Relations between Confidence and Achievement in Adult Education Students

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ABSTRACT

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The primary aim of this thesis is: understanding to what extent gender differences in mathematics confidence persist among students of adult education, and to study the relationship between mathematics confidence and achievement within that student body. This is an important question as confidence in mathematics is central to the willingness to pursue higher mathematical studies and it is well known that women are under represented in the pure and applied sciences. Further, the study of adult students requires separate consideration in that adult students carry with them a mathematics history that often includes failures which greatly impact the adult student's mathematics confidence.

In the present study, students were asked to estimate their test results, and the difference between this estimate and the actual result is taken as indicative of mathematics confidence. Interviews were also conducted and included questions relating the student's individual 'math story', as well as a problem solving session. Results are interpreted within the theoretical framework of Autonomous Learning Behaviours as influenced by an individual's Internal Belief System, confidence being a component of the latter.

This study shows that gendered differences in confidence do persist among students of adult education with female students demonstrating less confidence than their male peers despite superior achievement. However, lesser confidence did not predict lesser achievement, whereas an excess of confidence did. Irrespective of gender, those who underestimated their grade were more likely to achieve a mean of 70% or higher. It is concluded that overconfidence compensates in part for lack of knowledge.

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INTRODUCTION

Confidence, Achievement, Gender and Adults

The differences between the sexes, scientists now believe, begin in the uterus when sex hormones such as testosterone and estradiol begin to be produced... [Differences] exist from birth on... By the time children play with others (at this age [one] they engage in parallel play), it becomes clear that, in general, boys are much more aggressive both physically and verbally, while girls are more compliant.

(Eisenberg, 1996, p. 375)

Of course all students should receive the same educational opportunities. On the other hand, gender differences remain undeniable in mathematics, particularly with the under representation of women in the pure and applied sciences. In this day and age, one can hardly argue that women lack equal opportunity to study mathematics. In North America at least, no law or individual stands between women and calculus. The trouble is more subtle than that: "women should be equally willing to pursue mathematics" (Fennema, 1990, p. 5). Why then, are women unwilling? *Are* women unwilling?

Mathematics education literature recognizes gender differences to the detriment of females with regard to mathematics confidence across various age groups (Campbell, 1995; Damarin, 1995; Fainsilber, 2003; Felgner, 1996; Fennema, 1990; Leder, 1990; Stanic, 1995; Walkerdine, 1989). In days gone by there was also a gender difference in achievement, equally to the detriment of females, though the performance gap here in Quebec has since been closed (Fainsilber, 2003). Despite now equal opportunity in combination with equal or superior performance, female students continue to report less confidence in mathematics that their male peers. While gender sameness is neither possible nor desirable, gender equality must yet be pursued in mathematics education.

Researchers have shown that previous failures in mathematics can negatively impact mathematical confidence (Duffin & Simpson, 2000; Evans, 2000; Harris 2000; Llorente 2000). This is of particular relevance for confidence of adult learners with a history of mathematical failures, but sheds no light on the question of gendered differences in mathematical confidence where adult students are concerned. Fennema explores confidence within the framework of Autonomous Learning Behaviours and each gender's respective engagement with these. Fennema's work provides a fruitful context for the study of the following research question: **To what extent do gender differences in mathematical confidence persist in adult education, and what is the relationship between confidence and achievement in this setting?**

In the present study, students were asked to estimate their grades on four exams after having written but before submitting the exam, in an effort to address this research

question. The purpose of asking for this estimate after having written the exam rather than before was to provide the students with the possibility of assessing their own performance to the best of their ability. Asking for a result prior to considering the exam would constitute more of a prediction than estimation. Results were gathered from a total of eight exams over two years. The difference between the estimated result and the actual result was taken to be indicative of the student's confidence with under-estimation reflecting a lack of confidence and over-estimation reflecting over-confidence. Confidence in one's results is thus taken here as confidence in one's ability to learn and perform in mathematics.

The resultant range of confidence was so wide and relatively consistent for each individual, that a closer look was taken through case studies representing students who over-estimated , under-estimated, or accurately estimated their performance. Though these case studies were all taken from the same school, in fact studying under the same teacher, they nonetheless constitute a group diverse in age, ethnicity and educational background representative of English speaking adult education students in the province of Quebec. Eight students were interviewed to obtain their 'math stories'. Interviewees were equally observed in problem solving situations to understand how they determined if their solutions were correct or not. The assumption was that students were 'checking' their work, evaluating 'correctness' in order to estimate their results. This, however, was found not to be the case though test results estimation could be used as an indicator of their confidence in mathematics.

Outline Of The Thesis

The first chapter provides a survey of the mathematical literature. It is divided in two parts. The first part of this chapter considers research related to mathematics and adult students. The adult experience of mathematics education is different in that it incorporates a wealth of history and experience. Among the issues reviewed are signifiers and emotional charge, 'school math' vs. 'practical math', affective and cognitive aspects, and the transfer of learning. The second part of this chapter considers

research regarding mathematical gender differences including differences in confidence, attributional style, achievement, and gender ideology and sex role congruency.

In the second chapter the theoretical framework of the thesis is outlined using Fennema's notion of Autonomous Learning Behaviours in order to contextualize how confidence relates to an individual's internal belief system. This also provides a means of linking confidence to the willingness to pursue and participate in mathematics.

The third chapter addresses the methodology of the research conducted for this thesis. Here a detailed account of quantitative data collection and analysis is given. Interview and problem solving questions are provided as well.

Chapters four and five consider quantitative and qualitative results of the study respectively. Here a closer look at manifest gender differences and similarities is taken. Individual 'math stories' are also considered as is their impact on individual and gendered confidence.

Chapter six is devoted to the conclusions that can be drawn from the research. Statistical conclusions are considered separately from interview and problem solving conclusions. Implications of the results are taken into account and recommendations for future research and practice are made.

Briefly, it is found that lesser confidence does not predict lesser achievement, but than an excess of confidence does, irrespective of gender. Gender differences in confidence were apparent, with female students reporting less mathematical confidence than their male peers; confirming the findings of contemporary mathematics literature. Gender differences were also found in attributional style; a component of the internal belief system. The interview process revealed that student confidence estimates were not based on 'checking' techniques to evaluate the correctness of provided solutions. Interviews also revealed that a problem contextualized by 'practical mathematics' yields greater confidence in students, but not always greater performance.

CHAPTER ONE
Survey of Literature

Part I: ADULTS Learning Mathematics

Part II: GENDER Differences in Mathematics

The advantage for the teacher when a learner comes to them as an adult is in the changed nature of the teacher-learner role pair: the elective role pair allows the relationship to be one of partnership. In this partnership the learner can give their pedagogic trust to the teacher and the teacher can help them see that there are things they can do and understand.

(Duffin & Simpson, 2000, p. 97)

PART I: Adults Learning Mathematics

Adult mathematical learning is a uniquely textured field of study, combining the particularities of both mathematics education and of adult education. What is particular about working with adult learners, as opposed to child learners, is that they bring a greater wealth of experience to the classroom. Children are more accustomed to doing what they are told simply because they were told to do it. There is a measure of acceptance and lack of reflection, which is not so uniform across a body of adult students. What's more, adults have generally attended school in the past, and are pressed upon by long-standing, and often negative, self-perceptions. They are "people who have, in their own view at least, previously failed to learn mathematics and are now returning to study with the partial understandings they have built" (Duffin & Simpson, 2000, p. 88). In addition to whatever earlier schooling they have (partially) acquired, adult students have lived independent lives, worked jobs, eaten at restaurants, bought groceries; some have even built and supported families of their own. All of this life experience contributes to the way the adult learner understands and approaches problem-solving situations in mathematics.

The adult learner has the life experience that allows them to solve problems using either 'school math' or 'practical math', or some combination thereof. Their problem solving has both affective and cognitive aspects, each of these influencing the other in often-unexpected ways. Gender differences do exist in adult learners, but gender itself is not a determining factor of performance. Taking all of these elements into consideration, it becomes possible to consider questions of transfer. "Everyday thinking or what is termed instrumental learning, is governed by both efficiency and a systematic consideration of alternatives ... everyday knowledge interpreted as instrumental learning, may rapidly be transformed into contextualized knowledge" (Llorente, 2000, p. 77). What is transfer? How does it occur? How does context and affect relate to transfer? Let us begin, by distinguishing between school mathematics and practical/ everyday mathematics, in order to better understand the experience of the adult learner.

Signifiers and Emotional Charge

Saussurian linguistics takes the meaning of ideas, expressed in signs, to be engaged with the notion of the signifier-signified pair. The following joke comes to mind in illustration of this. *Did you hear about the mathematician who forgot to pay her electricity bill? When they found her she was cold and calculating.* In this joke, one could use the signifier 'cold' to signify literal temperature, but also possibly her 'unfeeling' character. What makes the joke funny is the multiplicity of meaning held by the signifier 'cold'; in other words, it can be paired with more than one 'signified'.

Evans recognizes the relationship between discourses, or interdiscursive practices through multiplicity of meaning. Interdiscursive practice is "the particular practice or mix of practices in which subjects are engaged, [and] *positions* the latter within that practice (or mix)" (Evans, 2000, p. 97). Evans also considers the affective component of the signifier-signified pair. One might view affect as "*charges attached to particular signifiers*. This allows us to see the unconscious as 'structured like a language', as a repository of repressed chains of meaning, and to analyze ... the movement of charges of feeling along a chain of signification" (Evans, 2000, p. 130). In the case study of Fiona, Evans requests a chain of signifiers associated to her father's work:

> capitalist...corrupt...business-like...
> ...*mathematical...calculating*...
> ...devious...unemotional...
> ...The *key signifier* in this chain is 'calculating', located at the intersection of family discourses about the father/ his work, and mathematical discourses. In the former it exhibits or signifies disappointment and anger, which is suppressed; in the latter of course, it signifies a central activity of the practice, and this may explain her ambivalence about getting clear how to calculate. (Evans, 2000, p. 195)

This sort of play on words in the unconscious mind is not unlike the aforementioned 'cold and calculating' joke. Multiplicity of meaning and its interdiscursive associations is slippery and unpredictable, but also rich with unconscious insight. They are however also widely open to interpretation, perhaps even too much so. Interdiscursive discourses alone are insufficient for understanding the variables at play.

Affective and Cognitive Aspects of Learning

In addition to the experience that adult students bring to the classroom, they also carry "'emotional baggage' they will have built up with the previous 'failure'" (Duffin & Simpson, 2000, p. 88) to learn mathematics. Often the adult learner is returning to school after a period of absence from it. Many have either failed mathematics courses in the past, or struggled with them, and take that experience as evidence that they are not good at, or worse, not able to learn mathematics. "[F]ailure is often, of itself, sufficient to have made mathematical situations anti-goals for the learners involved and this brings with it emotional indicators which can prevent an otherwise intelligent adult from attempting any form of mathematical task" (Duffin & Simpson, 2000, p. 97). Anti-goal is taken here to mean something that is avoided or moved away from in an effort to gain relief (Duffin & Simpson, 2000, p. 93). The 'emotional experience' of failure can be a traumatizing one that may carry with it shame, guilt and disappointment. This 'emotional baggage' then, creates dialectic between the affective and cognitive aspects of learning that is fundamental to adults learning mathematics. Initially it was thought that a student who felt confident and relaxed would have an easier time, and possibly perform better, than a student who felt insecure and anxious. With such interpretation, the learning process of adults who judge themselves incapable in mathematics, whether they are strong in mathematics or not, is impeded by their negative disposition. Countering this negativity "to enable our students to achieve confidence in mathematics" (Duffin & Simpson, 2000, p. 84) thus became the goal.

In his analysis, however, Evans finds what he calls an "inverted U" relationship between emotions and performance which suggests "there is a moderate level of maths anxiety that is 'optimal' for performance" (Evans, 2000, p. 64), with lower performance levels for both higher and lower anxiety levels. This is noteworthy, as anxiety was previously believed to be detrimental to the learning process. Earlier suggestions were that "anxiety is debilitating for performance at all levels" (Evans, 2000, p. 229). Instead, Evans' findings indicate that anxiety, in moderate amounts can actually improve performance, rather than simply acting as emotional interference. Perhaps this 'feeling' of moderate anxiety, however, is not anxiety at all. Perhaps it would be better termed

between fear and excitement. Regardless, good or positive feelings with regard to mathematics need not necessarily indicate or lead to better performance, just as bad or negative affect need not inescapably interfere with cognition. This is interesting as many of my own students report difficulty concentrating on their work unless they have an exam coming up for which they must 'cram'. The procrastinator 'cramming' mentality in students is common to many fields, with the anxiety of upcoming performance evaluation acting as a motivator, or learning catalyst.

Affective factors have an influence on the cognitive aspect of understanding and performance, affecting "how they [the students] approach new ways of thinking" (Duffin & Simpson, 2000, p. 84). The one cannot be studied without taking the other into account. Evans' study of *anxiety* and performance in adult students can help to understand the interplay between affective and cognitive aspects of *confidence* and achievement. Examining the relationship between thinking and emotion, Evans attempts to "measure anxiety in different contexts as different *types* or dimensions – namely, 'maths test/ course anxiety' (TCA) and 'numerical anxiety' (NA)". (Evans, 2000, p. 228) He does this, by self-report on a questionnaire, and realizing the limitations of this, is forced to seek out a more direct observational standpoint. Acknowledging that anxiety can sometimes be unconscious and therefore unavailable for self-report, he makes use of interviews to observe emotional reactions directly. In addition to looking for evidence of anxiety itself, indicators of defences against unconscious anxiety must also be sought. "Success or failure in mathematics tends to be played out in the balance between the anxieties produced by mathematics, and the defences using mathematics, or not, to combat these anxieties" (Evans, 2000, p. 119). Defences may be phobic against mathematics (avoidance, repression, projection) or manic using mathematics (reparation, introjections, reversal). Reparation "where mathematics is felt as useful", introjections "of order and stability", and reversal by "seeking to neutralize a disagreeable feeling" are all ways in which a student can manifest manic defences via mathematics. Phobic defences against mathematics can include avoidance of mathematics in general, or claiming that mathematics is meaningless. (Evans, 2000, p. 118)

The presence of, and need to observe, defences is not the only limitation of 'test/course anxiety' and 'numerical anxiety' categorization. A further limitation lies in the difficulty of studying anxiety apart from emotions in a broader sense since anxiety and other emotions may well be intertwined with the defences that mask them. Hence, the observation of anxiety as such, during a mathematics session, is not a sufficient indicator for the conclusion that this anxiety is mathematical anxiety as such. In considering one particular case study, in the context of a problem of calculating a tip, Evans makes note of the following interplay of aspects, which define the context.

> Apart from purely conceptual problems, the subject is thinking in a context, influenced by a complex of factors...
> - Affective factors, separate from cognitive ones
> - Beliefs, for example about mathematics and about herself as a solver of problems
> - Social class and gender
> - Mathematics anxiety, especially about percentages
> - Some anxiety about the interview
> - Anxiety about the relevant practice, namely tipping
> - Apparently chronic anxiety about money (Evans, 2000, p. 184-185)

The affective dimension of this particular case study's problem solving context includes all of the factors above. Mathematical anxiety does figure among these factors, but one must be careful not to misinterpret other anxieties, relative to money for example, as being mathematical anxiety. Sorting the affective pieces then becomes one of the important challenges of research in mathematical anxiety; a challenge which requires first the identification of anxieties at play. Chains of signifiers as well as understanding the emotional charge that flows along these is one means of differentiating mathematical anxiety from other affective factors. While this is slippery work, it is not entirely impossible given a learner willing to vocalize their problem solving process, and a researcher interested in the make up of that learner's problem solving context. Similarly, it is important that teachers listen to their students in order to understand not only what the student can't do, but also what they *are* doing in order to catch any conceptual misunderstandings that the student may or may not be aware of.

Transfer of Learning

Transfer refers to "the use, in one context, of ideas and knowledge learned in another" (Evans, 2000, p. 74). This can include both the application of scholastic learning to everyday activities, as well as the 'harnessing' of life (out-of school) knowledge for classroom learning. While the students may not consciously consider life experience as being mathematical in nature, the transfer of knowledge nevertheless can facilitate the acquisition of required class skills. If equations similar to those of a given word problem have been manipulated before in life, the student is equipped with a level of familiarity and is better able to solve the problem: "familiarity (with the practice) normally means clearer thinking and more effective problem-solving" (Evans, 2000, p. 131).

Assuming the context of a given problem, be it school, practical, familiar or alien, carries with it some important limitations. In the first place, assuming context assumes that contexts are discreet, which is of course not the case. Further, a subject may well interpret, in a pedagogic context, a word problem assigned to an everyday context by the researcher. This was a difficulty encountered by Evans throughout his study. He found it effective to evaluate the discourses called up by the student, thereby allowing the student a measure of control in their own positioning within the context of a problem. "[L]evels of performance of what appears to be 'the same task' vary dramatically across different contexts" (Evans, 2000, p. 75). In his study of transfer, Evans therefore aims to avoid the view held by 'utilitarians' that transfer is relatively unproblematic.

Evans is equally careful in avoiding the position held by what he calls the 'strong form' of situated cognition. This position argues that different contexts rely on their own respective 'structuring resources' (activities, relationships, experiences, standardized quantities such as money, etc...), and that cognition is specific to the given context, "thus aiming for transfer of learning from school or academic contexts to outside ones [or vice versa] is pretty hopeless" (Evans, 2000, p. 80). Instead, Evans proposes a sort of middle ground between these extremes. He acknowledges the potential obstacles that must be overcome in order for transfer to occur, but does not view these as insurmountable. He underscores the importance of taking into consideration affect and emotion, as well as

semiotic chains and the ways, in which meaning can be carried across them. He believes both of these factors, while a considerable limitation on possible transfer, provide the foundation for the possibility of transfer, or as he says: "translation across discourses" (Evans, 2000, p. 233).

For these reasons, Evans emphasizes broadening the discussion of transfer to include not only the similarities between practices, but also the differences that can be specified, thereby working toward a better understanding of how 'interdiscursive positioning' can influence understanding, context, and transfer.

'School Math' vs. 'Practical Math'

Evans applies the signifier-signified correlation to his notion of discursive practices, in order to better understand the context from within which learners are attempting to solve the mathematical problem set before them.

> In any situation, the play of signifiers in language, and the (related) flow of emotional charge along them, is such that a particular subject may *call up* (recognize, recall, select) one or more discourses – which may *or may not* be from among those considered 'at play' for subjects in general – which are used to examine, understand and resolve any problem.
> (Evans, 2000, p. 132)

This means that the context of any problem is, at least in part, specific to the subject because of the discourses called up. "The fact that the particular discourse(s) called up provide(s) the basis for the subject's examining a problem and thinking about it, means that cognition will be '*specific' to the discourse* called up" (Evans, 2000, p. 99). Despite the many discourses in play at any given time, Evans was able to determine what he considered to be the 'predominant' positioning of the subject, thereby classifying that predominant positioning as being either in 'school math' or 'practical math'.

With this understanding of context and positioning, he found that "performance on items where the subject had a 'predominant' positioning in 'practical math' was generally better than that where school mathematics was called up" (Evans, 2000, p. 226). Similar findings were also made by Carraher (1985), who found that when comparing the performances of children in street contexts with those in school-like testing contexts, "the

performances on what appeared to be 'the same task' were superior (in terms of correctness) in the street contexts" (Evans, 2000, p. 88). Note here that 'the same task' has been placed between quotations because it is difficult to compare cognition across contexts as will be discussed further in the section on 'transfer'. The same study also found "that correct performance was also correlated with the choice of procedure ... with 'oral' calculations being done correctly more often that 'written' ones" (Evans, 2000, p. 89). Taking oral and written calculation to be representative of 'practical math' and 'school math' respectively, this supports Evans' findings that performance was generally better given a predominant positioning in 'practical math'.

An Example from my Teaching

When studying equations at the grade-10 level at Place Cartier Education Center, the textbook used is SOFAD - Equations and Inequalities II. Students are asked to define variables and equations given a word problem. Consider the following example.

> *Example*: Tom has two-part time jobs with fluctuating schedules. One week he works 20 hours at his first job, and 15 hours at his second job to bring home $321.75 that week. The following week he works 23 hours at his first job, and 20 hours at his second job to bring home $390.50. Which job pays Tom more?

Solution:

Step 1: Assign x and y. Let x = $/hr of first job. Let y = $/hr of second job

Step 2: Determine equations. Week 1: Equation 1: $20x + 15y = 321.75$

Week 2: Equation 2: $23x + 20y = 390.50$

Step 3: Solve for x and y.

When teaching children to solve this type of problem, we teach them to solve step 3 using substitution, elimination, or comparison for example. For many, however, the most difficult aspect of these problems is not solving the equations, but rather determining from the word problem what are the equations to be solved, i.e. steps 1 and 2. While this is also true with adults, the set up for some is more easily understood because they have worked two jobs, and already have an understanding of calculating income. Transfer of knowledge thus occurs, simplifying the problem solving context. For

example, these students understand without difficulty that the total income will be the income from job 1 plus the income from job 2. They also understand that the income from job 1 is the hours worked times the hourly rate. Therefore, whereas child learners must build from the ground up, adults might begin with:

Total income = Income 1 + Income 2

Income 1 = (Hours 1) * $/hr 1

Income 2 = (Hours 2) * $/hr 2

From there it is a small and relatively simple step towards the aforementioned equations 1 and 2. While there may still be questions about how to choose variables, and then how to solve the equations, the context of the adult learners' lives nevertheless facilitates this particular problem-solving situation, which, once understood, can be used to model further problems of this type. Examples of such *harnessing* are reported, "where sellers... adapted calculation methods from selling practices, to attempt school-type problems, and performed better on such problems than non-sellers" (Evans, 2000, p. 87). The experience of budgeting life based on two variable incomes, while not necessarily recognized as mathematical in nature by the learners themselves, facilitates problem solving in this instance in a manner that is unavailable to child learners.

The student's predominant positioning in either 'practical math' or 'school math' may also influence their performance. While practical experience may be more likely to lead to a correct answer according to Evans (2000), its existence is no guarantee that it will be called up.

Teachers expend a great deal of energy responding to their students' sense of failure or inability: a reality, which currently holds little or no place in the textbooks from which the students learn and the teachers teach. Helping students "see that there are things they can do and understand... can begin to relieve some of the anxiety and frustration" (Duffin & Simpson, 2000, p. 97). Whether those frustrations are rooted in mathematical subject matter or not, the affective influence on the cognitive is undeniable, and understanding the learner is essential for the teacher to better shape the learning experiences, which will carry the student through the material to confidence. This might

be accomplished if the teacher could "build upon existing understandings... strengthen them through constructive conflict and use this new, stronger understanding as the basis for mathematics as a goal which learners feel they can move towards – thus giving them confidence in their mathematics" (Duffin & Simpson, 2000, p. 95). As educators of adults, we cannot ignore the understanding which our students already possess; we cannot treat them like blank slated children who will accept what we say simply because we say it. We must acknowledge and build on top of what they already know, while respectfully challenging, strengthening and expanding their understanding of mathematics. This must include bringing to light for them that which they can already do, as many students lack the confidence to recognize and be aware of their own capabilities. While confidence is not all that is required for optimal mathematical performance, it most certainly is an important building block for success, be that in terms of cognitive development, performance, transfer, or simply affective well-being.

PART II: Gender Differences in Mathematics

The long history of gender inequality in mathematics is well known. "There is no need to set up conspiracy theories when misogyny is preached from every pulpit in the land" (Harris, 2000, p. 178). During the Victorian era women 'permitted' to study were taught less and at a lower level. Women were believed to be at the mercy of their emotions, ever on the border of hysterics, incapable of rational thought. "For a girl, the purpose of education was ... not for a job but for a role in life, that of domestic supporter of males either in their own home as sister, daughter, wife or mother ...or in someone else's home as a servant" (Harris, 2000, p. 181). Today, gender ideologies remain rampant, with girls expected to be "neat, helpful, hard-working and well-behaved ... [which is then] read as evidence of their passivity. In contrast, boys' naughtiness and restlessness in the classroom is seen as testifying to their 'potential', 'mathematical flair' and so on" (Evans, 2000, p. 98). Nevertheless, progress has been made, as the view that 'men are innately more capable than women in mathematics' is now recognized as a decidedly sexist one.

In the United States, SAT-Math scores for men, however, remain higher than those of women for all ethnic/ racial groups despite the fact that female participation exceeds that of males. Fainsilber speculates that boys are freer to explore and solve problems as children, whereas girls are more protected, and that this 'early-independence training' "is conducive to the development of spatial perception" (Fainsilber, 2003, p. 25). Adjustments must then be made not only to the classroom and to pedagogy, but also to gender ideologies of North American culture that dictate restrictive fashion, domestic toys, and a lack of athleticism for the girls of its nations.

In Quebec, the situation is somewhat different from that in the United States, with girls outscoring boys on every Grade 10 enriched and Grade 11 regular government mathematics examination: "girls have outscored boys by between one and two percent" (Fainsilber, 2003, p. 9). This is admittedly a very small lead in favour of the girls, but one might thereby consider the gender mathematical gap to have been successfully closed in this province. What's more, the results in the present study show female students to

outperform male students by as much as 10% in Mathematics 436 at Place Cartier Adult Education Center.

Evans addresses another possible gender myth in his study of adult learners: the idea that "women are more anxious about mathematics than men" (Evans, 2000, p. 231). While the self-report portion of his study confirmed this, upon re-evaluation, the second portion of his study found that "women are simply more likely to *express* anxiety" (Evans, 2000, p. 231). He warns, however against generalizations with regard to men and women's respective ability to express their feelings, and instead advocates understanding gender differences in relation to positioning. Positioning as described by Evans can have an affective component that influences the cognitive one. It is related to the discourses called up by the learner in an attempt to solve a problem. "Gender is implicated in these positionings, but it is not determinant in any ultimate, or exclusive, sense" (Evans, 2000, p. 231-32). Gender alone cannot therefore be taken to account for the whole of initially perceivable differences. Understanding of cognition and anxiety must also be informed by other factors including: qualifications, age, social class, familiarity, confidence, culture/ socialization, as well as positioning generated by discourses called up by the subject. "Initially impressive gender differences were reduced, and made more specific (to subgroups) as a result of using controls" (Evans, 2000, p. 40). Evans controls his results for other variables, including age and mathematics qualifications, reducing what might otherwise have been taken for simple gender difference.

Many researchers point to confidence as being a key contributor to the continued lack of equity. Chipman found "gender difference in mathematics confidence may well be partially responsible for some of the under-representation of women in science and engineering fields" (Chipman, 1996, p. 293). It is suggested that this lack of confidence, combined with other factors such as performance, interest and gender ideology result in lower participation rates for women in mathematics. As early as high school girls report lower confidence prior to a decline in academic performance. "In general, girls are more apt than boys to doubt their competence in mathematics and to be less confident in their mathematics ability.... As Fennema and Sherman (1978) found, girls in early adolescence

experience a drop in their self-confidence in mathematics *before* they experience any academic decline" (Campbell, 1995, p. 226). Poor confidence feeds poor performance, which in turn feeds poor confidence. Amidst this downward spiral women turn their attention to other fields; or so the story goes. Researchers have found a "striking lack of career-focused women" (Felgner, 1996, p. 184) among girls who were interested in mathematics.

> Interviews also showed girls with good grades to be self-critical, whereas boys tended to view themselves too positively ... girls make more open-minded statements than boys about mathematical abilities and gender roles, but this does not correspond to the way a girl views her own person and future role. Girls still tend to lack self-confidence regarding mathematical ability, and their plans for their lives tend to remain within the scope of traditional ideas, where great importance is attached to social acceptability. (Felgner, 1996, p. 184)

A closer look then must be taken at confidence in mathematics *per se*. What is confidence? Are confidence and achievement related and if so, in what way? What are the consequences of this gender difference, and what steps can be taken in order to foster a more equitable result? How does this lack of confidence in females impact their achievement, participation in higher mathematics courses, enjoyment of the subject, problem solving approaches, and persistence with individual problems as well as with the subject matter as a whole?

Confidence forms a central part of one's internal belief system as understood within the framework of the autonomous learning behaviour model. For the purposes of this discussion, mathematics confidence will be defined as "one part of self-concept and has to do with how sure a student is of his or her ability to learn new mathematics and to do well on mathematical tasks" (Meyer, Koehler, 1990, p. 61). While each study of confidence varies in method, results are consistent: there is an undeniable gender difference where confidence in mathematics is concerned. "Differences in confidence levels between males and females still exist, to the detriment of females, even when they perform equally" (Gray, 1996, p. 27). That is to say, females remain less confident than their male counterparts despite equal performance. As we shall see, women continue to feel this way even despite superior performance.

Confidence and Achievement

Many studies focus on gender differences in mathematical achievement. This is in part due to the fact that gender differences in achievement were among the first to be observable to researchers. Initially, there was a "substantial body of evidence to suggest that, from the beginning of secondary schooling, males frequently outperform females in mathematics" (Leder, 1990, p. 13). The pursuit of gender equity in mathematics thus began with an attempt to understand and eventually erase this differential performance. Equal achievement, however is no longer in question.

Over time, it was found that there is a correlation between confidence on the one hand, and achievement on the other. Studies thus emerged to explore the confidence/ achievement dynamic. In one such study, Meyer concludes that "when a gender difference in mathematics achievement in favor of males was found, it was accompanied by a gender difference in confidence, also in favor of males. Gender differences in confidence were also found even when there were no differences in achievement." (Meyer & Koehler, 1990, p. 61) In this study correlation between confidence and achievement was undeniable; "confidence was more strongly correlated with achievement ($r = .40$) than was any other affective variable measured in the study" (ibid., p. 62).

This same conclusion was drawn in a 45-day study of a 7^{th} grade mathematics class (Stanic & Hart, 1995). It was found that white females were bound together by "doubt about their ability in mathematics... [For example] Wendy believed that doing her homework, studying a lot, and keeping her notebook neat covered up for some of the problems she perceived herself as having." (Stanic & Hart, 1995, p. 266-267) This notion of success as a result of hard work versus ability will be further explored in the section on attribution styles and how they relate to each gender. For the time being, it suffices to note that what has been termed 'lack of confidence' seems to be a cornerstone of women's mathematical experience.

Furthermore, it has been determined that affective variables, confidence in particular, carry a greater importance for women than for men.

> One noteworthy finding that emerged from the Fennema and Sherman studies (1977, 1978) was that males in Grades 6 through 12 consistently showed greater confidence than females in their ability to learn mathematics. Initially those differences were not reflected in differences in achievement; however, for the older students, confidence in mathematics was a good predictor of performance for females but not for males. (Leder, 1990, p. 19)

That is to say, greater confidence in mathematics predicts greater performance for females, and lesser confidence predicts lesser performance for females, but not so for males. This is an interesting nuance that requires careful consideration. We must ask not only why women are less confident of their mathematical ability, but *if* they are, as well as whether that confidence impacts performance in a gendered way.

One consequence of lack of confidence in mathematics may be a general dislike for the subject over time. "Females reported more often than males that they had less confidence in their ability to do mathematics and expressed feeling of dislike for the subject as they got older" (Croom, 1997, p. 3). Dislike, resulting from poor confidence, may thereby play into the unwillingness of females to take elective mathematics courses which in turn contributes to the under-representation of women in mathematical fields of study and work.

It is also possible that lack of confidence not only impacts women's willingness to participate in further elective mathematics, but also that "women's lack of confidence may inhibit them from trying alternate approaches to problems or experimenting with different techniques" (Gray, 1996, p. 30). This impact on problem solving, while a serious problem, provides a potential means for measuring progress when attempting to foster confidence. Problem solving approaches being an observable phenomenon may open the door to determining the criteria or characteristic goals of equity in mathematics confidence.

All of this considers lack of confidence and its consequences, but what of its cause? Why are women so doubtful of their mathematical abilities when their male counterparts are not? Why does that doubt impact women's performance more so than men's? If gender inequality and under-representation in mathematics is not a question of achievement or opportunity, what can it be?

Confidence and the Internal Belief System

"An internal belief system is hypothesized to influence willingness to work independently" (Fennema, 1990, p. 7-8). The components of the internal belief system as outlined by Fennema (1990), and used by Meyer (1990), are:

- *Confidence* in one's ability to learn and perform in mathematics
- Perception of *usefulness* of mathematics
- *Attributional style*: Pattern of success/ failure causal attributions in mathematics
- *Sex-role congruency*

Gender differences in each of these Internal Belief Systems components have been observed.

> Males have personal belief systems that enable them to pursue mathematics-related careers. Females, more than males, report less confidence, exhibit an attributional style that inhibits persistence and other achievement-related behaviors, and fail to perceive mathematics as a useful pursuit. (Fennema, 1990, p. 4)

Sex role congruency, also negatively impacts female willingness to participate in mathematics and engage in ALBs. Confidence is thus a central component of the internal belief system directly influencing the willingness to work independently engaging in ALBs.

> Confidence is essential to the autonomous learner because there is little certainty when engaging in high-level tasks. Confidence is an important prerequisite for choosing to do and persisting on high-level tasks. A sense of confidence also supports the learner in working independently. (Meyer & Koehler, 1990, p. 70)

Of course, a student's Internal Belief System does not operate in a vacuum. "Interacting with this internal belief system (and also directly influencing participation in ALBs) are external influences such as teachers, peers, and parents" (Fennema, 1990, p. 7-8).

An attribution scale was developed by Fennema & Peterson in 1984 "which tested some of the theories of the Autonomous Learning Behaviour model" (Meyer & Koehler, 1990, p. 68). Using Weiner's categories of ability, effort, task difficulty, and other (an expanded luck category), they found that "males were more likely than females to attribute their success to their ability and their failure to lack of effort. Females were more likely than males to attribute their success to effort and to help from others" (Meyer & Koehler, 1990, p. 68). This way, males claim more agency over their own success than do females thereby justifying their self-confidence. Males tell themselves that they succeed because they are skilled, and should they fail, they could have succeeded had they tried harder. The focus for males then seems to be on success. Conversely, females claim agency over their failures justifying lack of self-confidence. Females tell themselves that they only succeeded because they worked hard and received help from others. Sadly, "females attribute [failure] to ability" (Leder, 1990, p. 20), concluding that they simply are not able to succeed when they fail. Thus, the focus of females seems to be on failure. It is interesting that hard work and resourcefulness are not perceived by females as assets but rather as weaknesses.

There are also some differences as to how the genders perceive their success and failures in terms of luck. "Females habitually attribute their success to hard work or luck and their failures to lack of ability, whereas males see it the other way around (failure is attributed to lack of work or bad luck, and success to ability)" (Forbes, 1996, p. 87). Males are more likely to consider luck a factor when they fail, maintaining their confidence, whereas females consider luck a factor of their success. Because of this, even repeated success may not positively impact a young girl's confidence in her mathematical abilities, thinking she is simply fortunate rather than able.

Impact of Gender Ideology and Sex Role Congruency

"It is well known that women often lack confidence in their mathematical knowledge and abilities. But how confident can women be if they lack an intuitive grounding for mathematical ideas, and if the value of their knowledge is continually undermined?"

(Damarin, 1995, p. 253) Here it is suggested that the very institution of academia, as well as the society in which it is found, is responsible for undermining women's mathematical knowledge. This is not a particularly surprising assertion given centuries of misogyny. "A strong case could be made that the major gender problem in US mathematics education today is the gender difference in confidence driven by pervasive social stereotypes that fail to recognize the actual mathematical accomplishments of female students" (Chipman, 1996, p. 292).

In *Counting Girls Out*, Walkerdine investigates the myth of male superiority criticizing sexist interpretations and conclusions drawn by various studies. "Research on sex and gender overwhelmingly uses methods which search for *differences* ... Similarities are usually treated in terms of their failure to show significant differences: in other words, similarities become non-results" (Walkerdine, 1989, p. 13). She draws attention to result interpretation and the manipulation of 'significant' data. Women, in her view, are taken by the research itself to be different or lacking in comparison to their male counterparts. Deficit theories, as she calls them, blame the victim.

She also draws attention to stereotypical gender ideologies of educational institutions including textbooks, curriculum and teachers. "This phenomenon – of 'downgrading' the 'quality' of girls' good performance because it is thought not to be produced in the right way – is extremely common ... any child who is seen to be working *must* be lacking in *ability* or *flair*" (Walkerdine, 1989, p. 97). Teachers categorize boys into 'having flair' despite bad behaviour, and girls into 'hard working' with good behavior reflecting lack of flair. This assumption permeates the fabric of student belief, echoing down generations. Girls and women who do not identify with given ideologies often find their sense of sex role congruency to be conflicted. This dynamic, though largely unconscious, shapes the way teachers and students interact and can influence self confidence. "Teachers systematically extended boys' utterances and curtailed those of girls ... In the fourth year of secondary school girls were still performing better than boys overall but were often felt to be unconfident and put in the double-bind of not being pushed or helped and often not entered for more prestigious examinations" (Walkerdine,

1989, p. 203). In this way, the under-representation of women in higher mathematics falls on classroom culture and the subconscious dynamics of gender ideology. Walkerdine does not seek to blame teachers equally ensnared in such perceptions. Rather, she wishes to draw attention to the dynamic itself so that it might then be subverted.

Textbooks have also been regarded as partly responsible for the sexist undertones of gendered self-perception. This is a site where change can be made in a straightforward way: "it seems that Mathematics texts and examples focus on science and engineering and that when so-called feminine examples are inserted these involve pastimes like knitting or household tasks such as filling baths or tiling rooms" (Walkerdine, 1989, p. 207). This fiction of gendered-activity must be undone in order for equality to be possible and is "at least as important as the apparent issue of getting more girls to take higher-level mathematics" (Walkerdine, 1989, p. 208).

CHAPTER TWO
Theoretical Framework

Definition of Equity

At the end of schooling, there should be no differences in what females and males have learned, nor should there be any gender differences in how students feel about themselves as learners of mathematics. Males and females should be equally willing to pursue mathematics-related careers and should be equally able to learn new mathematics as it is required.

(Fennema, 1990, p. 5)

This research explores gender differences in mathematical confidence, that is, confidence in one's ability to learn and perform in mathematics. Confidence here is taken to be a component of the learner's internal belief system as outlined by Fennema (1990). A decline in confidence is supposed to accompany or result in a decline in autonomous learning activity.

Autonomous learning activity is defined as "active and willing participation in mathematical tasks that require knowledge and independent thinking" (Fennema, 1990, p. 7). Some gender differences may be explained by considering the lowered participation rates of females in these types of activities. The Autonomous Learning Behaviours (ALB) model explains "causation of gender differences in achievement on mathematical tasks ... the model hypothesizes that gender differences on these tasks are caused by differential participation by females and males in autonomous learning behaviours (ALBs)" (Meyer & Koehler, 1990, p. 69). Examples of ALBs include choosing to engage in tasks, preferring to work independently, and persisting with tasks. (Meyer & Koehler, 1990, p. 69) That is to say, females who prefer to work in groups, who engage less in tasks, and who fail to persist with those tasks may see decreased achievement when compared to their male counterparts who engage more, work independently, and persist. This model presumes a gender difference to the detriment of females and is thus categorized as a deficit theory according to Walkerdine (1989). The framework need not be abandoned, however. It can be gender neutralized by considering student engagement with ALBs to determine whether ALBs impact performance in a positive way.

Since ALBs require and develop an individual's ability to work independently, it follows that "these traits do not develop when one becomes an adult; instead, they are formed over a period of years as a person grows and develops" (Fennema, 1990, p. 7). Adult students have thus already developed their engagement with ALBs. This also falls in line with research findings that confidence declines over the course of teenage development as opposed to during adulthood. As ALBs develop, or fail to, so too would confidence in one's own mathematical abilities.

A closer look at ALBs and an individual's Internal Belief System provides insight into this decline in confidence and independent participation in mathematics.

In the interview case studies of this research, the *student's engagement with ALBs*, their *internal belief system,* and the context called up during problem solving will all serve as a theoretical framework for interpreting results. During interviews, it will be apparent which students engage actively with ALBs, and which do not. ALBs directly impact student achievement in this research with strong ALBs resulting in strong achievement. When considering the internal belief system, particular attention is given to confidence and attributional style, while there is lesser emphasis on usefulness of mathematics and sex role congruency. This is because the vast majority of students share the same view of the usefulness of mathematics (they 'need' this course and no more), whereas sex role congruency appears not to be an influential factor in the student's view of themselves as mathematicians.

In the adult student, it will be assumed here that the internal belief system is fully formed and engagement with ALBs has been virtually cemented. While confidence will be difficult to alter at this stage, it is worth noting that mathematical confidence may well vary across the perceived context of a given problem. Evan's notion of predominant positioning in either 'practical math' or 'school math' will also serve as theoretical framework for the interpretation of student solutions provided during a problem solving session. A 'school math' context is signalled through a written solution, a procedural solution as taught in a classroom (cross multiplication or long division, for example). A 'practical math' context is signalled through a mental calculation or 'real world' reasoning. In particular, a tipping problem as modeled after Evan's own study provides an interesting opportunity to examine his notion of predominant positioning and how it can impact student problem solving and the correctness of solutions put forth by students.

CHAPTER THREE
Methodology of Research

The more we learn about the universe, the more complicated it appears to be, but we have discovered that beneath those complexities lie deep simplicities, laws of nature.

(Cohen & Stewart, 1993, p. 5)

Participants

Mathematics 436, or advanced grade-10 mathematics, is a critical course for those who aspire to higher education, though it is not required for high school graduation. It is required for the study of the sciences and commerce, but also for social science in some CEGEPs, as well as for many professional or vocational programs including nursing. While teaching this class in adult education over the summer of 2004, I became intrigued by the various levels of confidence and frustration exhibited by my students, and wanted to explore in greater depth their reasons for persisting with this course; I also wished better to understand their problem solving process in the hopes of improving my own teaching in the future.

The course consisted of 4 books each with one exam covering (1) Logic, Set Theory, and Relations (2) Straight Lines II (3) Factoring (4) Algebraic Fractions. The first book, Logic, is the longest and includes the most material. Straight Lines II is the shortest book and is generally considered to be the easiest, covering parallel and perpendicular lines as well as the distance formula. Factoring is fairly straightforward and includes the factoring out of common terms, factoring polynomials by grouping, factoring trinomials and difference of squares. The final book, Algebraic Fractions, builds on factoring and explains how polynomials in the numerator and denominator cancel out.

Classes were given five days per week, for three hours each day. I also volunteered my time in the afternoons for 'extra help'. The pace of the material was intense and required a measure of dedication on everyone's behalf. Absolutely all of these students took this course because of 'need' either to graduate high school or as a pre-requisite for further study. The programs they were bound for required mathematics 436 and, because they had either failed that course previously or not taken it at all, they now found themselves learning this material in a summer school. Students were therefore carrying an "'emotional baggage' they will have built up with the previous 'failure'" (Duffin & Simpson, 2000, p. 88). The resultant shame and disappointment of these 'failures' is explored in greater detail through interviews with the students. This

'baggage' is a further adult quality despite other youthful characteristics of the study's demographic such as age.

With their first exam on Logic, I handed out a questionnaire to be completed on a voluntary basis. The purpose of this exercise was in part to get to know my students better, but also to help qualify the summer session adult education demographic. Students were asked to identify their gender, age, whether or not they were working. Students who were working were asked to specify their job and the number of hours they work each week. Students were also asked about their scholastic/ professional intentions for the upcoming school year (fall 2004). Finally, students were asked to describe how they were feeling during the test they had just written.

The first part of the research consists of comparing student test results with the student's earlier estimation of those results. The difference is taken to be reflective of the student's confidence in their own mathematical ability. In 2004 as well as in 2005, virtually all students in the class participated in this estimation process. The data from 2004 is collected from 27 students (10 male and 17 female). The data from 2005 is collected from 34 students (16 male and 18 female). The second part of the research involves eight case studies via semi structured interviews which include a problem solving session. Participants signed a consent form a sample of which is available in Appendix C.

Method

On the first exam in the summer of 2004, I requested that the students provide me with an estimate of their test grade after having completed the exam, but just before handing it in to me. I wanted to see how accurate their estimation of their own performance would be. I repeated this estimation process on all three subsequent exams, to determine whether a gender related difference in confidence was consistently observable. On the fourth exam, most students were so eager to be done with the course that they 'forgot' to estimate their grades leading me to exclude the few estimations that were provided from confidence

analysis. The experiment was again repeated with a different group in the summer of 2005 at the same school, taking the same course, with the same teacher.

In 2004, as I was collecting the first batch of data and searching for a possible explanation of these apparent gender differences, I grouped the class into three categories, underestimates, accurate estimates, and overestimates. I proceeded to interview 4 women and 4 men via semi-structured interviews. The purpose was to determine how the students were evaluating the correctness of their solutions, and to consider the effect of both confidence and frustration levels to the student's self-evaluation. Understanding motivation for taking the course, and approaches to problem solving were also goals. The first part of my interviews revolved around the following questions:

1. How did you come to Place Cartier? What is your mathematics story?
2. Why are you taking mathematics 436 now?
3. Why did you not take mathematics 436 before? or Why did you fail mathematics 436 previously?
4. What would you change to better perform, or to enjoy mathematics more?

In youth sector public high schools, students are divided into 'regular' 416 mathematics or 'enriched' 436 mathematics in grade 10 (secondary 4). Five of the interviewees, all 4 men and 1 woman, were originally placed in 416 mathematics and now needed 436 mathematics to be admitted to John Abbott College. The personal story was the most interesting part of this process for me simply because, as teachers, we rarely get to know a student's history in such detail.

Question 1 & 2- Logic

For the second part of the interview I prepared 5 problems to solve beginning with 2 logic problems.

1) If p is true and q is false, determine the truth value of the following:

p: I live on earth
q: I have 7 brothers

a) $\neg (p \wedge q)$ b) $\neg (p \vee q)$

2) $A = \{ 3, 6, 7, 8 \}$
$B = \{ 7, 8, 9 \}$
$U = \{ 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 \}$

Find $\mathbf{B \cap A'}$

Interviews were several weeks after that part of the course; I was interested to see how much had been retained. I also favoured these because they offered many possible solutions. I anticipated at least three possible solutions including (1) recollection of negation rules (ex. $\neg \neg p \Leftrightarrow p$), (2) truth table, (3) verbal solution (using statements to reason). Logic, however, is no longer part of the course. Question 1 would therefore be omitted in a repeat of the study. For question two, I expected students to use Venn diagrams, lists, and truth tables. Furthermore, since there were multiple approaches available, taught in class only a few weeks prior, I expected that the students would use one approach to solve the problem and another to check their solution.

Question 3 – Word Problem

The third problem was a word problem that involved fractions. Both word problems and fractions appear to be hurdles for students, and I wanted to observe their approach to these. I also wrote out all of the numbers as an added challenge: for example. 'twenty' instead of 20. The problem was given as follows:

3) Stacy lives two kilometres from her friend's house. It takes her twenty minutes to walk from her house to her friend's. If she leaves her house at ten am, at what time will she be nine tenths of the way to her friend's house? How far will she have walked?

Stacy's house Friend's house

Students finishing grade nine should be able to solve this problem. Possible strategies included (1) fraction arithmetic, (2) cross multiplication, and (3) the 'Straight Lines II' approach from this course. Fraction arithmetic here would involve multiplying the total time and/ or the total distance by nine tenths. Cross multiplication would involve establishing ratios such as (x/20) = (9/10) or (x/2) = (9/10) and cross multiplying to solve for the unknown x. A functional approach, that is finding the equation of the line given two points (0,0) and (20, 2), was not anticipated as it was not a part of the current course

and likely had not been used by students in several years. The Straight Lines II approach involves finding "the coordinates of a point [P] that divides a line segment in a particular ratio a:b, given the endpoints of that line segment" (Perreault, 2003, p. 4.2). If the endpoints of the segment have coordinates (x_1,y_1) and (x_2,y_2) then the coordinates of the point P are given by the formula $\left(\frac{bx_1 + ax_2}{a+b}, \frac{by_1 + ay_1}{a+b}\right)$. Students are given this formula in class and are taught to apply it. The formula is not however derived or proved making its application primarily a question of memorization and procedural application.

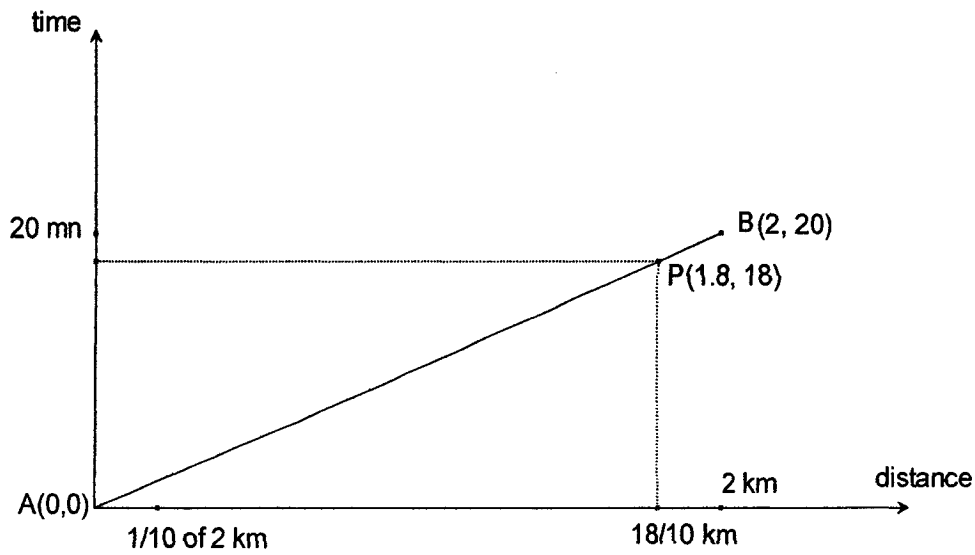


Figure 1. The "Straight Lines II" Approach

In the given example, the ratio is 9:1, so one can take a = 9 and b = 1. If the endpoints of the segment are A(0, 0) and B (2, 20) (see Figure 1), then, according to the formula, the coordinates of P are (1.8, 18). Here, the x-coordinate represents distance, and the y-coordinate represents time. If Stacey leaves at 10am, she will arrive 9 tenths of the way at 10:18 am having walked 1.8 km.

Question 4 – Algebraic Fractions

4) Perform the following multiplication:

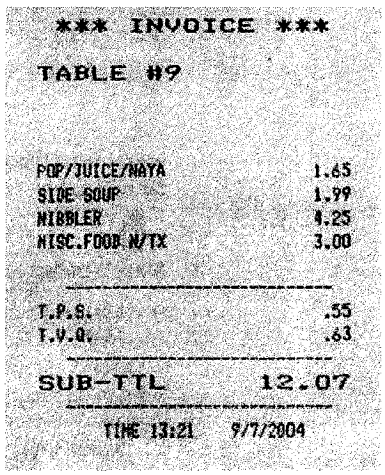
$$\left(\frac{Z^2 - 49}{2Z^2 - 13Z - 7} \times \frac{2Z^2 - 13Z - 7}{Z + 7}\right)$$

A question on algebraic fractions was originally included as it was the current part of the course and performance on this question could be contrasted with performance on the logic questions from earlier in the course. Also, these problems involve some factoring, which students could have used to check part of their solution. Unfortunately, so much time was spent struggling with problem three, interview time constraints required this question be abandoned in favor of question 5.

Question 5 – Tipping

The fifth problem consisted of a tipping question, which was intended to provide a real life context from within which I hoped to observe the students' predominant positioning in either 'practical math', or 'school math'.

5) You go out to a restaurant for breakfast and have to pay the following bill at the end of your meal. How much would you leave as a tip for a waitress who served you well, but not especially so?



This question is similar to one used by Evans (2000) and I was hopping to make some comparisons between my results and his.

In the current study, problem 5 included a photocopied receipt and the mention that the service was good, but not especially so. I control for what might be termed the

service variable by assuming that the service is not a distinguishing factor in an effort isolate the calculation of a tipping percent. Here, too, more than one strategy was anticipated with which the interviewees could have calculated the percent and then checked the correctness of their answer. Possible strategies anticipated were: (1) Multiply the total before tax by 0.15 (2) Multiply the total before tax by 1.15 then subtract the total (3) Add the tax and (4) Shift decimal of the total before tax to determine 10%, then add half of that. The receipt total after tax was $12.07, but the total before tax was not explicitly written on the receipt making anticipated solution (3) the most likely.

As these problems proved more time consuming than anticipated, I opted to focus on question 3 (word problem) and question 5 (tipping) in describing the results in the next chapter. Complete transcripts of these interviews, as well as consent forms and the interviewee's solution sheets may be found the Appendices.

CHAPTER FOUR

Quantitative Confidence Results

[G]ood or positive feelings with regard to mathematics need not necessarily indicate or lead to better performance, just as bad or negative affect need not inescapably interfere with cognition.

(Evans, 2000, p. 64)

Results from the preliminary questionnaire from 2004 provide a snapshot of the classroom demographic and are summarized in Table 1. Of the 30 students in the class at that time, 3 have been discounted from this study as they only took 1 test and therefore are not representative of the course as a whole. Of the remaining 27 students, 18 women and 9 men, I received 19 completed questionnaires. Here, I will define mature students to be 18 years of age or older, who have spent some time out of school, working or otherwise. Using this definition we find that only 7 students in the class might be considered mature. The group nevertheless possesses some 'adult' qualities as nearly half of respondents work as well as study. This balancing of profession and education may be considered a mature activity in addition to the aforementioned 'adult emotional baggage' of the students.

Table 1 – Preliminary Questionnaire – summer 2004

Gender		
	Male	7
	Female	12
Age		
	17 or younger	12
	18 or older	7
Currently Working		
	Yes	9
	No	10
In the Fall		
	CEGEP	12
	Working	1
	School	5
Feeling in Exam		
	Nervous	7
	Bad, scared	4
	Good, relaxed	3
	Unspecified	2
	Confused	2
	Concentrated/ Remembering	1

We can also see from **Table 1** that only three students describe themselves as feeling good or relaxed during the first exam. Most of the class (12/19) had already graduated from a "regular" high school in the youth sector, meaning not in adult education, and had

plans to attend CEGEP in the fall. This constituted a highly motivated group; all of these students want to receive credit for this course because of 'need', though not all *initially* invest sufficient effort in order to pass.

Table 2 summarizes the **results** of student estimations as compared to their actual test results on the very first exam (logic) in 2004.

Table 2 – 436 "Logic" Test and Estimation Results 2004

Female (17)	Test 1 (%)	Estimate (%)	Confidence Difference (%)
F mean	73.59	70.88	-6.38
	81	70	-11
	78	75	-3
	50		
	65	70	5
	96	85	-11
	65	50	-15
	89	85	-4
	71		
	92	60	-32
	81		
	80	95	15
	69	70	1
	64	62.5	-1.5
	50		
	75	63	-12
	72		
	73	65	-8
Male (10)	**Test 1 (%)**	**Estimate (%)**	**Confidence Difference (%)**
M mean	60.30	55.08	3.92
	49	65	16
	49	50	1
	60	60	0
	32	33	1
	70		
	85		
	69	70	1
	60		
	48	52.5	4.5
	81		

What proved interesting was the gender divide, which was too pronounced to overlook: 53% of women (9/17) underestimate their performance whereas 0% of men underestimate their performance. Similarly, 60% of men (6/10) overestimate their

performance, though half of those by only 1%, as compared to 18% of women (3/17) who overestimate their grade, one of them by only 1%. This striking confidence divide between the genders seemed particularly odd given that women not only outnumbered men by nearly twice as much, but also outperformed them by more than 10%. Also noteworthy is the fact that only 12% of women (2/17) failed this test, whereas 40% of men (4/10) failed. At the end of summer 2004, there was a clear and consistent tendency of underestimating women and overestimating men.

A Bird's Eye View

Data varied significantly from the first year of the study to the second, particularly in terms of the gender differences represented. Results for both years are summarized below in **Table 3**. Achievement mean is the average scores of the four tests. Confidence is evaluated as the difference between the estimated result and the actual test score. Negative confidence results from underestimation of performance whereas positive confidence reflects overestimation.

Table 3 – 436 Summer Course Test and Estimation Results

2004	Achievement (mean)	Confidence (mean)	Confidence Standard Deviation
Male (10)	67.60	0.68	7.88
Female (17)	80.91	-9.97	9.83
Class (27)	76.67	-6.42	10.41
2005			
Male (16)	78.97	-5.83	6.87
Female (18)	83.05	-7.99	8.42
Class (34)	81.12	-6.97	7.69

Female students outperformed male students in both years. Female performance improved slightly the second year, and male students did significantly better in 2005 than in 2004. On average, women in both years underestimated their performance. An interesting difference also appears in the confidence of males who are notably less confident in 2005 (-5.83) than in 2004 (+0.68). A further difference appears in standard deviations: standard deviation in confidence is larger for women than for men in both years, but notably reduced from 2004 to 2005.

Figure 2 plots the confidence (x) and achievement (y) means of students in 2004. It is clear that a vast majority of females, 82% or 14/17 underestimate their achievement, whereas the vast majority of males, 70% or 7/10 overestimate their achievement. Also, it is apparent that while 90% (9/10) of males estimate their grade on average to within 10%, only 41% (7/17) of females estimate their grade on average to within 10%. *Irrespective of gender*, of students who underestimated their grade, 94% (16/17) achieved a mean of 70% or higher on their tests. Comparatively, of those students who overestimated their grade, only 20% (2/10) achieved a mean of 70% or higher.

Figure 2 – 436 Summer Course Confidence and Achievement 2004

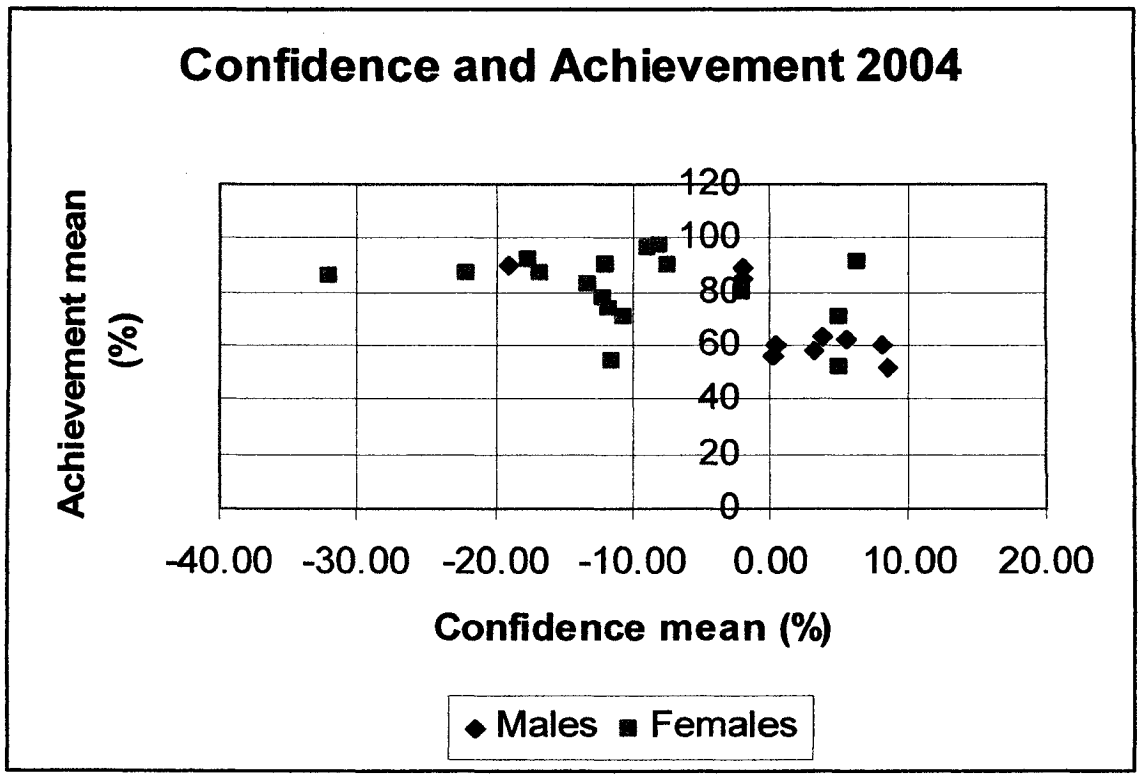
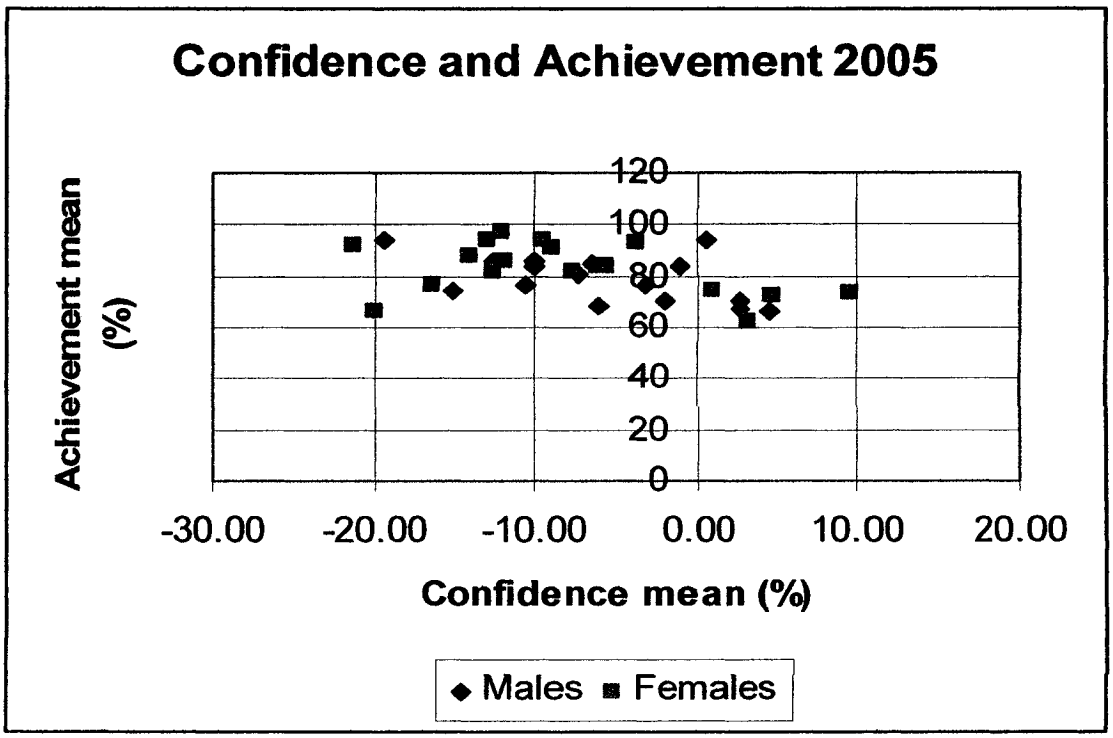


Figure 3 plots the confidence (x) and achievement (y) means of students from the 2005 class. Here again, most females, 78% or 14/18, have negative confidence, but this time only 25% of males (4/16) have positive confidence. This is an important difference from data collected the previous year. Again, it is apparent that while 75% (12/16) of males estimate their grade on average to within 10%, only 56% (10/18) of females

estimate their grade on average to within 10%. The gender difference is therefore reduced in 2005 by comparison to 2004, forcing one to consider other, possibly more important, influences on confidence aside from gender.

Figure 3 – 436 Summer Course Confidence and Achievement 2005



Irrespective of gender, of those students who underestimated their grade, 92% (24/26) achieved a mean of 70% or higher on their tests. Comparatively, of those students who overestimated their grade, only 25% (2/8) achieved a mean of 70% or higher. This is more in keeping with the finding from the previous year. The data from both years therefore suggests an inverse relationship between confidence and achievement. That is to say, lower confidence is more likely to accompany higher achievement, and higher confidence is more likely to accompany lower achievement. In this way, the so called 'lack of confidence' displayed by female students might be viewed in a more positive light.

Confidence Throughout the Course

These averages conceal the range of student estimations. For example, a student who underestimates by 20% on the first test, but only by 5% on subsequent tests will show a confidence average of -8.75 masking the depth of insecurity demonstrated by the initial underestimation. For this reason it is telling to consider the confidence data particular to each of the first three tests. Again, confidence is measured as the difference between the estimate and the test score, with negative confidence indicating under estimation. Empty boxes signify that no estimate was provided by the student for that particular test.

Table 4.A. – 436 Summer Course Confidence Difference 2004

F mean	-6.38	-12.25	-11.17
*	-11	-23.5	-12.5
*	-3	-4	-15
*		-15	
*	5	-17.5	-27.5
	-11	-9	-1
*	-15	-8	
*	-4	-15	-5
		-3	13
*	-32		
*		-8	-16
**	15	-4	
*	1	-9	-27
*	-1.5	-10	-20.5
		-6	2
*	-12	-14	-24
*		-22	
*	-8	-28	-0.5
Male (10)	Logic (%)	Straight Lines II (%)	Factoring (%)
M mean	3.92	-5.55	7.11
**, *, **	16	-15	18
	1	0	11
	0	-7	8
**	1	16	
*		-23	-15
		-9	5
	1	0	0
**		-13	24
**	4.5	-10	17
		0	-4

2004

* Single *under* estimation of 15% or more.
- 14 female
- 3 male

** Single *over* estimation of 15% or more
- 1 female
- 5 male

Table 4.B. – 436 Summer Course Confidence Difference 2005

F mean	-4.03	-8.69	-5.81
*	9	-18	-10
	3	11	12
	5	3	-9
*	-25	-22	4
	-12		-4
			-10
	-2	3	-11
	4	1	
	-10	-1	-10
*	-18.5	-20	-5.5
*	-14	-10	-22
*	-1	-25	-3.5
	10.5	8	5
*	-14	-22	-8
*	1	-25	-5
	-7	-1	6
*	-13.5	-24	-22
**	16	3	
M mean	-0.40	-10.97	-0.5
**	19	-9	14
*	-5		-18
	-6	-7	14
*	8	-25	-5
*	-9	-15	-5
	-6	-13	-3
	-4	-4	16
	4	2	0
*	2	-19	-15
*	-4	-16	
	7	-9	10
	-7	3	-13
*, **	0	-17	25
	3	-3	-6
*	-8	-22.5	-21
		-10	

2005

* Single *under* estimation of 15% or more.
  - 11 female
  - 9 male

** Single *over* estimation of 15% or more
  - 1 female
  - 2 male

Of the estimations made over the course of the two years, 28% of female estimations (25/90) and only 17% of male estimations (12/69) are under their corresponding result by 15% or more. Comparatively, 2% of female estimations (2/90) and 10% of male estimations (7/69) are over their corresponding result by 15% or more. There is an important difference between the classes of 2004 and 2005 as well. The 2004 group

shows greater gender differences between underestimates and overestimates of 15% or more, whereas the 2005 group echoes this difference on a much smaller scale highlighting the dangers of concluding based on small sample groups. While gender differences do make themselves known in this study, differences between the two classes and even between two tests must also be taken into consideration.

Notable is also the relatively lower confidence for both men and women in both years on the second test as compared to the first test. This may be due to the fact that the first test was significantly harder than many expected, whereas the second test was comparatively easy. Because grades were lower than hoped for on the first test, students reacted with decreased confidence in prospective results on the second test and hence made lower estimates. What is also interesting is that while male confidence seems to have been nearly restored to original levels or beyond on the third test, female confidence struggles to recover. In 2004 the confidence means moves from -6.38 to -12.25 to -11.17 on each of the three tests respectively. Female students from the 2005 group fare better in confidence recovery, though still not as well as their male counterparts with the female confidence mean moving from -4.03 to -8.69 to -5.81. Does this indicate that female students are impacted more heavily by long term mathematical history, whereas male students are impacted more heavily by recent history? Perhaps, but there is insufficient data to make a conclusive statement; further investigation is required.

Some students chose not to estimate their grade on certain tests, which bodes the question: why? The Straight Lines II test may be judged to be the easiest as it received the highest achievement; it also obtained the least number of blank estimates. In this way we may link the difficulty of an exam with the refusal to provide an estimate.

Table 5 – Blank Estimates

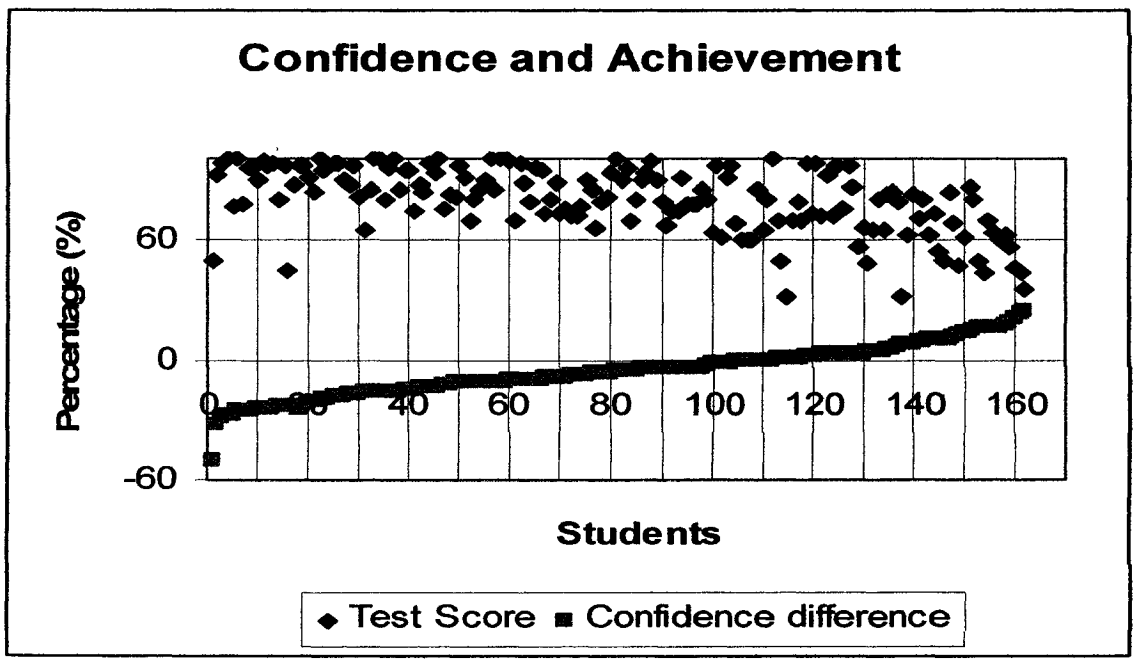
2004 Blanks (27)	**9**	**1**	**6**
2005 Blanks (34)	**2**	**3**	**4**
Total Blanks (61)	**11**	**4**	**10**
Test Mean	**72.98%**	**86.75%**	**78.20%**

While some simply forgot to estimate, reasons for refusing to estimate resembled reasons for providing low estimates: fear of appearing conceited by estimating high, not wanting to 'jinx' the result by estimating high, and refusal. Superstition and stress seemed the most common responses offered by those who chose not to estimate. One female who would not estimate her Straight Lines II test achieved a perfect score of 100%. She explained her fear: "I don't even like talking about my grade. I won't do it. I'm afraid I'll do bad if I talk about it... it's like a phobia I have. I don't like doing it! I won't do it." It's as though they feel the process of estimating their result might somehow impact the result itself. The refusal to estimate, in this case at least, is motivated by fear.

Similarities Across Gender

The relative trend of graph 1 and 2 suggests that irrespective of gender, poor performance is accompanied by an excess of confidence. Graph 3 does not use means but actual test scores and estimates. It plots each student's confidence difference and test score for each of the first three tests. Blank estimates have been omitted. The sample size is therefore n=163. **Figure 4** is structured so that the confidence difference is presented in ascending order with corresponding test scores.

Figure 4 – Individual Test Results of Confidence and Corresponding Achievement



The graph clearly shows a drop off in achievement after the 130th student. That particular student has a confidence difference of +4. The test mean for the 30 students whose confidence difference is greater or equal to +4 is 63.12%. This is significantly lower than the test mean for students with lesser confidence which is 84.21%. *All students* who achieve a test result of 90% or higher, have a confidence difference of less than +4%.

Differences do exist between the genders in this particular group. It is a highly motivated group as students 'need' this course for graduation or future study. The group is majority female (2004: 17 Female to 10 Male, 2005: 18 Female to 16 Male) where, on average, female students outperform male students on every test. Further, these are students with a history of low achievement in math. Their 'need' for this course stems from either having failed it previously or having been sent into a lower level course in high school. This group is therefore characterized as having adult qualities such as: (1) studying within an institution of adult education, (2) balancing profession and education, and (3) carrying the 'emotional baggage' of previous mathematical 'failures'.

Despite the relative strength of females in this group, both in number and performance, results suggest that female students are generally less confident than their male counterparts, a fact which is confirmed by mathematics education literature. In this study, male students were more likely than female students to overestimate their performance, and female students were more likely than male students to underestimate their performance. "'[S]elf-confidence' is viewed as the key to girls' success, the mode of achieving it appears to be gender differentiated. While boys may be described as 'abounding in confidence', 'overconfidence' in girls is a bad quality" (Walkerdine, 1989, p. 104). This view of overconfidence as being a negative quality in girls may contribute to their relatively lower estimations, wanting to offer a conservative estimate rather than appear conceited. This is confirmed by those who would not estimate their performance out of fear of 'jinxing' the final result. Other factors, aside from gender, influence confidence, as will become clear from the interview analysis. So far, we have seen that these include past performance, superstition, and the year in which the data was taken.

CHAPTER FIVE

Qualitative Results : Eight Case Studies

The fact is that a life remembered, like any great work of art, constantly generates new meanings.

- J. Bernatchez

Of the 8 interviewees (4 male and 4 female), 3 were prone to over-estimating their results, 3 made accurate estimations and 2 were prone to under-estimating their results. **Table 6** summarizes the interview demographic.

Table 6 – Interview Demographic

Interview	1	2	3	4	5	6	7	8
Gender	Female	Female	Male	Female	Male	Male	Female	Male
Estimate	Under	Under	Over	Over	Over	Accurate	Accurate	Accurate
Age	35	17	18	41	17	18+	19	17

While specific ethnicities are not listed for each of the interviewees, they nevertheless constitute a diverse group of individuals, representative of the Place Cartier Adult Education summer program. Interviewees were from Canada, St. Vincent, The Philippines, Lebanon and Italy. The mathematics stories were quite varied, as was the response to interview question 3 regarding what they would change to make mathematics more enjoyable. One wanted simply to understand; another wanted smaller classes, yet another wished for family support.

Cassy's Story – Under-estimates

Interviewee number 1, here called 'Cassy' was a 35 year old mature student, an aspiring nurse with a family and financial obligations. She was the kind of student who sat front row center in the classroom. She had returned to school in order to become a nurse, and selected her courses by requirement. Like the rest of the class, she studied mathematics because she must. At one point in her interview she mentioned that she might like to take more mathematics because she 'enjoys it', but that she would no longer 'need' more mathematics, and so most likely would not take any more classes. She was an excellent student, completing the course with a 96% average overall. She was always eager to learn and to show her completed homework, yet seemed to feel sure that she had misunderstood something, though she rarely did. She was one of the first to volunteer when I mentioned my interest in interviews to the class, and 'reminded' me about the interview before we had set a date. When she arrived for her interview she seemed nervous, or anxious, glancing regularly at the recorder, and she struggled a great deal more than I had expected her to with the problems I gave her to solve. When we declared

the interview to be over, however, she tackled the problems head on when I left the room for just a few minutes. Unfortunately, later that same day I realized that her interview had not been properly recorded. I therefore proceeded to write down everything I could remember about the interview. This detailed reflexive account replaces what would otherwise have been the interview transcript.

Table 7 – Cassy's Test Results and Estimated Test Results

96	85	99	90	96	95	95	80

In the statistical portion of this study, Cassy fell into the category of women who underestimated their mathematics performance on exams. As the course progressed, however, her estimations became increasingly more accurate passing from underestimation by 11% to 1%, before falling dramatically on the fourth and final exam to an underestimation of 15%. In her interview, she qualified herself as one who enjoys mathematics when she is 'getting it', but who had never been good at mathematics despite being among the best in the class. One day after class she told me: "I'll be okay if I can get just a 60." Her greatest source of frustration appeared to be the feeling of inability that she experienced when learning new mathematics concepts. Her perception was that because she must study and take the necessary time to learn the material, she was not good at math. She struggled against gender ideology and conflicted sex role congruency as well as the 'shame' of not understanding. She tried to overcome her feelings of inability by studying and preparing a great deal. That same day after class she said: "I always do bad on tests. I just freeze up. I go blank ... I guess I just have to relax but I get so nervous." Judging by her performance, this worked well for her achievement. It also explained her anxious reaction during the interview, as she was unable to prepare for it. Her anxiety could then be classified as test anxiety according to Evans (2000) and not numerical anxiety.

A second source of frustration for her was in balancing her life as a student with her family life as a mother. She told met that she did not like to do mathematics at home

because she did not want to ignore her son. She therefore did all of her homework in the afternoon while he was in daycare/ school, so that she only had to do mathematics at home before a test. I'm not certain that it was a good thing that she hid her mathematics from her child, but it allowed her to cope with the frustrations of balancing her many responsibilities.

During the problem-solving portion of the interview, Cassy appeared quite agitated. Her breathing became more laboured; she fidgeted a good deal, and glanced regularly at the tape recorder. She experienced a complete blank, reading and rereading the problems without making any progress. She told me, "It's just, I'm just feeling tense, and it's like I go blank, and the problem is just words." Her use of the work *tense* here was interesting because it was the same word that she used to describe her feeling on the initial questionnaire during the first exam. This was her word to signal impairing anxiety. Skipping forward to the third problem (word problem) she attempted to cope with this anxiety by underlining information from the problem, and eventually managed to write down some ratios, which, unfortunately, did not contain a variable for her to solve for. She proceeded to write the correct ratio of time, and then changed it for an incorrect ratio. Somehow though, she got to 1/18, and one of the answers in the problem was 18 minutes, so she was close, but she did not know what to do with the numbers on her page and abandoned the problem altogether. Written calculations assigned her a predominant positioning in 'school math' for this problem.

By the time we got to the final tipping problem, she was more relaxed but did not use any algorithm to determine how much she would tip. Instead, she assigned a default tip of $2.50 saying, "That's what I always leave if I'm eating just me... I always leave the same, $2.50 is fine." This was the first time in the interview that she displayed resolute and unwavering behaviour, which was interesting given her positioning in 'practical math' on this question. She was also more relaxed because she had been doing mathematics for several minutes now and was 'warmed up'. It would be interesting to investigate further whether or not the mistakes that she does make on exams occur at the beginning while she is still feeling *tense.* She told me that she was generally a nervous

person, and just needed to relax and start "getting it" to be okay. Sometimes she needed to stop and close her eyes and breathe for a few minutes.

When we concluded the interview, she was apologetic for her performance, though I attempted to reassure her of how valuable this had been for me. I stepped out of the room for a few minutes, and returned to find that she had attempted the first two problems which she had previously left blank (her answers are incorrect because of a negation error), and had a correct answer for the third problem. She told me, "I'm getting it now". Earlier in the interview she mentioned this as being one of the things she liked about math: the feeling of "getting it".

Clearly Cassy engaged and persisted with tasks as she continued to work on the interview problems even after the interview has concluded. She did like to work with a partner, but was also strong as an independent thinker. Her impressive achievement in this course could then be understood in terms of her participation in ALBs (autonomous learning behaviours). Her internal belief system, interestingly enough, seemed not to have impacted her ALBs. She was low on confidence, did not speak of mathematics as useful except as a prerequisite, and struggled with sex-role congruency. Her attributional style, attributing success 'only' to hard work and not ability would also be expected to inhibit persistence. Given these factors one has to wonder how her persistence, ALBs and consequent achievement have faired so well. Is she simply an exception to the rule or is some larger dynamic at work?

Melissa's Story – Under-estimates

Interviewee number 2, here called 'Melissa' was 17 years of age. Though the school board considered her mature enough to be an 'adult' student, she did not fit our definition of mature student, in large part because she had not been out of school for two years or more, and was not 18 at the time of this study. She did have a job however, and so had to balance both work and school, as did the majority of 'mature' students. She also had a history of failure with resultant 'emotional baggage': another 'mature' quality. Melissa hoped to become a policewoman, and mathematics 436 granted her entry into a

correctional course for one year, at which point she hoped to be accepted into Police Technology. The correctional course she referred to relates to law enforcement without being a part of the Police Technology program at John Abbott College. Melissa was a quiet student who stayed after class to ask questions because she did not want to ask them in front of others. Like Cassy, she too experienced the 'shame of not knowing'. She qualified herself as being weak in mathematics from the beginning of the course, right up to the end of the course. On the initial questionnaire, her mathematics insecurity is apparent as she described her emotional state during the first exam as follows: "I was very nervous because math is definitely [sic] one of my weaker points". Her greatest obstacle appeared to be this 'lack of confidence' despite her performance being 'middle of the pack'.

Table 8 – Melissa's Test Results and Estimated Test Results

Test 1 (%)	Estimate	Test 2 (%)	Estimate	Test 3 (%)			
73	65	98	70	68	67.5	73	--

Her overall average for the course was 77% as compared to the class average of 79%. Though she was far from being one of the weakest in the class, she was one who drastically underestimated her results in the statistical portion of the study, by as much as 28% in the case of the second test. This was a reflection of her insecurity as well as of the respective difficulty of the first test *despite having done better than she expected* on that test. In the past, her feelings of inability were reinforced by academic failures that overshadowed her victories. She had not taken 436 before, partly because she did not qualify for it coming out of grade 9, but also because, "I *couldn't* [my emphasis] do that...'cause I thought 416 was hard enough". This became even more 'true' for her after she failed 416 in grade 10 and had to do it again in grade 11. Notice how strongly she felt about her inability, she did not say in would be difficult, or that she would struggle, she says "couldn't", as though it were impossible for her to succeed in 436, despite the fact that at the time of this interview she was doing just that. In this sense, she blocked on 'I can't do math' and is mathematically frustrated.

M: ...I've never ever been good at math in my entire life.
L: Is that what you feel? Or is that what your grades reflect?
M: [no hesitation] That's what my grades reflect. [nervous laugh]

L: Why do you think that... like, why math instead of like history?
M: I'm not good at that either. [laughs]
L: So what's your best subject?
M: Um, oh Lord, I don't know, English I guess or ... I did okay in French.

One gets the impression from the exchange above, that her lack of confidence extended beyond the boundaries of mathematics, and that possibly she was a weak student in general. Her performance estimates do improve in the second half of the course, suggesting the formation of a more realistic perception of her performance, and possibly a slight diminishing of her mathematical insecurities.

One of the hardest parts of mathematics for her was: "Trying to remember what steps come after [laughs] the next one". In retrospect, that seemed true enough given that she would normally pause until I either asked her what the next step was or told her what to do. Generally, however, she was able to overcome this by practicing problems until she simply remembered what she needed to do. Again, this natural part of learning was being interpreted by her as a reflection of her 'being slow'. This shame of studying was reminiscent of the previous interview and will be revisited by other interviewees. Despite this sense of shame, she never appeared ready to quit. When I ask her what she might change in order to succeed better in, or enjoy, mathematics, she said:

M: I would probably study [coughs] I would probably study more 'cause I didn't really study a lot and I wouldn't really change anything about my behaviour 'cause I can't really do anything about that, it's just kinda the way I am.
...
L: What would make math more enjoyable instead of just better. What would make it more pleasant?
M: Um, understanding it? [both laugh]

'Lack of understanding' was a source of frustration for her. During the problem-solving portion of the interview, her confusion, or 'lack of understanding' became apparent. For example, her use of the word 'factoring' instead of 'distributing' suggested that she is unclear of the direction of each activity.

Turning to question 3, she attempted to solve the word problem using the Straight Lines II technique we made use of in class, adopting a 'school math' positioning. While this was neither the most direct, nor simplest approach, it was arguably the most familiar. She began by reading the problem out loud and dividing the line into 10 pieces in order to

determine the 'ratio' of parts traveled over parts remaining. She caught and corrected a mistake made in dividing up the line into 10, but then noticed that she was lacking coordinates for the start and end points. Here she blocked: "It's just I've always worked with coordinate points, I don't know how to do it without them", and can go no further. Lack of familiarity was thus another source of frustration for her.

The final tipping question presented the least amount of difficulty for her, though there was some confusion in recollecting what the appropriate tipping percentage was, thinking first 7.5%, and then 15%. She finally used 18/ 100 (instead of 15/ 100) multiplied by the total of the bill adopting a predominant positioning in 'school math' for this problem as well. I allowed her to use a calculator. Her answer on the calculator (2.1726) had 4 decimal places and she was unsure about how to convert this number into currency. She therefore assumed that she may have made a mistake and tried reversing her fraction using 100/ 18 multiplied by the total (67.1092). She realized it was a rather large tip, however, and with help managed to make something of her initial answer.

> **M**: Okay, she must have been really friendly to get like 67 bucks [both laugh] So
> **L**: So wait wait, you're saying this is 67 bucks?
> **M**: I don't know [laughs]
> **L**: So if this is 67 bucks, then what would this be? [I point to her previous answer of 2.1726] Up here? [M: Two] Your original answer was 2.1726... do you know?
> **M**: [26 seconds of counting/mumbling to herself] ... rounded... like... [inaudible] 2 point one seven?

She remained unsure of her answer, but was more confident of it for having attempted a different strategy that she felt was 'less right'. Nevertheless, changing positioning from 'school math' to 'practical math' enabled her to identify and correct an error. Finally, I asked her what might make her feel more confident in mathematics, to which she answered: "If it gave me a round number". This was interesting as high school sometimes conditioned us to interpret round numbers as more correct than decimals.

Melissa was not particularly persistent and did not work well on her own. Weak ALBs could be taken to account for her 'middle of the pack' achievement. Low confidence in mathematics impacted her ALBs in the most significant way. She did not engage or persist freely because she was convinced of her own inability before she had begun: "I couldn't." She attributed her success to effort and help, and her failure to

ability, or lack thereof. This too impacted her ALBs in a negative way to the detriment of her achievement.

Laurent's Story – Over-estimates

Interviewee number 3, here called 'Laurent' was a very soft-spoken 18 year-old, non-mature student by our definition. Laurent sat towards the front of the class with chatty girls and was easily distracted by them. I moved him to another seat on more than one occasion. He was one of 5 in the class who did not complete 436 with me that year, returning instead the following summer. He failed the fourth exam and did not finish the rewrite because he wanted to drive to Toronto. He therefore could not take 536 (the next mathematics course) the following term as he had intended. Note here that he also failed the first exam with me, but passed his rewrite. His motivation for taking these classes was his aspiration to get admitted into computer science. Despite his seeming lack of focus on his studies, he performed very well during the interview.

Table 9 – Laurent's Test Results and Estimated Test Results

Test 1 (%)	Estimate	Test 2 (%)	Estimate	Test 3 (%)	Estimate	Test 4 (%)	Estimate
49 (rewrite 61)	65	80	65	62	80	49	62.5

The above table demonstrates the way in which he over estimated his performance on every test except for the second one, which, as previously stated, was easier than the others and followed the disappointment of the first exam. Though his overall average of 63% was significantly lower than that of the class average of 79%, he remained confident in class and was not afraid to ask questions. His interview revealed that this may be because he perceived his sources of frustration to be outside of himself; unlike those students we have seen who have internalized feelings that they have never been good at math.

> **Laurent**: Uh, 516 I failed that course, 416 I got like 80.
> **Laura**: Okay, so what happened in 516 then?
> **Laurent**: Um, the teacher was bad, like a lot of people failed. [Laura: Okay] And he would mix up diving with math, he was a diving teacher, [Laura: Okay?] so he would mix up diving and math and laugh and talk at the same time so you don't know what he's saying. He was weird.

Notice how he glossed over his failure by recollecting a previous success suggesting his sense of ability. In his view, the teacher was the problem, not himself, and certainly not his work habits or lack of focus. Later in the interview he identified large class sizes as a source of frustration, because he preferred to work one on one. When I suggested a tutor, however, he blamed a tutor's alternate methods for failing to help him.

> **Laura**: Okay. Do you have a tutor?
> **Laurent**: Uh, no I don't.
> **Laura**: 'Cause if you like one on one learning that would probably help.
> **Laurent**: I did have one a long time ago but uh, he taught me a different way from what they taught me in school, [Laura: Okay] and it just confused.

He identified a source of frustration shared with interviewee number 2, and that is lack of familiarity, or broken habit. He was not interested in learning 'another way'. Over the course of the semester, I came to conclude that his largest mathematics obstacle was general laziness and lack of focus. His prime motivation was the need to qualify for computer science, which to him, meant that he did not need to do well, only pass. Consequently, he never made much effort above or beyond the barest of minimums; sometimes he did not even make that effort.

During the problem-solving portion of the interview he correctly solved both of the logic problems with minimal difficulty, in large part because he had recently reviewed that material with me in preparation for his rewrite. Recollection, for him, therefore was not such a challenge. Still, he was not completely sure of his answers. He did not dwell on this, however, but dove straight into the next question. Again with problem 3 he had very little difficulty. He did not divide the line into 10 pieces as did the others, but rather manipulated the fraction on paper, was able to determine that it would take 18 minutes to move from point A to point P, and correctly answered that the person would arrive at 9 tenths of the 2 km distance at 10:18 am. Here he was positioned in 'school math' by his written solution. He was also able to conclude (correctly) that the girl in the problem would have walked 1.8 km but did this in his head. This switch to 'practical math' left him unable to explain how he achieved that answer.

> **Laura**: How are you deciding? 'Cause you haven't written anything down, right? You did that in your head? So how did you do that in your head?
> **Laurent**: um, 9 times kilometres [2 seconds] I don't know how I got it.
> **Laura**: So write it down. How do you, do you have any way of checking it out, to make sure that it's good?

Laurent: Uh. [8 seconds]
Laura: Does it feel right?
Laurent: It feels right.

Turning to question 5 (tipping) he read the question silently and said, "But Miss, this is about being generous." It is interesting that he did not think of the 'practical math' problem as being a question of mathematics at all, but rather saw this as a question of generosity. Ultimately his written answer stated "15 is an even number so I would pay 15.07$ and leave 3$ tip for the waitress." Again we see the tendency towards whole numbers, though it is interesting that he did not opt to leave 15$. He valued the whole-ness of the answer (how much tip would you leave?) more important that the whole-ness of the total paid.

Laurent did not view his failures as being a question of lack of ability. In line with the literature, he attributed failure to bad luck (bad teachers, class size and unhelpful tutors) and on a lesser level to his own lack of effort. His attributional style and confidence in his ability positioned his internal belief system so as to foster ALBs. While he did work well independently, he rarely chose to do so, and did not engage with mathematical tasks by his own initiative. He did however engage and persist with those tasks set before him during the interview. To improve achievement, he would need to engage and persist with his studies. Unfortunately, he did not even persist with his final exam. Possibly, if he truly believed in its usefulness and impact on his life, he would have invested the required effort.

Mildred's Story – Over-estimates

Interviewee number 4, here called 'Mildred' was 41 years old. She already had her high school diploma, as well as a certificate in midwifery. Like Cassy, she too was an aspiring nurse with a family, a front row center type of student, and one of the best students in the class with an overall average of 91%. Mildred was taking mathematics 436 as a prerequisite to her nursing program set to begin in September of 2005. Her reason for taking the course, however, was not the nursing program, but rather the possibility of improving her financial situation thereby providing a better life for her three children.

Mildred was very particular as a student, as she would not write anything down unless she was sure it was absolutely correct. She would *never* cross out, she would erase, and the less certain she was of something, the less she would press down on her pencil lest she imprint her error on the page as a testament to her 'not knowing'. In this way she too manifests the 'shame of not knowing'. Her shame was hidden, however; she was so prepared that, to others, she appeared to always have the answer. All lines were made with rulers and she was always holding up her immaculate assignment asking me "is it right? Is it correct? Oh my God!" During the interview she explained this to me in the following way.

> **M: mhm. You know what? Uh, I'm making notes, that's why I make clean notes, [L: mhm] I will keep it so that I could teach my kids. They are in grade 4 and grade 3 now. [L: Okay] So I could teach them, when they will be confused [L: Yeah], that's why I had a nice clean notes [L: Okay]. It's also for my kids, not only for my study.**

Her children not only motivated her towards higher education and a better career, but also towards excellence in her study habits and academic performance. Possibly, however, she has taken this perfectionism too far, as no student of mathematics should have an anxiety attack if their teacher writes something in pencil on the side of their paper. It is important to note here that she never spoke to me of being nervous, and did not complete the question regarding 'emotional state' on the original questionnaire. She did not talk about her anxiety so much as she manifests it. At the end of the course, she expressed interest in seeing the study once it was completed and made sure that I had her email before she left on the last day of class.

Table 10 – Mildred's Test Results and Estimated Test Results

80	95	99	95	96	--	89	97

Mildred certainly seemed to exhibit anxiety during class but is not under-confident. In the statistical portion of the study, she was one of the few women whose tendency it was to overestimate her grade. She was also one of the few women to express an enjoyment and proficiency in math. Throughout the first half of the interview, it was apparent that she was very confident in her mathematical ability. Despite this confidence, there were many times during the interview where she exhaled deeply, or said 'Ahhhhh',

or 'mhm, so hard...', as though it were a great burden for her to solve the given problem. I was, therefore, unsure of how genuine her confidence was. The interview situation is emotionally distracting and it may have been difficult for students to concentrate or think, but she did this during exams or solving problems after class as well.

> **M:** It's interesting, because uh, since uh, elementary I love math.
> ...
> **M:** mm, no, I just uh, I just uh, solve it quickly, understood it quickly, and I don't have so many things to memorize. [laughs]
> **L:** Okay, well 'cause some people feel like there's a lot to memorize in math.
> **M:** mm, no, just understand it and that's it. Do the step by step and understand it, the rules, and you can get it immediately.
> **L:** That's good to hear. So you've always liked math. Were you always good at math?
> **M:** Yeah. [laughs]
> **L:** Yeah. [laughs]. Is math your best subject?
> **M:** Oh, yeah.

In this sense then, Mildred was different from others interviewed in that she did not attribute her frustration to lack of understanding, difficulty memorizing, poor teachers, or confusing tutors. Instead, she attributed frustration to linguistic difficulty seeing as how English is her second language. She attributed success to ability and hard work, and did not need to attribute failure to anything because she did not fail. She was the only student in this study who did not have, or report, a history of mathematical failure. This attributional style placed her on the fence between what the literature considers 'masculine' and 'feminine'. By attributing success to both ability (masculine) and hard work (feminine) she fostered persistence and was generally unwilling to leave a problem until she felt she understood it.

During the interview she tackled the word problem by reading it to herself and writing down what she considers 'relevant' information as she went. She did this information extraction on her first pass through the problem, as opposed to some others who read several times before they begun to write anything. She got stuck on 9 tenths, and exhaling deeply proceeded to read and re-read that portion of the problem. She then stoped interacting with me. I continued to ask her questions, but she was talking to herself and it was as if I was no longer in the room.

> **M:** yeah, 9 tenths. How far will she have walked? [exhaling deeply] Huuuuuhhhhh. [13 seconds] What time she will be in 9 tenths... What time will she be... 9... 10... At what time will she be 9 tenths... done this... 9 tenths... 9 is to 1... formula...
> **L:** What formula? You saying they forgot the formula...

M: How far will she have walked... Stacy's house... [5 seconds]
L: You've set up a ratio...
M: Could be 20 ...

Ultimately she determined that if it took 20 minutes to travel the whole distance, then it would take 10 minutes to travel ½, and therefore 15 minutes to travel ¾ of the distance. She seemed to feel that ¾ and 9 tenths were the same and gave 15 minutes as her final (incorrect) answer. I asked her how she decided if her answer is correct; she told me that she was distracted, thinking of her final which is set for the following day. It was not that she cannot solve the problem, only that she was prioritizing the understanding of material that 'counted' towards her grades and this interfered with her interview performance. She did not see the usefulness in this problem, and this component of her internal belief system inhibited her persistence.

When attempting problem 5 (tipping) she relied on a rule saying: "The tip should be ... same as the tax." Initially she positioned herself in 'practical math' but switched to a predominant positioning in 'school math'. She proceeded to multiply the GST and the PST. When I asked her what operation she was performing on the tax, we again had some linguistic confusion before she answered multiplication, then, realizing her mistake attempted to erase her 'bad' work.

M: Okay okay. I thought it's the, it's just, add the tax. Just add the tax...it's one eighteen... The tax is one eighteen... so it's up to you if you could give her a $1.25 or $1.50, or $2... but what I have heard, the tax is the same amount that you could give to the waitress as a tip.

Note that even though she understood what the exact *tip* 'should' be, she nevertheless maintained that there was an element of choice, and that her choice was to leave the same as the tax. Her predominant positioning was thus one of 'practical math' despite the 'school math' of her written solution. Before the interview ended she looked over her earlier problems and seemed dissatisfied with her answers.

M: [she flips the page over and looks over the earlier problems. Speaking under her breath] I don't know what this [both laugh]
L: Alright, thank you very much.
M: I mix up because I thought I will be multiplying [laughs] the tax
L: It's a big tip 34$
M: Yeah, it's a big tip and the total only is $12. Just add the tax. [exhales] aaahhhh.

I turned off the recorder and she asked me how to do the problems that she struggled with, I told her that it's okay, she did very well, but despite these reassurances she was very insistent, and in the end, I spent another 10 minutes with her, solving the interview problems. She wanted to change her solutions on the questionnaire now that she knew how to do them correctly, but I would not let her.

Mildred's attributional style, confidence, and perception of the usefulness her mathematical understanding will bestow on her children, worked together to form an internal belief system which operated to the benefit of her achievement. What's more, she did not exhibit any difficulty with sex-role congruency with regard to her high confidence, high achievement, and role as a mother. She exhibited all major ALBs by engaging, working independently, and persisting with tasks. This impacted her achievement in positive ways as evidenced by her test scores.

Jason's Story – Over-estimates

Interviewee number 5, here called Jason, was the biggest discipline problem in the class. He had a smart mouthed answer for everything and was kicked out of class more than once. He was playful and distracted, exhibiting the 'boyish' behaviour taken in the past as indicative of mathematical 'flair' and 'ability'. His cell phone was a focal point of interest for him. He would take calls sometimes, yet continued to attend class, overworked and tired but present. He worked in his father's restaurant, and when a few employees quit, he worked between 50 and 65 hours per week for the first few weeks of the term. While this certainly reflected 'adult' frustrations of balancing school and work, he was only 17 years of age, and therefore not a mature student by our definition. I believed that if it hadn't been work "preventing" him from excelling to his full potential in my class, it would have been something else. He simply was not a serious student.

Jason was taking this course as a prerequisite to Food Service and Restaurant Management at LaSalle College. He did not require the full 436, however, he only needed 426, and ultimately, this is why he never wrote the fourth and final test. He might have been interested in trying to pass it, but had fallen so far behind at that point, that he was preparing for the rewrite of the first test.

Table 11 – Jason's Test Results and Estimated Test Results

32 (re write 66)	33	44 (re write 80)	60	79	--	(never wrote)	--

The statistical portion of the study revealed little more than his own understanding that he was not prepared for the first exam, and that he wished to pass the second. Generally, however, his behaviour was over proud, and he tried to seem as though he knew and understood more than he did at all times. For this reason, I found his self-report throughout the interview to be generally unreliable. During the interview he identified several potential sources of frustration, the first of which being 'not understanding'. He stated that when he understood one thing the rest may follow, but that other days he was just stubborn and could not understand. He did not consider himself unable, only stubborn.

> **J**: Um, I like math but... it depends. If I ... like, I *like*, I *like* math, *but* if I'*m*... like some days I'm just stubborn. I won't understand anything. But there's other days that I really want to ... like as soon as I understand one thing, then the rest of the stuff I have no problem. Like I'll understand the hard stuff, but the easy stuff will give me a hard time.

This notion of 'easy stuff' vs. 'hard stuff' recurred in the interview, and it seemed that he qualified the things he understood as hard, whereas the things he struggled with were perceived as easy. When I asked him if this has always been the case, he said no, just in this class. I could only assume this was a defence against feeling stupid for not understanding because if he were 'stupid' he could understand what is easy, but not what is hard. This defence could be categorized, as by Evans (2000), as a manic defence with respect to math. Specifically, it seemed to be a *reversal*, seeking to neutralize a disagreeable feeling by reversing it into the opposite. Here the disagreeable feeling was the 'shame of not knowing' what was easy, and its opposite was knowing what was hard.

A second source of frustration for him was 'balancing school with work', though there was also a family component to consider as he worked for his father. Note that this

family business was a restaurant and likely swayed his choice to pursue studies in restaurant management.

> **L:** How many hours a week were you working?
> **J:** Like a week? Like before? [L: Yeah] Like when we first started school? Oh, like, between 70 and 80, like [L laughs] a *lot* [both laugh] yeah, crazy hours.
> **L:** So it's difficult to concentrate on math when you're working 80 hours a week.
> **J:** Yeah, it's a family business so I don't have a choice, you know. It's like, we were stuck.
> ...
> **J:** Like I had no time for nothing, you know? [L: Right] Like see now I can come in and stay 'till, stay 'till six. You know I've nothing to do. Like I took, I have my week off now. I told my father like that's it, you know? Like he understands also you know? Like, he didn't, he wasn't uh... he wasn't for the fact that I was working... you know, he wanted me to go to school. Like, thing is, he works night shift, so if I wasn't at work he'd work all night and all day. And I can't let that happen.

Clearly he was working too many hours to be taking an intensive mathematics course, in large part due to his sense of obligation towards his father who would have to work day and night otherwise. "I don't have a choice... I can't let that happen", he said. I wanted to believe him when he told me that the only reason for his struggle in my class was this one time working problem that he was having, but the fact remained that he had serious difficulty focusing in general. Struggle with focus was, in my opinion, the most significant source of frustration for him, and severely impeded his success 436. When I asked him what he might change to make mathematics more enjoyable, he told me that he liked mathematics and would change nothing, "it's one of those things if you don't listen you're screwed ... here, you miss a class you're screwed, forget it. You're like, you're so like, you're... a month behind. So. I don't know, it's fun." This did not sound like a person who enjoyed mathematics, but rather, one who made light of feeling overwhelmed or left behind. Again this showed *reversal*, neutralizing disagreeable feelings.

Throughout the interview, Jason interrupted repeatedly, spoke quickly, offered immediate answers, and gave up on tasks the second he did not have the answer. There was no perseverance, no patience for thinking, or even finishing sentences. In the problem-solving portion of the interview he attempted the first problem because we had recently been reviewing logic. When he did not immediately know the answer he became distracted by the other problems on the page and wanted to move forward. He then whispered 'I have no idea' so that the tape recorder did not record his uncertainty. This

was something which some of the other interviewees also did indicating a sense of shame in 'not knowing'. Generally, Jason was not concerned with the correctness of his answer.

> J: No. No usually I just, if if I know, if I feel like an answer... no, even if I don't feel comfortable, I'm just, I'm just, I don't know, that's my problem, I go too fast. [L: Okay] Like I'm a person that [whistles low to high] You know like a... [L: Okay] don't check let's go. Wrong wrong right right. But bad, it's a bad problem.
> ...
> I fail faster if I don't check.

This last comment was surprisingly negative and perhaps underscored a greater lack of confidence than his otherwise cocky demeanor suggested.

When solving the word problem, he rapidly and correctly determined that it would take 18 minutes to travel 9 tenths of the distance in the problem. He then offered up an immediate (incorrect) answer to the second part of the problem saying 9 tenths of 2 km was 2.5 km. The problem was that he did not know how to divide 2 by 10 without a calculator and so estimated 2/10 to be 0.5 before adjusting his estimate to 0.25 and quitting. His position here was difficult to ascertain. He seemed to be predominantly positioned within 'practical math' but it was insufficient for him to solve the problem and she was unwilling to make the switch to 'school math'.

> J: [5 seconds] point 5. [12 seconds] It's point 25. [10 seconds] Usually, I would just stop. [L: You would just stop. You quit] so let's say this was on 10, I'd estimate right there that I'd get 7
> L: And you just stop?
> J: I'd stop, and do something else, and come back to it in the end if I have time, if, I, I'd come back to at the end and [inaudible] [L: Really?] And you just come back to it, and you look at it again, and if on the second time I can't find it

I suggested we try another problem then return to this one, since that is what he said he would do, but he was not interested in doing that. I pressed a little further to see if we could use his estimation technique to close in on the correct answer, but after less than a minute he becme angry.

> J: [exhales deeply] UH! [loudly] 2.5 km. [quietly]That's my final answer. [pause]
> L: Alright. Now do you feel [interrupted]
> J: Sorry, I'm not a good guinea pig Okay.

He knew that 2.5 km was wrong but was beyond frustrated and was now angry; he refused to press on any further. The tipping question posed much less difficulty for him,

however. He knew that a tip was 15% and he knew to multiply the total by 0.15. Here I allowed him to use his cell phone as a calculator, he multiplied the total by 1.15 then subtracted the total from this new sum in order to determine what he called the 'technical tip'. In this way he positioned himself with 'school math' using calculator and classroom procedure. It was interesting to note that he also assumed the waiter in the problem to be male, though it said waitress. His experience working in a restaurant had facilitated the tipping process for him. In other words, transfer had successfully occurred. Possibly, this same experience allowed him to identify the server as male. After he had offered his answer I continued to question him about what he would leave in this situation, his confidence seemed shaken as evidenced by his sudden stuttering. He was sure his answer was 'right'; he was so sure that we were finished, and now had that expectation upset by my continued questioning. Possibly the upset expectation made for some unexpected frustration? Ultimately he used humour regarding the quality of service to cover up any remaining insecurities regarding the 'rightness' of his answer.

Jason attributed his success to ability and his failure to forces outside of his control (stubbornness, employment, luck). He seemed confident that he was able to understand and achieve given the right circumstances. These components of his internal belief system should positively impact his ALBs, but they were insufficient. He did engage tasks, but could not focus to work independently or persist with them once engaged. For this reason he did not perform well. He did perform better when rewriting previously failed tests, but even in this he did not go above and beyond what he considered the minimum possible scholastic investment in order to pass.

Moe's Story – Accurate Estimates

Interviewee number 6, here called Moe sat towards the back of the class between two girls who thought they were helping him by doing problems for him, or showing him solutions right away. He was certainly over 18 years of age, but did not include is age on the original questionnaire. and so may or may not be a 'mature' student as per our definition. It is possible that he was a mature student, as he had been out of high school for two years pursuing a mechanics program. His attention span was rather short and he,

like Jason, was prone to quick frustration and occasional bouts of anger; frequently he gave up on the material before he had really made an attempt. When he wasn't following in class he would tell me that he had to look at it at home. He would write down all of the notes, but did not try to follow the class. He was taking this class as a pre-requisite for Social Science in CEGEP, hoping to later transfer into business. He chose to take the course at Place Cartier, rather than at John Abbott College, because Cartier did not have a comprehensive final exam.

> **M:** I had the choice between eh coming to Cartier or Abbott and eh I chose Cartier because it was closer, it had eh they do the book, you finish a chapter, that's why I did it. And I have to write a final exam for it so **I would do better without [a final exam].** [my emphasis]

Throughout the interview he spoke in the negative as reflected by his defeatist approach to problem solving. From the statistical portion of the study, we can see that he was a weak student with a fairly accurate perception of his mathematical performance.

Table 12 – Moe's Test Results and Estimated Test Results

49 (rewrite 60)	50	60	60	54 (rewrite 78)	65	68	69

He did not suffer from the 'I've never been good at math' syndrome; however, he did feel that there was a time when he was in fact good at mathematics.

> **M:** I was, honestly, really good at it at the beginning, and then, and then... I used to get 80s and 90s and now, and now [almost inaudible] no.
>
> ...
>
> **M:** Grade 7 that was when I was good. That was when I had a good teacher and I was doing really good. Grade 8 it wasn't too bad and then... actually grade 8 is when I failed because I had ahhh a really bad teacher and he basically told me don't worry you'll be fine, you'll be fine, you'll be fine. Just wait 'till this you'll pass that and I never passed it. He kept on saying that to my mom also, he's like, don't worry, he'll do it he'll do it and then I'd be failing. So I'd have to redo it and I passed it, and from then on I was...

The first part of his statement suggested that 'bad grades' may well have formed a source of frustration for him. The second part of his statement was, however, more revealing in that it allowed us to see the way in which Moe absolved himself of responsibility for his poor mathematical performance. He identified a 'bad teacher' as being the source of his 'bad grades' whereas he had done 'really good' when he had a 'good teacher'. Not only did he claim to have been doing well with a good teacher, but also that he himself was

able in mathematics: "I was good". It was the following year he failed "because I had ahhh a really bad teacher". There was also no mention of his liking mathematics, and it meant little to him other than as a requirement for school. When he explained how he chose what mathematics class to take in order to graduate high school, he said "It was either my 514 I take or I take 436. It's the same thing". For him they were interchangeable because they would both permit him to attend CEGEP; it had virtually nothing to do with the content of the course.

A third and important source of frustration for Moe was 'difficulty with concentration'. Like Jason, he was distracted by others in the class, and struggled with the attention span required for studying.

> **M:** To go better for me, I think there'd have to be like a smaller class. When there are a lot of kids, it's a lot harder to focus, you know, on one person.
> ...
> **M:** If I really want to study, I'm with someone to study, then it can be for an hour, 2 hours, but if I'm by myself ... I look at it for 1/2 an hour and then bam, I'll be like daydreaming out.

After only 30 minutes of studying he felt the need to stop, and did not return to the task later on. We see here that he did not easily engage in ALBs as he did not work well independently and did not persist with tasks. When I asked if he had a tutor, he made a face and told me that he used to have one when he was redoing his grade 8 mathematics.

> **M:** No he actually really helped me. I had big huge problem with algebra. Big problem with that. Like it would never click. It was like...
> **L:** Well, and algebra is grade 8.
> **M:** Yeah, *never click, never, never, never, never, never.* I'd failed it, I re did it. I had him there, and then all of a sudden wack click in my head and I was doing okay.

We see then that the initial abstraction required to make the move from arithmetic to algebra constituted a sort of block for Moe, emphasized by his repeated use of the word 'never' to describe his understanding of it. He was not, however, particularly interested in having a tutor to help him with his mathematics despite previous tutoring success, and it struck me that his only true difficulty with mathematics lay in his own unwillingness to pursue mathematical success. He did not like to focus, or try, or study, or learn, and it seemed doubtful that he would find success in a business program.

During the problem solving portion of the interview, he tackled the word problem with 'school math' by dividing the line into 10 pieces in order to mark off 9 tenths of the way. From there, however, he was unable to go any further as he was "trying to remember... how to do it". He was recalling the straight lines portion of the course, but was unable to extract the mathematics from the over-large context of the entire course. Abstraction truly was then a source of frustration for him. He did not persist, giving up very quickly after only a few minutes of reading and re-reading the problem.

The tipping problem offered less difficulty. He began by volunteering $1.50 as an answer, but when asked to justify his choice turned his attention the receipt and asked what a certain item was. He then decided that he would not leave $1.50 but would instead add the tax to determine the tip.

> **M**: Why? 'Cause there was something I remembered my parents saying you give them 15% or something like that. The taxes. That's what you give them [He's breathing heavily, but his voice is relaxing as if the moment of "stress" has passed.]

Calling up 'practical math' he recalled advice from his parents and was able to transfer that advice, applying it to the problem at hand. Ultimately he was able to correctly calculate a tip of $1.18 and concluded that he would round the tip to $1.25, positioning himself predominantly in 'practical math'.

We have seen how Moe attributed his success to ability and good teachers whereas his failures were attributed to circumstance (luck, bad teachers/ tutors, large classes) This attributional style was reflective of 'masculine' attribution as characterized within the literature. However, this was insufficient to foster participation in ALBs as he did not work well alone and failed to persist with tasks. This ALB failure explained his generally poor performance over the course of his mathematical history.

Estelle's Story – Accurate Estimates

Interviewee number 7, here called Estelle, was a soft spoken and articulate young woman. At the time she was only 19 years old and, having never left school, qualifies as a non-mature student. She had already graduated high school, had nearly completed her DEC in Social Science, and was taking 436 as a pre-requisite for a two-year intensive nursing

program. She rarely asked me questions in class, but she did sit next to another girl who explained much to her throughout my classes. Estelle failed her first exam with me, but proved very capable after some individual tutoring to clear up the material before her rewrite. She represented those women whose estimates where quite accurate suggesting a reasonable perception of her own ability and performance.

Table 13 – Estelle's Test Results and Estimated Test Results

50 (rewrite 76)	50	85	79	98	100	80	85

This was the only student that I felt I really reached, in terms of adjusting her own confidence in her mathematical performance. At the start of the course she told me that she was not very good in mathematics, and after she failed the first exam I almost believed her. When she asked me questions, I remember being surprised by how calm and articulate she was, as well as by how far along her reasoning was. Her questions were not preliminary, but rather the questions of one who has studied and understood a fair amount and needs only to iron out some details. On the third test, she came to me beforehand and said that she had studied all she could and that she didn't even want to look at the material anymore, that she just wanted to write the test. She scored a 98%. I told her *that* was the headspace she should always seek out no matter what she studies. Once you've studied to saturation, you know you'll be okay. By the end of the course, she was able to tell me that she felt good about her accomplishment in the class, and concluded that she wasn't so bad at mathematics after all.

Her interview revealed that she had failed a year in mathematics sometime early in high school, and so, a year behind in mathematics, tried to take 436 in order to graduate. Unfortunately, she failed and found herself in summer school taking 514 "because *they* said it was easier to pass my 514 then to pass my 436." [my emphasis] Like other interviewees before her, we see that she took mathematics only because she was required to do so, and that she cared little for what material was covered so long as it met her pre-requisite. She did not intend to take more mathematics because she was not

required to do so. Her interview also revealed that 'not understanding' was her greatest source of frustration in mathematics.

> E: When I don't understand and classes keep going, then that's when I start getting frustrated because I'm not understanding this and they're still trying to get to new material and that just....
> L: So what do you do when you start to feel frustrated?
> E: Most of the time I just sort of like 'Ah whatever' and I just stop doing homework and stop doing this because I'm not gonna understand even if I like sit down at home and try figure it, I'm not gonna understand.
> L: So do you... like if you could change anything to make the learning more enjoyable for you, like, what would help that out? That blocking and not wanting to continue?
> E: I think that when I have trouble with the material I need to just stop and see what's going wrong. Make sure that I get rid of that problem, and once I figure it out, it's okay, then move on. It's the part that moving on when you don't understand something that's worse for me.

This was an intelligent and reflective young woman with a fairly accurate picture of herself. She knew that it is 'not understanding' that frustrated her, she knew that this resulted in her wanting to give up on hope of ever understanding, and knew that all she needed to do was stop and put in the extra effort towards understanding before she could move on. She also demonstrated that she had overcome mathematics frustration in the past when discussing her career choices.

> E: I wasn't planning to go into nursing because I said 'oh I can't do it, you know, I'm a grade behind now, I'll just go into another field.' But then afterwards it was like 'I'm gonna work at it and I'm gonna get it', so then once I had that motivation I think that helped me.

When she became frustrated by 'not understanding' her immediate reaction was to give up, however, she did not express or manifest 'shame of not knowing'. It was perhaps for this reason that she was able to engage and persist with mathematical tasks. She was confident in her ability to overcome her mathematical frustrations. What's more, she was motivated by professional ambition to do so thereby exhibiting her sense of the usefulness of mathematics. I asked her if she had ever had a tutor; she replied that she had but did not seem very enthusiastic about it. A second source of frustration could be identified in the contradiction she experienced when she hired a tutor to help her overcome 'not understanding', and though this helped, it did not help enough for her to pass her final exam. Unfortunately she only hired this tutor for the final exam, and recognized that perhaps this was too late.

She approached the third problem in a very straightforward way, articulating her thought process throughout.

> **E:** Okay. Here it says that if she leaves her house at 10 am, what time will she be nine tenths of the way, so I'm dividing this into 10 spaces [counts to check that she has 10], and I put a dot at the 9th part [L: okay]. So it's the 9/10th place and uh How far will she have walked? It takes her 20 minutes, so it would be 20 divided by 10. So that means she's doing... 2 minutes per part... yeah, 2 minutes per km, so how long will it take her to get back to there... It will take her 18 minutes to get there.

This (correct) answer obtained via 'school math' was upset when writing out her solution. She said 9 x 2 as she wrote 9 x 18. When I tapped her paper to point out her mistake, I interrupted her momentum and even after correcting her mistake she was unable to carry on with the problem because, like Jason, she did not know how to perform 2 / 10 in her head; she did not so much as volunteer a guess. Again, she had no means of checking her answer, telling me only that she was "pretty sure" it was right.

During the problem five (tipping), Estelle appeared to be unsure of the regular tipping amount.

> **E:** Yeah so I would just add this up, I would calculate 10%, 10% of 12.07... [11 seconds] I would give that amount for the tip.
> **L:** Okay, so what's that amount? [11 seconds]
> **E:** I think it equals out to... 'cause 10% of 10$ is a dollar, I believe. I would give like $1.25 or something. I can't use a calculator?

This was a fair estimate as we have seen from interviewees before her and she accomplished it through 'practical math'. She asked to use the calculator on her cell phone, like Jason again, and thought it was funny that my phone did not have this option. She then changed her answer for a less accurate estimate before expressing her frustration about tipping in general.

> **E:** Let's say I would just give 2$. Yeah, I'd just give 2$. I don't like tipping maybe 'cause I've never been a waitress. But I find everywhere you go these days, everyone expects a tip. Tim Horton's wants a tip, the gas station wants a tip, cab drivers want a tip...

She told me that 2$ is a little tip even though it is quite large, and that 5$ (on a 12$ bill) would be a big tip. Possibly she rounded up leaving over large tips because of her resentment at the need for tipping and the possibility of being perceived as cheap. Generally, however, Estelle demonstrated sound problem solving skills, and seemed held up only by mental arithmetic, and possibly fractions.

In the end her internal belief system worked in her favour. She was fairly confident in her ability, perceived professional usefulness of mathematics, and attributed

her success to a mix of hard work and ability. What's more, there was nothing to indicate any conflict of sex-role congruency here. Influenced by this seemingly ideal internal belief system, she actively engaged in ALBs, worked independently, and persisted with tasks. Despite this very positive picture and general success, she would not study mathematics further suggesting that more is required than ALBs for students continue their studies in higher mathematics.

Timothy's Story – Accurate Estimates

Interviewee number 8, here called 'Timothy', was only 17 years of age. He, unlike some of the other students in the class, experienced some serious struggle with the course material. We can see from the table below that his estimates were fairly accurate, suggesting that he had a sense of his own performance and whether or not his answers were correct.

Table 14 – Timothy's Test Results and Estimated Test Results

Test 1 (%)	Estimate	Test 2 (%)	Estimate	Test 3 (%)	Estimate	Test 4 (%)	Estimate
60	60	72	65	32 (rewrite 72)	40	60	60

Though he only failed one exam (factoring), he frequently stayed with me after class to review material that he felt was not clear, and to better prepare for exams. He was not afraid to ask questions during class and did not display the 'shame of not knowing' as did some of his peers. As a matter of fact, he was very comfortable with 'not knowing'; he was at peace with it. He also had a private tutor for the entire duration of the course that he met with a minimum of once per week. This in combination with perfect attendance and engagement with the class yielded an overall average of only 66%, well below the class average of 79%. During the interview he revealed that he failed grade 7 mathematics and so, found himself a year behind in mathematics. He then failed grade-9 mathematics when he was in grade 10 and had to take that course in summer school. He found himself in my class fulfilling graduation requirements, hoping to attend Dawson College in January of 2005. As one might expect, repeated failure and struggle with mathematics have negatively impacted both his confidence and enjoyment of the subject. Ultimately he wanted to go into interior design, or to work with autistic children.

One of Timothy's primary sources of mathematics frustration might then be identified as 'being left behind' or 'being left out'. He experienced this on two levels: the scholastic and the familial. He articulated his frustration and resentment about being held back in high school at the very beginning of the interview with "I was *always* a year behind in math" (my emphasis), and "*hoping* that I'd go to CEGEP on time with everyone else". Later on, however, when I asked him how he felt about mathematics in general he mentioned his family along with his dislike of mathematics.

> T: Ah, math comes a lot harder than me, TO me, than it does my family members, um, but it's not, I mean it's a challenge. Like sometimes people like challenges... I like it when I get, like you know, I like I you know, obviously when you finish it and your like 'Yeah', you know, and like, pat yourself on the back, 'yeah I rock', but... I don't like it at all, no.

He perceived mathematics as being a sizable challenge for him, but not for his family members. He mentioned his father in particular later on when I ask him what change would make mathematics more enjoyable for him. It should be noted however that he also said he might "buckle-down" and work harder.

> T: Um, at home wise, I think I'd like my father to be home more often 'cause he's an accountant and he works very very hard to make sure he's first eh, from the top, you know. Um, and he's great at math, so maybe his help could have improved my math skills and my math you know marks and stuff.

A second source of frustration for him was the poor grades he received, despite regular tutoring and success in other subjects. He said "math always drags my mark down" and that it had prevented him from making honour role when he otherwise would have, "I was always not that strong [in mathematics]". While he generally adopted responsibility for his own mathematical shortcomings, there was a moment in the interview where placed the responsibility of his success and failure in the hands of his tutors.

> T: I've had a tutor for History, Science and Math. So I failed my history but then I did it, my supplemental, and did really well. [L: okay] Great tutor I had, really good. Science this time, wasn't that good. My tutor wasn't as great but what can you do?

In this way he attributed failures in mathematics to lack of ability, but also to the quality of help, or lack thereof, he received from others (father, family, and tutors). He may well have perceived the quality of his tutors as a third source of frustration, but I tended not to think so because he was very casual about it, "what can you do?" He did not sound upset when he said this, he did not mention a bad tutor again, and it had not prevented him from

seeking out other tutors in his pursuit of success. Certainly though, it provided him with a comforting excuse should he need some reprieve from self-blame.

During the problem-solving portion of the interview, he was rather pessimistic about his own ability to solve the word problem, though he performed no worse than many of the other interviewees. He began by asking me questions I did not answer.

> **T:** Nine tenths? Oh, okay, so this is um, um um um um, I forget what it's called... It's like a number line, right? And you have your dots?
> **L:** However you want to solve the problem is how you do it. [17 seconds]
> **T:** So you can't even help, you can't tell me anything, what to do right?
> **L:** No.

Like those before him, he divided the line into 10 pieces, and indicated the point 9 tenths adopting a 'school math' positioning. He then paused to ask me whether or not the problem was solvable, before proceeding to set up an incorrect cross multiplication, indicating difficulty with fractions. He said he did not remember how to do long division but nevertheless managed it quite well. Ultimately his answer stated that if it took 20 minutes to get from A to B, it took 22.2 minutes to get 9 tenths of the way. He realized that this did not make sense, using 'practical math' to verify the accuracy of his 'school math', but was unable to resolve his mistake. We left the problem and returned to it later without success. His biggest problem while trying to solve this word problem was that like Moe he was trying to recall how to solve it, and in the process was calling up the context of the entire course. He was unable to abstract from that context and made reference to several unrelated sections of the course: relations, straight lines, ratios, graphs, and systems of equations. It would not be surprising to me if this difficulty with abstraction were at the very core of his difficulty in mathematics.

Turning his attention to the tipping problem, it was interesting to note that he, too, did not consider this to be a mathematics problem at all, adopting a positioning in 'practical math'.

> **T:** I'm really cheap. [L: laughs] I'm very cheap um. Normally what I'd do is I'd add up the taxes. This is just like not even mathematical wise. Like, this is what I do is I add the taxes because the tax is 15% right?

He correctly added the tax by hand and determined that the tip should be $1.18, which he said he would round to $1.50 or $2 before asking "you want this mathematically or just

logically?" as though the two were mutually exclusive. Here, too, he called up a huge context in making his decision for determining the tip.

> **T**: I would probably give her a dollar fifty because at dinner, normally I'd give 2 dollars 'cause I'm really cheap, but I'd probably give her a dollar 50 because this looks like, it looks like a really... 'Nibbler', I would never know what that is.
> **L**: [laughing] I think it's a sandwich.
> **T**: okay, so this is probably lunch.
> **L**: yeah, probably. Well what does it say in the problem? It says breakfast.
> **T**: OKAY. Well break... okay well then breakfast yeah, chances are they'll be working the rest of the day so they'll, my tip won't even matter [laughs].

In order to decide on a simple tip he determined how his tip would fit into the context of the waitress's entire day. Again, this difficulty with abstraction was complicating the mathematical process unnecessarily, and was likely the chief obstacle in the way of his success.

Timothy's struggled with mathematics despite willingness to engage and persist with tasks. The ALB he struggled with most seemed to be working independently as he made tremendous use of help from others. His confidence was low, likely as a result of repeated failure, but not so low as to result in under estimation of his own performance. This is interesting and difficult to explain. His attributional style, attributing failure to ability and success to help from others, positioned him in what the literature terms 'feminine', making his accurate estimations all the more surprising. To make sense of this case study, I would seek out a follow up interview to gain greater insight into his sense of mathematical usefulness and sex-role congruency. In any case, unwillingness to work independently is the ALB which most negatively impacts his achievement.

CHAPTER SIX
Conclusions

Confidence is an important prerequisite for choosing to do and persisting on high-level tasks. A sense of confidence also supports the learner in working independently.

(Meyer & Koehler, 1990, p. 70)

A two year study involving 151 high school students and their scores from the Fennema-Sherman Mathematics Attitude Scales and from the Mathematics Attribution Scale, found some gender difference where affective variables were concerned. "The affective variables considered were confidence, mathematics as a male domain, usefulness, teacher attitude, and causal attributions" (Meyer & Koehler, 1990, p. 89). The study concludes that affective variables may "have a more important influence on the achievement and participation of females than they do for males" (ibid., p. 91). In particular, confidence most frequently predicted achievement and participation. *Confidence is key but does not stand alone.* Fainsilber's 2003 study concludes that in Quebec, the differences between the public and private sectors, as well as between the French and English sectors are of greater statistical significance than are the discrepancies between the respective performances of men and women. Evans also finds that "Initially impressive gender differences were reduced, and made more specific (to subgroups) as a result of using controls" (Evans, 2000, p. 40).

Because of their mathematical histories, many adult students fall on the extremes of either over-confidence as a defensive technique, or under-confidence as a result of past failures. While both of these extremes can cause problems, it is important to remember that trying to influence confidence is by no means the most effective means for improving performance. While confidence is not all that is required for optimal mathematical performance, it most certainly is an important building block for success in terms of cognitive development, performance, transfer, and affective well-being.

The connection between confidence and achievement has been considered in a number of studies suggesting that where affective variables are concerned, confidence has a primary impact on the academic performance of students in mathematics. One such study found that greater confidence in mathematics predicts greater performance for females, and lesser confidence predicts lesser performance for females, but not so for males (Leder, 1990, p. 19). This result was not confirmed by the present study. Rather, it was found here that lesser confidence did not predict lesser performance, but that an excess of confidence did, and this, irrespective of gender. Other gender differences

reported in the literature include differences in Internal Belief System, (confidence, usefulness, attributional style, sex-role congruency), predominant positioning in either 'school math' or 'practical math', and participation in Autonomous Learning Behaviours (ALBs). The present study showed gender differences in the Internal Belief System, particularly confidence and attributional style, though predominant positioning did not appear to be gendered.

Statistical Conclusions

Gender differences were found in this particular group which has adult qualities and is highly motivated by 'need'. Despite being a majority female group both years with women outperforming men, on average, on every test, female students remain less confident than male students. This is confirmed by contemporary mathematics education literature which simply finds women less confident than men. Here, male students tended to overestimate their performance, whereas female students tended to underestimate theirs. Also, it was found that more male students estimated their grade to within 10%, and that irrespective of gender, those who underestimate their grade are more likely to achieve a mean of 70% or greater.

"'While boys may be described as 'abounding in confidence', 'overconfidence' in girls is a bad quality". (Walkerdine, 1989, p. 104) In the current study, 'overconfidence' was found to be a negative quality irrespective of gender. Confidence and achievement were shown here to be inversely correlated. Overestimation or overconfidence was linked by the estimation data to poor achievement in many cases, whereas underestimation or low confidence resulted in higher achievement. Parallel to this, Evans' findings indicate that anxiety in moderate amounts can actually improve performance, rather than simply acting as emotional interference. Regardless, "good or positive feelings with regard to mathematics need not necessarily indicate or lead to better performance, just as bad or negative affect need not inescapably interfere with cognition" (Evans, 2000, p. 64). The goal then is not to lead female students over the gender divide to a more masculine sense of innate entitlement, but rather to provide *all* students with a stronger, more accurate self-perception of their potential and ability. Armed with this

kind of *moderate* confidence, students might be empowered to take greater charge of their own educational experience using their agency to bring about positive change and emotional well being.

Unfortunately, beliefs are not easily altered, particularly when embedded in a culture which reinforces gender ideologies regarding women's general inability in mathematics. What is worse is the message sent to young girls, not that they are incapable, but that it is okay for them to be incapable. The first talking Barbie said: "Math is hard. I like boys. Let's go shopping." Printed T-shirts in a popular store read: "I'm too pretty to do math". We tell girls to focus on their strengths and not to worry if those strengths don't include mathematics. We tell boys to try harder, that they are able, that they will need mathematics. These messages permeate the very fabric of their budding beliefs which later become nearly irreversible. The result: low confidence and low participation for females in mathematics. Equity may yet be some way off.

In North America at least, there is also this notion among students that if you are not good at mathematics then you are stupid. This is in comparison to not being good at history, for example, which signifies only that you are not good at history. Such a conclusion in the face of previous failures in mathematics might impact not only mathematics confidence but also self-confidence as a whole. Somehow, students have attached this very powerful judgement of intelligence to mathematics as reflected in both attitudes towards mathematics as a subject as well as in achievement and the willingness to pursue the study of the subject. Improving mathematics confidence might then have larger psychological implications calling for further investigation.

The data of the present study suggest that 'overconfidence' is an undesirable quality irrespective of the gender in which it presents itself. It was shown that overestimation, or overconfidence was often linked to poor achievement while underestimation or low confidence was linked to high achievement. This contradicts the mathematical education literature which finds that "confidence correlates positively with achievement in mathematics, and that the relationship is generally quite strong, with

correlation coefficients of greater than 0.40 appearing in studies at the secondary school level (Reyes, 1984)" (McLeod, 1992, p. 583). Possibly the contradiction can be explained by the context from within which the data in this study was taken, specifically, that of adult education. Also, the desire to simply pass may equally impact estimates made by students, making estimates reflective of ambition rather than confidence in some cases. This would seem particularly applicable for students who failed tests but estimated 60%. Nevertheless, the negative correlation between confidence and achievement in this study is a surprising result that merits further investigation.

Another study concerned with gender and mathematical confidence assessed differences between lower-class and middle-class girls. It was found that "some of the middle-class girls underestimated their performance...The middle-class girls were *expected* to achieve a high standard, so they were never sure they were 'good enough'." (Walkerdine, 1989, p. 101) Expectation may also play a role in this study as it did for Walkerdine in 1989. Perhaps the differences manifested as being in gender, are actually differences in expectation on the part of family. Means must be devised to control for this variable and others in subsequent studies. Other factors seen here, aside from gender, influencing confidence included: age, familiarity, culture, positioning, interest, expectation, qualifications, past performance, superstition, and the year in which the data was taken. The view of overconfidence as a negative quality in girls may equally contribute to relatively lower estimations by female students who may offer a conservative estimate rather than appear conceited. We must not conclude that women are lacking in confidence but rather that overconfidence can indicate or predict poor performance and is hardly an attribute to be aspired towards. More accurate views of one's abilities aught to be cultivated in order for students to improve their achievement.

"We think that gender differences are fictions with no firm basis in reality." (Walkerdine, 1989, p. 206) While gender differences were observed, they certainly do not exist in a vacuum nor do they assert any form of lack on the part of women. The relationship between confidence and achievement need not necessarily be gendered. The difference in confidence observed here between the genders might well be viewed as a

lack of confidence on the part of female students. A more accurate view however is that overconfidence compensates in part for lack of knowledge. Perhaps overconfidence acts as reversal; a manic defence using mathematics, "seeking to neutralize a disagreeable feeling" (Evans, 2000, p. 118). The disagreeable feeling in this case may be the shame of not knowing, as expressed and exhibited repeatedly throughout the interviews.

Interview Conclusions

During the interviews, it became clear that several sources of frustration impact students both in terms of the way they view mathematics, as well as in terms of the way they view themselves as mathematicians. Struggles with understanding, failure, and the ability to abstract led some students, particularly female students, to feel under-confident of their mathematical abilities. Interestingly, re-learning does not figure on the list of frustrations given below, though it has been shown to be one of the most important sources of frustration in adult students. Its absence here is indicative of the majority 'non-mature' students from this sample. Sources of frustration included:

- Not understanding (Teacher, poor concentration, trouble memorizing)
- Mathematical History (Being held back/ poor grades)
- Inability to abstract from a larger context.
- Time involved in learning (Balancing home/ family/ work/ school)
- Lack of familiarity/ broken habit.

Coping mechanisms included relaxation/ breathing techniques, studying, tutoring, extra help, summer school and *reversal.* Adjusting confidence in mathematics does not figure as a priority because all of these students, without exception, seek qualification or pre-requisites with no intention of revisiting mathematics. They do not care if answers are right so long as they pass and receive the qualification they seek.

The consequence of these frustrations include quitting a given problem, quitting a particular course, a lack of confidence in one's own mathematics performance, and unwillingness to pursue the subject or a career which requires the subject. Interviews revealed attributional styles which were generally in agreement with the literature. Males were more likely to attribute success to ability and failure to bad luck, bad teachers, or

circumstance. Females on the other hand were more likely to attribute success to good luck or hard work, and failure to lack of ability. These attributional styles, along with the other components of the Internal Belief System (confidence, usefulness and sex-role congruency) impact the student's engagement in ALBs. ALBs considered were engaging in mathematics tasks, working independently, and persisting with mathematics tasks (Meyer, Kohler, 1990, p69). Ultimately, engagement in ALBs, or lack thereof, greatly impacted achievement. Those students who engage, work independently and persist succeed; those who do not risk and even find failure. Thus it appears that a gendered adjustment in the Internal Belief System is at the core of increasing female participation in mathematics. Nevertheless, the one female student whose ALBs were ideal will not study further mathematics and so other factors must also be considered.

Problem Solving Conclusions

During the problem solving portion of the interviews, I had been hoping to find that those who had made accurate estimations of their performance on exams had some means of verifying the accuracy of their answers and so had a better picture of what was right and what was wrong. This was not the case. Almost no one had any means of checking the accuracy of their answers, and I am therefore unable to say whether a check would impact their confidence levels. This resistance towards 'checking' deserves consideration onto itself. Why aren't the students checking their work? Part of the reason undoubtedly has to do with some laziness on the part of many students who do not wish to do more than the minimum that is required of them. Often they ask me, "Does it count for marks? How many marks is it worth?" There is also a fear of paradox. It is not unusual for students to have a strong reaction to the paradoxical situation of having two solutions to the same problem, each with a different answer. Rather than do 'extra' work and risk facing this kind of 'uncomfortable' situation, students avoid 'checking' altogether. Helping students acquire the confidence to persist in the face of an error, ultimately to correct it, is an important autonomous learning skill which needs development.

It seems that the degree to which interviewees have experienced mathematics frustration is related to their mathematics confidence. Even this, however, cannot account

for the discrepancy between the low estimates of the women in the class, as compared to the high estimates of the men. One potential insight lies in that those who overestimated their performance tended to be those perceiving sources of frustration to be external, whereas those who had internalized frustration with 'I'm not good at math' were more likely to underestimate themselves.

On questions 1 and 2, while all three of the anticipated approaches were used, only one student was able to use a second approach to check, and even then, he was not sure of his answer. Of those who attempted these problems, the tendency was to call up the entire context of the course when trying to recollect the rules of negation. Overwhelmed by the magnitude of that context, they found themselves unable to abstract the information they required, leaving them with a solution of which they were completely unsure. The word problem presented in question 3 was expected to be challenging for my students, though it never occurred to me that they would be unable to solve it. Question 4 was abandoned altogether as interviews took longer than anticipated.

The tipping problem of question 5 was comparable to a similar tipping question in Evans' study of adult learners (2000). In considering one particular case study, Evans makes note of the following interplay of aspects, which define the context.

> Apart from purely conceptual problems, the subject is thinking in a context, influenced by a complex of factors...
> - Affective factors, separate from cognitive ones
> - Beliefs, for example about mathematics and about herself as a solver of problems
> - Social class and gender
> - Mathematics anxiety, especially about percentages
> - Some anxiety about the interview
> - Anxiety about the relevant practice, namely tipping
> - Apparently chronic anxiety about money (Evans, 2000, p. 184-185)

In a problem involving a 10% tip, Evans found that "almost half of the women – but no men – called up school mathematics" (Evans, 2000, p. 162). This last result is particularly interesting because it provides a means of explaining differences in performance, that appear strictly gendered, in terms of positioning. As previously noted, performance is generally better where practical mathematics is the predominant

positioning, and poorer performance is likely for a predominant positioning in school mathematics. If women are more prone to call on school mathematics, then the female performance disadvantage in his study can be understood in terms of school mathematics positioning rather than in terms of gender alone. Of course, there is no female performance disadvantage to speak of in the present study, as chapter 4 has shown. Still, positioning comparisons can be drawn. Evans also says that men were found to persevere longer than women, thereby producing more answers, though "the men's perseverance did not result in more correct answers" (Evans, 2000, p. 164). It is important to note, Evans emphasizes that his findings need replication, as the number of interviews in the second phase of his study was small (n = 25). This result was replicated here with the four female interviewees generating a combined total of 6 answers, and the four male interviewees generating 8 answers out of a possible total of 12 on questions three and five. Men, in this case, also produced more correct answers despite the women in the interviews performing better throughout the course. This suggests the interview process itself to be an important variable in problem solving results.

The students' reaction to the 'practical math' tipping problem proved interesting; they would appear to relax or experience relief when they read this question after the previous struggle with word problem. More than one student seemed to feel that this wasn't a mathematics question at all, but rather a question of generosity. This suggests the inherently perceived difference between 'school math' and 'practical math'.

The only check that seemed to be used freely and accurately throughout the problem solving was personal logic. If an interviewee felt that their answer 'didn't make sense' they were able to determine that it was incorrect. As a teacher, this tells me that word problems which resemble 'real life' will result in students who know when their answers are grossly incorrect (a 63$ tip on a 12$ tab for example). From this small sample, however, it does not appear as though this would help them to perform better, seeing as how, even knowing that the answer was wrong, they were unable to set it right. Two students suggested indirectly that 'round' answers would reassure them of their correctness, but preparing exams with clean answers seems contrived against the best interest of the students' understanding; they should feel comfortable with the idea that a

fraction or a decimal is no less correct than a natural number. The problem strikes me as being not so much one of understanding on the part of the students, but rather one of engagement. So long as they care only about passing, and do not care about improving or understanding, it will be difficult to make them care about verifying their answers.

In problem solving, a positioning in practical mathematics, while not always yielding superior performance, certainly provided a context within which the student was more confident of their mathematical result. Students became visibly relaxed when answering a problem they perceived as being practical mathematics, and, in several instances, did not consider the calculation of a 15% tip to be a mathematics problem at all. As we have seen, students did not doubt their answers on such a question whether correct or not. In his study, Evans found that half of women but no men call up 'school math' while solving a tipping problem. In this study, half of women (2/4) also called up 'school math', but one quarter (1/4) of men call up 'school math'. It is possible to conclude then that more women than men call up 'school math'. Evans also found better performance with a predominant positioning in 'practical math', but that finding was not reproduced here. An equal number of correct 'practical math' and 'school math' solutions were produced in solving the word problem and more correct 'school math' solutions were produced while solving the tipping problem. Finally, Evans found that men produced more answers than women, though not more correct answers. This was also true here. It is note worthy that women appear more cautious both in the estimations and answers they volunteer.

Implications and Recommendations For the Future

Female mathematics students must begin taking responsibility for their successes rather than attribute them to luck and help from others. The shame experienced by some for their 'hard-work' or 'not knowing' must be replaced with pride in cultivated ability. All students could benefit from the development of an accurate self-perception gaining confidence in their ability to take higher mathematics courses. Increased confidence could contribute to an increase of female participation in autonomous learning behaviours

which could in turn impact not only future achievement, but also participation in higher mathematics. We, teachers and parents alike, must foster the confidence of young girls. Teachers must interact as much with female students as with male students, asking similarly difficult questions, encouraging *everyone* to participate in higher mathematics and to consider the impact of mathematics on their careers. "Effective teachers (1) are competent in the subject matter, (2) provide all students with high-level knowledge regardless of the students' previous categorization or labelling, and (3) have appropriately high standards and expectations for [all] their students" (Malloy, 1997, p. 29) Parents must not accept poor achievement in mathematics from their daughters, deferring them instead to English or the Humanities. Instead they must foster the success of daughters with the same diligence and expectation they hold for their sons. We all must praise female students of mathematics, not solely for their cooperative behaviour, hard work, and meticulous note taking, but also, and more importantly, for their ability and the mathematical content of their work. Becoming aware of the problem and our role in it is the first step towards the change necessary for gender equity in mathematics to be achieved. Only in this way can we "undo the fiction of gendered activity" (Walkerdine, 1989, p. 208).

It is possible that lack of confidence not only impacts women's willingness to participate in further elective mathematics, but also that "women's lack of confidence may inhibit them from trying alternate approaches to problems or experimenting with different techniques." (Gray, 1996, p. 30) This impact on problem solving, while a serious and undesirable outcome provides a potential means for measuring progress when attempting to foster confidence. Problem solving approaches being an observable phenomenon may open the door to determining the criteria or characteristic goals of equity in mathematics confidence.

It might be interesting to investigate further whether people who perceive only external sources of frustration are more confident in mathematics as well as to consider whether those who perceive only internal sources of frustration are less confident in mathematics. Is there a gender, age or class divide between the two groups? How do

teachers, family and friends impact the way a student perceives their frustrations and consequent self-confidence in mathematics?

Upon conducting a repeat of the present study several considerations ought to be taken into account. Though the content of Mathematics 436 has now been changed by the school board, teaching seven books instead of four, this measure of evaluating self confidence through test score estimation remains relevant. Perhaps confidence could be split into cognitive confidence and affective confidence. The former could be measured as it is in the present study through a cognitive estimation process; "how do you *think* you did?" As for the affective confidence, it might be measured through result prediction prior to writing the exam; "how do you *feel* you will do?" A third dimension of confidence might include what could be termed behavioural confidence as witnessed by the researcher in a problem solving context. Future initiatives will include class discussion of these findings, feelings and confidence in mathematics, incentives for accurate estimation, and a continued study of confidence/ achievement correlation as well as the development of techniques to encourage the confidence to persist with mathematics.

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APPENDIX A

Interview Transcripts

Hidden from all
I will speak to you without words.
No one but you will hear my story
Even if I tell it in the middle of the crowd.

Rumi

"Hidden Music"

Interview with Student 1 – Cassy

The tape recording of this interview was no good, and so I have to rely on memory as to what happened.

Math Story

Cassandra attended high school in St. Vincent (Caribbean?) more than 20 years ago. She did not complete high school there partly because she felt she was too slow and/ or, not a strong enough student. She only got to grade 9 math before leaving school altogether. She tells me, "I've never been good at math".

When I ask her how she ended up at Place Cartier, she says there is a nursing program that she wants to get into, and she can't do that with just grade nine. I asked her "So you need a high school diploma to get into this nursing program?" and she says no, but you do need 436 (enriched grade 10 math). She says that when she first came to Cartier and they put her in 416 Prep (preparation for regular grade 10 math), she felt as though she had been put in the wrong class because, she says, "I didn't know what was going on". She had her teacher go to administration with her to correct the mistake, but in the end, she was in the right class after all.

It is important to note, however, that she is easily one of the strongest students in my class. I say, "Well, as you know you're doing very well in my class, do you still feel like you're not good at math?" She answers, "No, I feel I've overcome that, by working hard and learning all the things. I have to study a lot but I overcome that feeling."

I asked her if she would be doing anymore math after 436, and she says, "No, I mean I would like to, but I only need 436 for my program, so... but maybe if I could get my high school diploma while I'm here too, maybe I would do more math because I enjoy it, you know. I feel like I'm getting it and I like that feeling, of working a problem and getting it and getting it right." She says she might go talk to the counselor to see what else she can take, but her nursing program starts in January 2004 and so she can only take one more semester at Place Cartier.

When I ask her what she might change in her environment (teachers, classroom, personal behaviour, home life, etc) in order to make math more enjoyable, or easier, she says, "For me I wouldn't change nothing." She says that she feels "very comfortable" learning at Place Cartier. She does mention, however that she has a little boy, and she doesn't like to ignore him even if she has homework. To get around this, after her morning class with me, she attends the afternoon Individual Math class and does her homework there. That way, only when she has a test does she need to do math at home.

Problem 1 – Logic

Throughout the previous section of the interview, student 1 seems relaxed enough. When I hand her the questions, she begins to wiggle a little in her chair and coach herself, it seems. "Okay, okay, what do we have, okay..." and she glances at the tape recorder. There is a long silent pause while she reads, then re-reads, then re-reads the first question. "So what's going on right now?" I ask her, to which she replies, "I don't know, I'm just not getting the words you know, it's like just words with no meaning." She goes on to tell me that this happens sometimes, when she gets nervous. "It's just, I'm just feeling **tense**, and it's like I go blank, and the problem is just words." I ask her to read the first problem out loud to me, which she does, but she is rubbing her eyes, scratching her head and breathing deeply as though to forcibly relax. Another minute or so passes with nothing written before she says, "I just don't know. I'm not getting it."

Problem 3 – Word Problem

Okay I tell her, let's skip down to number 3 (distance/time/fraction). Again she reads the problem 4 or 5 times before putting pencil to paper. The third time, she underlines information from the problem, and begins to write some of it down under the diagram. It looks, however, like she is killing time without

really attempting to solve the problem. "I don't know how to put it together", she says. "Well, just give it a shot; see what you come up with". She proceeds to write the correct ratio of time, and then changes it for an incorrect ratio... then frozen silence. We go over what she's done so far but she is unable to go any further.

Problem 5 – Tipping

Turning our attention to the 5th and final problem (tip), she is no longer breathing with such deliberation, and only needs to read the problem once before she has a sense of what it is asking for and decides right away, "I would leave about $2.50, yup, if this was my bill that is what I would leave." When asked how she came up with that number, she issued the surprising response, "That's what I always leave if I'm eating just me". I ask okay, what if the bill was twice as much, and she says, "I would still leave $2.50". I say, "So you're not estimating with a percentage or anything?" and she says, "No, I know some people do, but I always leave the same, $2.50 is fine".

As we are closing the interview, the student is apologetic for her display of anxiety, despite my reassurance that this is exactly what I'm looking for. She tells me that she is generally a nervous person, who gets nervous often and easily. I ask her if this is only true in math, or in school, and she says no. I ask what other situations my make her tense and she hesitates before responding, "Like if I'm meeting a lot of people I don't know." This is the only other example, but she says it always happens with math. I ask, "So what do you do when that happens? How do you fight it?" "Well", she answers, "I prepare a lot, so if I can just relax and start getting it then I'm okay. I remember one time on this test I couldn't do anything so I just had to stop trying and close my eyes and breathe for like 20 minutes, and then I was okay. Once I get going I'm okay. I guess partly I'm nervous because I'm aware of what's going on [glances at the tape recorder], but partly it's just the problems."

At this point I turn off the recorder, and leave the room to get some other students. When I return (3 minutes later) she has attempted to solve the 1st problem and has decided that the answer to the 3rd problem is 18 minutes... the power of anxiety. "I'm getting it now", she says.

Interview with Student 2 – Melissa

L: Tuesday morning August... what...10th. So I'm here with student number 2, and we need to get your story a little bit. So how did you end up here at Cartier?

Math Story

M: Uh, when I was in grade 10 I failed the 416 math course so I had to redo it in grade 11 [L: okay]. So when I passed I only had 416 which wasn't enough to get me into any program at John Abbott [CEGEP] [L: okay] and uh originally I was supposed to take the uh 426 course at PC [Pierrefonds Comprehensive High School], 'cause the guidance counselor told me I could, but I couldn't because I'd never taken the course before. [L: OH, okay] So they told my mom that I could come here and do 436.

L: So what program are you going into at Abbott?

M: At the moment, for the first semester, I'm going into a correctional course, but that's only for 1 year, hopefully, until I can get like my license and all the requirements I need for Police Tech.

L: Ouuu, you're goin' to Police Tech, alright, that's pretty cool. So what do you think went wrong in 416?

M: Uh, I don't really know because I've never ever been good at math in my entire life.

L: Is that what you feel? Or is that what your grades reflect?

M: [no hesitation] That's what my grades reflect. [Nervous laugh]

L: Why do you think that... like, why math instead of like history?

M: I'm not good at that either. [laughs]

L: So what's your best subject?

M: Um, oh Lord, I don't know, English I guess or ... I did okay in French.

L: What's the scariest part of math for you?

M: Trying to remember what steps come after [laughs] the next one.

L: Okay, order of operations, that's alright. Let's see what else we need now... um... Why, when you took 416 originally, did they have 436 as one course? Like, why did you choose 416 instead of 436 originally?

M: Well at PC, 436 would be advanced grade 10, [L: okay], and I couldn't do that.

L: Like, they wouldn't let you take it?
M: Um
L: Or you didn't want to take it.
M: Um I didn't want to take it, 'cause I thought 416 was hard enough.
L: okay, alright. What do you think of this now? 'Cause you're doing it now and you're doing okay.
M: Yeah, well, the part that we're doing at the moment I find like really really hard. Like I really don't get it
L: okay, so Algebraic Fractions is not your favourite... but factoring went really well.

M: yeah it went okay. [L: really well], yeah, okay

L: What else do we want to know? And this was... you just finished grade 11?

M: yeah I graduated this year

L: Okay, so it's not like you've been out of school for a couple of years.

M: No

L: You went straight through. So in a perfect world, what would you change about either your behaviour or your study habits or your classroom, or your teachers... like what would help you get through math easier do you think?

M: I would probably study [coughs] I would probably study more 'cause I didn't really study a lot and I wouldn't really change anything about my behaviour 'cause I can't really do anything about that, it's just kinda the way I am. [both laugh]

L: Okay, what about the classroom size? Like this is a big class, like, do you prefer smaller classes, or do you like this? [30 students]

M: The classroom size doesn't bother me at all because I've had both large and small classrooms and even this year in grade 10 I've had like 30 people in one class and...

L: So that's fine [nods] okay, alright, well 'cause in CEGEP they'll big normal classes. What would make math more enjoyable instead of just better. What would make it more pleasant?

M: Um, understanding it? [both laugh]

L: Okay, that's fair, understanding it would make it more pleasant, alright. Let's look at some problems and see. There's a couple of problems on here, um, if you don't like 1 and 2, then we'll focus on 3 and 5... and we'll do whatever else we can, but if you want to give 1 and 2 a shot, like how would you approach these? And you've gotta think out loud [M: laughs] 'cause the tape recorder doesn't read minds. [M: laughs]

Problem 1 – Logic

M: Negation, factoring in not p,q. Not p AND q becomes Not p OR Not q. [long pause while looking at the problem]

L: Okay, so how would you know if that's right?

M: I wouldn't. I'd wait until I got the test back.

L: Oh no. Okay but if you wanted to check. If you wanted to check, to know, if it was right, what would you do?

M: Uh, ...

L: Well what are they asking for? What's the question?

M: If p is true and q is false, what is, what is the truth value of the following? p AND whatever, q is [inaudible] ... so p is true...

L: You can write underneath

M: Can I cross it out?

L: No no, don't cross out your work,

M: p is true [dragging out the word hesitantly trrrruuuuue] so p [12 seconds] AND NOT q [4 seconds]

L: So what are you doing now?

M: uhm, leaving p alone because, I think, it's true? And uhm putting the negation sign into q because it's supposed to be false.

L: You're making a face.

M: Yeah [laughs] I don't know which is right, they could both be wrong.

L: If you went by gut instinct what would you decide? [9 seconds] Okay, so what does that mean when they ask what's the truth-value? What are they asking for?

M: Um, whether it's true or false? [13 seconds] The truth-value, isn't that whether it's true or false though?

L: Well, you gotta decide, you gotta tell me.

M: Okay. [9 seconds.] Okay. The truth-value is whether it's true or false.

L: So then...

M: if p is supposed to be true, I do live on earth, it has to stay true, and q is false, I don't have 7 brothers, it's not q.

L: Alright? [M: Okay] Alright, try 3, skip 2 and try 3.

Problem 3 – Word Problem

M: I read it out?

L: Yeah, read it out so the tape knows.

M: Stacey lives 2km from her friend's house. It takes her 20 minutes to walk from her house to her friend's. If she leaves her house at 10 am, what time will she be... what time will she be nine tenths of the way to her friend's house. How far will she have walked [7 seconds then so quietly it's almost inaudible.] split the line into 10 pieces [12 seconds] 10 pieces. They're not even [nervous laugh]... [still very quiet] she walked...so we have 10...[she mumbles to herself over for the next 39 seconds]

L: So what are you correcting? What's happening now?

M: Um, I'm ... making... the ratio... to find out... what time... I mean, what time it'll be when she's nine tenths of the way to her friend's house.

L: Okay, so what ratio are you finding?

M: [4 seconds – laughs – 22 seconds] That's nine, I got that...

L: So you divided the line into 10 pieces, [M: Yeah], and you, you marked off the first 9 pieces...
M: ... and that's left over [pointing to the remaining part, she notices that she has made a mistake – 8 seconds]

L: Alright, so you're erasing 'cause you only have 8 pieces marked, but you wanted 9, [M: Yeah], so you've changed it to 9.

M: [4 seconds] Here... [4 seconds]...[inaudible] ratio... [Inaudible mumble]...[26 seconds]

L: So what's 'a' over 'b'?

M: Um. It was supposed to be number but I don't have any numbers. Like the coordinates of like A and B. [5 seconds]

L: Could you set some up?

M: I don't know [laughs], like just give it two numbers? Like... 1 part or like 8, 9 or something? I could do that?

L: [pause] You're telling me.

M: I didn't know I ... I... [5 seconds]

L: Okay, so ballpark, let's say you don't even have to solve the whole thing, how would you... like what would your approach be for the rest of the problem? What would you try to do?

M: I don't even have to solve the whole thing?

L: Well let's say you don't actually have to put it down on paper, but what would your strategy be?... like why do you, why do you need the points?... at, at the first house, like Stacy's house and at the friend's house? You want the coordinate points?

M: Yeah.

L: Why?

M: It's just I've always worked with coordinate points, I don't know how to do it without them.

L: Okay

M: [22 seconds] I really don't know what to do.

L: That's actually alright. [inaudible]... but that's totally great. Alright. Now we're gonna try 5. [I flip the page over] We're gonna try this one here.

Problem 5 – Tipping

M: You go out to a restaurant [inaudible], and have to pay the following bill.[inaudible]... How much would you leave as a tip for a waitress who served you well but not especially so? [7 seconds] like, not especially so, is that like, just like, normal? She wasn't like extra nice or anything? Okay. [20 seconds] *I* heard that tip, usually like, times whatever the total is by like 7.5 or something...

L: Okay, so how much tip do you want to leave this woman? Or this man? Is it a waitress or a waiter? [M: waitress] uhg. Should have made it a waiter. [M: laughs, why?] Because they always say waitress, it's not fair [M: laughs] There are men who wait tables too.

M: Okay. Um. Am I aloud to use a calculator?

L: Sure.

M: Alright so, I've always heard that you always leave like ... or is it like 15 percent? [8 seconds]

L: So you're entering the total of the bill, twelve-o-seven ... [5 seconds] times point 18, okay... and did it work?

M: [inaudible] doesn't make sense.

L: How much did the answer say?

M: ... 2 point one seven two six.

L: So, what doesn't make sense about that for you?

M: the one seven two six. [laughs – 18 seconds]

L: So you're saying 100 over 18... [10 seconds] now you're doing 18 by 100 and that gives you point 18. Alright.

M: And then try it times twelve [mumbles]....

L: That's from the 100 over 18? And that gives you 67.1092

M: Okay, she must have been really friendly to get like 67 bucks [both laugh] So

L: So wait wait, you're saying this is 67 bucks?

M: I don't know [laughs]

L: So if this is 67 bucks, then what would this be? [I point to her previous answer of 2.1726] Up here? [M: Two] Your original answer was 2.1726... do you know?
M: [26 seconds of counting/mumbling to herself] ... rounded... like... [inaudible] 2 point one seven?

L: Alright, the last question I'm going to ask you. Even though you don't look sure. [she laughs] you don't look sure. The last question I'm going to ask you is, what would help raise your confidence in math?

M: If it gave me a round number. [laughs]

L: If it gave you a round number in this problem yeah [laugh]. Would better grades help raise your confidence?

M: maybe.

L: Would more individual attention help raise your confidence?

M: Well, I have like a tutor... and stuff...

L: Okay.

M: He helps me understand sometimes. But yesterday like I still didn't really... get it? Like he's coming again today to help me study for the test.

L: Well we'll do more problems today. Maybe preparation will help raise your confidence. Thank you very much.

Interview with Student 3 - Laurent

Wednesday Aug 11th, 2004

Laura: I need to know how you ended up at Place Cartier

Math Story

Laurent: Uh, I needed 436 math to go onto computer science.

Laura: You're going into computer science? [he nods] Which CEGEP are you going to?

Laurent: Uh, John Abbott.

Laura: John Abbott? And where were you at high school before?

Laurent: John Rennie.

Laura: John Rennie. Okay, was that last year?

Laurent: Yeah

Laura: Okay. Did you take 436 before?

Laurent: No

Laura: No, what did you take?

Laurent: 416 and 516.

Laura: 416 and 516. Did you have a choice for 416 or 436 [Laurent: uh, no] You didn't? They made you take 416 [Laurent: yeah] Okay, and then they didn't ask you like, would you like to do 436? [Laurent: No] Were you upset about that? Did you want to take 436?

Laurent: Uh, I didn't know I needed it until I got into John Abbott and they told me I needed 436. [Laura: Okay] And I decided to take it.

Laura: Okay. And they didn't offer it at your school.

Laurent: They do offer it, but they never told me to take it.

Laura: Okay. Um. Did you, like, how did you do in 416 and 516?

Laurent: Uh, 516 I failed that course, 416 I got like 80.

Laura: Okay, so what happened in 516 then?

Laurent: Um, the teacher was bad, like a lot of people failed. [Laura: Okay] And he would mix up diving with math, he was a diving teacher, [Laura: Okay?] so he would mix up diving and math and laugh and talk at the same time so you don't know what he's saying. He was weird.

Laura: He was weird? Had he been a teacher there very long?

Laurent: Who?

Laura: Your diving slash math teacher

Laurent: I think so.

Laura: You think so. Was it, like, proportionally, do you think about half the class got through.

Laurent: Uh, probably less than half.

Laura: Less than half you think... Okay, was that the only 516 class offered?

Laurent: Uh, no, the others were too but I was uh [inaudible]

Laura: Okay. Did you do any of the sciences?

Laurent: Uh yeah I did social science.

Laura: You did social science. Where did you go study the social science?

Laurent: [almost inaudible] Uh, Chemistry, Biology [Laura: Okay], some physics

Laura: Okay, so you know some stuff about that. Uh. And you said you're going to John Abbott? Is that what you said.

Laurent: In January.

Laura: In January. Oh. What are you doing in the fall?

Laurent: I'm doing 536?

Laura: Here?

Laurent: Yeah

Laura: Oh Okay! You're gonna be back.

Laurent: Are you staying?

Laura: I'm I'm always here. [laugh] I don't have 536 though, you'll have Paul Pompa, for 536, it'll be great. Um. Okay, so in a perfect world what would you have changed in those classrooms to make math either more enjoyable, or easier...

Laurent: Less people.

Laura: Less people?

Laurent: So you can one on one.

Laura: Okay. You like smaller groups? How many people were in that diving slash math class?

Laurent: Uh. 34

Laura: 34, so it was a big group.

Laurent: It was a lot.

Laura: Okay, and how about the size here, like 27.

Laurent: It's better than what I've been through before, but it's still big [inaudible] more, faster advanced, 4,5,6, they help you more, they listen more.

Laura: Okay. Do you have a tutor?

Laurent: Uh, no I don't.

Laura: 'Cause if you like one on one learning that would probably help.

Laurent: I did have one a long time ago but uh, he taught me a different way from what they taught me in school, [Laura: Okay] and it just confused.

Laura: Okay, so you need someone who can stick to the way that you learned. You'll like Paul's classes this fall. ... what else do we need to know. Um... Maybe... let's look at some problems. Tell me how you would do these. You can do it in pencil if you want, or in pen. If you don't like the first one or the second one, they come out of our logic piece, then I want you to look at number three. But, look at them first, you know what I mean, before you decide if you don't want to do them... you gotta think out loud because the tape recorder won't know what you're doing.

Laurent: [reads the question mumbling to himself and writes on his paper – 37 seconds]

Problem 1 – Logic

Laura: What's the symbol? What's the hat symbol?

Laurent: AND.

Laura: That's "AND"? Okay.

Laurent: [inaudible]

Laura: Alright. so write that down if that you gonna use. Like write your rules so I know what you're using. [12 seconds.] Okay, circle it... alright!

Laurent: Is this right?

Laura: It's not a matter of if it's right. I just want to know how your solving.

Laurent: The other one too.

Laura: Yeah, it's the same problem, well... different... equation.

Laurent: P is true, Q is false, [inaudible mumbling/reading the problem to himself – 18 seconds] true? [46 seconds – he begins to do question 2]

Problem 2 – Logic

Laura: Alright, so is that your answer for B intersection A prime? Is 3 and 6? Like, what does 3 and 6 represent?

Laurent: The interval.

Laura: Alright, so write that down. [inaudible] [13 seconds] You change your mind. Alright show me, so what are you changing?

Laurent: [explanation is completely in audible ... at the very end of the tape]

[turn the tape]

Laura: Okay, so we agree, we've got these 7, 8, 9 ...that's good. We also crossed some things out of the Universe, what did you cross out of the universe?

Laurent: All of the A's out of the Universe so we have the A prime.

Laura: All of the A's out of the Universe so you have A prime. Okay. So what's A prime?

Laurent: A prime is all the elements [3 seconds] 0,1,2, 4,5,9,10

Laura: Okay

Laurent: And B and A prime means all the elements of B in A prime... [inaudible]

Laura: Okay

Laurent: So, B and A prime [10 seconds mumbling to himself] that.

Laura: So how are you deciding if these are right? How do you know if these are right?

Laurent: [barely audible] I follow the rules you taught us. [pause]

Laura: And hope you remember them right? [Laurent: Yeah] Okay, so you're relying on memory? [Laurent: Yeah] Okay.

Laurent: [inaudible]

Laura: So what about number 3.

Problem 3 – Word Problem

Laurent: [mumbles/reads the problem to himself then re-reads parts of it, several times over the next minute or so]

Laura: What are you punching in the calculator?

Laurent: 20 by.... No... 20 divided by...

Laura: Set up what you want to do on here, and then you can punch it in your calculator.

Laurent: [mubling, writing, calculating – 40 seconds]

Laura: No no don't erase don't erase. So let's re-write that down. 20 by 10 is equal to 2. So what does 2 represent?

Laurent: Oh, 2 represents uh each uh[7 seconds] 2 minutes should be uh 1 tenth of the of the way [inaudible]

Laura: Okay. Alright.

Laurent: So then [3 seconds] 9 tenths multiplied 2 by 9 will be 18 [4 seconds] So in 18 minutes she'll be 9 tenths of the way there.

Laura: Alright. How far will she have walked?

Laurent: 2 times... [4 seconds] 1.8 kms.

Laura: How are you deciding? 'Cause you haven't written anything down, right? You did that in your head? So how did you do that in your head?

Laurent: um, 9 times kilometers [2 seconds] I don't know how I got it.

Laura: So write it down. How do you, do you have any way of checking it out, to make sure that it's good?

Laurent: Uh. [8 seconds]
Laura: Does it feel right?

Laurent: It feels right.

Laura: Like if I, if I, told you it was wrong you would be surprised?

Laurent: Yeah

Laura: Yeah? Okay [inaudible] Alright. Let's try one more. We can skip 4, 'cause 4 is sort of some algebraic fractions, and that's gonna take a little while, but try 5.

Problem 5 – Tipping

Laurent: [mumbles/reads the problem to himself – 21 seconds] But Miss, this is about being generous.

Laura: [laughs] It's about being generous? Well I just want to know; like how do you decide how much tip you leave?

Laurent: 3 dollars.

Laura: You leave 3 dollars? Alright, how do you decide on 3 dollars?

Laurent: [inaudible] 3 dollars would be a good tip.

Laura: Alright, so, so you'd better write some of that down. So you're saying 15 is an even number?

Laurent: Can I write it in a sentence?

Laura: yeah yeah yeah, you can write it in a sentence... [5 sec] So you like nice round numbers? You try to find something round? [25 seconds] Okay, now do you consider that a generous tip, since you say it's about being generous?

Laurent: [turns back to the question – mumble/reads] she served... not especially so...

Laura: Like, is that a good tip or is that an average tip?

Laurent: It's an average tip.

Laura: It's an average tip?

Laurent: A good tip would be 8 dollars.

Laura: A good tip would be 8 dollars? On a bill of 12 dollars I'd say 8 dollars would be a crazy tip! [laughs] Alright, now that's wonderful, honestly, thank you very much. Alright?

Interview with Student 4 – Mildred

L: Okay, so we're here with Student number 4. Today is still Wednesday, August 11th, and um, we're going to talk about how you came to Place Cartier. How did you end up here?

Math Story

M: Uh, it's because of our financial situation. Uh, before I uh worked in an electronics company, but I realize that I have to do overtime, overtime and that's the income I should have while uh, uh, attending school, and to have a degree, it would be better for us. It will increase my income, and our lifestyle, and most of all I couldn't give to my kids what they want. But I don't have enough money, and also my husband, 'cause we're paying mortgage and the everyday... expenses. [L: mhmm] So by this, uh, it will increase my income. That's why I come here.

L: Okay. [M: To study] Okay. So how long ago were you in high school.

M: High school was... I graduate in 1980, in our country.

L: Okay, in the Philippines?

M: Yes. And uh, I was also stopped for 5 years 'cause I take, took care of my mother who's diabetic [L: Okay] And I graduated midwifery 1987, and that's um, my last education, 1987.

L: Okay, so you have a high school diploma.

M: I have a high school diploma, and I have a certificate for midwifery, [L: Okay] and have also board exam there, and I pass also the board exam.

L: Okay. So how come you have to do high school again here?

M: No I didn't do the high school. I'm doing the pre requisite for nursing.

L: Oh! Okay.

M: The three subjects. Physical science, and math 436, and chemistry.

L: Okay, do you have to do any more maths after this?

M: No, I have to do physical science.

L: Okay. How do you feel about math?

M: It's interesting, because uh, since uh, elementary I love math.

L: You love math?

M: Yeah. [pause]

L: What's your favorite part about math? What do you love about math?

M: All of them [both laugh]. All of them.

L: Is it like, the, the feeling of solving a problem [M: mhm], and getting it right [M: Yes], or is that for sure there's right and wrong?

M: mm, no, I just uh, I just uh, solve it quickly, understood it quickly, and I don't have so many things to memorize. [laughs]

L: Okay, well 'cause some people feel like there's a lot to memorize in math.

M: mm, no, just understand it and that's it. Do the step by step and understand it, the rules, and you can get it immediately.

L: That's good to hear. So you've always liked math. Were you always good at math?

M: Yeah. [laughs]

L: Yeah. [laughs]. Is math your best subject?

M: Oh, yeah.

L: Yeah? Always always? [L: mhm] mhm. Alright. If you could change anything: if you could change like something about the classroom, or your life, or your set up, or your work habits, what would you

change to make it better or more fun, or more.... Would you like it to be more challenging? What would make it better for you?

M: A better life for our, for my family, especially my kids.

L: Would make math more fun?

M: Uh yeah. [both laugh]

L: Are you, like you don't have to do more math, but if you could, like if it was part of your nursing program, would you choose to do more math?

M: Yes.

L: You would?

M: mhm. You know what? Uh, I'm making notes, that's why I make clean notes, [L: mhm] I will keep it so that I could teach my kids. They are in grade 4 and grade 3 now. [L: Okay] So I could teach them, when they will be confused [L: Yeah], that's why I had a nice clean notes [L: Okay]. It's also for my kids, not only for my study.

L: Okay, that's really cool. Let me see if I have any more questions. That's pretty good. Mmmm, why did you... um, o, you didn't leave school, you graduated, so it's not like.... What made you wait so long before deciding to change jobs?

M: Um, because financially, and the situation first, had three kids, and I couldn't leave them, left them *in* my mother in law because we, I have lots of nephews and nieces. So I take time, wait for the right time. So it end up, I think it's, 9 years now that I, since I came here. [L: Okay] and I went to school here [L: Okay, so now's the right time] Yeah, it's the right time, we are... in the school for the whole day, and before I couldn't go because financially first

L: Yeah, so you're going to take, have taken physics and chemistry yet?

M: I had to take in high school

L: You had it in high school?

M: Yeah, physics and chemistry.

L: Do you have to do them again though, to get into nursing?

M: It's uh prerequisite: Chemistry 436 I think, and Physical science, I forget the number.

L: Okay. So, are you doing that in September?

M: Yes, this September.

L: This September. And then, when does your nursing program start?

M: Oh, it will start September 2005.

L: Okay, so you have a year.

M: After the two subjects I want to study French, level 1, until what level I could have [L: Okay] before my next school days.

L: Okay, work on your French. Alright. So let's try some problems.

M: Ohhhh

L: Just a couple, you go Ohhhhh, [laughs] Just a couple. If you don't... problem 1 and 2 come out of logic [M: mhm], if you don't want to do those, or if you start them and you can't figure them out, we'll focus on problem 3. And we're gonna concentrate on this one [points to number 5], but try this one first [points to number 1].

Problem 1 - Logic

M: What's this? [exhales deeply]

L: You have to think a little bit out loud so the tape recorder can hear you.

M: I will, uh, read it. [L: mhm] If p is TRUE AND q is FALSE... Determine the truth value of the following. [as she reads she taps her pen down for every word] p is I live on earth it's TRUE. q I have seven brothers it's FALSE. Can I make [makes a writing motion with her pen over the paper]

L: Yeah yeah, write all over.

M:... A is NOT times p OR q... and B is NOT p OR q... is this the answer that I will check? [L: Mhm] Okay... I live on earth... I don't have brothers... AND... [10 seconds]

L: What are you thinking?

M: [5 seconds] You have p AND NOT q. This is true... I use uh, it should be A because uh I live on earth is not consistent to brothers. It should be AND, not OR, this is OR.

The confusion here is that she is thinking of the problem as being multiple choice. The thinks the beginning of the problem is the whole problem, and A and B are the possible answers from which she must select the correct one.

L: These are different problems. They're asking you, find the truth value of A, and then find the truth value of B. It's not like multiple choice.

M: Oh! I thought it's multiple choice. [5 seconds] If p is TRUE and q is FALSE... am I doing the true true like that?

She's asking if she should make a truth table.

L: You solve it however you want to.

M: Okay. I'm going to get this [she gets up to get a ruler out of her bag.] p, q, and so [mumbles to herself]. Did I miss something here?

L: So you're setting up a truth table?

M: Yes. [Continues to mumble to herself – 20 seconds] q and and and true if true true...

L: Write down the rule that you use at the top so I know what your reasoning is.

M: true, true, OR is false if false false... and that's...true... I will do this [inaudible] and this way? [Writing – 16 seconds] p OR q false if false false

L: So now you've got a truth table set up for 1b.

M: mhm, so hard....

L: Write it down, you're allowed to write on the paper.

M: false if false false... [16 seconds] So what would I do this now?

L: Well, what's the question? What are they asking?

M: If p is true and q is false, determine the truth value of the following. [4 seconds] so here, p AND q is false false... and... p AND q's true true... [whipsers] I don't know what. [now at normal volume] What do you mean with this one?

L: Okay, so you would leave it like this, if this was the question.

M: [mumbling/ reading to herself – 22 seconds] ... so it's the answer... [9 seconds]

L: hmm, you said that all quiet. You said, I don't know what I'll do here. Alright, so leave it then. That's good.

M: [laughs] I don't know that one.

L: Alright, try, try number 3.

M: How about this one [points to number 2]

L: We'll skip 2, it'll be too long.

M: Okay.

L: We'll try number 3.

Problem 3 – Word Problem

M: [reading out loud] Stacy lives 2km from her friend's house... [Reading in her head]... 20 minutes walk... [46 seconds] At what time will she be nine fifths ...?

[Rustling noise I reach over to correct my mistake on her word problem]

L: Alright, so you've written a lot of things down here. You've started. You're writing as you read the problem right? [M: mhm] So you read, "Stacy lives 2 km from her friend's house" and then wrote down 2 km. And it takes her 20 minutes to walk, and you wrote down 20 minutes walk. She leaves her house at 10 am, so you wrote down 10 am. So I have to make a little correction here. That's my fault, the problem is badly written. It's 9 tenths in stead of 9 fifths. [M: Ohhhhh] I'm sorry I'm sorry. Alright, what have you written next to 2 km?

M: 20 minutes walk. It's the duration from her house to her friends.

L: From her house to her friends. Alright, next to 20 minutes walk. What did you write here, next to 2 km?

M: It's away from her friend's house.

L: Okay. 10 am left at home, and then you wrote 9 tenths.

M: yeah, 9 tenths. How far will she have walked? [exhaling deeply] Huuuuuhhhhh. [13 seconds] What time she will be in 9 tenths... What time will she be... 9... 10... At what time will she be 9 tenths... done this... 9 tenths... 9 is to 1... formula...

L: What formula? You saying they forgot the formula...

M: How far will she have walked...? Stacy's house... [5 seconds]

L: You've set up a ratio...

M: Could be 20 ...

L: You've got a ratio of 9 to 1, so what does the 9 to one represent? What does 9 to 1 stand for?

M: It's the 9 tenths... at the 9 it's the question, how far will she have walked.

L: Okay, what about these other lines that you've added? On the diagram? What are these for? These first two lines?

M: Uh, I just, took, left one 'cause it's 9 tenths, for the 10... and make it half for the 20 minutes... I think it's 15 minutes walk?

L: How do you decide on 15?

M: Because it's only 20 minutes walk from her friend's house, and it's half it's 10. And from 9 is to 1, it's, she's around 5 minutes more... so I choose 15 minutes.

L: Okay. [4 seconds]

M: Is this the question, how far will she have walked? [L: Yeah] How many minutes? How far...

L: Well how... we have 2 questions. At what time will she be 9 tenths of the way to her friends house

M: So this is the time. 15 minutes at 9 tenths at 15 minutes.

L: Okay, and then how far has she walked

M: How far has she walked? It's 3 fourths from her house... from her house to her friends.

L: What's three fourths?

M: 'cause in half way it's 10 minutes walk. [L: Okay] and then on the 9 tenth, it's 15 minutes walk, so you divide it by 4, it's 3 fourths from her house.

L: Okay. Now how, if you're doing these, let's say on a test or something, how do you decide if your answer is right? Like what, do you have a check, or a trick for checking?

M: For now I almost mix up. [Laughs] Because my mind is uh, my final is tomorrow.

L: Yeah I know, I know, and you're thinking about algebraic fractions I know. [M: mhm] But how about, even up here with the truth tables that you did? How do you know if they're right? How do you check if it's right?

M: Well because of the rules. The rules is AND it's true if true true, [L: Okay], and the rules in OR false if false false.

L: Okay, so you count on your rules.

M: Yeah. So I put the... in here...

Problem 5 – Tipping

L: Okay. Alright. Let's try one more. There's one more question. Okay? Number 5 down here.

M: [exhaling] hhhhhhh.

L: It's not so bad. This one's a little one.

M: You go out to a restaurant for breakfast; you have to pay the following bill... how much would you leave as a tip for a waitress who served you well but not especially so. Let's see. [She reads the items on the bill – inaudible] and tax. Ahhh. The tip should be ... same as the tax. [Add the tax – 38 seconds]

L: So what operation are you doing here? You've got the two taxes written down, you've got 55 cents, and 63 cents, what are you doing with those?

M: Uh... I think this is the tip for uh, if you buy something from waitress, it's the tip.

L: Yeah? So what operation are you doing?

M: The multiplication?

L: You're multiplying? Okay.

M: oh. No. no. no. Not multiplication.

L: Don't erase don't erase!

M: Ahhh!

L: Do it next to it.

M: Okay okay. I thought it's the, it's just, add the tax. Just add the tax...it's one eighteen... The tax is one eighteen... so it's up to you if you could give her a $1.25 or $1.50, or $2... but what I have heard, the tax is the same amount that you could give to the waitress as a tip.

L: Okay. So you would leave $1.18?

M: Yeah, as the tax.

L: Alright.

M: This one is in tax?

L: No, that's uh [M: miscellaneous food?] miscellaneous food, it's probably desert or [M: no tax I think] Oh, maybe no tax, that's possible.

M: It's only 12 dollars.

L: Looks good.

M: [she flips the page over and looks over the earlier problems. Speaking under her breath] I don't know what this [both laugh]

L: Alright, thank you very much.

M: I mix up because I thought I will be multiplying [laughs] the tax

L: It's a big tip 34$

M: Yeah, it's a big tip and the total only is $12. Just add the tax. [Exhales] aaahhhh.

Interview with Student 5 – Jason

L: Okay, so I'm here with Student number 5, today is Thursday [J: 12th], August 12th, and it's 2: 02 in the afternoon. So, student number 5... How did you end up at Cartier?

Math Story

J: How did I induct?

L: How did you *end up* at Cartier?

J: Oh, how did I end up, oh, I need 436 to get into my program at LaSalle College.

L: What program are you going into?

J: Food Service and Restaurant Management

L: Food Service and Restaurant Management, okay. Is that, you need 436

J: [interupts] I need 426 [L: okay], so, I only had 416 and 514 so I came to come get my 436.

L: What high school were you at before?

J: P.C.H.S.

L: Pierrefonds Comprehensive?

J: [interrupts] Pierrefonds Comprehensive.

L: Okay. Did they uh, offer 436?

J: No it's not that it's because I did 416 and then... I didn't get... Like, the next year after, I had a choice to do it there [L: Okay], but then I did 514 instead of 436.

L: But why didn't you do 436 the first time?

J: Because if I wanna get my 536, I still need my 514, no?

L: Oh, I don't know. Some high schools have them as a like block classes. Like you don't have to take 416 and then 436. Sometimes you can just take 436.

J: Well, I did 416... maybe 'cause my grade wasn't high enough to go into 436 [L: Okay], or something like that. And, and I did 514. They told me the best thing is to come back and do it in summer school.

L: Okay. So you just graduated last year?

J: This year.

L: This year. [J: Yeah] Okay. And have you been accepted at LaSalle College? [J: Yeah] You're taking [J: Yeah] How, how are you as a math student? Like, how do you qualify yourself?

J: Um, I like math but... it depends. If I ... like, I like, I like math, but if I'm... like some days I'm just stubborn. I won't understand anything. But there's other days that I really want to ... like as soon as I understand one thing, then the rest of the stuff I have no problem. Like I'll understand the hard stuff, but the easy stuff will give me a hard time.

L: Okay. Do you find, like is it a personal mental block? Or is it just some days you can't concentrate?

J: [interrupts] No it's like a personal mental block. Like, if you were to show me like, if we were to do algebraic fractions before factoring, I would probably have understood that and then not fractions. [L: Okay] Just 'cause I'm like that.

L: Okay. Was it always like that for you in math?

J: No. Just like... just now actually.

L: Like how did you do in 416? 514?

J: Oh, 416 I passed with like 80. [L: Okay] And 514 I passed like 73.

L: Okay. Do you...Did you go to all your classes when you were at PC?

J: Yeah. For sure.

L: Okay. And that helps.

J: Yeah, big time.

L: Did you study a lot when you were there?

J: No. Never.

L: Have you been studying more or less for this class?

J: For this class? More. [L: more?] Yeah, 'cause... [L: It's intense] That and also that, I fell behind in the beginning, 'cause of all the work, so I had a *lot* of catching up to do. [L: Yeah] and then...

L: How many hours a week were you working?

J: Like a week? Like before? [L: Yeah] Like when we first started school? Oh, like, between 70 and 80, like [L laughs] a *lot* [both laugh] yeah, crazy hours.

L: So it's difficult to concentrate on math when you're working 80 hours a week.

J: Yeah, it's a family business so I don't have a choice, you know. It's like, we were stuck.

L: Okay. What's the family business?

J: It's a restaurant.

L: Okay, that's why you're going into Restaurant Management [J: Yeah] at LaSalle?

J: Yeah

L: Okay, it all comes together. [J: So] Okay [J: But...]

J: Like I had no time for nothing, you know? [L: Right] Like see now I can come in a stay 'till, stay 'till six. You know I've nothing to do. Like I took, I have my week off now. I told my father like that's it, you know? Like he understands also you know? Like, he didn't, he wasn't uh... he wasn't for the fact that I was working... you know, he wanted me to go to school. Like, thing is, he works night shift, so if I wasn't at work he'd work all night and all day. And I can't let that happen. [L: no] So. Yeah. So.

L: So, in a perfect world, how, what would you change? Clearly some of the work hours be on the list of things to change, but what would you change to make math more enjoyable, or more pleasant, or easier? What would help you out?

J: [long pause] You shouldn't change anything actually. [L: no?] I like math, it's it's fun. [L: yeah?] Like, I would enjoy going to math class because, it's one of those classes that I would pay attention in because if... it's one of those things if you don't listen you're screwed. Kind of thing. You know, not so much in the year, but like if you miss one class in the year you... the next class they're not that far ahead, you know? But here, you miss a class you're screwed, forget it. You're like, you're so like, you're... a month behind. So. I don't know, it's fun.

L: But if you, let's say like, if you had not had to work so much, that would have made it easier.

J: Yeah, a lot easier. I wouldn't be, you know, doing logic now. I probably would have time to study for...

L: So if you think, like, when you're gonna be in CEGEP are you gonna have to work those kinds of hours?

J: No, that's the thing. That was just, it was just like one of the, like then, it's never happened before, that you know like, it's just three guys, like we had to fire three guys, and then you know? Short staffed, and you just, it's hard to find employees, you know? Good ones that ... so. It was just for that week. [L: Alright] Hopefully it won't happen again.

L: Alright. So let's look at some problems. They're not bad problems, [laugh] and for a lot of people, the first two out of the logic section, for a lot of people these were far away, but you've been working on them now, so you might not find them so difficult. Give them a shot, see, how would you do number 1?

Problem 1 - Logic

J: See. This would be, I would be doing a truth table no?

L: Well, you just answer the question. Do whatever you need to do to answer the question.

J: [16 seconds]

L: Okay, so you've written down "I don't live on earth" is for 1a). I don't live on earth OR have 7 brothers. So what's the truth value of that statement?

J: What do you mean? Like what ah, this stuff?

L: Well, they're asking, what's the truth value of NOT p AND q.

J: Well, it's false.

L: It's false? Okay, so write that down. How would you check if that was right?

J: [5 seconds] I would do the truth table.

L: Okay, so check it and tell me if it's right. … No, just do it on the side, don't even mind b, we won't do b.

J: No? [22 seconds] This is true and true is true?

L: You decide. You've got your truth table; you're filling it out. This last one, this is for AND. [10 seconds] So let's just cross out b) so I know it doesn't go with b. Alright. So how is this truth table checking your answer?

J: Well, they're saying that, they're saying NOT p, so not p, I don't live on earth, and I don't have 7 brothers…

L: So you're saying the truth value of this whole thing is false, so where's your false in here [pointing to the truth table]?

J: This one probably. [Whisper] is it true? [louder] or isn't it? … We have all these to do? [Looking at the other questions on the sheet]

L: You can say, you don't have to pretend. You can say I have no idea. You whisper so the tape recorder doesn't hear you. [Laughs] Alright, so that's okay. So you have an idea. Do you still feel confident that false is your answer?

J: Yeah.

L: Okay. Would [coughs] on an exam like, would you have bothered to check? Or you just would have left the answer that you had originally.

J: Well *now* I wouldn't bother to check, but I'll know to check tomorrow.

L: Okay, do you usually check [J: No] on an exam.

J: No. No usually I just, if if I know, if I feel like an answer… no, even if I don't feel comfortable, I'm just, I'm just, I don't know, that's my problem, I go too fast. [L: Okay] Like I'm a person that [whistles low to high] You know like a… [L: Okay] don't check let's go. Wrong wrong right right. But bad, it's a bad problem.

L: Well, you get out of your exams early. [both laugh quietly] It's good to check. Make sure that you're doing things right. Or try

J: I fail faster if I don't check.

Problem 3 – Word Problem

L: Try 3.

J: [28 seconds] 9 fifths?

L: Oh, I'm sorry. I made this mistake on all of them and I'm supposed to change them. I mean 9 tenths. I'm sorry I'm sorry.

J: [18 seconds] [inaudible] [4 seconds]

L: Alright, so you've split the line into 10

J: 'Kay, then you do this, you have a ratio of 9 to 1

L: Okay.

J: It takes you 20 minutes, so then divide no? [20 seconds] It'd take her 18 minutes. She'd be 18 minutes there.

L: So how are you choosing 18?

J: 'Cause I did 20 divided by 10, which is 2...

L: Okay, why are you dividing by 10?

J: Because there's 10 sections, well 10, whatever, it's cut off it 10 [L: Okay]. She only walked 9 tenths, so there's still like 1 on 10 that she didn't walk [L: Okay], so 9 times 2 is 18. So she takes 18 minutes.

L: Alright, so write 9 times 2 so I know what you're doing. [4 seconds] Alright, so what was our question?

J: If she leaves her house at 10 am, at what time will she be 9 tenths ... so 10 so she should be at ten eighteen.

L: Okay.

J: Is it pm? No.

L: And then the last question? How [J: far will she have walked] far will she have walked?

J: 2 km so, [4 seconds] 2.8 km? [Whispers] Is that right? [Laughs] [4 seconds]

L: Well, how are you getting 2.8?

J: Wait. [10 seconds mumbling to himself] 2 divided by 10 is, 0.5 right? Can I use a calculator?

L: [laughs] You could use a calculator, but you could do it in your head too.

J: [5 seconds] point 5. [12 seconds] It's point 25. [10 seconds] Usually, I would just stop. [L: You would just stop. You quit] so let's say this was on 10, I'd estimate right there that I'd get 7

L: And you just stop?

J: I'd stop, and do something else, and come back to it in the end if I have time, if, I, I'd come back to at the end and [inaudible] [L: Really?] And you just come back to it, and you look at it again, and if on the second time I can't find it

L: That's quick to quit eh? Like a second into the problem.

J: It's not that. I wouldn't quit, I'd go and come back to it, and if again I can't find it, then, even using my calculator, which I don't have now... I'd just leave it; I'd take some marks, whatever it is

L: Okay, Alright, so tell you what, we'll come back to it. How's that?

J: It's good stuff.

L: Is that what you want to do?

J: No, it's alright.

L: It's alright, you don't want to come back?

J: It's good, it's good. I'll take the 7.

L: Okay, so say that 2 divided by 10 is point two five, if it was, let's just say your calculator told you that was right, what would you do next?

J: For the... it can't be point two five, 'cause then it would be, this would be a km, this would be another km, it'd be 2, but she lives 2 km away...

L: So you can tell that's wrong 'cause you're adding point two five for every piece [J: Yeah] and you run out of pieces... or you, you hit 2km before you're done with your pieces. So point two five is too big.

J: [12 seconds] it would be point 10, no, [11 seconds]

L: So what happens if you put point 10?

J: It's the same thing.

L: How many pieces do you get to if you put point 10?

J: 8, well not 8, 1, 2, 3, 4, 5, 6, 7, 8, 9...

L: So how far has she walked when she gets to 9/10ths?

J: [exhales deeply] UH! [Loudly] 2.5 km. [Quietly]That's my final answer. [Pause]

L: Alright. Now do you feel [interrupted]

J: Sorry, I'm not a good guinea pig Okay.

L: do you feel... NO, it's not a question of you being not a good guinea pig, do feel like that's right?

J: No, I know it's not right.

L: You know it's not right. Okay. Do you want to try to find something that's right or you just want to leave it...

J: No, I'm gonna leave it.

Problem 5 – Tipping

L: Okay. Alright, the last one I want you to do is this one here. It's not so bad number 5.

J: What's this (points to number 4)

L: Eh, we won't do number 4, number 4's long

J: [snorts] I'm going to a restaurant... [12 seconds] I'd leave 15 percent.

L: Okay, so how much would you leave?

J: Twelve-o-seven times one point one five. [no hesitation]

L: [pause] Okay , so what does that give you? Go get your calculator for this one.

J: 15 percent... [Long pause... beeping in the background while student scrolls through menus on his cell phone to access the calculator...mumbles to himself... more beeping.]
So that would give 13 point 88... [Long pause... more beeping.]

L: Okay, so you've done 12 point-o-seven times 1 point one five... [beeping] gave 13 point eight eight and now you're subtracting ... the total? Twelve-0-seven?

J: Yeah. [Beeping] from 13 eighty eight [L: Okay]... [Beeping]... so technically I should be leaving him a dollar and eighty once cents.

L: Okay, is that what you leave?

J: Is that what I leave? [L: yeah] Usually? [L: yeah] No... I ... usually I, well it depends. If the guy is like, you know? If like every time like I, it depends of the service.

L: Okay, if the service is just average.

L: It's just okay.

J: If it's okay and it's twelve bucks I'd give him fifteen.

L: Really? For just average service?

J: No. For just average service, he'd have to give me back a dollar, so I'd give him 2 dollar tip. But... if it was good, you know, fifteen tip.

L: Okay, alright, but this is your 'technical' tip is 1 point eight-one.

J: If the guy SUCKS yeah. [I laugh] You still have to tip you know, it's the law.

L: It's the law. Alright, that's great. Thank you so [interrupted]

J: Oh no, it's no problem

L: ... much

Interview with Student 6 – Moe

Friday August 13th 2004, 8:51 am

L: So how did you end up here at Place Cartier?

Math Story

M: I had the choice between eh coming to Cartier or Abbott and eh I chose Cartier because it was closer, it had eh they do the book; you finish a chapter, that's why I did it. And I have to write a final exam for it so I would do better without.

L: They had a final exam at Abbott?

M: Yeah they had a final exam over there. At Abbott they don't do chapter by chapter by chapter. They do all four chapters and then they make you write an exam.

L: okay. And you need... are you going to Abbott in the fall?

M: Yeah, I'm going to Abbott.

L: In what?

M: In September I'm going into Social [science] first and changing into business.

L: Okay. So did you need 436 to get into social?

M: Yeah I need 436 to get into Abbott.

L: Abbott period [M: yeah] okay. So where did you go to high school before this?

M: Ah.... In ah St Thomas but that was 2 years ago. Last year I was eh, I was in a mechanics program and then I came here 'cause I didn't want to do the mechanics anymore, I wanted to learn new stuff.

L: Where was your mechanics program?

M: It was at PC [L: okay] Pierrefonds Comprehensive [L: okay]

L: There's a lot of PC students in the class. So when you were in high school, what made you choose 416 [math] ?

M: What do you mean?

L: Like, why did you take 416 instead of 436?

M: 'Cause I had to. My marks weren't good enough for for 436.

L: What's the cut off? 'cause a couple of people have told me that?

M: I think if you get like 80 or above you can go into 436... something like that. I was always like in the 70s or something.

L: Okay. How do you feel about math, like, as a subject.

M: I was, honestly, really good at it at the beginning, and then, and then... I used to get 80s and 90s and now, and now [almost inaudible] no.

L: When did that start to turn for you?

M: Uhh [4 seconds] Sec [5 seconds then rushed] 2 or 3 I can't remember.

L: So shortly before 436. Was it like after word problems? I think they start word problems in grade 7.

M: Grade 7 that was when I was good. That was when I had a good teacher and I was doing really good. Grade 8 it wasn't too bad and then... actually grade 8 is when I failed because I had ahhh a really bad teacher and he basically told me don't worry you'll be fine, you'll be fine, you'll be fine. Just wait 'till this

you'll pass that and I never passed it. He kept on saying that to my mom also, he's like, don't worry, he'll do it he'll do it and then I'd be failing. So I'd have to redo it and I passed it, and from then on I was...

L: So did you have to repeat all of grade 8 or only grade 8 math?

M: Just the math. So I was behind a year in math. That's why when I finished high school I was in back, I was I had just done 416. [L: okay] instead of 514 [L: okay]

L: But you graduated high school?

M: Yeah. I didn't have my 514 or else I wouldn't have been able to get into CEGEP. It was either my 514 I take or I take 436. It's the same thing.

L: So you choose 436. [M: yeah] That's neat. That's really neat. Um. What would you... like in a perfect world, what would change about your math classes? Either your teachers, or the course, or the size of the class, or your study habits... what would you change to make it more enjoyable? Or have it go better for you?

M: To go better for me, I think there'd have to be like a smaller class. When there are a lot of kids, it's a lot harder to focus, you know on one person. Obviously it's harder to teach 'em. But uh ... I don't know, is it for me? Like basically for myself? [L: Yeah, for yourself] Study habits.

L: You don't study a lot?

M: I study, but I can't focus for that long.

L: How long can you focus for?

M: If I really want to study, I'm with someone to study, then it can be for an hour, 2 hours, but if I'm by myself ... I look at it for 1/2 an hour and then bam, I'll be like daydreaming out.

L: Okay, and then if you turn your attention away from it, can you come back? Like, how long of a break do you need before you can come back for another 1/2 hour?

M: If I go on a break, forget it. It has to be there... that's why I have to study with someone.

L: Okay, to help keep you

M: Yeah, 'cause as soon as I'm studying with someone I can we both focus on the same thing, you know we'll... have the person there to keep me ... I've studied with Mary Jo and Amanda for... a while...

L: Do you have a tutor?

M: Uh, I had one...

L: You're making a face

M: No he actually really helped me. I had big huge problem with algebra. Big problem with that. Like it would never click. It was like...

L: Well, and algebra is grade 8.

M: Yeah, never click, never, never, never, never, never. I'd failed it, I re-did it. I had him there and then all of a sudden wack click in my head and I was doing okay.

Problem 3 – Word Problem

L: So let's look at some problems. We're gonna jump right down to number 3 since a little bit short on time. So read it out and then let me know what you would do. Like how would you approach that?
(20 seconds)
You've gotta think out loud a little.
(8 seconds)

M: You have to do a line thingy?

L: You have to do a line thingy? [M laughs] Well how would you start it? There's no have to do there's just what would you do? How do you approach this?
(M: re-reads the problem 30 seconds)
L: So when you have a word problem, any word problem, how do you start it?

M: Write it down, the information.

L: okay, [4 sec pause] so what do you mean information? What information?

M: Uh... [Inaudible] stuff you use, like what time would she be nine tenths of the way to her friend's house? [Mumbles while he re-scans the problem - 13 sec] 10 a.m. [7 sec] you dissect this line into nine? [Looks at me for confirmation]

L: There's no have to, there's what you do. You tell me what you do to solve it.
[50 sec] Okay, so while you were writing, how many parts did you break it into?

M: [counts] 10 [counts again] 10.

L: 10 parts

M: and... [10 seconds] 9/10 of the way? [17 seconds]

L: alright, so you marked of 9 parts and 1 part. [M: exhales heavily - 17] What are you going to do with that information?

M: [almost inaudible] I'm trying to remember

L: What are you trying to remember though?

M: How to do it.

L: Is it that you've seen a problem like this? [15 seconds] Where would you have seen something like that? [42 seconds]

M: [almost inaudible] I don't know

L: So you wrote down 2 km and 20 minutes 'cause that's your information alright, so on an exam what would you do? You would just leave it like this?

M: No, hopefully not.

L: And it's okay if you say that you would, right. The whole idea is that there's no right or wrong, it's just you letting me know what you do.

M: I don't know.

Problem 5 – Tipping

L: Alright, that's great. Try 5. [19 seconds - M coughs - 4 seconds]

M: 15 percent?

L: So how much do you leave?

M: Calculator?

L: Noooo. How do you figure it out? You're at a table, you get a bill, no calculator, how do you decide?

M: I'd leave her a dollar fifty.

L: Okay, so write that down and then tell me why. [27 seconds] Well you were calculating something just there in your head. You were doing something?

M: Ehhhhh... I write out what I would do here? [L: Yeah] I would give 1 dollar [13 seconds] 50 cents

L: Alright, so why $1.50, how do you arrive at that number?

M: 'Cause... [6 seconds]

L: You're making a face.

M: What's this here? [Points to an item on the bill]

L: It's a random drinks or something, for 3 dollars.

M: So I wouldn't give him $1.50.

L: You wouldn't? [M: No.] What would you give him?

M: I'd add them together [pointing to the tax].

L: You're gonna add the tax?

M: Yes. [L: Okay] and give him that. [With confidence]

L: Okay. Why would you do that?

M: Why? 'Cause there was something I remembered my parents saying you give them 15% or something like that. The taxes. That's what you give them [He's breathing heavily, but his voice is relaxing as if the moment of "stress" has passed.]

L: Okay, so then write that down.

M: Wait. So what, the two numbers? What do I write down?
L: I don't know, you're telling me. You're giving her that and put a line next to it [I am pointing at the tax on the receipt]. So what's that?

M: So it's 33, 55, uh..[22 seconds] there you go.

L: Alright, so you're changing your mind and giving him $1.18?

M: Yeah. I'd round it to $1.25 [inaudible]

L: Well yeah, 'cause you're leave like 3 pennies [both laugh] alright. That's great, thank you so much.

Interview with Student 7 – Estelle

L: Today is still [August] Friday the 13th, it's 9:52 in the morning, and we're here with student number 7. How did you end up at Place Cartier?

Math Story

E: Uh, I came here last semester. The first time I came here was because I had failed math 436 in my high school and I needed to take 514 to get into CEGEP, so I came here to do 514. And now I need 436 to get into Nursing.

L: Okay. So how long ago were you in high school? Like plain ol' high school?

E: I graduated in 2000.

L: Okay, so a little while ago. How old are you?

E: 19

L: Okay, alright, it's confusing 'cause the rest of the class is like 17. So that's... you graduated high school 4 years ago, and did you go to CEGEP after you did 514 here?

E: Yeah. I've been in CEGEP for two years.

L: What have you been doing in CEGEP?

E: Social

L: Are you finished your DEC?

E: I'm finishing this semester, and then I'm going into intensive nursing because for intensive nursing you need to have finished all your general courses.

L: Okay, now when you took 436, what high school were you at originally?

E: McDonald high.

L: Okay, and did you do 416 before you *did* 436? *Or* you went straight to 436?

E: I went straight to 436 because.... I was one year behind in math, so I was told, if you pass your 436 it's equivalent to 514 so you can graduate with it... but I didn't pass it so I had to come here and take my 514. They told me to take my 514 because they said it was easier to pass my 514 then to pass my 436. So I graduated with that.

L: Okay. Did you do 514 in the summer here?

E: Yeah.

L: Okay. So what do you think went wrong for you in 436 at McDonald?

E: Um. I think I didn't have basic understanding of the material before [inaudible] because before 436 [inaudible] I was doing grade 9 math, or something like that. I just, I didn't have a good understanding of the material before I went into it. And then, it just, it was faster paced too.

L: Okay. Do you remember anything like specifically being a block or a wall for you?

E: It was every mostly everything... the only thing that I had, like I was okay with, was the geometry part. I was okay with that, but the rest, it just, it was hard. And I think also, at that point, I wasn't planning to go into nursing because I said 'oh I can't do it, you know, I'm a grade behind now, I'll just go into another field.' But then afterwards it was like 'I'm gonna work at it and I'm gonna get it', so then once I had that motivation I think that helped me.

L: Did you feel your grades weren't high enough in all of your subjects or was it specifically

E: No it was just math.

L: Okay. So do you like math or do you find it

E: I've always liked math when I understand.

L: When you understand.

E: When I don't understand and classes keep going, then that's when I start getting frustrated because I'm not understanding this and they're still trying to get to new material and that just....

L: So what do you do when you start to feel frustrated?

E: Most of the time I just sort of like 'Ah whatever' and I just stop doing homework and stop doing this because I'm not gonna understand even if I like sit down at home and try figure it, I'm not gonna understand

L: So do you... like if you could change anything to make the learning more enjoyable for you, like, what would help that out? That blocking and not wanting to continue?

E: I think that when I have trouble with the material I need to just stop and see what's going wrong. Make sure that I get rid of that problem, and once I figure it out, it's okay, then move on. It's the part that moving on when you don't understand something that's worse for me.

L: Would a smaller classroom help? Or would a tutor help?

E: Maybe being tutored, that would be better, not necessarily a smaller classroom.

L: Do you have a tutor now? [E: No] Have you ever had a tutor? [E: Yes] How was that?

E: It was okay. [L: Yeah] It helped a little bit, but it didn't help me pass my year. It didn't help 'cause I had a tutor to help me with my, studying for my exam in high school, but I still didn't pass it

L: Was it like for your final exam you brought in a tutor?

E: Yeah

L: Okay, so that was maybe, like, late, 'cause you're saying you want it sort of along the way.

E: Yeah. I know my sister was having difficulty in math and my mother got her a tutor that helped her every day after school [L: Okay] and, I mean, she's just doing great. So whatever material she doesn't

understand at the end of the day her tutor explains to her. And she's like 'Oh okay'. So she's just fine. I think that would help a lot

L: And do you have more math to do after this?

E: Nope, I'm only doing chemistry, which, I don't know exactly what Chemistry is, but I hear there's a bit of math in it.

L: There's a little bit of math yeah. Well any of the sciences

E: No, but I'm done after this. 'Cause I just need 436 for nursing.

L: And you've done 514? [E: Yeah] And you're not interested in 536?

E: No because I don't need it. [L: You don't need it] [Inaudible]

L: And how long is nursing.

E: I'm doing intensive so it's 2 years.

L: Is it at John Abbott? [E: Yeah] Yeah. Alright that's really cool. Thank you very much.

E: Okay

Problem 1 – Logic

L: We're gonna look at some questions, they're not so bad... you gotta skootch a little bit closer so I can see what you're doing. Um, the first two come out of the logic section, so that's a little bit further away. Uh, if you want to give just the first one a try, that would be great, but we're gonna focus on 3, and we're gonna focus on 5.
So do you want to try 1A and see if you remember any of that? I mean how would you approach this. [11 seconds] So how are you deciding?

E: what that is? [L: Yeah] I'm sort of trying to remember what the table looked like that you wrote on the board?

L: The table?

E: Remember you wrote, not the table but the, yeah the table where you're like 'NOT p and then it goes equal... NOT NOT p equals p' and then you wrote all the other ones?

L: Okay so you're looking at the list of rules for negation.

E: And this is NOT p AND q and I know the AND goes to an OR, and the NOT goes to both of them, so it's NOT p OR NOT q.

L: Alright, so do you have anyway of checking to know if that's true? [E: No] So on an exam, like what were you doing on the logic exam to know if your answers were right?

E: I didn't really have any, any check.

Problem 3 – Word Problem

L: Okay, try 3. [32 seconds] Alright so you gotta tell me what you're doing.

E: Okay. Here it says that if she leaves her house at 10 am, what time will she be nine tenths of the way, so I'm dividing this into 10 spaces [counts to check that she has 10], and I put a dot at the 9th part [L: okay]. So it's the 9/10th place and uh How far will she have walked? It takes her 20 minutes, so it would be 20 divided by 10. So that means she's doing... 2 minutes per part... yeah, 2 minutes per km, so how long will it take her to get back to there... It will take her 18 minutes to get there.

L: Okay, so write down how you're getting to 18 minutes. [11 seconds]

E: Okay, I divided, this by 10 and then it says... 2, Stacy lives 2 km... 20 minutes from A to B, so 20 divided by 10 is 2. And then, she walked 9 out of the ten what ever this is, so I did 9 times 2 [as she says 9 times 2 she writes 9x18, so I tap on the 18 hoping she will catch her mistake]... [Inaudible] it's taking her 18 minutes. How far will she have walked? [7 seconds] Why did you point this out?

L: 'Cause you wrote 9 times 18 but you said 2 when you wrote over it.

E: How far will she have walked though? Like they're not looking for the amount of time.

L: Well one of the questions is for time.

E: Okay, if she leaves her house at 10, what time... at 10 okay, so she'll be there at uh... [40 seconds] How far will she have walked? 2 km.

L: So you've written 10:18 she'll be 9/10 of the way. Alright, so how far has she walked, is your last question. [17 seconds]

E: I'd have to divide. It's 2 km from A to B... but I don't know how to, what each of these parts would be. No, I don't know. [Re-reads the problem - 37 seconds] No.

L: Okay so you would leave it like that? [E: Yeah] Do you have anyway of checking if your 10:18 is right?

E: No I don't.

L: Do you feel like it's right?

E: Yeah.

L: Like, how sure are you?

E: [inaudible] Pretty sure.

L: You're pretty sure?

E: Yeah.

Problem 5 – Tipping

L: Alright and let's try 5. It's the last one. [18 seconds]

E: For this one here? I would just leave the uh, you're supposed to leave 10 percent? 10 percent for the tip?

L: I don't know, I don't know how much you would leave.

E: No I'm saying the regular amount that we usually give is 10 percent, I believe. So I would just... [re reads the problem out loud] So I would add this up 1.65$, 1.95$

L: No calculator. This is just your bill; this is what they bring you.

E: Yeah so I would just add this up, I would calculate 10%, 10% of 12.07... [11 seconds] I would give that amount for the tip.

L: Okay, so what's that amount? [11 seconds]

E: I think it equals out to... 'cause 10% of 10$ is a dollar, I believe. I would give like $1.25 or something. I can't use a calculator?

L: No. 'Cause say you didn't have a calculator at dinner, you know what I mean?

E: I've got my cell phone though. I would calculate it on my cell phone [L: REALLY!?!] though.

L: oh my goodness, that's hilarious. I didn't even know, like um, one of the other students was using his cell phone to calculate stuff [E: You didn't know you could do that?] I don't have a calculator on my cell phone. [E: oh, that's funny].

E: Let's say I would just give 2$. Yeah, I'd just give 2$. I don't like tipping maybe 'cause I've never been a waitress. But I find everywhere you go these days, everyone expects a tip. Tim Horton's wants a tip, the gas station wants a tip, cab drivers want a tip...

L: You don't like tipping.

E: No I don't.

L: Do you consider 2$ like a big tip or a little tip?

E: Little tip.

L: What's like a huge tip, like if she was the best waitress you ever had, how much would you leave?

E: Maybe five?

L: On a 12 dollar bill?

E: Yeah

L: Thank you so much.

Interview with student 8 – Timothy

L: We're here with student number 8. It is Monday August 16th, at 9:51 am. Um, so how did you end up at Place Cartier?

Math Story

T: Um, in grade 7 I failed my 116 math, so in high school I was always a year behind in math, so I needed to make up the 436 or 514 or 536 whatever. Well not 536 but I need 436 to get 536 or something?

L: Right.

T: Yah so I graduated with 416, and I did 436 in the summer, hoping that I'd go to CEGEP on time with everyone else.

L: Okay, so, like when you were coming out of your grade 9 math into grade 10, what made you choose 416 as opposed to 436 right away?

T: It wasn't an option. I wasn't able to. My marks weren't high enough to go into 436.

L: Okay, what kind of marks do you need to go straight into 436?

T: I think... I think you have to be in enriched math in grade... like in grade 8. I think there's always... like in grade 7 I think it's like 116 then in grade 8 there's, I don't know what it's called, 214 or something like that, 2 something. And then, and then there's like maybe one higher like 216 or something like that I don't know, but you know, like there's always something higher. And if you're in grade 8 and you're in the higher math, and if you pass it, then automatically your into like 336 I think it's called, or and then they have 436. Something like that, I'm not really familiar with the numbers.

L: Yeah, okay so they split you as of grade 8?

T: Right. Or something like that.

L: And then what if let's say you're in grade 9 and you're doing okay, like do you need like an 80 to be allowed to take 436?

T: Maybe, you also need your teacher recommendation and stuff like that...

L: Oh yeah... so what kind of average did you get coming out of grade 9 math?

T: Grade 9 math I had to do it in the summer because I failed it, so I passed summer school with... I don't know, mid 60s I don't know, maybe 67 or so.

L: Okay, alright, so you got through okay [T: yeah] So how do you feel about math in general?

T: Ah, math comes a lot harder than me, TO me, than it does my family members, um, but it's not, I mean it's a challenge. Like sometimes people like challenges... I like it when I get, like you know, I like I you know, obviously when you finish it and your like 'Yeah', you know, and like, pat yourself on the back, 'yeah I rock', but... I don't like it at all, no.

L: Do you find, like is it... how does it compare to your other subjects?

T: It brings me down. It really does because I have great leadership skills, I was on student council and I was ... leadership grade 9 and 10 leadership classes and I mean, socially I'm great, and in English I'm okay, and all these other subjects I'm great... and math always drags my mark down. And and I could get that honor role but then, I'll fail a term in math or I'll get like a 60 or a 62 in math, and like only a 78 overall, and I'm like 'damn it'. [Laughs]

L: How about before high school, like in grade school, what was that like?

T: Um... I guess the same. I mean it's not like I just sparked and became bad at math, I mean I was always not that strong.

L: Okay. Do you find, is it like your computational skills, multiplying and dividing, like is that not too bad?

T: I think it's, yeah, that I'm okay with. I mean you do it so often that it kind of stay in your head so you know like 3 time 7 is 28 I MEAN 21! [Both laugh] So funny.

L: Alright, um and then OH, and what high school were you at?

T: Riverdale high school in Pierrefonds.

L: Okay. Um AND, in like ah perfect world, what would you change about I don't know, maybe your environment, at home, or your school environment, or your classroom, or your peers or your study habits, like what would you change to make math easier, but also more enjoyable?

T: Um, at home wise, I think I'd like my father to be home more often 'cause he's an accountant and he works very very hard to make sure he's first eh, from the top, you know. Um, and he's great at math, so maybe his help could have improved my math skills and my math you know marks and stuff. Um, school wise, I've been to tutors, I've been to and I've stayed behind. I mean, I'm the kind of student that will stay behind 'cause you know like, if you need help and the teacher offers, I will do that. But I mean, I had a tutor, this summer I had a tutor so my problems I'd take to the tutor, you know. But I've had a tutor all my life, and when I needed it I had more. Would I change? Well maybe I'd, well maybe I wouldn't be as lazy. Maybe I'd you know, buckle down and do my work better than I do now. [Laughs]

L: Alright, did you always have a tutor only for math? Or have you had tutors for other things?

T: I've had a tutor for History, Science and Math. So I failed my history but then I did it, my supplemental, and did really well. [L: okay] Great tutor I had, really good. Science this time wasn't that good. My tutor wasn't as great but what can you do?

L: And what's your plan coming out of, let's say, like when you leave here? You're taking 536 next semester?

T: I'm taking 436 physical science.

L: Okay.

T: And, hopefully, knock wood I will be at Dawson in January... and now that I'm applying again, I can change my mind what I want to do. I have to really, either I want to do interior design, or I want to work with... I want, like autistic children or children with Down syndrome, because, they're so, like, I see my uncle and he's so cute. [Both laugh.] He's so fun that I want to, you know, I want to understand them better, you know.

L: What does your uncle have?

T: My uncle is... mentally challenged. He is, well they used to call it retarded, and he has the mind of a 5 year old. [L: okay] and he's forty... forty four, forty five maybe. [L: That's cool] Yeah, he's really nice.

L: That's really cool. Okay, alright. So let's try... let's try some problems. Um, start with number 3, 'cause the first problems on here came out of the logic section of the course, so we can, depending on how... there are two problems I want to look at, so we'll do 3 and 5, and then depending on how we're doing, we'll see if we have time. You'll decide if you want to do any of those.... You've gotta think out loud a little bit, or the recorder won't hear you.

Problem 3 – Word Problem

T: Okay. [14 seconds] Okay so this is relations?

L: Well what are they asking? It's just how would you do it, how would you approach... [T: How would I do it?] yeah, like how would you approach the problem? [14 seconds]

T: Nine tenths? Oh, okay, so this is um, um um um um, I forget what it's called... It's like a number line, right? And you have your dots?

L: However you want to solve the problem is how you do it. [17 seconds]

T: So you can't even help, you can't tell me anything, what to do right?

L: No

T: Good help Laura [both laugh - 5 seconds] This is what you taught us... so...

L: So what are you doing? You're breaking it up?

T: I'm breaking the line up into 10 parts. [L: okay - 6 seconds] I'm making the line a little bigger [12 seconds] So this would be... Stacy right here right? [puts a dot - 10 seconds] Oh, okay so, Stacy's house is here, she walks, we want to find out this distance.

L: Okay, so you've put a dot um

T: Nine tenths of the way to her friend's house.

L: Okay and you're saying we want to find the distance between, and then you pointed to Stacy's house and the dot that you put.

T: Right

L: Alright, so how are you going to do that?

T: Not quite sure... I mean, it's not, I mean, this is actually solvable?

L: Yeah

T: okay

L: It would be mean if I gave you a problem you couldn't solve.

T: I'm trying to remember. This is your A over B or something. Your ratio? I don't even remember. I would, like my approach, like my initial approach, I thought it was um relation and you know how you could solve with the graph like that [L: okay?]... I forget how, it's like it's like the form y=ax uh, mx+b. But it's uh, I don't know. So all of this is 2 km, so [24 seconds - reading] She leaves her house at 10 am. It takes her 20 minutes... So it's 20 minutes in total to get to her house. But you want to know how long it takes to get nine tenths from her house... [10 seconds] You do 20... x... this is so wrong... nine over ten? [6 seconds] It's for sure wrong, but let's try it. It's pretty dirty. [9 seconds] [Inaudible] do my long division.

L: Alright, so you've cross multiplied [T: mhm], and that gave you 9x times... equals 10 times 20? You're dividing by 9, so you're isolating your x [T: right]. Alright,

T: So, 9 goes into 20 two times... 18... that's 2, you bring down the zero... so now, ou, I'm sorry, that's a zero, okay, that's another 2 times... 18... remainder 2... so that's point 2... I don't remember how to do long division; I used my calculator so many times... I don't know if that's right. But that doesn't make sense.

L: Why doesn't it make sense? [8 seconds]

T: It doesn't make sense because it takes... your looking for the minutes right? [L: okay] and if it takes 20 minutes to get to her house... it shouldn't take 22 point 2 minutes to get nine tenths to her house...

L: okay, so what could have gone wrong? How are we going to fix it?

T: The way I ... this is completely wrong but... like the equation [points to ratio setup]

L: So you don't like the ratio. So what what could you change about the ratio?

T: [barely audible] I don't know

L: Just a second. [Paused the tape because we were interrupted by someone looking for another teacher]

T: Um, I'm not quite sure how to do this. [7 seconds] and I'm sure it's really easy once this tape is over and you show me how to do it. [Laughs]

L: Well, you think you know what's wrong right? You've decided that there's something wrong with the ratio.

T: Right. I mean, it doesn't make sense, at all. And it's two questions, 'cause it's 'at what time will she be nine tenths of the way to her friends house' and 'how far will she have walked'. You know she's walked uh, nine tenths of the way so I mean, you want that in kilometers right?

L: mhmm. [10 seconds] So what would you do, like if it was a test question? Would you just leave it knowing that it's wrong?

T: I wouldn't leave it, but I would leave it and come back to it. And then I'd try it again, but something some word or something's supposed to probably pop up at me and I'm not seeing it. [10 seconds - reading] It takes her 20 minutes to walk to her house. To her friend's. If she leaves her house at 10 am, at what time will she be nine tenths of the way to her friend's house? [9 seconds] I really don't know.

L: Okay, so let's leave it and come back.

T: Okay.

L: 'Cause that's what you would do.

T: I would do that.

Problem 5 – Tipping

L: Try number 5. [T reads the problem silently 15 seconds]

T: I'm really cheap. [L: laughs] I'm very cheap um. Normally what I'd do is I'd add up the taxes. This is just like not even mathematical wise. Like, this is what I do is I add the taxes because the tax is 15% right? [L: okay] and you're supposed to leave the tip 5 % right?

L: Okay. If you say so, so how much would you leave?

T: I would, ohhho this is cheap. So she wasn't that good of a waitress eh?

L: She was just a waitress.

T: Friendly? Not even? Eye contact? [L: laughs] That's what I look at. [8 seconds] I don't think I'd leave... it comes out, 'k you take your two takes of the TPS and the TVQ, which is point 55 and point 63. It comes out to a dollar and 18 cents. I wouldn't give her that. I'd probably would either round it to a dollar fifty or two dollars.

L: Okay

T: But you want this mathematically? Or just logically?

L: No, well, I want to know how much you would leave. So this is how you get like your ballpark range. Like, you've added up your taxes

T: I would probably give her a dollar fifty because at dinner, normally I'd give 2 dollars 'cause I'm really cheap, but I'd probably give her a dollar 50 because this looks like, it looks like a really... 'Nibbler', I would never know what that is.

L: [laughing] I think it's a sandwich.

T: okay, so this is probably lunch.

L: yeah, probably. Well what does it say in the problem? It says breakfast.

T: OKAY. Well break... okay well then breakfast yeah, chances are they'll be working the rest of the day so they'll, my tip won't even matter [laughs].

L: Alright, so write your answer then.

T: Okay.

L: And that'll be your answer.

T: Right.

Problem 3 – Word Problem Continued

L: Alright, we're coming back. [I flip the page back to number 3]

T: Back to the dirty.

L: What do we do?

T: I don't... know. [9 seconds]

L: Well, how long would you work on a problem before you decide

T: To give up? [L: yeah] I don't, it depends how much the question's worth. Because if it's worth like 20 marks like that God awful test was [Algebraic Fractions], then I'd spend, like, a million days on it. [laughs] But this, I don't know. Say it's worth like 5 marks, I'd probably spend like 7 to 10 minutes on it.

L: okay. And then how do you decide if it's right? How do you usually check?

T: Well, I would check using, I mean I would check using the method the teacher re...no requires but you know like informs us to use. Like you informed us to use FOIL [First Outside Inside Last - for double distributivity to check factoring] to check our answers to um... Algebraic fractions or FACTORING, when you factor out. I would use that. Or um... multiply out and see if you find out... yeah, kind of stuff like that. Stuff you taught me to do during the day.

L: Alright, and then here you used a little bit of logic for yourself to decide if that was right. You're saying it doesn't make sense.

T: It doesn't make sense at all. It looks pretty dirty, and I haven't used long division in the longest time. Like I'm talking like grade 8 uh grade 9. I didn't have my calculator when I was in that grade. [13 seconds] I'll be killing myself when you tell me how to do it. It's easy isn't it.

L: It's not... it's not a question of easy, honestly. I mean, it's just a question. It's a question and you approach it how you approach it and that's all I'm looking at. You're not being graded.

T: Well that's for sure. [10 seconds] I'm sure it's some... okay. [12 seconds] You know what, it can't be relations problem because normally what it is is your... I'm thinking of systems? When you have your two equations and you find where they meet... you're solution sets. And it can't be relations only because Stacy is the only one leaving and walking to her friend's house. It's no like another one of her friend's are leaving five minutes after her and when will they and when will they end up meeting. You know? So chuck the relations idea. It's something different. Like you taught us this in 436 right?

L: It's just a word problem. It's not like... we looked at some ways that you could solve it, but there are many paths, there are many solutions.

T: We didn't even do this too long ago. This was um straight lines or something? Don't be discouraged. I did learn something in your class.

L: There's no discouraged. There's only problem solving, no worries. [13 seconds]

T: I really don't know how to approach this. I mean, I thought that... you don't flip it do you? I remember how to flip it, but you only flip it when it's like um you're looking for "M" one equals one over "M" two or "M" two... you're looking for the equation then you flip it. See, I did learn something didn't I? [7 seconds] [Inaudible]

L: Look, and I mean, you gave it a go.

T: I did, I feel bad for your professor if he's going to listen to this... It's pretty dirty...

L: So you want to call it?

T: I'm gonna call it quits. 'Cause it's not worth anything.

L: Alright. Thank you very much.

APPENDIX B

Questionnaires

Words serve as window to the world.
We do not see the words.
We do not see the glass
We look through both ... for truth

Age: 35
Student 1

Questionnaire 1.A

(DO NOT WRITE YOUR NAME ON THIS QUESTIONNAIRE)

1. Male ☐ Female ☑

2. Occupation: Unemployed
   a. Work hours/week: _____
   b. Do you currently pay rent? Yes
3. Parent's occupation: _____

4. Birthplace: St. Vincent, West Indies
5. Parent's Birthplace: Same
6. Languages Spoken: English
7. Languages Written: English

8. What other classes are you taking now?
   only Maths

9. Where will you be studying or working in the fall? (2 months from now)
   Place Cartier

10. Describe your emotional state (how you were feeling) while writing this exam.
    tense

real
60%*
D

11. Estimate your grade on this exam: 85

12. The easiest part of this test was:
    The first part (logic)

13. The hardest part of this test was:
    relations

Age: 17
Student 2

Questionnaire 1.A
(DO NOT WRITE YOUR NAME ON THIS QUESTIONNAIRE)

1. Male ☐ Female ☒

2. Occupation: Cashier
   a. ~~Work~~ hours/week: _____
   b. Do you currently pay rent? NO
3. Parent's occupation: Airplane tape salesman (VP of company M.T.I)

4. Birthplace: Quebec
5. Parent's Birthplace: Ottawa and ?
6. Languages Spoken: French and english
7. Languages Written: French and english

8. What other classes are you taking now?
   None

9. Where will you be studying or working in the fall? (2 months from now)
   Hopefully at John Abbot College in a correctional course

10. Describe your emotional state (how you were feeling) while writing this exam.
    I was very nervous because math is definitly one of my weaker points.
    → one of my stronger students

11. Estimate your grade on this exam: 60-70

12. The easiest part of this test was:
    Making truth tables and finding the solution set, also, the arrow diagrams.

13. The hardest part of this test was:
    Set notations, and multiple choice.

Age: 18
Student 3

Questionnaire 1.A
(DO NOT WRITE YOUR NAME ON THIS QUESTIONNAIRE)

1. Male ☑ Female ☐

2. Occupation: student
   a. Work hours/week: /
   b. Do you currently pay rent? /
3. Parent's occupation: Mother - housewife
   Father - Door Maker
4. Birthplace: Sri Lanka
5. Parent's Birthplace: " "
6. Languages Spoken: English
7. Languages Written: English

8. What other classes are you taking now?
   nothing

9. Where will you be studying or working in the fall? (2 months from now)
   C.N.C operator

10. Describe your emotional state (how you were feeling) while writing this exam.
    kinda of nervouse

11. Estimate your grade on this exam: 60-70

val 79% *

12. The easiest part of this test was:
    T/F tables

13. The hardest part of this test was:
    negation

Age: 41 y/o

Student 4

Questionnaire 1.A

(DO NOT WRITE YOUR NAME ON THIS QUESTIONNAIRE)

1. Male ☐ Female ☑

2. Occupation: _____
   a. Work hours/week: _____
   b. Do you currently pay rent? _____
3. Parent's occupation: _____

4. Birthplace: PHILIPPINES
5. Parent's Birthplace: PHILIPPINES
6. Languages Spoken: ENGLISH, "TAGALOG"
7. Languages Written: ENGLISH, "TAGALOG"

8. What other classes are you taking now?

_____

_____

_____

9. Where will you be studying or working in the fall? (2 months from now)

PLACE CENTER

_____

_____

10. Describe your emotional state (how you were feeling) while writing this exam.

_____

_____

_____

_____

100

58 * 11. Estimate your grade on this exam: AS L

5) 12. The easiest part of this test was:

[illegible]

USUAL DIAGRAM, TENTH TABLES

13. The hardest part of this test was:

CONVERSION GRAPH BY INVERSE

_____

Age 17

Student 5

Questionnaire 1.A

(DO NOT WRITE YOUR NAME ON THIS QUESTIONNAIRE)

1. Male ☒ Female ☐

2. Occupation: Manager of A restaurant on Crescent
   a. Work hours/week: between 50 & 65 hours
   b. Do you currently pay rent? no
3. Parent's occupation: entrepreneurs

4. Birthplace: Lebanon
5. Parent's Birthplace: Lebanon
6. Languages Spoken: English, French, Arabic, Spanish, Italian
7. Languages Written: English, French, Arabic

8. What other classes are you taking now?

   None

9. Where will you be studying or working in the fall? (2 months from now)

   studying and working

10. Describe your emotional state (how you were feeling) while writing this exam.

    I was not ready for this test I kept getting interrupted this weekend while I was studying

11. Estimate your grade on this exam: 33%

12. The easiest part of this test was:

    none, maybe the back part

13. The hardest part of this test was:

Age:

Student 6

Questionnaire 1.A

(DO NOT WRITE YOUR NAME ON THIS QUESTIONNAIRE)

1. Male ☑ Female ☐

2. Occupation: _____
   a. Work hours/week: 30 hr
   b. Do you currently pay rent? NO
3. Parent's occupation: Mom cooks, Architect → u know what im talking about..

4. Birthplace: Montreal
5. Parent's Birthplace: Montreal
6. Languages Spoken: English
7. Languages Written: English

8. What other classes are you taking now?
   NONE!! Thank GOD!

9. Where will you be studying or working in the fall? (2 months from now)
   John Abbott

10. Describe your emotional state (how you were feeling) while writing this exam.
    Wasn't Feeling well at all Felt like screaming at someone as well as breaking something... (Just Joking)

11. Estimate your grade on this exam: 50 %

12. The easiest part of this test was:
    Answering NAME

13. The hardest part of this test was:
    From Question 1 to AHHHH 15

100
99% *

)

Age, 17

Questionnaire 1.A

(DO NOT WRITE YOUR NAME ON THIS QUESTIONNAIRE) Student 8

1. Male ☑ Female ☐

2. Occupation: student
   a. Work hours/week: _____
   b. Do you currently pay rent? _____
3. Parent's occupation: Couture accountant, Nurse

4. Birthplace: Montreal
5. Parent's Birthplace: Montreal, Budapest
6. Languages Spoken: english / french
7. Languages Written: english / french

8. What other classes are you taking now?

   none

9. Where will you be studying or working in the fall? (2 months from now)

   Dawson College, interior design

10. Describe your emotional state (how you were feeling) while writing this exam.

    Extremely nervous. Not all that confident.

11. Estimate your grade on this exam: 60 ← hopefully

12. The easiest part of this test was:

    the answer diagrams. And those were not so easy either.

13. The hardest part of this test was:

    Everything else.

Age: 17

Questionnaire 1.A

(DO NOT WRITE YOUR NAME ON THIS QUESTIONNAIRE)

1. Male ☐ Female ☒

2. Occupation: Retail
   a. Work hours/week: 15 hours
   b. Do you currently pay rent? no
3. Parent's occupation: _____

4. Birthplace: Canada, Montreal
5. Parent's Birthplace: Canada,
6. Languages Spoken: English, French
7. Languages Written: English, French

8. What other classes are you taking now?

   none

9. Where will you be studying or working in the fall? (2 months from now)

   at Centennial College

10. Describe your emotional state (how you were feeling) while writing this exam.

    Nervous

11. Estimate your grade on this exam: 50

12. The easiest part of this test was:

    Truth table

13. The hardest part of this test was:

    AVR: / C

Age: 16

Questionnaire 1.A

(DO NOT WRITE YOUR NAME ON THIS QUESTIONNAIRE)

1. Male ☐ Female ☑

2. Occupation: none
   a. Work hours/week: none
   b. Do you currently pay rent? no
3. Parent's occupation: _____

4. Birthplace: Canada
5. Parent's Birthplace: Canada
6. Languages Spoken: Italian, english, French
7. Languages Written: english, French

8. What other classes are you taking now?

   none

9. Where will you be studying or working in the fall? (2 months from now)

   I donno

10. Describe your emotional state (how you were feeling) while writing this exam.

    a bit nervous but re-read the questions and got through it ok.

11. Estimate your grade on this exam: 70

    final 92 *

12. The easiest part of this test was:

    The truth tables

13. The hardest part of this test was:

    The (AUB)C stuff

Age: 17

Questionnaire 1.A

(DO NOT WRITE YOUR NAME ON THIS QUESTIONNAIRE)

1. Male ☐ Female ☑

2. Occupation: Student
   a. Work hours/week: ——
   b. Do you currently pay rent? ——
3. Parent's occupation: Air Craft manager/engineer
4. Birthplace: Sri Lanka
5. Parent's Birthplace: Sri Lanka
6. Languages Spoken: Tamil / English
7. Languages Written: English

8. What other classes are you taking now?
   None

9. Where will you be studying or working in the fall? (2 months from now)
   John Abbott College

10. Describe your emotional state (how you were feeling) while writing this exam.
    Nervous & Anxious

11. Estimate your grade on this exam: 65-70

12. The easiest part of this test was:
    *1

13. The hardest part of this test was:
    *14, 15 *

Age: 17

Questionnaire 1.A

(DO NOT WRITE YOUR NAME ON THIS QUESTIONNAIRE)

1. Male ☐ Female ☑

2. Occupation: Day Care
   a. Work hours/week: 18
   b. Do you currently pay rent? no
3. Parent's occupation: father: printer
   mother: office / cloroxof canada
4. Birthplace: Canada, Que
5. Parent's Birthplace: Canada, NB + Italy
6. Languages Spoken: English, French, Italian
7. Languages Written: English, French,

8. What other classes are you taking now?

   none

9. Where will you be studying or working in the fall? (2 months from now)

   John Abbott

10. Describe your emotional state (how you were feeling) while writing this exam. :|

11. Estimate your grade on this exam: 63%

final 75% 2)

12. The easiest part of this test was:

    T, F and venn diagram

13. The hardest part of this test was:

    set builder notation

Age: 17

Questionnaire 1.A

(DO NOT WRITE YOUR NAME ON THIS QUESTIONNAIRE)

1. Male ☐ Female ☑

2. Occupation: working at my dad's company
   a. Work hours/week: 16-18
   b. Do you currently pay rent? No
3. Parent's occupation: Mom: house w

4. Birthplace: Canada, Montreal
5. Parent's Birthplace: India, Delhi
6. Languages Spoken: English, Hindi, French
7. Languages Written: English, French

8. What other classes are you taking now?

9. Where will you be studying or working in the fall? (2 months from now)
   Hopefully John Abbott, I don't think I'll be working

10. Describe your emotional state (how you were feeling) while writing this exam.
    Confident, but a bit scared that I wont pass because I'll feel as though I can't accomplish anything without a tutor or aid since I had none except for you.

cal
6 * 11. Estimate your grade on this exam: 60-65
59 60.5
5

12. The easiest part of this test was:
    the begining

13. The hardest part of this test was:
    the end

Age: 16

Questionnaire 1.A

(DO NOT WRITE YOUR NAME ON THIS QUESTIONNAIRE)

1. Male ☒ Female ☐

2. Occupation: Chef prepat pizzaline, "cook" at Mcdonalds
   a. Work hours/week: depends normally over 20
   b. Do you currently pay rent? nope
3. Parent's occupation: Father is a Engineer (architech) at Bombardier
4. Birthplace: Orangeville (guesse where that is)
5. Parent's Birthplace: Mom in Canada, Dad in Germany
6. Languages Spoken: French, English
7. Languages Written: French, English

8. What other classes are you taking now?
   none

9. Where will you be studying or working in the fall? (2 months from now)
   B.H.S
   still going to be working

10. Describe your emotional state (how you were feeling) while writing this exam.
    Confused

trial
39 * 11. Estimate your grade on this exam: 90-65 %

1525 12. The easiest part of this test was:
   arrow diagrams

·4.5

13. The hardest part of this test was:
    question 8 was hard

Questionnaire 1.A

(DO NOT WRITE YOUR NAME ON THIS QUESTIONNAIRE)

1. Male ☐ Female ☑

2. Occupation: Caregiver in Seniors Home
   a. Work hours/week: 20-40
   b. Do you currently pay rent? No
3. Parent's occupation: Mother at home, father R.C.M.P

4. Birthplace: Quebec
5. Parent's Birthplace: ~~Mother Birth~~ Quebec
6. Languages Spoken: French, English
7. Languages Written: " "

8. What other classes are you taking now?
   None

9. Where will you be studying or working in the fall? (2 months from now)
   John Abbott

10. Describe your emotional state (how you were feeling) while writing this exam.

11. Estimate your grade on this exam: 60%

12. The easiest part of this test was:
    arrow ~~dog~~ diagram of Cartesian product

13. The hardest part of this test was:
    All the rest

Age: 17

Questionnaire 1.A

(DO NOT WRITE YOUR NAME ON THIS QUESTIONNAIRE)

1. Male ☐ Female ☑

2. Occupation: WORK + School
   a. Work hours/week: 34 h/week
   b. Do you currently pay rent? NO
3. Parent's occupation: WORK

4. Birthplace: Canada, Qué
5. Parent's Birthplace: Canada, Qué + Italie
6. Languages Spoken: English, French, Italien
7. Languages Written: English, French

8. What other classes are you taking now?

   None

9. Where will you be studying or working in the fall? (2 months from now)

   John ABBOTT

10. Describe your emotional state (how you were feeling) while writing this exam.

    Concentrated + trying to remember the material

cal
99 * 11. Estimate your grade on this exam: 75

3) 12. The easiest part of this test was:

    #1

13. The hardest part of this test was:

    last question

Age: 17

Questionnaire 1.A

(DO NOT WRITE YOUR NAME ON THIS QUESTIONNAIRE)

1. Male ☐ Female ☑

2. Occupation: unemployed
   a. Work hours/week: _____
   b. Do you currently pay rent? no
3. Parent's occupation: bombardier quality controle, Avon Canada Sales rep.
4. Birthplace: Montreal
5. Parent's Birthplace: Montreal
6. Languages Spoken: English
7. Languages Written: English and French

8. What other classes are you taking now?
   no other classes

9. Where will you be studying or working in the fall? (2 months from now)
   John Abbott college

10. Describe your emotional state (how you were feeling) while writing this exam.
    I felt confident writing this exam, I understood the material and didn't find the exam too difficult

11. Estimate your grade on this exam: 85%.

12. The easiest part of this test was:
    Truth Tables and the negation problem

13. The hardest part of this test was:
    remembering what numbers were multiples or prime for the proportional forms

Age: 17

Questionnaire 1.A

(DO NOT WRITE YOUR NAME ON THIS QUESTIONNAIRE)

1. Male ☐ Female ☑

2. Occupation: _____
   a. Work hours/week: _____
   b. Do you currently pay rent? _____
3. Parent's occupation: _____

4. Birthplace: Toronto, Canada
5. Parent's Birthplace: Sri - Lanka
6. Languages Spoken: English, french, tamil
7. Languages Written: english, french

8. What other classes are you taking now?
   nothing

9. Where will you be studying or working in the fall? (2 months from now)
   place cartier -> studying

10. Describe your emotional state (how you were feeling) while writing this exam.
    relaxed, felt like I knew most the stuff except the number lines

11. Estimate your grade on this exam: 65-75%

12. The easiest part of this test was:
    all the truth tables.

13. The hardest part of this test was:
    number lines

Age: 18

Questionnaire 1.A

(DO NOT WRITE YOUR NAME ON THIS QUESTIONNAIRE)

1. Male ☑ Female ☐

2. Occupation: _____
   a. Work hours/week: Before Summer 40 - 45 hours
   b. Do you currently pay rent? _____
3. Parent's occupation: Comany Owner.

4. Birthplace: Montreal
5. Parent's Birthplace: Can.
6. Languages Spoken: ENG - Ocn.
7. Languages Written: ENG - Fren

8. What other classes are you taking now?

None.

9. Where will you be studying or working in the fall? (2 months from now)

Hopefully Dawson. ?

10. Describe your emotional state (how you were feeling) while writing this exam.

So fen good., Tired., then I got hungry. then slightly Full, now hungry for some more food. Peace out.

11. Estimate your grade on this exam: Between 70 - 75 min 65 worst mark ever.

12. The easiest part of this test was:
(T, F) mostly Logical.

13. The hardest part of this test was:
Small things I really didn't have to pay attention too. Key parts.

Age: 17

Questionnaire 1.A

(DO NOT WRITE YOUR NAME ON THIS QUESTIONNAIRE)

1. Male ☒ Female ☐

2. Occupation: Student
   a. Work hours/week: _____
   b. Do you currently pay rent? No
3. Parent's occupation: Father (Sales man)
   Mother (Crafter)
4. Birthplace: Montreal
5. Parent's Birthplace: Montreal
6. Languages Spoken: English, French
7. Languages Written: English, French

8. What other classes are you taking now?

   None

9. Where will you be studying or working in the fall? (2 months from now)

   John Abbott College

10. Describe your emotional state (how you were feeling) while writing this exam.

    Nervous

11. Estimate your grade on this exam: 70

    20/20 = 100%

12. The easiest part of this test was:

    the truth tables

13. The hardest part of this test was:

    Question 8 with the ven diagram

APPENDIX C

Sample Consent Form and Interview Problems

To plant seeds of knowledge
And believe that, one day,
They will burst into colorful bloom –
That is the faith of a teacher.

"Teachers Touch Tomorrow"

CONSENT TO PARTICIPATE IN RESEARCH

This is to state that I agree to participate in a program of research being conducted by Laura Gauthier under the supervision of Anna Sierpinska of the Department of Mathematics & Statistics of Concordia University.

PURPOSE

I have been informed that the purposes of the research are as follows:
To study and better understand problems experienced by adults in learning mathematics.
To design mathematics pedagogy and curricula better suited to adults.

PROCEEDURES

I am aware that I will be interviewed about my work in mathematics tests, and that this interview will be tape recorded. The tapes will not be used in conference presentations of the results of the research. In paper publications, fragments of conversations transcribed from the tapes may be used, for example, to illustrate a particular way of learning, but the identity of the participants will not be disclosed (codes will be used instead of names, e.g. Student 1, Student 2, etc.).

CONDITIONS OF PARTICIPATION

I understand that I am free to withdraw my consent and discontinue my participation at anytime without negative consequences.
I understand that my decision to participate or not to participate in the study will have no impact on my course grade.
I understand that my participation in this study is confidential.
I understand that the data from this study will be published.
I understand the purpose of this study and know that there is no hidden motive of which I have not been informed.

I HAVE CAREFULLY STUDIED THE ABOVE AND UNDERSTAND THIS AGREEMENT.
I FREELY CONSENT AND VOLUNTARILY AGREE TO PARTICIPATE IN THIS STUDY.

Name (please print) _____

Signature _____

Witness signature _____

Date _____

Interview Questions

1) If p is true and q is false, determine the truth value of the following:

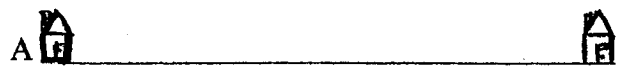
p: I live on earth
q: I have 7 brothers

a) $\neg(p \wedge q)$ b) $\neg(p \vee q)$

2) A = { 3, 6, 7, 8 }
B = { 7, 8, 9 }
U = {0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10}

Find $B \cap A'$

3) Stacy lives two kilometers from her friend's house. It takes her twenty minutes to walk from her house to her friend's. If she leaves her house at ten am, at what time will she be nine fifths of the way to her friend's house? How far will she have walked?



Stacy's house Friend's house

4) Perform the following multiplication:

$$\frac{Z^2 - 49}{2Z^2 - 13Z - 7} \times \frac{2Z^2 - 13Z - 7}{Z + 7}$$

5) You go out to a restaurant for breakfast and have to pay the following bill at the end of your meal. How much would you leave as a tip for a waitress who served you well, but not especially so?

*** INVOICE ***

TABLE #9

POP/JUICE/NAYA	1.65
SIDE SOUP	1.99
NIBBLER	4.25
MISC.FOOD N/TX	3.00
T.P.S.	.55
T.V.Q.	.63
SUB-TTL	12.07

TIME 13:21 9/7/2004

APPENDIX D

Program Flowchart

Mathematics, to be sure, is also subject to changes of taste. But a theorem, correctly proved within the severe constraints of logic, is a theorem forever.

-William Dunham

"Journey Through Genius"

THE PROGRAM FLOWCHART