40.6	45.3	41.2	45.5	42.9
Reproducing LSO	50.6	50.7	44.6	51.8	39.8	47.5
Achieving LSO	37.5	40.5	38.2	38.4	32.8	37.5
	43.3	43.9	42.7	43.8	39.4	

The three-way interaction, Inventory by LSO by School, is illustrated in Figure 4. This interaction signifies that the students responses differed across the two inventories and for the LSO variables contained within each inventory. The means for the three general LSO and the three math LSO variables for the five schools are displayed in Table 6.

Looking across the three general LSO variables and

Figure 3

The means of the learning style orientation (LSO) variables for the five schools

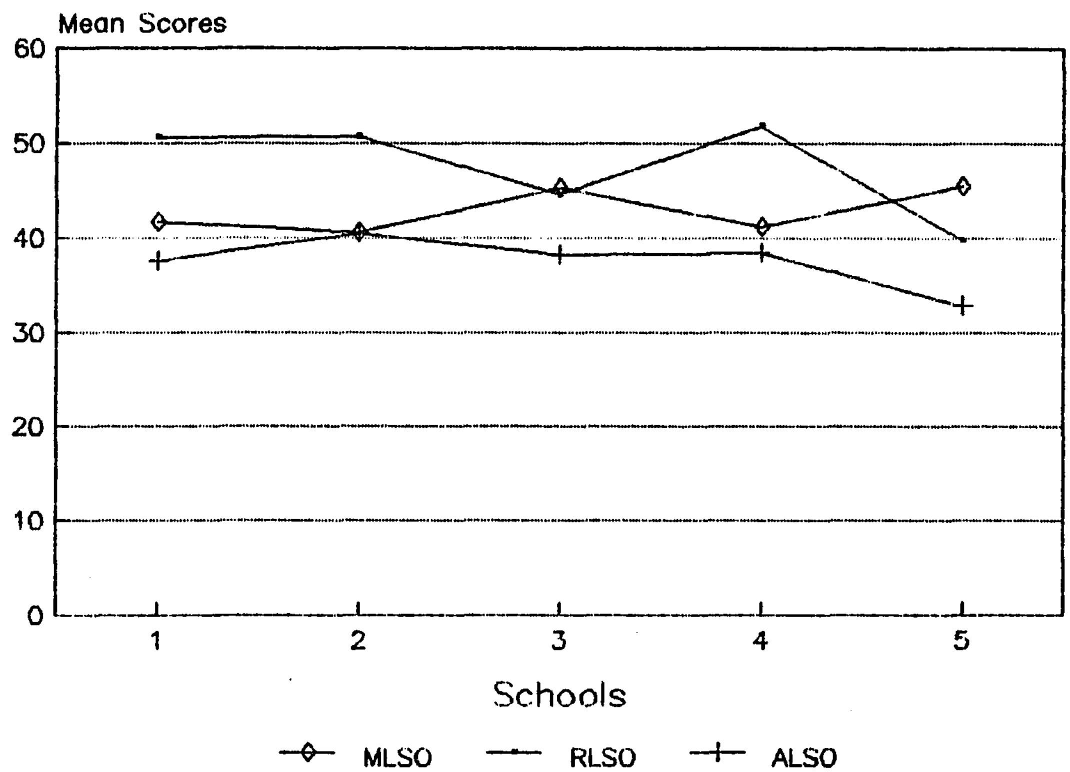
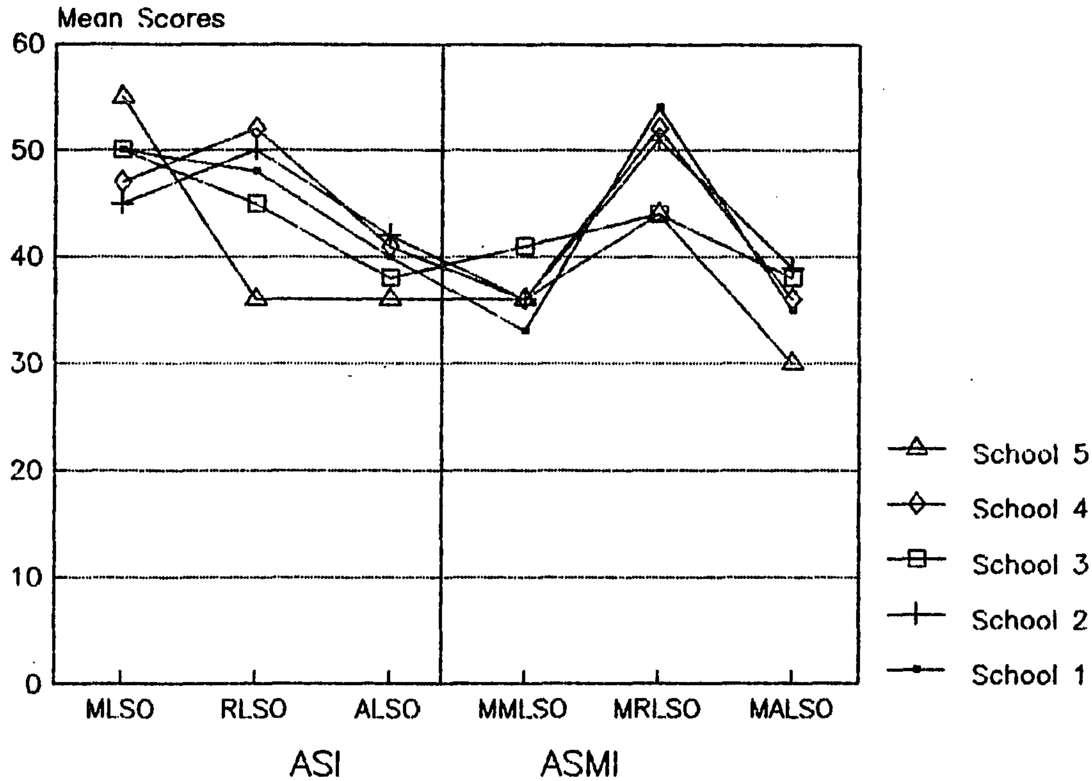


Figure 4

The means for the learning style orientation (LSO) variables contained in the two inventories for the five schools



the three math LSO variables for the five schools certain patterns emerge. Responses to the Achieving Orientation items on both the ASI and ASMI were similar except for School 5. All students' responded more positively to the general Meaning Orientation items than to the Math Meaning Orientation items. This pattern differed in magnitude (i.e, Schools 1 and 3) but not in direction. The reverse relationship held for Schools 1 and 5 for the Reproducing Orientation variables on both the ASI and ASMI.

These response patterns provided an illustration of students' varying approaches to studying. The students at most of the schools exemplified a Mathematical Reproducing Orientation. They scored higher on that scale, and lower on the math meaning and math achieving scales. However, not all of the students at the schools responded similarly on the ASI. For the ASI inventory, the students at Schools 1, 2 and 4, suggested a Reproducing Orientation approach but the students at Schools 3 and 5 did not. These students instead characterized themselves as meaning oriented when no content was specified.

These findings suggest a school profile as well as a description of the LSO variables contained in the ASI and the ASMI. The implications of possible school LSO profiles will be discussed in the next chapter.

Predictive Measures

In order to determine if students' LSO responses could be used to predict grade point averages and SAT scores, a series of multiple regression equations were generated. Four series of equations were derived, one for GPA, one for math GPA, one for verbal SAT, and one for math SAT. The regression equations for GPA and VSAT used the general LSOs, school, and gender. The regression equations for MGPA and MSAT used the math LSOs, school, and gender.

The regression equations were used to address the hypotheses advanced within Hypotheses 5. These statistical procedures used stepwise analyses, with a criterion limit of .05, to determine the combination of independent variables that best predicted each dependent variable. The beta weights and squared multiple correlations are given in Table 17. Each of these equations will be assessed separately.

Predicting GPA. The first regression equation explored the relationship between GPA and Meaning Orientation, Reproducing Orientation, Achieving Orientation, school, and gender. The stepwise analyses identified only RLSO and ALSO as significant predictors for GPA. The beta weights for RLSO and ALSO were -.29 (t = -6.05, p < .0001) and .18 (t = 3.90, p < .001) respectively. None of the other variables were Table 17

Table 17
Beta weights and squared correlations for the stepwise regression analyses, using school, gender, and ASI or ASMI variables to predict high school grades and SAT scores

Independent Variables	GPA	MGPA	VSAT	MSAT
School	.09		.42**	
Gender	-.05		.05	
MLSO	.01		.18**	
RLSO	-.29**		-.38**	
ALSO	.18**		-.09	
School		.07		.45**
Gender		-.05		.12*
MMLSO		.07		.13*
MRLSO		-.24**		-.29**
MALSO		.17**		-.06
r^2	.10	.09	.50	.38

Note. * - $p < .0001$ ** - $p < .00001$

significant.

Hypothesis 5(1) stated that GPA would be directly related to RLSO. This hypothesis was not supported. The equation instead indicated that GPA was best predicted by a combination of a negatively weighted RLSO variable and a positively weighted ALSO variable. The MLSO, gender, and school variables did not significantly add to the prediction for GPA.

Predicting MGPA. The next regression equation explored the relationship between math grade point average and Math Meaning Orientation, Math Reproducing Orientation, Math Achieving Orientation, school, and gender. The stepwise analyses identified only MRLSO and MALSO as significant predictors for MGPA. The beta weights were -.24, $t = -6.05$, $p < .0001$ for MRLSO, and .17 for MALSO, $t = 3.90$, $p < .001$. None of the other variables were significant.

Hypothesis 5(2) stated that MGPA would be directly related to MRLSO. As with the first hypothesis, this hypothesis was not supported. Similar to the equation for GPA, MGPA was best predicted by a combination of a negatively weighted MRLSO variable and a positively weighted MALSO variable. The MMLSO, gender, and school variables did not significantly add to the prediction for MGPA.

A comparison of the first two regression equations showed a similar relationship of the dependent variables for both GPA and MGPA. In both cases a high grade point average was predicted by a low score on the reproducing orientation variables (RLSO and MRLSO) and a high score on the achieving orientation variables (ALSO and MALSO). The meaning orientation variables (MLSO and MMLSO) did not predict either GPA or MGPA.

Predicting VSAT. The third regression analysis examined the relationship of VSAT to the ASI variables. VSAT was predicted by MLSO, RLSO, and the school variable. Gender was not predictive of the VSAT. The beta weights were .42 for school (t = 11.14, p < .0001), -.38 for RLSO (t = -9.59, p < .0001), and .18 for MLSO (t = 4.41, p < .001). Hypothesis 5(3), which stated that VSAT would be directly related to MLSO and ALSO, was not totally supported. While the MLSO variable was included in the equation, the ALSO variable was not. Further, school, not MLSO or ALSO, was the best predictor of VSAT. The negative beta weight for the RLSO variable is consistent with the relationship between MLSO and RLSO.

Predicting MSAT. School was also the best predictor for MSAT. The other variables included in the equation were MMLSO, MRLSO, and gender. The beta weights were .45 for school (t = 11.15, p < .0001), -.29 for MRLSO (t = -6.91, p < .0001), .13 for MMLSO (t =

3.18, $p < .0001$), and .12 for gender ($t = 3.04$, $p < .01$). Therefore hypothesis 5(4) was not supported. While MLSO was identified as a positive predictor of MSAT, and MRLSO was a negative predictor, the MALSO variable was not significant. Even more important, in terms of predicting MSAT, school was the most substantial variable. In addition, gender was also included in the prediction equation.

These equations suggest that high SAT scores are best predicted by knowing which school the student is attending as well as whether the student manifests a high Meaning Orientation and a low Reproducing Orientation. Further, gender somewhat added to the prediction of MSAT but not the VSAT. The implications of these regression equations will be discussed in the next chapter.

Summary of the Findings

The four research questions advanced by the present study were investigated by means of factor analyses, repeated-measure Analysis of Variance, and stepwise multiple regression analysis.

The factor analysis suggested first of all, that the students in this study did respond to the ASI in a manner similar to that of other students. A comparison of the factor structure of the current students' responses was similar to previous factor analyses. The three learning style orientations characterized by Entwistle were also found in the present study. These findings supported Hypothesis 1.

Secondly, the subject did matter to the students when answering questions about how they learn and study. Students responded differently to the ASMI than they did to the ASI. The learning style orientations for math were similar but not identical to the general learning style orientations. There was some indication that students relate learning math for meaning with learning math for achieving.

Students reported two main mathematical learning style factors. One factor incorporated the Math Meaning LSO and the Math Achieving LSO. The other factor isolated the Math Reproducing LSO. Therefore, hypothesis 2 was not supported.

Based on the results of the ANOVA tests, all students reported a higher reproducing orientation for math than when no subject matter was specified. In other words, the participating students more often reported taking a surface approach to math, learning math in a serialist style, and being motivated by fear of failure and/or the math credentials they will receive.

The variations in the students' responses were associated, in part, with the schools that they attended. School was an important variable. This suggests that the students' approaches to learning and studying may be influenced (or reinforced) by the schools that they attended. Other variables, including gender also contributed to the variations in responses. These findings support Hypotheses 3 and 4.

The regression analyses indicated that certain LSOs did predict students' GPAs and SAT scores. Specifically, a high overall GPA was predicted by a low Reproducing Orientation rating and a high Achieving Orientation rating. A high math GPA was predicted by a low Math Reproducing Orientation score and a high Math Achieving Orientation score. High verbal SAT scores were predicted by the school variable, a high Meaning Orientation rating, and a low Reproducing Orientation score. High math SAT scores were predicted by the school variable, a high Math Meaning Orientation rating, a low Math Reproducing Orientation score, and gender.

The ten items included in the third section of the School and Schoolwork questionnaire did not provide any additional characterization of the students in the study. The correlations of these items with the other variables (see Appendix C) suggested some basic relationship between students' Reproducing LSO ratings and their view towards the MSAT. However, no specific relationships that would augment the other results of this study were discerned.

VI. Discussion

The findings of this research have provided some useful information about the relationship of context to students' approaches to learning. Previous research has focused either on characterizing students' approaches to learning (Entwistle, 1988, Entwistle & Kozeki, 1985), or on correlating students' learning style orientations with different types of tasks (Laurillard, 1984, Ramsden, 1984, 1988). The present study was a first effort at defining learning style orientations that were specific to the context of mathematics. This involved first corroborating the original classification of learning style orientations and then comparing these classifications to the proposed mathematical learning style orientations.

The New York City students' responses to the Approaches to Studying Inventory (ASI) were similar to the other populations. As expected, the students delineated the three learning style orientations identified by Entwistle, although some additional variables were associated with each factor.

The Meaning Orientation factor, was associated with a deep approach, a holist style, intrinsic motivation, and conscientiousness. In other words, the students responses coincided with Entwistle's characterization of meaning oriented as being concerned with understanding, integrating new information with previous knowledge, and being intrinsically motivated. The inclusion of conscientiousness, a variable Entwistle associated with the Achieving Orientation, may suggest that students see intrinsic motivation and conscientiousness (effort directed towards self-satisfaction) similarly.

The Reproducing Orientation was characterized by a surface approach, a serialist style, instrumental motivation, hope for success, and most especially fear of failure. The emphasis given to fear of failure may provide some clue as to when a reproducing orientation is most often adopted. It is possible that students utilize a reproducing orientation when they believe they will not succeed. An alternative explanation may be that situations that demand rote learning from a narrowly prescribed syllabus may evoke a stronger fear of failure. However, without further investigation of the context(s) that students inferred when responding, no definite conclusions as to the reasons for this factor loading can be drawn.

The Achieving Orientation was identified by the strategic approach, conscientiousness, hope for success, deep approach, serialist style, and intrinsic motivation. Had both of the corresponding approaches (deep and surface) or styles (holist and serialist) been included in this factor, the interpretation of the Achieving Orientation as the versatile approach to learning would have been a feasible. However, the inclusion of only serialist style and deep approach may suggest that some students' identify the strategic approach as one where learning the facts and details leads to both understanding and high achievement. Here again alternative explanations exist making it impossible to speculate without further definition of the learning context.

The Approaches to Studying Mathematics Inventory provided a way to compare the students' learning style orientations within a defined context. The items were still broadly conceptualized, but more narrowly defined than the original inventory. While it might be expected that not all students conceptualized learning mathematics alike, their responses were still based on a partially bounded domain. Specifying the content limited the breadth of the learning situation the student had to envision. Asking students to respond to how they learn and study mathematics elicited a set of responses specific to that domain. If content did not influence students' approaches to learning the students' responses to both inventories would have been similar. This was not the case. Learning style orientations were found to differ when a mathematical context was imposed.

The second hypotheses, that the factor structure generated by the ASMI variables would be the same as the ASI factor structure, was not supported. The clustering of the variables was similar to the original inventory, but not identical. This allowed for retention of the three hypothesized mathematical learning style orientation constructs. Specifically, the initial factor analysis identified only two factors for the math inventory. One was identical to Entwistle's Reproducing Orientation, and the other combined the Meaning and Achieving Orientation variables.

The Math Reproducing Orientation was represented as taking a surface approach, using a serialist style, and motivated by a fear of failure. This construct may best characterize the stereotypical math learner. This collection of variables suggests a math learner who prefers a detailed, step-by-step approach to learning math, who focuses on carrying out the teachers' instructions, and whose effort is derived from anxiety about assessment. The students in this study strongly identified with this learning style orientation.

The collapsing of the Math Meaning and the Math Achieving Orientations into one factor may suggest that the students regarded achieving in math as leading to understanding. The students rated the Math Meaning and Math Achieving Orientation items similarly. Subsequent factor analyses allowed for clearer differentiation of the general and math LSOs.

The general Meaning Orientation was characterized by a preference for learning by seeing the overview, using analogies and relating to experience (i.e., using a holist style), taking a deep approach, and being intrinsically motivated. This indicated that students could visualize an approach to learning that focused on overall understanding, which would be motivated by interest and the enjoyment of learning.

In contrast, the Math Meaning Orientation was characterized by the strategic approach, conscientiousness, and hope for success, as well as with deep approach, holist style, and intrinsic motivation. This may indicate that students presume that adopting a meaning orientation towards mathematics leads to high achievement in mathematics.

Conversely it may indicate that students believe that high grades in mathematics can only be achieved through understanding. The math meaning orientation suggests a relationship between understanding, and succeeding in mathematics.

Few students could be classified as <u>only</u> meaning oriented, reproducing oriented, or achieving oriented for either inventory. However, certain patterns of responses across the two inventories emerged for females and males and related to the school variable.

Comparing the students' responses across the ASI and the ASMI showed a clear divergence in the rate of agreement for the meaning and reproducing orientations. Students' general MLSO and RLSO ratings, while significantly different, were not as divergent as the students' MMLSO and MRLSO ratings. Apparently when the content to be learned was math, a reproducing orientation, and <u>not</u> a meaning orientation was the approach students chose. This was true for the students at all five schools. Even at the two schools with the highest math SAT scores, the students rated the reproducing orientation higher than the meaning orientation for math, but not for learning in general.

The differences in responses across the schools suggested a connection between the approaches students take to learning and the schools they attend. This relationship was evidenced by the students' responses to the general inventory, and by the comparison of the students' responses across the two inventories. For example, the students in Schools 2 and 4 reported a reproducing orientation for both general and math learning. On the other hand, the students from Schools 1, 3, and 5 reported a meaning orientation when approaching learning in general but a reproducing orientation when learning math. This difference was especially pronounced for School 5.

These between school differences may suggest that the students' recognized that mathematics requires a different learning approach. On the other hand, the findings may indicate that some students adopt a reproducing orientation when learning math, while some students employ a reproducing orientation regardless of the context.

The responses of females and males across the five schools showed some consistent patterns. The females, at all schools, more strongly agreed with statements in all scales in the ASI and ASMI <u>except</u> those related to learning math for meaning. This means that except where the statements related to learning math for meaning, the girls tended to choose the positive responses (agree or strongly agree).

When responding to how they approached learning in general, the females definitively reported a meaning orientation. When asked about how they approached math, the reproducing orientation was affirmed with the same amplitude. The boys responses were not very different except in magnitude. Like the females, they also reported a reproducing orientation when learning math and a meaning orientation when no content was specified.

These findings further suggest that all the participating students, especially the females, utilize a surface approach and serialist style, rather than a deep approach and holist style, when learning math.

The third hypothesis, concerned with predicting students' GPAs and SAT scores from their LSOs, was not supported as specified. While LSO variables did predict students' GPAs and SAT scores, they were not the variables predicted in hypothesis 3. High GPA and MGPA were both predicted by a combination of a low reproducing orientation score and a high achieving orientation score. This means that students with the highest overall grade point averages reported taking an achieving orientation to learning, not a reproducing orientation. Similarly, students with higher math grade point averages characterized themselves as achieving oriented towards math learning, not reproducing oriented.

Verbal SAT scores were best predicted by school, RLSO (negatively weighted), and MLSO. Math SAT scores were best predicted by school, MRLSO (negatively weighted), MMLSO, and gender. Knowing which school the student attended was the single best predictor of a high SAT score. However the students' reported learning style orientation augmented the predictions to some degree. Students with low reproducing orientation scores and high achieving orientation scores attained higher VSAT scores, on average. Males with low reproducing orientation scores and high achieving orientation scores attained higher MSAT scores.

Taken together the findings of this study suggest that students did profess different learning style orientations for the context of mathematics. Most claimed to adopt a reproducing orientation rather than a meaning orientation. This was especially true for the females included in this research.

Notwithstanding, low reproducing orientation scores were indicative of higher grade point averages and higher SAT scores. High achieving orientation scores also contributed to predicting these variables. The breach between how students report learning math and the LSO variables that predict high grades and test scores is evident.

Educational Implications

The findings in this research are of importance to educators for several reasons. First and foremost, these findings clearly indicate that many students are not approaching mathematics for understanding and/or enjoyment, but rather for recall and/or extrinsic rewards. Math is being perceived as a subject where getting the right answer and knowing the facts are most important.

The present instructional model may offer some reasons for the students' attitude. Presently many math teachers do focus students' attention on getting the right answer and/or learning particular algorithms. This emphasis reinforces students reproducing approach to math learning.

In order to encourage students to learn math for meaning, teachers need to present math as an interesting, meaningful subject. School mathematics must focus on the process and substance of mathematics. Math instruction needs to link mathematics to the students' lives and experiences.

Secondly, schools play an important part in shaping students' approaches to learning. The consistency, within some schools, of the students' responses across the two inventories provided some insight into what approaches students believe to be most productive. An assessment of students' preferred learning style orientations could offer some additional information for teachers and administrators.

The relationship between low reproducing orientation scores and high GPAs and SAT scores should alert educators as to the difficulties that exist for those students who preferentially adopt a reproducing orientation. To encourage a deeper understanding of mathematics, educators need to refocus students attention towards different approaches to learning mathematics.

Suggestions for Further Research

The present investigation provided a starting point for establishing students' approaches to learning math but more research is needed. The specification of context allowed for more plausible explanations about students approaches to learning math. However, each of these hypothesized mathematical learning style orientations must now be characterized. The parameters of the mathematical learning style orientations need to be explored. It is not clear whether it is the approach, style, or motivational variables, or some interaction of these that define math LSOs.

While it was evident that many of the students included in this study reported taking a reproducing orientation towards math, the full effect of their endorsements remain unclear. Performance differences for students professing different LSOs must be investigated.

This is especially important given the results of the regression equations. Both verbal and math SAT scores were negatively correlated with Reproducing Orientation scores; the variable that many students said they employed when learning math. This information evokes many questions. It would be useful to explore the approaches to learning that students take when preparing for standardized tests like the SAT. Further, it is necessary to examine the restrictions that students' approaches to learning math put upon both their school performance and their standardized test scores.

Appendix A

School and Schoolwork Questionnaire

SCHOOL AND SCHOOL WORK

Please fill in the details below and read the direction before you begin. Any information you provide will be kept strictly confidential. Thank you.

Name: ____

School: ____________________ Grade: __________________

Date of Birth: ____/____/____ Sex (circle one): Female
Male

Please read these instructions carefully.

This questionnaire, in three sections, contains comments made by students about their school work in general, their work in school mathematics, and the Scholastic Aptitude Test (SAT). To what extent do you agree or disagree with their comments? The comments are based on feelings and personal experience, so there are no right or wrong answers. We are interested in your opinion or experience.

Read each comment carefully and then immediately show how closely you agree or disagree with that comment by circling the letter(s) at the right-hand side of the page. For example:

CIRCLE the letter(s) that best describes your answer.

I enjoy the work I do at school SA A NS D SD

		Column Heading
SA	strongly agree with this statement	Strongly Agree
A	agree somewhat with this statement	Agree
NS	not sure or not understood	Not Sure
D	disagree somewhat with this statement	Disagree
SD	strongly disagree with this statement	Strongly Disagree

Try to avoid the "not sure" answer if you possibly can. It is important that you give an answer to EVERY question.

SECTION 1

		Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree
1-1.	I try to relate ideas in mathematics to those in other subjects, whenever possible.	SA	A	NS	D	SD
1-2.	When I'm doing math, the ideas sometimes produce vivid images in my mind.	SA	A	NS	D	SD
1-3.	I find math so interesting that I would like to go on with it after I leave school.	SA	A	NS	D	SD
1-4.	I find I have to rely on memorizing a good deal of what we have to learn in math.	SA	A	NS	D	SD
1-5.	I prefer to tackle each part of a math topic or problem in order, working through it one step at a time.	SA	A	NS	D	SD
1-6.	I suppose I'm more interested in the qualifications I'll get, than in the math courses I'm taking.	SA	A	NS	D	SD
1-7.	In math exams I tend to panic.	SA	A	NS	D	SD
1-8.	I'm very good at organizing my math study time effectively.	SA	A	NS	D	SD
1-9.	When doing math, I hate admitting defeat, even in trivial matters.	SA	A	NS	D	SD
1-10.	If I have mathematics to do, I feel it's worthwhile only if I do it well.	SA	A	NS	D	SD
1-11.	I generally try to understand math even when it initially seems rather difficult.	SA	A	NS	D	SD
1-12.	I like to play around with mathematical ideas of my own, even if they don't get me very far.	SA	A	NS	D	SD
1-13.	Some of the math work in school is really exciting and gripping.	SA	A	NS	D	SD
1-14.	I don't usually have time to think about the implications of the math I have done.	SA	A	NS	D	SD
1-15.	I'm more ready to follow well-tried approaches to math problems than unfamiliar ones.	SA	A	NS	D	SD
1-16.	My main reason for studying mathematics is so that I'll be able to get a good job.	SA	A	NS	D	SD
1-17.	I worry alot when math teachers criticize my work.	SA	A	NS	D	SD
1-18.	I very rarely require extra time to complete written math work.	SA	A	NS	D	SD
1-19.	I enjoy competing with other pupils in math school work.	SA	A	NS	D	SD
1-20.	I feel it's my duty to work hard at math.	SA	A	NS	D	SD

	Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree
1-21. Often I ask myself questions about the math I hear in lessons or read in books.	SA	A	NS	D	SD
1-22. I enjoy doing mathematics where I can use my imagination or my own ideas.	SA	A	NS	D	SD
1-23. My main reason for being in school is so that I can learn more about the math courses which really interest me.	SA	A	NS	D	SD
1-24. The best way for me to understand what the technical terms in math mean is to remember just the text-book definition.	SA	A	NS	D	SD
1-25. I think it's important to look at math problems cautiously and logically without relying on intuition.	SA	A	NS	D	SD
1-26. When I work hard in math, it's only so that I can continue my education.	SA	A	NS	D	SD
1-27. I am always worrying that I will get behind with my math work.	SA	A	NS	D	SD
1-28. I always organize my math work very carefully.	SA	A	NS	D	SD
1-29. It is important to me to do math better than other students, if I possibly can.	SA	A	NS	D	SD
1-30. I don't mind working long hours to complete my math work satisfactorily.	SA	A	NS	D	SD
1-31. I try to relate what I do in math to the previous math work I've done.	SA	A	NS	D	SD
1-32. I prefer math teachers who use lots of examples, or their own experiences, to help us understand things.	SA	A	NS	D	SD
1-33. I spend a good deal of my spare time finding out about interesting math topics which have been discussed.	SA	A	NS	D	SD
1-34. I like to be told precisely what to do in math.	SA	A	NS	D	SD
1-35. I prefer to stick to one approach to a math problem until I'm absolutely sure it won't work.	SA	A	NS	D	SD
1-36. When I work hard in math it's only because I don't want to let my parents down.	SA	A	NS	D	SD
1-37. I never seem to be able to do math as well as I feel I could.	SA	A	NS	D	SD
1-38. If I do something badly in math, I try to work out why, so that I can do better next time.	SA	A	NS	D	SD
1-39. If I want something badly in math, I don't mind really pushing to get it.	SA	A	NS	D	SD
1-40. When I've started working on a math problem, I stick with it even if I'm finding it really hard.	SA	A	NS	D	SD

	Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree
1-41. I prefer to make my own notes in math when I can.	SA	A	NS	D	SD
1-42. I suppose I'm a bit too ready to jump to conclusions concerning math.	SA	A	NS	D	SD
1-43. I am fascinated by some of the math topics we meet in school work.	SA	A	NS	D	SD
1-44. I make my own notes only when the math teacher tells me to.	SA	A	NS	D	SD
1-45. I prefer math teachers who stick to the point and don't go off at a tangent.	SA	A	NS	D	SD
1-46. I suppose I'm in math class only because I don't seem to have any real choice about it.	SA	A	NS	D	SD
1-47. Other people always seem to be able to do math better than I can.	SA	A	NS	D	SD
1-48. If conditions aren't right for me to study math, I always try to do something to change them.	SA	A	NS	D	SD
1-49. I feel tense before a math exam, but that seems to make me work better during it.	SA	A	NS	D	SD
1-50. I take my math work seriously, no matter what.	SA	A	NS	D	SD
1-51. In trying to understand new ideas in math, I often try to relate them to real-life situations.	SA	A	NS	D	SD
1-52. When doing math work I try to solve it my in own way whenever possible.	SA	A	NS	D	SD
1-53. I get very enthusiastic about some of my math school work.	SA	A	NS	D	SD
1-54. Generally I do only the math we are specifically told to do.	SA	A	NS	D	SD
1-55. When I'm explaining something in math, I generally try to give a lot of detail.	SA	A	NS	D	SD
1-56. I work well in math only when the teacher puts me under a good deal of pressure.	SA	A	NS	D	SD
1-57. Worrying about math school work often prevents me from sleeping.	SA	A	NS	D	SD
1-58. I plan my math working time carefully to make the most of it.	SA	A	NS	D	SD
1-59. I play any game in math to win, not just for the fun of it.	SA	A	NS	D	SD
1-60. Even when I'm tired, I try to finish all the math I have to do.	SA	A	NS	D	SD

SECTION 2

	Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree
2-1. I try to relate ideas in one subject to those in others, whenever possible.	SA	A	NS	D	SD
2-2. When I'm reading, the ideas sometimes produce vivid images in my mind.	SA	A	NS	D	SD
2-3. I find some subjects so interesting that I would like to go on with them after I leave school.	SA	A	NS	D	SD
2-4. I find I have to rely on memorizing a good deal of what we have to learn.	SA	A	NS	D	SD
2-5. I prefer to tackle each part of a topic or problem in order, working through it one step at a time.	SA	A	NS	D	SD
2-6. I suppose I'm more interested in the qualifications I'll get, than in the subjects I'm taking.	SA	A	NS	D	SD
2-7. In exams I tend to panic.	SA	A	NS	D	SD
2-8. I'm very good at organizing my study time effectively.	SA	A	NS	D	SD
2-9. I hate admitting defeat, even in trivial matters.	SA	A	NS	D	SD
2-10. If I have something to do, I feel it's worthwhile only if I do it well.	SA	A	NS	D	SD
2-11. I generally try to understand things even when they initially seem rather difficult.	SA	A	NS	D	SD
2-12. I like to play around with ideas of my own, even if they don't get me very far.	SA	A	NS	D	SD
2-13. Some of the work in school is really exciting and gripping.	SA	A	NS	D	SD
2-14. I don't usually have time to think about the implications of what I have read.	SA	A	NS	D	SD
2-15. I'm more ready to follow well-tried approaches to problems than unfamiliar ones.	SA	A	NS	D	SD
2-16. My main reason for studying is so that I'll be able to get a good job.	SA	A	NS	D	SD
2-17. I worry alot when teachers criticize my work.	SA	A	NS	D	SD
2-18. I very rarely require extra time to complete written work.	SA	A	NS	D	SD
2-19. I enjoy competing with other pupils in school work.	SA	A	NS	D	SD
2-20. I feel it's my duty to work hard at school.	SA	A	NS	D	SD

	Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree
2-21. Often I ask myself questions about the things I hear in lessons or read in books.	SA	A	NS	D	SD
2-22. I enjoy doing things where I can use my imagination or my own ideas.	SA	A	NS	D	SD
2-23. My main reason for being here is so that I can learn more about the subjects which really interest me.	SA	A	NS	D	SD
2-24. The best way for me to understand what technical terms mean is to remember just the text-book definition.	SA	A	NS	D	SD
2-25. I think it's important to look at problems cautiously and logically without relying on intuition.	SA	A	NS	D	SD
2-26. When I work hard, it's only so that I can continue my education.	SA	A	NS	D	SD
2-27. I am always worrying that I will get behind with my work.	SA	A	NS	D	SD
2-28. I always organize my work very carefully.	SA	A	NS	D	SD
2-29. It is important to me to do things better than other pupils, if I possibly can.	SA	A	NS	D	SD
2-30. I don't mind working long hours to complete my work satisfactorily.	SA	A	NS	D	SD
2-31. I try to relate what I read to previous work.	SA	A	NS	D	SD
2-32. I prefer teachers who use lots of examples, or their own experiences, to help us understand things.	SA	A	NS	D	SD
2-33. I spend a good deal of my spare time finding out about interesting topics which have been discussed.	SA	A	NS	D	SD
2-34. I like to be told precisely what to do in essays or other set work.	SA	A	NS	D	SD
2-35. I prefer to stick to one approach to a problem until I'm absolutely sure it won't work.	SA	A	NS	D	SD
2-36. When I work hard it's only because I don't want to let my parents down.	SA	A	NS	D	SD
2-37. I never seem to be able to do things as well as I feel I could.	SA	A	NS	D	SD
2-38. If I do something badly, I try to work out why, so that I can do better next time.	SA	A	NS	D	SD
2-39. If I want something badly, I don't mind really pushing to get it.	SA	A	NS	D	SD
2-40. When I've started a piece of work, I stick at it even if I'm finding it really hard.	SA	A	NS	D	SD

	Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree
2-41. I prefer to make my own notes when I can.	SA	A	NS	D	SD
2-42. I suppose I'm a bit too ready to jump to conclusions.	SA	A	NS	D	SD
2-43. I am fascinated by some of the topics we meet in school work.	SA	A	NS	D	SD
2-44. I make my own notes only when the teacher tells me to.	SA	A	NS	D	SD
2-45. I prefer teachers who stick to the point and don't go off at a tangent.	SA	A	NS	D	SD
2-46. I suppose I'm at school only because I don't seem to have any real choice about it.	SA	A	NS	D	SD
2-47. Other people always seem to be able to do things better than I can.	SA	A	NS	D	SD
2-48. If conditions aren't right for me to study, I always try to do something to change them.	SA	A	NS	D	SD
2-49. I feel tense before an exam, but that seems to make me work better during it.	SA	A	NS	D	SD
2-50. I take my work seriously, no matter what.	SA	A	NS	D	SD
2-51. In trying to understand new ideas, I often try to relate them to real-life situations.	SA	A	NS	D	SD
2-52. In written work I try to put over my own view whenever possible.	SA	A	NS	D	SD
2-53. I get very enthusiastic about some of my school work.	SA	A	NS	D	SD
2-54. Generally I read only what we are specifically told to read.	SA	A	NS	D	SD
2-55. When I'm explaining something, I generally try to give a lot of detail.	SA	A	NS	D	SD
2-56. I work well only when the teacher puts me under a good deal of pressure.	SA	A	NS	D	SD
2-57. Worrying about school work often prevents me from sleeping.	SA	A	NS	D	SD
2-58. I plan my working time carefully to make the most of it.	SA	A	NS	D	SD
2-59. I play any game to win, not just for the fun of it.	SA	A	NS	D	SD
2-60. Even when I'm tired, I try to finish everything I have to do.	SA	A	NS	D	SD

CHECK BACK TO MAKE SURE YOU HAVE CIRCLED AN ANSWER CHOICE FOR EACH QUESTION.
Then answer the remaining questions.

SECTION 3

	Strongly Agree	Agree	Not Sure	Disagree	Strongly Disagree
3-1. I find math tests like the Scholastic Aptitude Test in math (MSAT) very interesting.	SA	A	NS	D	SD
3-2. To get a high score on the math SAT I need to know alot of mathematical formulas.	SA	A	NS	D	SD
3-3. I rely on what I have memorized to answer many of the math questions on the SAT.	SA	A	NS	D	SD
3-4. Whenever I take a math test like the SAT I tend to panic.	SA	A	NS	D	SD
3-5. A high score on the math SAT is very important to me.	SA	A	NS	D	SD
3-6. To get a high score on the math SAT I need to know a lot of shortcuts, tricks, and quick ways to find the correct answers.	SA	A	NS	D	SD
3-7. I generally understand what the math problems on the SAT are about.	SA	A	NS	D	SD
3-8. I never have enough time to finish math tests like the math SAT.	SA	A	NS	D	SD
3-9. To get a high score on the math SAT I need to have a thorough understanding of the mathematics involved.	SA	A	NS	D	SD
3-10. I do as well on the math SAT as I do on regular class math tests.	SA	A	NS	D	SD

SECTION 4

4-1. Which type of subject do you enjoy most? (Circle number)

English/Social Studies	*Math/Science*	*Both Equally*	*Neither*	*Not Sure*
1	2	3	4	5

4-2. What is your overall high school average for all subjects (circle one):

99-95 94-90 89-85 84-80 79-75 74-70 69-65 under 65

4-3. Please fill in your PSAT and SAT scores.

PSAT Verbal ____________ Math ________________

SAT Verbal ____________ Math ________________

4-4. Did you take an SAT preparation course to improve your SAT score (check one)?
Yes _____________ No _______________

4-5. Please fill in the score you received for any *College Board Achievement* math tests you have taken.

Mathematics Level I _____________ Mathematics Level II _______________

4-6. Please fill in the final grade you received for each subject. If you are presently taking the course place a "X" on the line. Place a "0" on the line if you have not taken the course.

9th Grade English ______ 10th Grade English ______ 11th Grade English _______

Algebra ____________ Geometry ____________ Intermediate Algebra ________

Trigonometry ________ Pre-Calculus ________ Calculus ____________________

Other High School Math Courses (Course name and Grade received):

................__________ ....__________

................__________ ....__________

Appendix B

Items Included in the ASI and ASMI Variables

The following items from the ASI inventory were combined to form the 10 variables listed:

Deep Approach
1, 11, 21, 31, 41, 51

Holist Style
2, 12, 22, 32, 42, 52

Intrinsic Motivation
3, 13, 23, 33, 43, 53

Surface Approach
4, 14, 24, 34, 44, 54

Serialist Sytle
5, 15, 25, 35, 45, 55

Fear of Failure
6, 16, 26, 36, 46, 56

Instrumental Motivation
7, 17, 27, 37, 47, 57

Strategic Approach
8, 18, 28, 38, 48, 58

Hope for Success
9, 19, 29, 39, 49, 59

Conscientiousness
10, 20, 30, 40, 50, 60

Math Deep Approach
1, 11, 21, 31, 41, 51

Math Holist Style
2, 12, 22, 32, 42, 52

Math Intrinsic Motivation
3, 13, 23, 33, 43, 53

Math Surface Approach
4, 14, 24, 34, 44, 54

Math Serialist Sytle
5, 15, 25, 35, 45, 55

Math Fear of Failure
6, 16, 26, 36, 46, 56

Math Instrumental Motivation
7, 17, 27, 37, 47, 57

Math Strategic Approach
8, 18, 28, 38, 48, 58

Math Hope for Success
9, 19, 29, 39, 49, 59

Math Conscientiousness
10, 20, 30, 40, 50, 60

Appendix C

Correlations for the Subscales included in the School and Schoolwork Questionnaire

Table C-1. Inter-item correlations for the Approaches to Studying Inventory.

	G1	G2	G3	G4	G5	G6	G7	G8	G9	G10	G11	G12	G13	G14	G15	G16	G17	G18	G19	G20
G1	1.00																			
G2	.40**	1.00																		
G3	.34**	.37**	1.00																	
G4	-.12	-.01	-.17**	1.00																
G5	.12	-.04	-.04	.06	1.00															
G6	-.10	-.06	-.17**	.30**	.08	1.00														
G7	-.01	-.08	-.19**	.25**	.06	.10	1.00													
G8	.00	.05	.03	-.00	.18**	-.13*	-.01	1.00												
G9	.15*	.13*	.16**	-.01	-.00	.06	.01	.03	1.00											
G10	.02	.20**	.12	.01	.02	.06	.02	.08	.17**	1.00										
G11	.14*	.25**	.22**	-.08	.18**	-.08	-.07	.14*	.04	.15*	1.00									
G12	.38**	.43**	.41**	-.09	.04	-.07	-.06	.02	.18**	.21**	.26**	1.00								
G13	.25**	.38**	.47**	-.14*	.01	-.16**	-.13*	.13*	.11	.14*	.31**	.40**	1.00							
G14	-.18**	-.33**	-.30**	.11	-.03	.12*	.16**	-.04	.04	-.14*	-.10	-.24**	-.30**	1.00						
G15	-.04	-.08	-.13*	.10	.06	.25**	.09	.01	.06	.05	-.00	-.23**	-.13*	.20**	1.00					
G16	.00	.11	.01	.10	-.00	.25**	.13*	.01	.14*	.18**	-.04	-.00	-.03	.09	.15*	1.00				
G17	.14*	.14*	.12*	.08	.02	.08	.32**	-.01	.26**	.20**	.01	.10	.06	-.04	.14*	.18**	1.00			
G18	.02	.12	.14*	-.17**	-.08	.03	-.26**	.06	.07	.05	.03	.12	.06	.03	.12*	-.02	-.05	1.00		
G19	.11	.20**	.29**	-.09	.05	-.00	-.22**	.05	.19**	.17**	.19**	.29**	.22**	-.13*	-.03	.12*	.05	.11	1.00	
G20	.13*	.21**	.14*	.03	.20**	-.00	.08	.27**	.06	.19**	.28**	.12	.22**	-.10	.11	.19**	.21**	-.01	.22**	1.00
G21	.33**	.39**	.29**	.01	.10	-.10	.05	.08	.08	.12	.22**	.43**	.32**	-.20**	-.06	.01	.09	-.04	.18**	.23**
G22	.41**	.47**	.38**	-.04	.01	-.06	-.01	.02	.12*	.16**	.25**	.50**	.35**	-.30**	-.15*	.02	.15*	.06	.13*	.14*
G23	.34**	.41**	.43**	-.06	.00	-.06	-.01	.13*	.12	.16**	.21**	.31**	.37**	-.24**	-.03	.20**	.23**	.04	.13*	.27**
G24	-.08	-.00	-.01	.20**	-.04	.15*	.02	-.06	.10	-.04	-.16**	-.04	-.01	.10	.12	-.01	.11	.03	-.04	-.06
G25	-.07	.03	-.05	.09	.10	.12*	.16**	.16**	.00	.12*	.07	-.06	-.02	-.03	.14*	.22**	.03	-.02	-.00	.16**
G26	-.06	.01	-.15*	.14*	.05	.32**	.12*	-.05	.10	.12	-.02	-.08	-.09	.09	.19**	.31**	.12	-.03	-.00	.14*
G27	.06	.01	-.02	.24**	.04	.09	.40**	-.04	.10	.07	.06	-.03	-.06	.10	.14*	.14*	.31**	-.25**	-.05	.13*
G28	.00	.05	.04	.02	.14*	-.00	.04	.47**	.04	.14*	.13*	-.05	.11	-.02	.17**	.17**	.10	.08	.15*	.35**
G29	.19**	.25**	.35**	-.06	-.00	.08	-.04	.01	.29**	.25**	.20**	.30**	.25**	-.09	.01	.24**	.23**	.16**	.50**	.26**
G30	.21**	.25**	.25**	-.07	.13*	-.09	.02	.21**	.07	.18**	.27**	.23**	.32**	-.16**	-.01	.03	.15*	-.05	.21**	.35**
G31	.26**	.08	.13*	-.13*	.15*	-.15*	.10	.04	.05	.03	.23**	.21**	.25**	-.10	-.01	-.05	.06	.04	.11	.03
G32	.16**	.15*	.03	.12	.09	.06	.14*	-.00	.07	.10	.22**	.10	.15*	-.02	.10	.14*	.22**	-.02	.03	.22**
G33	.28**	.35**	.36**	-.02	.06	-.05	.06	.11	.13*	.19**	.12*	.36**	.30**	-.26**	-.11	.02	.14*	-.01	.16**	.13*
G34	-.13*	-.08	-.14*	.22**	.07	.19**	.29**	-.01	.02	.03	-.02	-.17**	-.16**	.20**	.29**	.18**	.18**	-.06	-.04	.10
G35	-.07	-.02	-.06	.10	.07	.17**	.10	.04	.16**	.08	.00	.01	-.03	.12	.21**	.06	.12	-.05	-.04	.12
G36	.04	.05	-.03	.06	.01	.24**	.23**	-.10	.13*	.12	-.04	.00	-.06	.18**	.12	.33**	.21**	-.05	.00	.16**
G37	-.01	-.07	-.19**	.16**	.07	.11	.40**	-.16**	.10	.01	-.02	-.07	-.07	.15*	.05	.10	.17**	-.15*	-.11	.04
G38	.18**	.13*	.11	-.04	.15*	-.06	.07	.15*	.06	.09	.37**	.17**	.18**	-.06	.16**	.02	.11	-.00	.17**	.28**
G39	.22**	.33**	.22**	.01	.02	.03	.03	.07	.14*	.16**	.28**	.31**	.18**	-.16**	-.04	.15*	.20**	.07	.19**	.23**
G40	.28**	.20**	.27**	-.09	.15*	-.06	-.00	.25**	.16**	.17**	.34**	.29**	.22**	-.12*	-.04	.04	.13*	.11	.23**	.26**
G41	.11	.04	.06	.03	.07	-.02	.03	.16**	-.02	.00	.12	.11	.13*	-.11	.02	-.09	.01	.00	.02	.09
G42	.04	.00	.04	.06	.03	.08	.19**	-.11	.09	.00	.00	.13*	-.00	-.00	-.01	.02	.15*	.00	.06	.03
G43	.25**	.24**	.35**	-.11	.06	-.12*	-.06	.10	.07	.15*	.23**	.35**	.58**	-.24**	-.10	-.08	.12*	.11	.20**	.20**
G44	-.05	.05	-.06	.12*	-.05	.13*	-.02	-.11	.12*	-.02	-.09	-.03	-.14*	.09	.03	.19**	.07	-.04	.03	-.07
G45	-.03	.06	.00	.07	.12	.17**	.06	.00	-.10	.03	-.06	-.04	-.03	-.01	.17**	.21**	.10	-.07	.06	.20**
G46	-.21**	-.09	-.29**	.20**	-.13*	.28**	.20**	-.16**	.04	-.05	-.27**	-.21**	-.28**	.20**	.07	.09	.00	-.03	-.17**	-.27**
G47	-.17**	-.16**	-.22**	.12*	.09	.13*	.42**	-.08	.01	-.03	-.08	-.20**	-.12*	.19**	.11	.08	.13*	-.23**	-.19**	-.00
G48	.07	.10	-.04	.10	.19**	-.00	.13*	.29**	-.00	.07	.18**	.06	.06	-.06	.12	.10	.05	-.04	.07	.24**
G49	.01	-.00	.04	-.01	.10	.02	-.05	.09	.10	.01	.11	.05	.11	-.03	-.00	.09	.02	.01	.09	.16**
G50	.04	.09	.09	-.00	.12	-.07	.08	.36**	.02	.18**	.22**	.07	.15*	-.07	.06	.13*	.16**	-.05	.13*	.43**
G51	.24**	.24**	.10	-.01	.10	-.03	.01	.24**	.06	.16**	.20**	.21**	.21**	-.11	.02	.16**	.16**	-.00	.15*	.33**
G52	.28**	.38**	.31**	-.07	-.04	-.07	-.04	-.04	.09	.09	.11	.39**	.27**	-.16**	-.07	.04	.14*	.09	.20**	.07
G53	.30**	.37**	.52**	-.09	.01	-.12*	-.10	.04	.02	.10	.30**	.42**	.57**	-.25**	-.10	-.04	.13*	.05	.27**	.26**
G54	-.23**	-.29**	-.38**	.12	-.01	.14*	.09	.00	-.02	-.05	-.17**	-.37**	-.27**	.31**	.26**	.09	-.01	-.00	-.09	-.06
G55	.20**	.22**	.11	.06	.08	-.02	-.01	.10	.10	.09	.16**	.21**	.14*	-.20**	-.03	-.05	.17**	.02	.12	.15*
G56	-.05	-.03	-.01	.15*	-.04	.09	.13*	-.05	.06	.02	-.11	.02	-.08	.10	.05	.09	.11	-.01	.07	.01
G57	.13*	.13*	.12*	.17**	-.00	.02	.34**	-.03	.14*	.10	.00	.12*	.02	-.01	.00	.10	.32**	-.16**	-.01	.12
G58	.09	.10	.02	.03	.18**	-.03	.11	.45**	.06	.18**	.11	.05	.06	-.01	.13*	.11	.13*	-.02	.07	.29**
G59	.11	.09	.14*	-.05	-.04	.05	-.15*	-.00	.24**	.15*	.06	.13*	.05	.00	.07	.14*	.05	.15*	.22**	.03
G60	.19**	.21**	.23**	-.03	.09	-.07	-.00	.28**	.06	.20**	.23**	.13*	.18**	-.15*	-.02	.07	.06	-.01	.17**	.32**

Note. N = 420 * - p < .01 ** - p < .001 (2-TAILED)

Table C-2
Inter-item correlations for the Approaches to Studying Inventory.

	G21	G22	G23	G24	G25	G26	G27	G28	G29	G30	G31	G32	G33	G34	G35	G36	G37	G38	G39	G40
G21	1.00																			
G22	.40**	1.00																		
G23	.40**	.41**	1.00																	
G24	.02	-.08	.04	1.00																
G25	.02	-.06	.06	.03	1.00															
G26	.00	-.00	.09	.04	.24**	1.00														
G27	.11	.02	.06	.05	.13*	.20**	1.00													
G28	.07	-.00	.17**	.02	.28**	.10	.13*	1.00												
G29	.20**	.24**	.31**	-.07	.06	.12*	.03	.12	1.00											
G30	.29**	.27**	.29**	-.05	.09	-.04	.10	.24**	.22**	1.00										
G31	.24**	.20**	.07	.00	.00	-.03	.02	.05	.03	.16**	1.00									
G32	.20**	.23**	.20**	-.06	.13*	.13*	.22**	.14*	.16**	.15*	.15*	1.00								
G33	.39**	.35**	.37**	.02	.06	.01	.05	.06	.21**	.29**	.18**	.03	1.00							
G34	-.05	-.13*	.02	.13*	.25**	.21**	.28**	.18**	-.02	-.06	-.06	.19**	-.02	1.00						
G35	.07	.00	.03	.08	.14*	.14*	.20**	.04	.07	.01	.00	.06	-.01	.30**	1.00					
G36	.03	.03	.10	.13*	.12	.31**	.21**	.01	.15*	.06	-.05	.03	.13*	.23**	.21**	1.00				
G37	.03	-.03	-.02	.06	.10	.19**	.34**	-.04	-.01	.02	.10	.15*	.02	.19**	.10	.25**	1.00			
G38	.22**	.15*	.19**	-.19**	.14*	-.01	.15*	.27**	.15*	.29**	.26**	.25**	.13*	.02	.02	.00	.12*	1.00		
G39	.27**	.36**	.29**	-.04	.05	.06	.09	.18**	.27**	.29**	.19**	.25**	.20**	-.05	.00	.07	.06	.38**	1.00	
G40	.22**	.28**	.26**	-.19**	.07	-.04	.01	.21**	.24**	.45**	.20**	.10	.30**	-.16**	.05	.00	-.05	.30**	.35**	1.00
G41	.15*	.18**	.15*	-.02	-.00	.01	.02	.10	.11	.24**	.12*	.12	.11	-.07	-.04	-.05	-.06	.11	.04	.17**
G42	.08	.07	.06	.07	.08	.03	.13*	-.00	.11	.01	.02	.02	.13*	.09	.05	.11	.06	-.03	.05	.10
G43	.26**	.31**	.25**	-.05	-.06	-.11	-.05	.08	.23**	.32**	.18**	.13*	.29**	-.12	-.11	-.07	-.01	.16**	.18**	.24**
G44	-.06	-.05	-.06	.04	.05	.13*	.03	-.10	.03	-.06	-.14*	-.02	.05	.15*	.09	.21**	.13*	-.13*	.08	-.03
G45	.05	-.01	.11	.07	.18**	.19**	.06	.11	.07	.05	.00	.00	.08	.14*	.12*	.10	.11	.07	.09	.05
G46	-.15*	-.14*	-.23**	.21**	.02	.24**	.11	-.12*	-.12*	-.28**	-.16**	-.09	-.10	.19**	.13*	.23**	.23**	-.23**	-.14*	-.24**
G47	-.00	-.09	-.17**	.08	.10	.17**	.35**	-.01	-.13*	.00	.02	.08	-.03	.24**	.20**	.17**	.46**	-.00	-.08	-.10
G48	.18**	.13*	.13*	-.07	.17**	.04	.09	.32**	.07	.27**	.04	.12*	.11	.11	.05	.01	-.02	.23**	.12*	.21**
G49	.04	-.01	.07	.02	.04	.14*	.04	.10	.10	.10	-.05	.00	.00	.02	.09	.16**	-.01	.06	.09	.06
G50	.14*	.12	.21**	-.11	.21**	.09	.07	.37**	.16**	.39**	.08	.07	.12	.00	.13*	.08	-.02	.35**	.24**	.35**
G51	.27**	.31**	.26**	-.02	.11	.15*	.06	.25**	.17**	.31**	.11	.13*	.24**	-.02	.06	.08	-.01	.23**	.21**	.29**
G52	.29**	.40**	.29**	-.04	-.04	-.08	-.01	-.04	.30**	.17**	.12	.14*	.32**	-.15*	.01	-.00	-.10	.09	.18**	.20**
G53	.30**	.35**	.35**	-.04	-.04	-.11	-.05	.03	.30**	.36**	.18**	.17**	.36**	-.16**	-.07	-.01	-.07	.21**	.26**	.28**
G54	-.30**	-.33**	-.30**	.10	.10	.13*	.05	.05	-.12	-.26**	-.11	-.03	-.33**	.23**	.11	.08	-.00	-.06	-.19**	-.17**
G55	.16**	.21**	.20**	.03	.07	.03	.09	.14*	.10	.12*	.14*	.13*	.27**	-.05	.00	-.03	-.05	.15*	.25**	.22**
G56	-.01	-.01	-.02	.17**	.09	.09	.12*	-.05	.06	.01	-.03	-.02	.09	.17**	.17**	.21**	.13*	-.10	.04	-.01
G57	.19**	.23**	.13*	.05	.05	.08	.31**	-.04	.16**	.16**	.07	.16**	.22**	.08	.07	.20**	.24**	.08	.09	.09
G58	.17**	.14*	.26**	-.07	.24**	.02	.18**	.52**	.08	.28**	.04	.13*	.16**	.11	.12	.02	-.04	.25**	.12	.33**
G59	-.00	.08	.13*	.07	.03	.04	-.07	.02	.28**	.06	.00	-.00	.03	.02	.02	.12	-.05	-.04	.19**	.17**
G60	.17**	.21**	.20**	-.06	.17**	-.02	.05	.35**	.15*	.38**	.10	.11	.16**	.00	.07	.02	-.02	.23**	.21**	.38**

Note. N = 420 * - p < .01 ** - p < .001 (2-TAILED)

Table C-3
Inter-item correlations for the Approaches to Studying Inventory.

	G41	G42	G43	G44	G45	G46	G47	G48	G49	G50	G51	G52	G53	G54	G55	G56	G57	G58	G59	G60
G41	1.00																			
G42	.22**	1.00																		
G43	.18**	.07	1.00																	
G44	-.38**	.01	.10	1.00																
G45	-.04	.01	.04	.09	1.00															
G46	-.12	.12*	.25**	.23**	.00	1.00														
G47	-.00	.09	.10	.08	.15*	.30**	1.00													
G48	.19**	.04	.03	-.07	.07	-.08	.05	1.00												
G49	.00	.01	.03	.10	-.03	-.02	-.08	.15*	1.00											
G50	.10	.01	.13*	-.10	.12*	-.21**	.02	.31**	.16**	1.00										
G51	.19**	.05	.23**	-.04	.09	-.16**	-.05	.21**	.14*	.64**	1.00									
G52	.17**	.17**	.24**	-.01	.02	-.15*	-.14*	.09	-.01	.10	.22**	1.00								
G53	.14*	.10	.57**	-.01	.04	-.36**	-.17**	.02	.03	.17**	.23**	.36**	1.00							
G54	-.17**	-.04	.20**	.09	.06	.26**	.13*	-.00	.08	-.05	-.09	-.25**	-.29**	1.00						
G55	.09	.07	.18**	-.04	.05	-.07	-.07	.10	-.02	.11	.15*	.19**	.17**	-.12	1.00					
G56	.01	.03	.03	.16**	.08	.18**	.13*	-.07	.15*	-.11	-.06	-.00	-.00	.15*	.04	1.00				
G57	-.00	.15*	.01	.09	.06	.13*	.30**	.12*	-.07	.16**	.16**	.15*	.02	-.09	.17**	.08	1.00			
G58	.13*	-.03	.07	-.09	.09	-.11	-.00	.40**	.00	.40**	.32**	.07	.04	-.03	.11	-.00	.16**	1.00		
G59	.00	.05	.08	.12	.04	.01	-.07	.00	.05	.09	.17**	.13*	.07	.01	.08	.14*	.09	.11	1.00	
G60	.08	.03	.13*	-.06	.09	-.19**	-.07	.27**	.03	.34**	.21**	.10	.16**	-.15*	.17**	-.05	.17**	.34**	.19**	1.00

Note. N = 420 * - $p < .01$ ** - $p < .001$ (2-TAILED)

Table C-4
Inter-item correlations for the Approaches to Studying Mathematics Inventory.

	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15	M16	M17	M18	M19	M20
M1	1.00																			
M2	.55**	1.00																		
M3	.49**	.57**	1.00																	
M4	-.18**	-.19**	-.26**	1.00																
M5	.08	.04	.03	.08	1.00															
M6	-.26**	-.30**	-.39**	.28**	.07	1.00														
M7	-.13*	-.16**	-.18**	.28**	.16**	.22**	1.00													
M8	.13*	.06	.16**	-.11	.17**	-.11	-.09	1.00												
M9	.12*	.22**	.19**	-.13*	.04	-.03	-.04	.08	1.00											
M10	.29**	.19**	.21**	-.04	.16**	-.06	.00	.13*	.21**	1.00										
M11	.26**	.27**	.29**	-.11	.24**	-.10	-.05	.18**	.15*	.26**	1.00									
M12	.48**	.51**	.53**	-.19**	.01	-.24**	-.11	.05	.27**	.21**	.28**	1.00								
M13	.52**	.49**	.63**	-.21**	.07	-.34**	-.12*	.22**	.12	.22**	.31**	.46**	1.00							
M14	-.28**	-.38**	-.39**	.27**	-.03	.27**	.18**	-.10	-.08	-.04	-.14*	-.23**	-.35**	1.00						
M15	-.17**	-.23**	-.17**	.22**	.18**	.25**	.13*	.04	-.15*	.09	-.08	-.24**	-.15*	.22**	1.00					
M16	.02	.01	-.00	-.01	.09	.21**	.04	.00	.12*	.11	-.04	.03	-.04	.10	.20**	1.00				
M17	.12	.10	.09	.01	.15*	.07	.19**	.02	.16**	.25**	.10	.10	.07	-.03	.11	.14*	1.00			
M18	.14*	.17**	.23**	-.09	.04	-.10	-.18**	.12	.16**	.09	.06	.19**	.16**	-.07	-.08	.03	-.04	1.00		
M19	.18**	.24**	.31**	-.18**	.11	-.10	-.14*	.19**	.24**	.22**	.24**	.27**	.33**	-.14*	-.10	.10	.03	.17**	1.00	
M20	.20**	.22**	.26**	-.06	.21**	-.06	.01	.27**	.12	.24**	.25**	.12	.28**	-.13*	.04	.19**	.18**	.04	.23**	1.00
M21	.41**	.46**	.48**	-.12*	.09	-.22**	-.07	.09	.22**	.21**	.28**	.49**	.48**	-.28**	-.19**	.04	.15*	.02	.23**	.27**
M22	.47**	.54**	.51**	-.15*	.06	-.23**	-.18**	.05	.18**	.20**	.25**	.61**	.44**	-.23**	-.20**	.02	.09	.14*	.24**	.22**
M23	.42**	.49**	.61**	-.21**	.05	-.29**	-.13*	.21**	.16**	.25**	.25**	.41**	.52**	-.28**	-.10	.04	.10	.14*	.22**	.27**
M24	-.17**	-.21**	-.30**	.29**	.01	.25**	.19**	-.06	-.09	-.00	-.18**	-.24**	-.23**	.20**	.21**	.03	.03	-.10	-.12*	-.09
M25	-.22**	-.17**	-.17**	.17**	.23**	.18**	.15*	.19**	-.01	.02	.01	-.23**	-.06	.18**	.23**	.16**	.08	-.09	.05	.13*
M26	-.06	-.05	-.09	.08	.15*	.26**	.16**	.07	.07	.05	-.05	-.05	-.07	.18**	.12	.45**	.14*	-.05	.05	.13*
M27	-.06	-.04	-.06	.17**	.15*	.14*	.33**	-.04	.06	.18**	.03	-.09	-.04	.14*	.14*	.08	.24**	-.16**	-.01	.18**
M28	.02	.00	.04	-.03	.18**	.01	.00	.62**	.11	.17**	.11	-.06	.08	-.03	.12*	.09	.10	.05	.06	.25**
M29	.18**	.18**	.29**	-.13*	.11	-.01	-.06	.12	.26**	.36**	.19**	.17**	.25**	-.04	-.02	.19**	.19**	.11	.52**	.29**
M30	.22**	.24**	.30**	-.09	.13*	-.13*	-.00	.30**	.13*	.26**	.32**	.20**	.35**	-.16**	-.04	-.01	.11	.00	.29**	.41**
M31	.36**	.17**	.18**	-.03	.08	-.12	-.00	.10	.09	.13*	.21**	.20**	.25**	-.13*	.00	-.06	.08	.02	.05	.10
M32	.11	.14*	.08	.02	.15*	.05	.07	.00	-.03	.06	.08	.06	.11	-.02	.12	.08	.23**	-.03	-.01	.12
M33	.35**	.31**	.41**	-.12	-.01	-.26**	-.01	.15*	.19**	.17**	.10	.37**	.37**	-.18**	-.15*	-.00	.11	.10	.19**	.14*
M34	-.24**	-.29**	-.30**	.20**	.18**	.33**	.25**	-.04	-.08	.09	-.08	-.27**	-.25**	.29**	.35**	.18**	.15*	-.10	-.10	-.00
M35	-.14*	-.20**	-.16**	.16**	.20**	.15*	.18**	.04	.04	.13*	-.12*	-.13*	-.13*	.18**	.21**	.15*	.08	-.09	.01	.06
M36	-.16**	-.20**	-.22**	.19**	.03	.29**	.26**	-.13*	.04	.05	-.10	-.14*	-.15*	.28**	.13*	.28**	.21**	-.05	.01	.06
M37	-.15*	-.09	-.19**	.22**	.04	.32**	.33**	-.23**	-.00	.04	-.06	-.07	-.16**	.22**	.15*	.22**	.12	-.18**	-.06	-.04
M38	.24**	.21**	.26**	-.04	.29**	-.10	.04	.25**	.07	.28**	.46**	.15*	.29**	-.13*	.01	.05	.17**	.04	.20**	.35**
M39	.40**	.41**	.47**	-.12*	.12*	-.15*	-.08	.15*	.20**	.24**	.30**	.40**	.39**	-.21**	-.04	.14*	.17**	.14*	.24**	.21**
M40	.35**	.31**	.30**	-.08	.20**	-.18**	-.08	.26**	.14*	.23**	.37**	.30**	.35**	-.16**	-.08	-.01	.13*	.14*	.31**	.20**
M41	.21**	.24**	.28**	-.03	.22**	-.10	-.00	.18**	.06	.11	.15*	.15*	.19**	-.12*	-.00	-.01	.17**	.06	.08	.12*
M42	.10	.09	.10	.06	-.00	.01	.11	-.08	.07	.04	-.02	.11	.06	.00	.03	.20**	.08	.06	.01	.09
M43	.51**	.49**	.61**	-.19**	.06	-.29**	-.21**	.16**	.16**	.23**	.32**	.48**	.71**	-.28**	-.18**	-.06	.03	.22**	.33**	.25**
M44	-.09	-.15*	-.21**	.13*	-.07	.17**	.01	-.03	-.02	-.04	-.16**	-.01	-.15*	.20**	.07	.20**	-.06	.02	-.01	-.16**
M45	-.16**	-.14*	-.16**	.17**	.09	.18**	.12	.05	.00	.07	.00	-.18**	-.08	.14*	.20**	.07	.00	-.11	.08	.08
M46	-.40**	-.38**	-.49**	.32**	-.09	.33**	.20**	-.20**	-.14*	-.29**	-.32**	-.32**	-.46**	.29**	.09	.07	-.05	-.16**	-.29**	-.31**
M47	-.21**	-.24**	-.30**	.27**	.00	.25**	.34**	-.20**	-.08	-.02	-.18**	-.29**	-.31**	.27**	.24**	.12	.13*	-.26**	-.26**	-.02
M48	.16**	.10	.16**	-.01	.21**	-.05	-.00	.31**	.10	.21**	.26**	.04	.10	-.05	.10	.11	.12*	-.00	.08	.19**
M49	.11	.12*	.14*	-.01	.04	-.03	-.03	.15*	.14*	.08	.13*	.10	.15*	-.05	.02	.11	.03	.03	.19**	.19**
M50	.17**	.13*	.20**	-.09	.17**	-.05	.00	.42**	.11	.25**	.29**	.11	.26**	-.09	.06	.14*	.17**	.05	.25**	.42**
M51	.29**	.25**	.21**	-.01	.15*	-.08	.03	.28**	.11	.21**	.20**	.23**	.21**	-.11	.03	.13*	.16**	.02	.20**	.27**
M52	.31**	.29**	.27**	-.08	.03	-.17**	-.05	.09	.13*	.21**	.18**	.39**	.27**	-.10	-.10	.03	.05	.12	.09	.10
M53	.52**	.45**	.63**	-.20**	.06	-.33**	-.15*	.22**	.15*	.25**	.29**	.48**	.70**	-.26**	-.13*	-.03	.11	.15*	.29**	.25**
M54	-.29**	-.37**	-.39**	.19**	.02	.30**	.16**	-.07	-.15*	-.09	-.13*	-.33**	-.31**	.32**	.25**	.13*	-.02	-.12	-.06	-.13*
M55	.23**	.23**	.21**	.00	.08	-.13*	-.01	.23**	.17**	.09	.17**	.21**	.16**	-.06	.00	.05	.17**	.06	.09	.23**
M56	-.02	-.03	-.10	.11	-.03	.15*	.10	-.08	.07	-.00	-.02	-.04	-.07	.19**	.13*	.20**	.12*	.01	.03	-.01
M57	.12*	.09	.06	.02	.05	.05	.32**	-.01	.08	.20**	.01	.05	.06	-.01	.07	.06	.28**	-.10	.07	.15*
M58	.18**	.11	.19**	-.08	.15*	-.05	-.01	.57**	.08	.18**	.13*	.06	.27**	-.12	.05	.02	.08	.03	.20**	.35**
M59	.07	-.00	.08	-.08	-.00	.12	-.04	.05	.25**	.13*	-.02	.14*	.08	.02	-.01	.17**	.08	.12	.29**	.09
M60	.18**	.15*	.18**	-.08	.14*	-.02	.05	.35**	.09	.29**	.23**	.20**	.17**	-.02	.04	.10	.08	.00	.18**	.26**

Note. N = 420 * - p < .01 ** - p < .001 (2-TAILED)

Table C-5
Inter-item correlations for the Approaches to Studying Mathematics Inventory.

	M21	M22	M23	M24	M25	M26	M27	M28	M29	M30	M31	M32	M33	M34	M35	M36	M37	M38	M39	M40
M21	1.00																			
M22	.52**	1.00																		
M23	.41**	.48**	1.00																	
M24	-.10	-.20**	-.15*	1.00																
M25	-.05	-.19**	-.13*	.18**	1.00															
M26	.02	-.03	.01	.15*	.30**	1.00														
M27	.07	-.01	.01	.14*	.20**	.23**	1.00													
M28	.08	-.00	.09	-.02	.28**	.09	.09	1.00												
M29	.22**	.18**	.17**	-.09	.12	.12*	.10	.17**	1.00											
M30	.28**	.24**	.28**	-.12	.09	.03	.14*	.30**	.29**	1.00										
M31	.26**	.22**	.16**	-.02	.00	-.02	.04	.13*	.04	.19**	1.00									
M32	.11	.16**	.11	.06	.10	.06	.22**	.11	.01	.09	.01	1.00								
M33	.37**	.37**	.45**	-.04	-.06	-.00	.02	.09	.17**	.32**	.18**	.10	1.00							
M34	-.15*	-.24**	-.18**	.26**	.26**	.24**	.25**	.06	-.03	-.14*	-.12	.18**	-.22**	1.00						
M35	-.03	-.03	.00	.24**	.18**	.23**	.20**	.07	.00	-.01	-.06	.04	-.04	.34**	1.00					
M36	-.06	-.16**	-.05	.24**	.13*	.32**	.23**	-.07	.03	-.04	-.07	.03	.04	.27**	.24**	1.00				
M37	.00	-.05	-.12	.12	.16**	.29**	.31**	-.14*	.01	-.06	-.04	.14*	-.06	.35**	.24**	.32**	1.00			
M38	.32**	.26**	.23**	-.10	.20**	.03	.15*	.28**	.21**	.35**	.28**	.18**	.16**	.04	.04	-.09	.02	1.00		
M39	.36**	.36**	.37**	-.12	-.08	.05	.03	.14*	.21**	.31**	.18**	.12*	.29**	-.11	-.04	-.10	-.03	.30**	1.00	
M40	.31**	.34**	.28**	-.14*	.11	-.01	.03	.14*	.15*	.36**	.25**	.14*	.27**	-.10	-.00	-.11	-.07	.42**	.38**	1.00
M41	.27**	.20**	.26**	-.03	-.02	-.00	.05	.06	.09	.19**	.18**	.12	.18**	-.03	.02	-.06	-.01	.23**	.24**	.31**
M42	.10	.08	.06	.07	-.00	.10	.12	-.10	.06	-.05	.03	.10	.14*	.04	.15*	.12	.24**	.00	.19**	.02
M43	.46**	.51**	.51**	-.23**	-.11	-.10	-.07	.07	.23**	.33**	.29**	.11	.38**	-.22**	-.11	-.15*	-.18**	.32**	.41**	.40**
M44	-.10	-.08	-.09	.16**	.09	.09	-.02	.00	-.06	-.14*	-.15*	-.03	-.06	.17**	.16**	.18**	.09	-.14*	-.07	-.16**
M45	-.01	-.13*	-.10	.19**	.23**	.13*	.12*	.12*	.05	.17**	-.10	-.02	-.05	.27**	.25**	.13*	.21**	.10	-.03	-.01
M46	-.30**	-.30**	-.36**	.29**	.08	.06	.01	-.17**	-.30**	-.35**	-.19**	-.13*	-.24**	.17**	.13*	.20**	.27**	-.31**	-.30**	-.28**
M47	-.09	-.17**	-.17**	.29**	.06	.21**	.31**	-.10	-.09	-.07	.02	.03	-.07	.28**	.21**	.26**	.51**	-.05	-.15*	-.18**
M48	.19**	.14*	.13*	-.05	.21**	.14*	.17**	.33**	.18**	.29**	.11	.17**	.12	-.00	.01	-.02	-.04	.30**	.24**	.30**
M49	.12*	.12*	.21**	-.06	.08	.17**	.11	.17**	.12	.15*	.04	-.02	.15*	-.05	.07	.11	-.01	.12	.19**	.13*
M50	.28**	.18**	.27**	-.03	.24**	.19**	.16**	.48**	.27**	.46**	.19**	.11	.21**	.00	.10	.01	-.07	.40**	.34**	.35**
M51	.26**	.31**	.28**	.01	.08	.14*	.12	.27**	.20**	.30**	.18**	.17**	.24**	-.03	.07	-.02	-.05	.29**	.26**	.25**
M52	.20**	.35**	.33**	-.01	-.10	.04	.09	.02	.08	.13*	.16**	.11	.28**	-.11	-.01	-.07	-.08	.19**	.25**	.25**
M53	.45**	.50**	.49**	-.23**	-.06	-.11	-.00	.12*	.28**	.38**	.26**	.15*	.45**	-.26**	-.09	-.22**	-.14*	.32**	.44**	.40**
M54	-.30**	-.40**	-.32**	.23**	.27**	.14*	.12*	-.02	-.10	-.22**	-.13*	.07	-.38**	.28**	.18**	.18**	.24**	-.08	-.20**	-.16**
M55	.24**	.18**	.18**	-.09	.06	.02	.02	.20**	.05	.24**	.15*	.16**	.25**	-.03	.02	-.04	-.01	.26**	.32**	.17**
M56	-.04	-.09	.02	.16**	.13*	.18**	.11	.00	.11	-.05	.05	.03	-.02	.22**	.12	.16**	.18**	-.03	.02	-.03
M57	.12	.07	.13*	.07	.03	.11	.35**	.02	.12	.15*	.09	.17**	.17**	.13*	.08	.23**	.23**	.10	.05	.02
M58	.21**	.12	.26**	-.00	.19**	.06	.09	.50**	.17**	.33**	.06	.10	.24**	-.06	.05	.00	-.13*	.26**	.18**	.21**
M59	.05	.08	.10	-.04	.07	.07	.04	.06	.33**	.06	-.01	.00	.14*	.01	-.00	.13*	.02	-.00	.11	.12*
M60	.14*	.18**	.18**	-.05	.11	.06	.12	.34**	.16**	.40**	.13*	.05	.19**	-.05	.01	-.05	-.06	.28**	.23**	.30**

Note. N = 420 * - p < .01 ** - p < .001 (2-TAILED)

Table C-6. Inter-item correlations for the Approaches to Studying Mathematics Inventory.

	M41	M42	M43	M44	M45	M46	M47	M48	M49	M50	M51	M52	M53	M54	M55	M56	M57	M58	M59	M60
M41	1.00																			
M42	.20**	1.00																		
M43	.21**	.07	1.00																	
M44	-.46**	-.00	-.10	1.00																
M45	-.02	-.03	-.07	.11	1.00															
M46	-.18**	.01	-.47**	.24**	.07	1.00														
M47	-.02	.15*	-.34**	.07	.21**	.40**	1.00													
M48	.21**	.08	.14*	-.03	.02	-.19**	.03	1.00												
M49	.10	.05	.17**	.02	.04	-.11	-.04	.12	1.00											
M50	.18**	.01	.26**	-.06	.15*	-.29**	-.03	.39**	.24**	1.00										
M51	.20**	.05	.29**	.00	-.00	-.19**	-.02	.32**	.11	.60**	1.00									
M52	.14*	.12	.31**	-.05	-.17**	-.21**	-.13*	.15*	.10	.11	.29**	1.00								
M53	.21**	.07	.68**	-.11	-.09	-.43**	-.26**	.15*	.13*	.26**	.30**	.37**	1.00							
M54	-.17**	.00	-.34**	.17**	.19**	.26**	.19**	-.06	-.09	-.07	-.14*	-.18**	-.34**	1.00						
M55	.20**	.07	.18**	-.07	-.02	-.20**	-.04	.19**	.05	.26**	.16**	.10	.25**	-.04	1.00					
M56	-.12	.13*	-.02	.22**	.10	.12	.22**	-.01	.15*	.04	.02	-.01	-.04	.12	.00	1.00				
M57	.09	.07	.01	.02	.00	.05	.22**	.17**	.09	.15*	.17**	.08	.12	-.03	.11	.11	1.00			
M58	.16**	.01	.20**	-.03	.16**	-.22**	-.11	.30**	.14*	.45**	.30**	.11	.25**	-.01	.25**	.00	.20**	1.00		
M59	-.06	.07	.05	.10	-.00	.02	-.03	-.01	.15*	.13*	.03	.02	.06	.05	-.00	.18**	.14*	.14*	1.00	
M60	.06	-.00	.21**	-.02	.07	-.22**	-.10	.29**	.09	.43**	.31**	.12*	.24**	-.05	.19**	-.01	.21**	.36**	.15*	1.00

Note. N = 420 * - p < .01 ** - p < .001 (2-TAILED)

Table C-7
Inter-item correlations for Section 3 of the School and Schoolwork Inventory.

Section 3 Items

	1	2	3	4	5	6	7	8	9	10
1)	1.00									
2)	-.02	1.00								
3)	-.06	.48**	1.00							
4)	-.12	.22**	.27**	1.00						
5)	.20**	.03	.10	.11	1.00					
6)	.05	.17**	.25**	.36**	.21**	1.00				
7)	.24**	-.41**	-.29**	-.43**	-.02	-.20**	1.00			
8)	-.12*	.26**	.24**	.51**	.04	.27**	-.39**	1.00		
9)	.11	.35**	.27**	.26**	.20**	.15*	-.29**	.20**	1.00	
10)	.12	-.10	-.06	-.36**	.02	-.29**	.38**	-.33**	-.12	1.00

Note. N = 420 * - $p < .01$ ** - $p < .001$ (2-TAILED)

Table C-8
Inter-item correlations for Section 4 of the School and Schoolwork Questionnaire.

	Section 4 Items												
	SCHOOL	GENDER	VSAT	MSAT	GPA	NOM	MGP	MLSO	RLSO	ALSO	MMLSO	MRLSO	MALSO
SCHOOL	1.00												
GENDER	.04	1.00											
VSAT	.55**	.07	1.00										
MSAT	.51**	.19**	.74**	1.00									
GPA	.12	-.07	.39**	.48**	1.00								
NOM	.28**	.07	.38**	.51**	.33**	1.00							
MGPA	.13*	-.03	.23**	.27**	.30**	.48**	1.00						
MLSO	.13*	-.18**	.24**	.15*	.09	.16**	.04	1.00					
RLSO	-.16**	.10	-.40**	-.27**	-.19**	-.21**	-.13*	-.35**	1.00				
ALSO	-.08	-.27**	-.12	-.16**	.12*	.01	.10	.24**	-.04	1.00			
MMLSO	.12	-.07	.11	.21**	.20**	.23**	.14*	.46**	-.20**	.20**	1.00		
MRLSO	-.14*	-.06	-.21**	-.30**	-.25**	-.24**	-.08	-.08	.37**	-.01	-.29	1.00	
MALSO	-.13*	-.18**	-.15*	-.07	.18**	.05	.15*	.18**	-.08	.59**	.39**	.07	1.00

Note. N = 420 * - p < .01 ** - p < .001 (2-TAILED)

Table C-9
Correlations for Section 3 and Section 4 variables, of the School and Schoolwork questionnaire and the Learning Style Orientations.

	Section 3 Questions									
	1	2	3	4	5	6	7	8	9	10
Section 4										
SCHOOL	-.05	-.15*	-.19**	-.20**	-.02	-.16**	.30**	-.27**	-.15*	.17**
GENDER	.12	-.08	-.04	-.21**	.01	-.10	.15*	-.08	-.02	.15*
VSAT	-.08	-.34**	-.35**	-.39**	-.10	-.25**	.45**	-.33**	-.32**	.26**
MSAT	.11	-.44**	-.37**	-.43**	-.00	-.23**	.60**	-.39**	-.32**	.34**
GPA	.04	-.35**	-.22**	-.14*	.06	.00	.29**	-.15*	-.07	.08
NOMa	.05	-.30**	-.23**	-.17**	.03	-.11	.34**	-.16**	-.16**	.13*
MGPA	.06	-.23**	-.10	-.11	.03	.01	.17**	-.09	-.06	.04
MLSO	.09	-.04	-.01	.05	.03	.05	.13*	.04	.06	.07
RLSO	.08	.17**	.22**	.21**	.16**	.13*	-.12*	.14*	.17**	-.06
ALSO	.00	.14*	.12*	.11	.09	.21**	-.11	.12	.13*	-.09
MMLSO	.31**	-.10	-.11	-.05	.22**	.01	.21**	-.10	.12	.12*
MRLSO	-.13*	.19**	.34**	.25**	-.00	.19**	-.25**	.25**	.00	-.12
MALSO	.22**	.07	.03	.01	.22**	.16**	-.01	.01	.15*	-.01

Note. * - p < .01 ** - p < .001 (2-TAILED)

a - Number of high school Math Courses taken (NOM)

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