STUDENTS' PERCEPTIONS OF EFFORT IN MATHEMATICS

By

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ABSTRACT

This study was designed to investigate students' conceptualization of effort and its relationship to gender and achievement. Seventy-six intermediate students (aged 12-14) responded to a question that elicited statements describing students' perception of effort. The statements were categorized under three main effort categories: Actions, Beliefs and Cognition. Boys used significantly more statements classified as "Actions" than girls and there was a tendency for girls to use more of the "Beliefs" descriptors. No gender differences were found for the "Cognition" category. There was only one significant correlation between effort categories and achievement: The frequency of "Cognition" statements was positively related to achievement.

DEDICATION:

This thesis is dedicated to my husband, Tim, and my children Matthew, Steven, Jessica, and Stephanie, who sacrificed many hours with their wife and mother for the sake of this research and to my advisor Erika Kuendiger for the unbelievable number of hours and guidance and unwavering support provided during the writing of this paper.

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CHAPTER I

PURPOSE OF THE STUDY

The Education Quality and Accountability Office (E.Q.A.O.) test, used across the province on Ontario's children to assess language and mathematics skills, has included surveys to investigate the students' perception of their abilities in relation to mathematics performance. In 1999, these surveys indicated a gender difference in the students' perception at the Grade 3 and Grade 6 levels. At Grade 3, 60% of female students indicated that they "like math" compared to 65% of male students. Only 44% of the female population believed that "I am good at mathematics" as compared to 58% percent of the boys. These differences were even larger by grade 6, where 41% percent of girls stated that "I like mathematics" as compared to 56% of the boys. The belief that "I am good at mathematics" dropped to 37% for female students, as compared to 57% for male students. This suggests that male attitudes toward mathematics remain relatively constant, whereas female students' beliefs and attitudes towards math changed dramatically in a negative direction (E.Q.A.O. 1999 Board Assessment, 1999). When grade 3 students were observed during the E.Q.A.O. test by the author, it was noted that some children gave up quickly and others persevered. The above shows the need to better understand the motivational aspects of learning mathematics in general and specifically the need to better understand how to keep up student effort and its effectiveness in improving achievement.

Interest in motivational research has spanned for decades and the question of what antecedent conditions motivate some children to achieve their maximum potential is still

being pursued. Attribution theory has been very successful in explaining how motivation is interlinked with past achievement, achievement behaviour and future expectations (Heckhausen, 1991; Weiner, 1972, 1980).

Weiner's Attribution theory emphasizes the connection between cognitive elements and academic achievement (Weiner, 1972). Weiner (1980) found that causal attributions occur as the result of interplay between emotion, thought, and behaviour. Past successes and failures are evaluated through one's ability, effort expenditure, task difficulty, and perceived luck, to create a feedback loop that produces specific expectations regarding future academic performance (Kukla 1972; Weiner, 1972, 1980). Effort is obviously a very important attribution because it can compensate for ability, is controlled by the individual, and can be influenced by the teacher (Beckman, 1970; Daubman & Lehman 1993; Midgely, Anderman & Hicks, 1995).

With regard to mathematical achievement, past research has supported the hypothesis that female students tend to attribute high achievement to effort, whereas male students tend to use ability as their predominant attribution. These attributional differences are viewed as one of the main reasons why female students tend to avoid courses or careers related to mathematics (Stipek & Gralinski, 1991). Research has shown that achievement related beliefs influence effort, as reflected in a student's task choices and strategy selection, which can perpetuate negative perceptions of performance outcomes (Craske, 1988; Pintrich & Blumenfeld, 1985; Tapasak, 1990). Thus, effort plays an important role within the mutual relationship between attribution and

mathematics, as well as in explaining gender differences related to math achievement. Identification of attributes that characterize effort may have a significant impact on the manner in which a teacher can motivate a student. Teachers may be able to utilize the student's perception of effort to increase their self-confidence and further mathematical progress.

If educators are to assist students to do their best work, it would clearly be advantageous to have an understanding of the actions and attributes that the student utilizes, and to determine the characteristics that are crucial to the realization of one's best effort. The purpose of this study is to determine students' conceptualization of effort and if there is any relationship to gender or achievement.

CHAPTER II

LITERATURE REVIEW

A. A Brief History of Motivation as it Applies to this Study:

Motivational research began with a psychological approach known as Drive Theory, where needs and a rewarding response lead to the motivation to strive for basic human requirements such as food and drink (for an overview see Stipek, 1998 Chapter 2). Subsequent theories considered that social and personal factors affected motivation and were examined in terms of learned behaviour and achievement constructs (Rotter, 1990). Thus, motivational research moved away from a mechanistic to a cognitive orientation. More contemporary research included exploration of motivation as it related to education and examined the cognitive elements that impacted academic performance (Blumenfeld, Pintrinch & Hamilton, 1986; Covington, 1984; Eccles, Wigfield, Harold & Blumenfeld, 1993; Heckhausen, 1991; Kloosterman, 1991; Stipek & Gralinski, 1991; Valas & Sovik, 1993; Weiner; 1972, 1980; Wigfield & Eccles, 1994).

Three major components of achievement motivation link cognition and behaviour, these are: the way the task is perceived, the way the student perceives him or herself in relation to the task, and the meta-cognitive elements that interconnect the internal and external aspects of performance outcomes (Covington, 1984; Covington & Omelich, 1985; Eccles et al., 1993, Pintrinch & De Groot, 1990; Weiner, 1972, 1980). Several researchers agreed that expectancy, value, and emotional components of motivation impact the choice of meta-cognitive strategies and the persistence utilized on academic tasks (Covington, 1984; Eccles et al., 1993; Pintrinch & DeGroot, 1990).

Several studies confirm the Expectancy-Value model of motivation that concluded achievement motivation is equal to the perceived value of a task to the individual. It was found that students of all ages consciously choose activities based on personal interest and the activities' potential to lead to success, praise, or other rewards (Eccles et al., 1993; Stipek, 1998; Wigfield, & Eccles, 1994; Wigfield, Eccles, Kwang, Harold, Arbreton, Freedman-Doan & Blumenfeld, 1997).

Researchers have also consistently found that successful individuals select meta-cognitive strategies that produce successful results, sustain effort and interest, and yield intrinsic and/or extrinsic rewards that reinforce the use of the initial strategies (Covington, 1984; Dweck, 1986; Patrick, Hicks, & Ryan, 1997; Schunk, 1996). This is the basic premise behind Covington's Self-Worth model of achievement motivation where positive student choices were found to create an ego-enhancing sense of mastery and self-efficacy regarding achievement behaviour choices (Covington, 1984; Covington & Omelich, 1985).

However, it is Weiner's theory of attribution that combines the self, the task, and internal ascriptions through the four attributional dimensions of achievement motivation and suggests that thought, feelings, and behaviour help a student to develop a conceptual framework of his or her achievement performance that influences future academic pursuits. (Barker & Graham, 1987; Covington, 1984; Covington & Omelich, 1985; Kukla, 1972; Heckhausen, 1991; Rotter, 1990; Weiner, 1972, 1980). Out of the four dimensions of causal attributions: ability, effort, task difficulty, and luck, only effort is

viewed as intentional and within the individual's power to control (Covington, 1984; Heckhausen, 1991; Kukla, 1972; Weiner, 1972; Weiner, Heckhausen, Meyer & Cook, 1972). The dimension of controllability was later added to the attribution model (Weiner, 1972).

B. The Impact of Attributing an Achievement Outcome to Effort:

Attribution theory asserts that academic behaviour is conceptualized in terms of self-perceptions of causality. Students try to make sense of an achievement outcome, through causality cognitions that influence feelings and behaviour from personal evaluation of the factors that surround the achievement event. Success or failure is assessed through ability, task difficulty, effort, and luck. As a result, expectations develop that influence to what degree the individual will put forward effort when confronted with a similar academic task in the future. Thus, a student's perception of his or her effort inherently becomes an important causal factor in achievement performance (Bempechat, Nakkula & Wu, 1996; Blumenfeld, Pintrinch & Hamilton, 1986; Frieze & Weiner, 1972; Heckhausen, 1991; Nicholls, 1976; Seegers & Boekaerts, 1996; Stipek, 1998; Weiner, 1972, 1980).

Studies have reported that a favourable attributional pattern, involves ascribing success to internal factors like ability and effort and failure to external factors like task difficulty and bad luck (Gilbert, 1996; Kukla, 1972; Heckhausen; 1991; Weiner, 1972). Weiner (1972) and Kukla (1972) indicated that effort expenditure influenced a person's affective response to achieving success. High effort exertion, studying hard, work habits, persistence, and task completion positively correlated with pride in success and absolved

guilt feelings for not trying hard enough in failure. A failure acceptance philosophy meant the students explained the failure event, without self-condemnation or shame, as well as due to the internal, but modifiable variable of effort (Craske, 1988; Eccles et al., 1993; Frieze & Weiner, 1972). Thus, the student developed productive self-efficacy beliefs, regardless of the outcome, that did not impede future successes (Barker & Graham, 1987; Beckman, 1970; Covington, 1984; Kukla, 1972; Nicholls, 1976; Weiner, 1972, 1980).

However, Covington (1984), Covington & Omelich (1985) and Nicholls (1976) found that students who assumed a failure-avoidance approach, evaded effort expenditure, as it was perceived as futile in altering academic performance. Since effort did not yield the expected results in the past, the student interpreted the reason for failure as personal deficiency, consequently triggering shame and humiliation and evoking avoidance behaviour in order to escape unsuccessful experiences in the future (Covington & Omelich, 1985).

Craske (1988) proposed that students gave up trying because they did not feel capable of success. However, several studies have found that attributional patterns can be changed (Weiner, 1972, 1980; Weiner et al., 1972). Creating an attributional change by emphasizing effort as the causal attribution for failure, rather than low ability, has been found to produce a corresponding increase in competence beliefs and academic performance (Bandura, 1977; Craske, 1988; Heller & Zeigler, 1996). Many researchers agree acquisition of favourable causal attributions builds an individual's self-confidence and influence academic performance (Meece & Holt, 1993; Midgley et al., 1995;

Nicholls, 1976; Pajares, 1996; Patrick, Hicks & Ryan, 1997; Pintrinch & Blumenfeld, 1985; Schunk, 1996; Weiner, 1972).

C. Teacher Attributions of Student Effort:

There is a growing body of evidence indicating that teacher expectancy has a major influence in the development of causal attributions and academic performance of students. Research suggests a strong link between teachers' attributions of the students' achievement and students' attributions of themselves (Beckman, 1970; Dweck, 1986; Midgley et al., 1995). Teachers instruct, assess and then provide feedback that the student utilizes in developing their achievement motivation and teachers use student achievement levels to re-evaluate their attributions of the students (Beckman, 1970; Midgely et al., 1995).

Beckman (1970) completed a study that examined the effect of student performance on teacher' attributions of causality and hypothesized that teachers have an ego-protective need to attribute success to good teaching and failure to external factors. Beckman compared the attributions of 56 student teachers and their belief that they were personally responsible for teaching concepts to students, to the attributions of 46 student teachers that merely assessed test results.

The first group was called "participants", the second group "observers". "Participants" presented 20-minutes worth of instruction on mathematical concepts and symbols regarding subsets to two elementary school children, through a one-way mirror. Although there were no real students, subjects believed they were teaching children who

were sitting in desks on the other side of the mirror. "Observers" only observed the teaching session. The 20-minute teaching period was broken down into 5-minute intervals. After each 5-minute instructional period, the "participants" and "observers" were provided with answer sheets that the students had supposedly completed. The answer sheets provided a variety of correct and incorrect answers.

"Participants" and "observers" were asked to judge the achievement level of the individual student's answer sheet and were asked to answer open-ended questions such as: "Why did the child perform as he did?" and "Which was more important in determining his performance? His ability? His motivation?" (Beckman, 1970, p 78). Beckman reported that "participants"', as well as "observers", ratings of the child's performance correlated with the child's actual level of performance. Perceptions of causality were acquired through the following categories: student motivation, ability, teacher presentation, student background and situational factors, such as lack of effort. Beckman (1970) found that "participant" teachers (teachers who thought they actually taught the students) perceived favourable responses as due to themselves and less favourable to situational factors more often than "observers".

Beckman concluded that teachers' expectations are influenced by student performance, which determines the type of feedback that the teacher imparts to the student. This contributes to the students' attributions and continues the cycle of performance outcomes (Beckman, 1970). This conclusion confirms the impact of the teacher-student relationship on the development of causal attributions.

Midgely et al., (1995) examined the students' perceptions of their ability to

succeed in school, as a modifiable concept, as well as its potential to impact on self-efficacy and school performance through a task versus performance based criterion. Task goals were defined as undertaking activities that developed skills and enabled a student to improve and do well on any assignment, as compared to performance goals that emphasized rating well in comparison to one's social group.

Fifty elementary teachers, 108 middle school teachers, 291 fourth and fifth grade students and 678 sixth and seventh grade students were given a survey that included items assessing school ability as a fixed or modifiable element. Teachers were given questionnaires regarding achievement goals for their students on task goals such as focusing on improvement versus performance goals such as receiving high scores on tests. Moreover, teachers' perception of "school ability" was obtained, for example, by asking whether the educator believed that natural ability is more important than effort for success (school ability-fixed) versus any student can succeed academically if he or she studies hard (school ability-modifiable) (Midgely et al., 1995).

Elementary and middle school student responses were compared on the basis of how they perceive a task. Students were given the Patterns of Adaptive Learning Survey (PALS) that measures personal goal orientation, efficacy, ability beliefs, and perceptions of school culture through task and performance-based criteria. The pattern in the task goal questioning and responses was that "trying hard" led to success and had the potential to modify school ability. Personal goals were viewed as the mediator between the environment and students beliefs (Midgely et al., 1995).

Midgely et al. (1995) found that teachers and students viewed middle school as

more performance based, where the emphasis is on the product and assessment is based on comparisons with others. However, Pintrinch and Degroot (1990) found that grade school students who adopted a task-based approach used deeper-processing strategies, such as how to discriminate important information from unimportant and determining how new information fits into one's existing schema, more than performance-based counterparts.

Weiner & Kukla (1970) and Covington (1984) established that teachers value effort expenditure, even in the advent of failure. Weiner & Kukla (1970) completed a study where college-aged subjects were asked to pretend they were teachers providing feedback to students. They assigned up to five positive or negative feedback points based on ability level (high or low), effort expenditure, (high or low) and exam performance (excellent, fair, borderline, moderate failure or clear failure). The researchers reported that regardless of ability, low performing, high effort pupils were given more positive feedback, rewarded more, and punished less than high performing students.

It is believed that this type of feedback enables a student to maintain his or her self-worth and sense of competency and thus the student would not develop unfavourable expectancies regarding future performances (Covington, 1984; Tapasak, 1990; Weiner, 1980; Weiner & Kukla, 1970). Several studies agree that both teachers and students working in an environment that stresses effort and views performance outcomes as modifiable, feel more self-efficacious (Bandura, 1977; Beckman, 1970; Covington, 1984; Dweck; 1986; Midgely et al., 1995; Tapasak, 1990; Weiner & Kukla, 1970). As indicated above, personal beliefs and perceptions are major contributors to positive causal

attributions and achievement outcomes.

D. Studies on Math Achievement, Attribution, and Gender:

Researchers agree that self-efficacy, competence beliefs, and general self-esteem have a significant impact on the choice of achievement-related behaviour and gender differences in causal attributions as it applies to the study of mathematics. (Blumenfeld, Pintrich & Hamilton, 1986; Pintrinch & Blumenfeld, 1985; Weiner, 1980; Wigfield, et al., 1997; Zimmerman & Martinez-Pons, 1990). Thorkildsen and Nicholls (1998) found that males and females are significantly different in how they combine motivational orientations, beliefs, and perceptions. Researchers have found that males and females do not differ in the perception of the importance of mathematics, the subject interest, or achievement expectations. A significant difference was noted in personal math competency beliefs that had the potential to impact mathematics performance and particularly task and strategy selection (Park, Bauer, Sullivan, 1998; Skaalvik, 1990; Stipek & Gralinski, 1991; Thorkildsen & Nicholls, 1998; Wigfield & Eccles, 1994).

The study of cognition, achievement behaviour (effort) and gender, in relation to mathematics achievement, has produced some very significant findings and holds great interest for researchers as it impacts on one's motivation and ability to learn (Kloosterman, 1991; Seegers and Boekaerts, 1993; Stipek and Gralinski, 1991; Tapasak, 1990; Zimmerman and Martinez-Pons, 1990). Kloosterman (1991) found that feelings, beliefs, and achievement behaviour (effort) culminate in a student's mathematics achievement. This study examined the impact of beliefs, and the importance of a belief system on a student's effort and performance outcomes in mathematics. Tapasak's (1990)

research focused on cognitive components and attribution patterns, as they relate to mathematics achievement. This type of research led to studies on the effect of specific cognition and feelings on learning intent (effort) (Seegers and Boekaerts, 1993). Zimmerman and Martinez-Pons (1990) investigated student perceptions of self-efficacy and learning intent as reflected by self-regulated strategy use. Stipek and Gralinski's study (1991) examined how achievement-related beliefs, emotional responses to achievement in mathematics, and the strategies employed are due, in part, to gender differences. And, all the studies viewed effort as a central component to achievement.

Kloosterman's study on Beliefs and Achievement in Seventh Grade Mathematics in 1991, viewed attributional style as a belief variable, and therefore another factor in learning mathematics. This was supported by the work of Bempechat, Nakkula and Wu (1996), Blumenfeld, Pintrinch and Hamilton (1986), and Dweck (1986). Although researchers do not agree on the attributions that are responsible for achievement, they all concede students' perceived abilities act as mediators for achievement.

Kloosterman (1991) investigated the concept that beliefs are the key to understanding behaviour and utilized Dweck's findings that students possess two distinct beliefs that affect academic achievement. Dweck (1986) suggested students either view learning as stable or variable (For an overview see Dweck, 1986). The study included 233 females and 196 male seventh grade students from lower middle to upper middle class schools in Indianna. A small percentage of the students, approximately 10%, were minorities. All students, with the exception of the extreme top and bottom 10% were tested. Scales for "effort as a mediator of mathematical ability " and failure as an

acceptable phase in the learning of mathematics" were designed (Kloosterman, 1991, p5). Two mathematics achievement tests were used, one on concepts and the other on applications.

The attributional style was measured with the Fennema-Peterson Autonomous Learning Behaviour (ALB) mathematics attribution scale. The scale contained Likert-style sub-scales with five items each in which students selected strong yes, weak yes, undecided, weak no and strong no for their responses. Sample items that measured beliefs about how mathematics is learned included: 1) self-confidence - "I'm not the type to do well in math", 2) effort – " Working can improve my ability in mathematics", failure as an acceptable phase – " when learning new math, it is O.K. to make some mistakes" (Kloosterman, 1991, p5).

Kloosterman's results found that students perceived success as due to effort more than ability and viewed failure as due to lack of ability and effort equally. Males believed effort made more of an impact and expressed more confidence in this strategy than females. Males also appeared to see making mistakes as more acceptable than their female counterparts. There was a considerable gender related difference in the self-confidence factor relating to this variable.

Males generally rated higher in all the variables. They displayed higher confidence in the impact of effort, and acceptance of mistakes as part of the learning process. Although females performed slightly better on the applications tests, they had less failure acceptance, expressed less confidence and indicated less faith in the role of personal effort on their success. Kloosterman concluded that detrimental beliefs should

be identified before they become so ingrained that they are impossible to alter.

Tapasak (1990) specifically studied differences in expectancy-attribution patterns in male and female eighth grade students in mathematics performance. The study was based on Weiner's 2x2 model with emphasis on the stability component (stable versus variable) (Weiner, 1972). Two hundred and thirty-nine eighth-grade mathematics subjects participated in this study, 122 males and 177 females. Students were measured on attributions for mathematics performance using the Mathematics Attribution Scale (MAS) (Fennema, Wolleat, & Pedro, 1979).

The Relative Math Expectancy (RME) was measured using a nine-point scale, in which students were asked to imagine that math classes had students at the bottom, middle and top ranges. The students had to indicate where he or she felt they would place in their math class, as compared to their classmates. Tapasak (1990) reported that expectancy attributions followed a distinct pattern. High RME positively correlated with the favourable model of expectancy attribution model and the Low RME group positively correlated with the unfavourable pattern. There was a significant difference with regards to gender. Males were more frequently reported in the high RME and females in the lower RME. Researchers did an analysis of variance with gender and RME and attribution (favourable and unfavourable) as independent variables and MAS scores as the dependent variables. In the case of success, females made significantly higher variable attributions than stable and the opposite was true for males. Tapasak (1990) concluded that many males and females utilized different cognitive styles and interpreted mathematics performance differently, regardless of the fact that females frequently held

higher grade point averages than the male students.

In Seegers and Boekaerts (1993) the goal of the study was to investigate how cognition and emotion affected the willingness to invest effort (learning intention) and task performance. The subjects were 162 students from grade 8, from 9 out of 20 schools in the urban region of Leiden, Netherlands. There were 80 boys and 82 girls. Mathematical ability was assessed using the Dutch National Assessment of Educational Progress (mathematics component). Questionnaires were developed to measure goal-orientation and attributional style.

The Goal-Orientation Questionnaire included 32 items that involved experiences and behaviour in class (during math), as well as items to assess ego-orientation ("I feel good when I solve a problem before the others") and task orientation ("I feel good when I have been working hard on mathematics tasks"). The Attribution Questionnaire included 20 items referring to social relationships in class. The items were mainly devised to assess attributions of success and failure to effort (" When I have a good (bad) result, it is because I worked hard (not hard enough) on a task"). Students indicated their feelings by filling in a scale with responses that ranged from "Completely true" to "definitely not true".

Seegers and Boekaerts (1993) developed a model to explain the willingness to invest effort and the affective response to the task. The researchers concluded that it is essential that students consider improved competence is within reach, when effort is invested. This allowed a disappointing result to stimulate an increased effort to improve

competence, rather than a confirmation of lack of ability. Seegers and Boekaerts (1993) recommended further research in determining how a student's belief system, attributional style, task appraisals, and learning intention (effort) develop over time.

Studies by Zimmerman and Martinez-Pons (1990) hypothesized that the students' choice of learning strategies highly correlated with verbal and mathematical self-efficacy beliefs. Zimmerman and Martinez-Pons compared students from fifth, eighth, and eleventh grades at a gifted and regular school, in the use of learning strategies and verbal and mathematics efficacy.

The interview instrument was structured to assess 14 learning strategies: "self evaluation, organizing, and transforming; goal setting and planning, seeking information; keeping records and monitoring; environmental structuring and self-consequating; rehearsing and memorizing; seeking peer or adult assistance; and reviewing tests, notes and texts" (Zimmerman and Martinez-Pons, 1990, p. 52).

Eight different learning contexts were described: " when writing assignments, completing mathematics assignments, when checking Science or English homework, when preparing for a test, when taking a test, when poorly motivated to complete homework, and when studying at home" (Zimmerman and Martinez-Pons, 1990, p. 53) For example, "Teachers usually expect much accuracy with students' math homework". Many of these assignments must be completed without the help of the teachers. Is there any particular method you use when you don't understand a math problem at home? What if the assignment deals with a very difficult type of problem?" (Zimmerman and Martinez-Pons, 1990, p. 53).

The verbal efficacy test was measured in the following manner:

> "For each word presented below, estimate how sure you are that you can define it correctly. You must give your answer in 10 seconds or less, so you will have time to write a definition. Give your best estimate of your confidence (any number between 0% and 100% that a teacher will judge your definition as correct. Some words are very difficult, and most students cannot define them. It is important that you do not guess, but give a realistic estimate of whether your answer is correct. If you are completely unsure of your answer, mark 0%, if you think you may have the answer, but are not sure of it, mark 50%; if you are completely sure of your answer, mark 100%".

The mathematical efficacy was measured the same way by replacing the term "word" with "math problem".

Math efficacy was found to improve with the grade level. In this study, girls were found to have comparable mathematics efficacy to boys. This was a rather unusual finding. The researchers completed an analysis of self-regulated learning strategies and gender and concluded that girls utilized significantly more record keeping, monitoring, goal setting, and planning than the boys. Zimmerman and Martinez-Pons (1993) found that female students are more actively involved in learning tasks, are more prepared to invest effort, and are greater users of learning strategies, but females are also generally less efficacious than males. This was supported by Seegers and Boekaerts (1996) who found boys experience learning situations in a more positive way than girls when confronted with a mathematics test and explained gender differences as the result of

differing participation patterns.

Stipek and Gralinski (1991) investigated gender-related differences regarding perceptions of performance, its attribute, and resulting emotions. The study involved 194 third grade students (94 girls and 100 boys) and 179 high school students (143 girls and 136 boys). Before a regularly scheduled test, the experimenter was introduced to the students as a person who was interested in student thought about mathematics tests. The researcher distributed a questionnaire and explained how the scale worked with illustrations. The posttest questionnaire was given 1-3 days later. The scale ranged from A to F with minuses and pluses.

The pretest queried students on the grade they expected to receive, how good the student believed they were in math, and how they thought they would do compared to peers. The posttest asked students what grade they did receive, how proud or ashamed they felt, and how much they felt like hiding the paper. All the questions were rated according to an appropriate scale, for example, how good the student felt he or she was in math was rated on a five-point scale ranging from 1 (bad) to 5 (very good). After these questionnaires, students were asked a series of attribution questions. Attributions for good outcomes had a green dot beside them and attributions for bad outcomes were written on a second page with a blue dot. Students were instructed to complete the green page if they thought they did well and the blue if they thought they did poorly (Stipek & Gralinski, 1991).

Students were told that the reason for their results was very important and they were provided with a list that included task difficulty, effort (studied and paid attention)

ability, and luck. They were asked to rate each attribution on a scale that ranged from 1 (not an important reason) to 5 (a very important reason). The test concluded with 2 questions on whether students would like to avoid mathematics and how well the student expected to do in the future (Stipek & Gralinski, 1991).

This study included attempts to measure the students' perception of the role of effort in achieving success and determined that boys attributed a good outcome to ability more than girls did. Boys felt pride with a positive outcome. Stipek & Gralinski found that the belief that success could be achieved through effort was positively connected with future expectations and negatively correlated with avoidance desires. Girls were found to develop more avoidance desires to mathematics and boys maintained higher expectations for future performances. Stipek and Gralinski (1991) found that girls were more inclined to become discouraged with failure, especially if they believed that they had tried hard, and viewed it as a symptom of low ability. As a result, many female students eventually engaged in a cycle of learned helplessness. This is a change from elementary years where grade 3 students, male and female, were found to believe that anyone could do well if they worked hard enough.

Thus, the results of this article emphasize the idea of gender differences in self-evaluation of mathematical ability. Male and female student's evaluation of their ability produced different conclusions based on the student's personal belief system. According to research, achievement related beliefs affect achievement behaviour, which culminate in the strategies that students choose to employ. Stipek and Gralinski recommended future research to include attributions related to effort.

Stipek and Gralinski (1991) made a very astute observation with regards to effort and student performance. The researchers found that the perception that success is the result of effort is separate from the belief that success has the potential to be achieved through conscious utilization of increased effort and strategy use. The researchers believed that this type of ideation prevents mathematics avoidance and unfavourable future expectations, based on the conception that increasing effort always has the potential for producing success, even in the face of a negative performance.

In summary, several researchers have hypothesized that effort is the connector between an individual's ability and conduct (Blumenfeld et al., 1986; Kukla, 1972; Weiner, 1972). In addition, the concept that gender has a significant impact on achievement behaviour has been studied and must be seriously considered (Bardos, Naglieri & Prewett, 1991; Daubman & Lehman, 1993; Hyde, Fennema & Lamon, 1990; Seegers & Boekaerts, 1996; Stipek & Gralinski, 1991).

Research has repeatedly confirmed that a student's perceptions and belief system have a significant effect on academic success (Covington & Omelich, 1985; Eccles et al., 1993; Ethington, 1992; Frieze & Weiner, 1972). Research also suggests that outside factors, such as teachers, have the potential to impact these beliefs (Beckman, 1970).

Blumenfeld, Pintrinch and Hamilton (1986) recommended continued research into how children define effort, particularly in relation to outcome versus mental exertion. Stipek and Gralinski suggested further research into student effort as it relates to strategy use. Seegers and Boekaerts concluded that adequate effort to maintaining a good performance is essential and suggests that future research focus on individual learner

characteristics. Tapasak recommended more study in the area of task persistence and motivation. The common point amongst all the researchers, regardless of whether they were investigating beliefs, academic behaviour or achievement results, was in the need to do further research in the conceptualization of effort.

Learning intent and achievement behaviour, observable in the form of student effort, have been suggested as major contributors to student achievement (Kukla, 1972; Pintrich & Blumenfeld, 1985; Stipek & Tannat, 1984; Thorkildsen & Nicholls, 1998; Seegers & Boekaerts, 1993). According to Weiner's theory of attribution, effort is the only modifiable or controllable variable that affects academic success (Weiner, 1972). Although all the research emphasized the importance of effort to achievement, there was no research that defined what effort means to the individual student and all the research indicated a need to pursue this particular attribute in more depth. Therefore, the purpose of this study is to identify student's conceptualization of effort and any connection to gender or achievement.

CHAPTER III

RESEARCH QUESTIONS, DESIGN AND DEFINITION OF VARIABLES

A. Research Questions:

The above literature search has emphasized the need to understand the students' perception of effort. The purpose of this study is to determine the answers to the following questions.

1. What connotative characteristics reflect the students' perceptions of effort?
2. Are there gender differences in the students' perceptions of effort?
3. How is achievement related to the effort categories?

B. Operationalization of the Variables:

The study is located within attribution theory, thus effort is looked upon as one of the causal factors to explain achievement. The purpose of the study is to find out how students operationalize effort. Students were asked to respond in writing to a question that elicited statements describing students' perception of effort. Details can be found under the section "Design and Procedures" below. The student effort-statement will then be categorized. In an earlier pilot study Cooper (1999), three categories were identified to classify these statements: Actions, Beliefs, and Cognition. If suitable, these categories will be used again in this study.

Student mathematical achievement was operationalized by the percentage grades reported by the classroom teacher.

C. Subjects:

This was a convenience sample of subjects from all the grade 7 and 8 classes at one school, i.e. 3 classes. The school could be looked upon as representative of an urban school of middle size. Intermediate students were selected because they had sufficient experience and cognitive maturity with the subject area. The students were from lower to lower-middle socioeconomic backgrounds. Fourteen per cent of the students had exceptional designations; 6% of the sample was comprised of minority students.

The homeroom teachers involved two males and one female. All of the Intermediate teachers had science or mathematics backgrounds and indicated an interest and comfort level in teaching mathematics.

D. Design and Procedures:

Permission was obtained from the Faculty of Education, University of Windsor Ethics Committee and the School Board in question, prior to commencement of the study (See Appendixes A & B). The principal of the school involved, as well as the Intermediate teachers of the target grades, gave written consent for the study to take place. Moreover, consent was obtained from the parents of each of the participating students (See Appendixes C, D & E). The return rate was 100% and parents indicated that they felt this was an important investigation.

To measure the students' perception of effort, an indirect method was used which took advantage of the naturalistic environment. It was normal procedure at this school, for the intermediate students to act as teaching mentors to the primary classes. Each class of intermediate students was involved in a preparation discussion in which they were informed that they would be working with the grade two students on a new mathematics

concept. The intermediate students, and their homeroom teacher, reviewed the concept of "doubling numbers". The intermediate students were instructed on the teaching approach, namely how they would fold a piece of paper in half in order to double the number one. Then fold each side in half, in order to double the number two to become four. Then fold the sections of four in half, in order to become eight sections, and so on. However, before the students could begin their teaching they were asked to answer the following question.

> "You will be teaching the students from the grade two class our new math concept. You want them to give their best effort, but they do not know how to go about it. What would you suggest to your grade two buddy, so that they can give their best effort to their work?"

The intermediate students were instructed to think carefully about what suggestions they could give to their grade 2 buddy and write them down on the paper that was provided by their homeroom teacher. Students were permitted, as much time as they required answering the question to their satisfaction and no limit was placed on the number of responses the student was willing to provide. Most students completed the task in 20 minutes.

The papers were handed in to the homeroom teachers who recorded the gender and current achievement level of the student and removed the student's name from the paper. When the class finished, the papers were given to the researcher for analysis. Student responses were categorized according as to whether they were in the Actions, Beliefs, or Cognition category. These categories were developed as a result of a pilot study in which it became evident that responses fell into one of these 3 classifications.

E. Data Analysis:

Effort responses were inspected with regards to possible categorization. This constituted the qualitative aspect of the analysis. The three categories identified in an earlier pilot study were found to be suitable. The computer programmes SPSS and Systat were used for the quantitative section of the analysis. A 5% significance level was used for all tests.

CHAPTER IV

RESULTS

A. Achievement and Gender of the Sample Population:

Table 1 provided the distribution of gender in all 3 classes. Overall, there were an equal number of males and females. Table 2 provided the average percentage marks of each class. The average achievement ranged between 71.68 (class 1, boys) and 64.75 (class 3, boys). The difference in performance between the classes and between boys and girls was tested with an Analysis of Variance (see Table 3). No significant interaction effect or main effect, for class or gender, was found. Thus, it was concluded that there were no gender differences, nor differences between classes.

Figure I provided the distribution of grades for the overall sample by gender. The students received percentage marks that corresponded with the Ontario Curriculum requirements for level assessment: Level I (55 and 59), Level 2 (65 and 69), Level 3 (75 and 79) and Level 4 (85 and 100). Any mark below 50 is given a rating of "R", which signifies a failure and a need for remedial assistance. Table 4 indicated the total percentages below Level 2 and above Level 3. The results were as follows: 26 % of the male students and 26% of female students received a mark below Level 2 and 8 % of the males and 18 % of the females received a mark above Level 3. The remaining two levels indicated that Level 2 and Level 3 were 26% and 34% for males and 29% and 31% respectively for female students; therefore both genders totaled 60% for these two levels. For the subsequent analysis, the students from the 3 classes were pooled and treated as one sample.

Table 1 Distribution of Gender by Class

	Male	Female	Total
Class 1	19	8	27
Class 2	11	14	25
Class 3	8	16	24
Total	38	38	76

Table 2 Average Marks

	Class 1	Class 2	Class 3
Males	$\bar{X}$ = 71.68 S = 13.20	$\bar{X}$ =67.55 S = 6.93	$\bar{X}$ = 64.75 S = 9.36
Females	$\bar{X}$ =70.00 S =11.95	$\bar{X}$ = 66.14 S = 9.31	$\bar{X}$ = 69.62 S = 9.28

Table 3 Analysis of Variance of Achievement by Gender and Class

Source	A. Sum-of-Squares	Df	Mean-Square	F-ratio	P
Class	224.067	2	112.034	1.025	0.364
Gender	6.062	1	6.062	0.055	0.814
Class*Gender	151.212.	2	75.606	0.692	0.504
Error	7647.797	70	109.254		

Figure 1 Distribution of Achievement by Gender

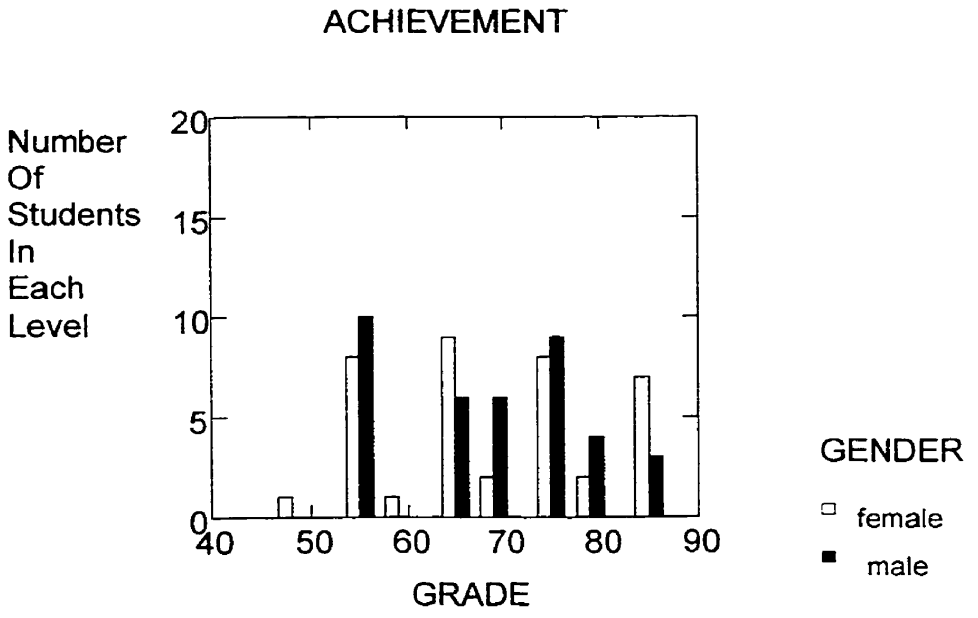

Table 4 Frequency of Achievement Levels by Gender

Level	Males	Females	Total
% range			
R – 35-48	0	1	1
1 – 55-59	10	9	19
2 – 65-69	12	11	23
3 – 75-79	13	10	23
4- 85-100	3	7	10
Total	38	38	76

B. Operationalization of Effort:

The 3 categories that were identified in the pilot study, Actions, Beliefs and Cognition, were validated. Table 5 provided the complete list of student generated characteristics that were collected from the sample population. The statements were unedited by the researcher. Different students chose the same statement; the frequency was indicated beside each statement e.g. 13 students wrote listen carefully, 35 students wrote persistence/never give up. The reader can see what statements were listed as Actions, Beliefs and Cognition.

The following criterion was applied to determine under which category each response should be placed. Actions were determined to be physical actions that a student could perform to accomplish the task, for example: practice, writing down ideas, doing questions over and over again, or impulse control (not talking) were all determined to be physical actions, under the student's control. "Working hard" was defined by the students as the use of Actions such as studying, practice, completing homework, completing more work then was expected etc. Therefore, this indicator was placed under the Action category.

Beliefs encompassed emotional responses, feelings, and the student's perceived needs, for example, the need to get good grades or to make their parents proud. Descriptors such as "tried their hardest" or "tried their best" were determined by students to mean the belief that one is working to one's maximum ability. Therefore, this indicator was placed under the Beliefs category.

A good attitude, focusing, using different strategies and setting goals were

viewed as part of the Cognition category. The way a person thinks and mentally manipulates their world distinctly differs from the previous two categories. The only attribute that was vague in this researcher's opinion was that of persistence, which this researcher initially saw as practice. However, on discussing this attribute with the students, persistence was perceived as the belief that the student should never give up and not the physical action of practicing a concept. Thus, persistence was recorded as a Beliefs statement.

The question arises as to whether the different effort categories were interrelated. Table 6 indicated a negative correlation between the main effort categories. There was a significant negative correlation between Actions and Beliefs ($r = -0.348^{**}$), meaning the more often a student described an Action, the less often he or she chose to record a Beliefs statement. There was also a negative correlation between Cognition and Beliefs ($r = -0.275^{*}$), meaning the more frequently a student used a Beliefs descriptor, the less often he or she chose a Cognition statement.

Upon further inspection, it became apparent that there were subcategories to the main headings of Actions, Beliefs and Cognition. These subdivisions are for descriptive purposes only. Characteristics for Actions were grouped into the following:

- Organization (ao) - the organization category included responses that physically organized the students' ideas or work.
- Work habits (ah) – appeared to be a more general group of academic behaviour descriptors in which any of the other actions could be found.
- Outside help (aoh) - involved asking questions of any individual and included

Table 5 Student Operationalization of Effort

Actions		Beliefs		Cognition	
A(Organization)		**B (Student Oriented Beliefs)**		**C (Cognitive Strategies)**	
Listen carefully	13	Tried your hardest	5	Use different strategies	7
Follow directions	1	Persistence/never give up	25	Compare differences; patterns	4
Get all the supplies	1	School is important	1	Use your imagination	1
Use a rough copy	2	Need to understand the purpose	2	Think about the question	1
Hand work in on time	2	What you believe you achieve	4	Brainstorm different ideas/solutions	1
Do work right away	5	Never say that you can't	1	Plan your work	2
Do work neatly	7	You can do it	4	Build on basic concepts	6
Agendas or written reminders	1	**Total**	43	Visualize	3
Total	32	**B (Need to Succeed)**		Memorize steps	6
A (Work Habits)		Need to compete	4	**Total**	31
Study	4	Need to meet goals	5	**C (Self-evaluation)**	
Practice	17	Need to pass	3	Able to think clearly	4
Do your homework	7	Need to get good marks	10	Exerting mental self-discipline/focus	20
Work hard	14	Need to give 110%	5	Understanding ideas	10
Do more than is expected	2	Need to do well in school	2	Work at your own pace	7
Take extra time on your work	2	Need to improve	2	Plan your time	3
Include more detail	2	**Total**	31	**Total**	44
Be more specific	1	**B (Self-Protection)**		**C (Self-Motivation)**	
Do your own work	6	It's okay to be wrong	4	Think positive	4
Finish/complete your work	5	Don't get mad	2	Anticipation of a reward	5
Total	60	Don't be afraid	3	Relate it to something that interests you	9
A (Outside Help)		Don't make excuses	1	Make it into a game	8
Ask your teacher	25	Need to be patient	1	**Total**	26
Ask a peer	3	It's okay to make mistakes	1	**C (Reflective Thinking)**	
Ask your parent	6	Don't put yourself down	1	Have a strong work ethic	1
Work with a friend	3	Don't worry about what others say	1	Be a risk-taker	2
Total	37	**Total**	14	Use a different perspective	2
A (Environment)		**B (Positive Beliefs)**		Learn from your mistakes	2
Don't talk when the teacher is	6	Pride in yourself	4	Think of a better way	2
Sit at a different seat	2	Do your best	31	**Total**	9
Attend school regularly	1	Be proud of your work	3		
Participate during lessons	1	Be happy with your work	1		
Total	10	Please yourself	1		
A (Teaching Aids)		Be satisfied with your work	1		
Use manipulatives	11	**Total**	41		
Use diagrams	8	**B (Long Term Goals)**			
Use calculators	2	Need to get a good job	2		
Use pictures	3	Need to get a good education	3		
Total	24	Decisions you make reflect on you	1		
A (Problem-solving)		Need to go to college	1		
Do the question twice	5	Need it for your career	2		
Look at examples	3	**Total**	9		
Do the easy question first	4	**B (Need to Please)**			
Talk it out	2	Need encouragement from teachers	5		
Show all your work	1	Need to make your parents proud	6		
Reread the question	1	**Total**	11		
Look up the information know	2				
Using a song to remember	1				
Using resources	7				
Do your work step by step	2				
Total	28				

working with a friend or use of rubrics in order to complete assignments.

- Environments (ae) – was comprised of responses that involved positively manipulating the external learning environment.
- Teaching aids (aa) – involved the students' choice of manipulatives, charts, calculators or any device that aided him or her to solve the problem and complete the task.
- Problem solving (aps) – was comprised of physical actions that functioned as precursors to the mental analysis of the work.

Beliefs statements were grouped into the following subcategories:

- Student Oriented Beliefs (bsob) – comprised those beliefs that included personal feelings regarding school or his or her own academic performance.
- Need to Succeed (bnts) – reflected reaching short-term goals, such as getting good marks or passing this year.
- Self- protection (bsp) – included statements that would reduce the stress and fear connected with being wrong or unsuccessful.
- Positive Beliefs (bpos) – differed from the first category in that these responses were more positive encouragement such as being satisfied, be happy, do your best, and take pride in yourself. These statements do not impose personal judgments like the Student Oriented Beliefs
- Long Term Goals (bltg) – expanded on the Need to Succeed subcategory to reflect future education and career objectives.
- Need to Please (bntp) – involved those responses that indicated the need for

external reinforcement in the form of praise or encouragement from significant adults.

The main effort category of cognition was defined as the way a student would analyze and mentally work through a problem. Therefore this group of responses was subdivided into the following:

- Cognitive Strategies (ccs) – were the responses that involved the mental manipulation of the information in order to solve the problem.
- Self-evaluation (cse) – included cognitive skills whereby the student would need to evaluate his or her own conceptualization of the information and /or his or her own skills in order to be successful.
- Self-Motivation (csm) – these responses involved a form of thinking that was innately rewarding and therefore more likely to encourage continued involvement and more positive results.
- Reflective Thinking (crt) – were responses that considered values the student had considered e.g. learn from your mistakes, have a strong work ethic, be a risk-taker.

These subcategories provided the researcher with a more detailed picture of the students' perceptions within the three main categories. Now this allows teachers to determine a baseline of attributional patterns and to develop a plan to modify these patterns accordingly to improve achievement. This will be discussed in detail in the summary.

C. Gender Differences in Choosing Effort Categories:

The number of effort related responses could be considered an indicator of how developed or how differentiated the students' concept of effort is at present. Do male and female students vary with regard to the number of effort related responses they produce? A two-sample t-test was completed (see Table 7). No significant gender difference ($p = 0.575$) was found. Thus, boys and girls used the same number of effort related responses.

It was investigated as to whether there were gender differences in the selection of main effort categories. Table 8 provided the average frequency of the main effort categories by gender and found that male students selected the Actions category significantly more often than female counterparts ($p = 0.005$). Moreover, there was a tendency for female students to choose more of the Beliefs descriptors ($p = 0.053$). There was no gender difference in the frequency of Cognition statements. The fact that any gender differences were found with respect to the effort categories, is in line with past research that indicated male and female students interpret mathematics performance differently (Tapasak, 1990).

D. Effort Categories and Achievement:

To determine whether there is a specific effort category that is relevant to achievement, Pearson correlation coefficients were calculated (see Table 9). There was a positive correlation between the use of Cognition statements and achievement. The more Cognition statements, the higher the achievement. There was no significant correlation between Actions and achievement or achievement and Beliefs. This result is

Table 6 Correlations Between the Main Effort Categories

		Actions	Beliefs	Cognition
Actions	Pearson Correlation			
	Sig. (2-tailed)			
Beliefs	Pearson Correlation	-0.348 (**)		
	Sig. (2-tailed)	0.002		
Cognition	Pearson Correlation	0.100	-0.275 (*)	
	Sig. (2-tailed)	0.392	0.016	

Note. ** correlation is significant at the 0.01 level (2-tailed). * correlation is significant at the 0.05 level (2-tailed).

Table 7 Response Grouped by Gender

Group	N	Mean	SD	T	Df	P
Male	38	6.053	2.079	0.564	74	0.575
Female	38	5.789	1.989			

Table 8 Gender Differences in Frequency of Response to Each Main Category

Main Category	Males	Females	T	Df	P
Actions	$\bar{X}$ = 3.947 S = 1.335	$\bar{X}$ = 3.026 S = 1.423	2.889	74	0.005
Beliefs	$\bar{X}$ = 2.579 S = 1.266	$\bar{X}$ = 3.326 S = 1.933	- 1.966	74	0.053
Cognition	$\bar{X}$ = 2.474 S = 1.033	$\bar{X}$ = 2.421 S = 1.328	0.193	74	0.848

Table 9 Correlations Between Achievement and the Main Effort Categories

	Grade	P
Actions	0.096	1.00
Beliefs	0.118	1.00
Cognition	**0.405**	.002

in line with research that shows that the use of cognitive strategies improves performance (Covington, 1984; Dweck, 1986; Patrick et al., 1997; Schunk, 1996).

CHAPTER V

SUMMARY

A. Summation:

One purpose of this research was to gain an understanding of the students' conceptualization of effort. The comprehensive list of attributes offered by the students, was extremely informative; these attributes could be grouped into three distinct categories. Students conceptualized effort in three forms, through Actions, Beliefs, and Cognition. There was a significant negative correlation between Actions and Beliefs and between Cognition and Beliefs, meaning the more often Beliefs descriptors were used, the fewer Actions or Cognition statements were employed.

It was possible to further group effort statements of each category into subcategories, which provided an even more in-depth picture of how students view the effort applied to mathematics. The implications for teachers will be discussed in the recommendations.

With regard to gender differences the following was found. The number of effort statements showed that the cognitive structures of boys and girls were equally elaborated. Male students used significantly more Actions than female counterparts and female students tended to choose more Beliefs descriptors. No significant difference was found for Cognition.

These results, relating to gender differences, may explain the growing discrepancy in the students' belief regarding his or her mathematical ability, as found in the E.Q.A.O. survey in the following way. From personal experience it seems that teachers and parents

encourage students through effort statements that were designated as Actions in this study e.g. practice, study, do your homework etc. This may inadvertently be devaluing the Beliefs and Cognition categories and reinforcing the idea that the males perform well and that the females do not approach mathematics in the expected manner. One of the results from this study is that males use significantly more Actions than the female students. This does not necessarily result in higher achievement in mathematics, but the reinforcement of action-type statements by educators may positively reinforce choices that fall under the Actions category.

Male students, regardless of their actual ability, overestimate their ability compared to females (Stipek & Gralinski, 1991). The reinforcement of action-type statements may also reinforce the belief that this student has an innate ability for this subject. Thus, the male student would tend to believe he is good at mathematics. This belief becomes crucial to the risk-taking behaviours and the persistence to actually become successful in mathematics. This is supported by the E.Q.A.O. 1999 Board Assessment survey results where a higher percentage of males indicated, "I am good at mathematics".

Students who choose "action" statements, think he or she performs well because this is the approach reinforced by teachers and parents. Students who choose cognition statements perform well, because cognitive strategies positively correlate with high achievement. Students who choose "beliefs" statements do not tend to select Actions or Cognition descriptors. One explanation is that the student develops a reliance on one's belief system as protection for what is perceived as a weakness in this subject area.

One reason might be that the female students employ some attributes that are not generally reinforced by the teacher? This may suggest to a student, she is departing from the accepted norm and, if she is not successful, that she was wrong and therefore not as good in mathematics as her male counterpart. This would make choosing an Actions or Cognition statement a risk to the student and a negative cycle ensues.

There is also the idea that one's belief system and cognitive use are very individual and personal attributes that greatly reflect the user. If a student's beliefs and strategy use result in a failure, this is a personal affront to the individual's way of thinking and may be perceived as personal failure. However, if a student does not use the correct actions e.g. practice, organize, or listen, this can be deemed as a choice that was completely separate from the person and so does not impact on the student's self-esteem or self-efficacy in this subject area.

Teachers need to be aware of the various ways students perceive effort and ensure that students are motivated across all three domains. This research found a significant positive correlation between the effort category Cognition and achievement. This result does not suggest that female students need to approach mathematics in the same manner as male students, or vice versa. In order to relate to the gender preferences of the students, teachers should be flexible in accepting Actions and Beliefs, but only operationalizations that are connected to Cognition are related to achievement. Obviously, it is very important for teachers to nurture the students' perception of effort as Cognition.

B. Recommendations:

This study showed that the effort category of Cognition could be subdivided into four categories. As this aspect of effort is so important to student achievement, the author, based on her classroom experience and the results of this study, has compiled a list of suggestions for the teacher to nurture each of the Cognition sub-categories.

Cognition:

Cognitive Strategies:

- Students need to work with manipulatives and discover patterns to solidify problem-solving concepts that aid in solving the math problems.
- Teachers need to introduce and reinforce a variety of strategies, as well as a variety of problem-solving techniques (work backwards, use diagrams, use manipulatives, look for patterns etc.). There is no longer one correct way to arrive at a solution.
- Teachers need to develop curriculum that crosses the learning modalities and encourage students to develop an understanding of their own learning style.

Self-Evaluation:

- Students should be encouraged to keep math journals to evaluate the strategies he or she experiments with and determine which strategies are most suited to their learning style (auditory, verbal, kinesthetic, tactile and oral).
- Students should be made aware that he or she does not have to complete questions in the same manner as another student.

- ❖ Teachers need to assist students in learning how to break assignments down into smaller sections and be instructed on time management.

Self Motivation:

- ❖ Students need to be encouraged to use different study and work methods to make the work interesting. This may include working with a friend, or making the math concepts into a game.
- ❖ Students emphasized the importance of making math fun. Teachers need to introduce the concept in a game, challenge students to find different ways of completing the questions in ways the students can remember and related to, arrange math days where students can experiment with manipulatives with no pressure to solve computations, have a "try again" bulletin board where problems can be posted to challenge students, or have students write a short story that involves a math concept.

Reflective Thinking:

- ❖ Risk-taking is important to being successful in math. Teachers can encourage students by accepting Actions or Beliefs, while introducing and modeling Cognition components.
- ❖ Teachers need to provide a safe environment where students are not concerned about giving answers and mistakes are accepted as part of the learning process.

APPENDIX A

From: XXXXX XXXXXX
XXX XXXXXXXXX XXXX
Windsor, Ontario
XXX-XXX

To: Dr. X XXXXXX
Chair of the Ethics Committee
Faculty of Education, University of Windsor
Windsor, Ontario

1999-08-19

Dear Dr. XXXXXX:

I am a graduate student at the University of Windsor, Faculty of Education who is currently pursuing my Master of Education degree. I am respectfully requesting permission from the Faculty of Education, Ethics Committee to conduct a research study on gender differences in students' perception of effort in mathematics. Dr. Erika Kuendiger has agreed to be my advisor and Dr. Benedicta Egbo has consented to be my second reader for a major paper or thesis depending on the decision of the graduate committee. I am currently preparing a thesis petition. Due to time constraints, I am requesting permission from the ethics committee at this time.

The method of data collection: It is common practice at XXXXX XXXXXXX School that the Grade 8 students teach grade 2 students. All homeroom students who agree to participate in this study will ask their students to respond, in written form, to the following research question:

> "You will be teaching the students from the grade two class a new math concept. You want them to give their best effort, but they might not know how to go about it. They do not know what it means to give one's best effort. What would you suggest to the student who you are going to teach, that he/she does to give their best effort?"

Consent from the school board as well as the participating homeroom teachers will be obtained in writing. Verbal communication with the principal and 3 teachers to be involved indicates that they have no problem with the above question. As the responses are turned in, the homeroom teacher will add the gender and mathematics grade of each student. All students' names will be removed from the samples before analyses.

Due to the age of the students, consent will be obtained from the students' parent or guardian. Participation will be voluntary and subjects will be free to withdraw at any time, typically by not answering the question. There is no risk to students or staff from participating in this study. Data will be collected anonymously, including only the student response, gender and mathematics grade, and treated confidentially.

If you have any questions or concerns about the study, please contact me at XXX-XXXX (home), XXX-XXXX (XXXXX XXXXXXX School) or coopertd@mnsi.net. I look forward to your response and any suggestions you may have to offer.

Yours sincerely,

APPENDIX B

XXXXX XXXXXX
XXX XXXXXXXXX XXXX
Windsor, Ontario
XXX-XXX

Dear XX XXXXXX:

I am a graduate student at the University of Windsor, Faculty of Education who is currently pursuing my Master of Education degree in Curriculum Studies. I am respectfully requesting permission from the XXXXXXX XXXXX XXXXXX Board of Education to conduct a research study on gender differences in students' perception of effort in mathematics. Dr. Erika Kuendiger has agreed to be my advisor and Dr. Benedicta Egbo has consented to be my second reader.

The method of data collection: It is common practice at XXXXX XXXXXXX School that the Grade 8 students teach Grade 2 students. All homeroom students who agree to participate in this study will ask their students to respond, in written form, to the following research question:

> "You will be teaching the students from the grade two class our new math concept. You want them to give their best effort, but they might not know how to go about it. What would you suggest to your grade two buddy, so they can give their best effort to their work?"

Consent from the participating homeroom teachers will be obtained in writing. Verbal communication with the intermediate homeroom teachers indicates that they have no problem with the above question. As the responses are turned in, the homeroom teacher will add the gender and mathematics grade of each student. All students' names will be removed from the samples before analyses.

Due to the age of the students, consent will be obtained from the students' parent or guardian. Participation will be voluntary and subjects will be free to withdraw at any time, typically by not answering the question. There is no risk to students or staff from participating in this study. Data will be collected anonymously, including only the student response, gender and mathematics grade, and treated confidentially.

If you have any questions or concerns about the study, please contact me at XXX-XXXX (home), XXX-XXXX (XXXXX XXXXXX School) or coopertd@mnsi.net. I look forward to your response and any suggestions you may have to offer.

Yours sincerely,

APPENDIX C

XXXXX XXXXXX
XXX XXXXXXXXX XXXX
Windsor, Ontario
XXX-XXX

Mr. XXXXXXXX XXXXXX (Principal)
XXXXX XXXXXXX Public School
XXXX XXXXXXXX
Windsor, Ontario
XXX-XXX

Dear Mr. XXXXXX:

I am a graduate student at the University of Windsor, Faculty of Education who is currently pursuing my Master of Education degree. I am respectfully requesting permission from you to conduct a research study on gender differences in students' perception of effort in mathematics in the intermediate level at XXXXX XXXXXXX School. Dr. Erika Kuendiger has agreed to be my advisor and Dr. Benedicta Egbo has consented to be my second reader for this study. Permission has been obtained from the Ethics Committee, Faculty of Education at the University of Windsor and the XXXXX XXXXXXX District School Board.

The method of data collection: It is common practice at XXXXX XXXXXXX School that the Grade 8 students teach grade 2 students. All homeroom students who agree to participate in this study will ask their students to respond, in written form, to the following research question:

> "You will be teaching the students from the grade two class our new math concept. You want them to give their best effort, but they might not know how to go about it. What would you suggest to your grade two buddy, so they can give their best effort to their work?"

Consent from the participating homeroom teachers will be obtained in writing. Verbal communication with the intermediate homeroom teachers indicates that they have no problem with the above question. As the responses are turned in, the homeroom teacher will add the gender and mathematics grade of each student. All students' names will be removed from the samples before analyses.

Due to the age of the students, consent will be obtained from the students' parent or guardian. Participation will be voluntary and subjects will be free to withdraw at any time, typically by not answering the question. There is no risk to students or staff from participating in this study. Data will be collected anonymously, including only the student response, gender and mathematics grade, and treated confidentially.

If you have any questions or concerns about the study, please contact me at XXX-XXXX (home), XXX-XXXX (XXXXX XXXXXXX School) or coopertd@mnsi.net. I look forward to your response and any suggestions you may have to offer. Your cooperation is essential and very much appreciated.

Yours sincerely,

APPENDIX D

XXXXX XXXXXX
XXX XXXXXXXXX Blvd.
Windsor, Ontario
XXX-XXX

99-09-27

Dear Intermediate Teacher:

I am a graduate student at the University of Windsor, Faculty of Education who is currently pursuing my Master of Education degree. I have obtained permission from the Ethics Committee at the Faculty of Education, University of Windsor and the XXXXXXX XXXXX County Board of Education to conduct a research study on gender differences in students' perception of effort in mathematics. Dr. Erika Kuendiger has agreed to be my advisor and Dr. Benedicta Egbo has consented to be my second reader for a major paper or thesis depending on the decision of the graduate committee.

I will need your assistance in the following manner, as you know, it is common practice at XXXXX XXXXXXX School to have the Grade 8 students teach grade 2 students. All homeroom teachers who agree to participate in this study will ask their students to respond, in written form, to the following research question:

> "You will be teaching the students from the grade two class our new math concept. You want them to give their best effort, but they might not know how to go about it. What would you suggest to your grade two buddy, so they can give their best effort to their work?"

As the responses are turned in, the homeroom teacher will add the gender and mathematics grade of each student. All students' names will be removed from the samples before analyses.

Due to the age of the students, consent will be obtained from the students' parent or guardian. Participation will be voluntary and subjects will be free to withdraw at any time, typically by not answering the question. There is no risk to students or staff from participating in this study. Data will be collected anonymously, including only the student response, gender and mathematics grade, and treated confidentially.

If you have any questions or concerns about the study, please contact me at XXX-XXXX (home), XXX-XXXX (XXXXX XXXXXXX School) or coopertd@mnsi.net. I look forward to your response and any suggestions you may have to offer.

I _____ agree to participate in the study in the role stated
(teacher's name)
above.

I also understand that data may be included in possible future publications of this research and that confidentiality of all the results will be strictly maintained.

_____ _____
Teacher's Signature Date

Yours sincerely,

APPENDIX E

XXXXX XXXXXX
XXXXX XXXXXXX Public School
XXXX XXXXXXXX
Windsor, Ontario
XXX-XXX

September 29th, 1999

Dear Parent or Guardian:

As a Grade eight teacher at XXXXX XXXXXXX School and a graduate student at the Faculty of Education at the University of Windsor in Curriculum Studies, I am preparing to begin a study of students' perceptions of effort in mathematics. This is a crucial area of study for a child's future and children achieve at widely varying levels. It is my intention to develop a list of characteristics, based on the students' responses, that will enable teachers and students to better understand how he or she is approaching this subject. In this way, it may be possible for the student to modify his or her strategy use, for more successful results.

During the school year 1999-2000, the students will be asked to respond in writing to the following research question:

> "You will be teaching the students from the grade two class our new math concept. You want them to give their best effort, but they might not know how to go about it. What would you suggest to your grade two buddy, so they can give their best effort to their work?"

This letter is to seek your permission to use the data collected from your child for analysis for this study. Confidentiality of individual responses will be guaranteed. Participation in the study is voluntary and students may withdraw at any time. All students' names will be removed from the samples before analyses. There are no risks from participating in this investigation and many benefits. Under all circumstances the student's results will remain anonymous and confidential.

Although these data will not be made available to individual participants in the study, the name of the publication will be given upon request should any article be published. The return of this permission form with your signature will be taken as an indication that you understand the information provided and that your consent is given. Please return the signed permission form, and a duplicated copy will be returned for your records.

The results of this study will be made known to you upon request at the conclusion of this study. Any concerns of an ethical nature are to be made known to the Chair of the Ethics Committee at 519-253-4232 Extension 3800. Should you have any other questions or concerns, or require further explanation, please contact Dr. Kuendiger, my advisor at 253-4232 or me at XXXXX XXXXXXX School XXX-XXXX. Your cooperation is very essential and appreciated.

Sincerely,

Permission is granted for data to be collected on my child (Student's name)_____, to be used in the analysis of this study. I understand that data may be included in possible future publications of this research and that confidentiality of all the results will be strictly maintained.

_____ _____

Parent/Guardian's Signature Date

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