

**MATH ANXIETY AND DEDUCTIVE REASONING AS FACTORS
IN CAREER APPRAISAL**

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THEORETICAL AND CONCEPTUAL BACKGROUND – LITERATURE REVIEW

CHAPTER 1: INTRODUCTION

Perry (2004) has stated that math anxiety is an extremely common phenomenon among the youth of today. In addition, since South Africa became a democracy in 1994, socioeconomic and government schooling systems have changed dramatically and no research has been done in terms of the attributes and appraisals that result in career choices being made by grade nine pupils. This outlook has encouraged this research to be conducted. The following quantitative and qualitative study will address math anxiety and deductive reasoning as factors that may affect appraisal of career attributes in grade 9 pupils.

As time goes by, our world is becoming more and more mathematically and technologically advanced and the necessity to encourage youngsters to choose mathematics as a subject they will take to Matric and use in future careers, increases drastically. This can be attributed to the fact that technology is advancing at an unprecedented rate and as a result, young children's confidence in their ability to do mathematics becomes even more important.

If this goal is not achieved and secondary education institutions do not strive for mathematics excellence in their institutions, those students who truly believe that they cannot succeed in math, will often stop trying to learn this subject at an early age and will choose career paths after high school that allow them to avoid the subject as much as

possible (Stolpa, 2004). As a result, these children will never fulfill their highest potential (Stolpa, 2004).

Deductive reasoning in terms of verbal reasoning is just as crucial to a child's future career choice as this reasoning is integral in one's ability to perform mathematics (Perry, 2004). Through this research study, both parents and teachers/educators of children should be encouraged to attempt to address math anxiety and deductive reasoning, to realize that it does exist in the classroom and home life and address the issue in a manner that will facilitate a child's career choice as one that best suits his or her potential. This in turn will aid in avoiding situations that may arise, so poignantly highlighted by Perry (2004). Through his qualitative research, Perry has captured the essence of these issues. He has made reference to a pupil by the name of "Jason" who has stated,

"I am not thrilled about math and quite frankly it frustrates me. I have come to find that I have a math anxiety. All the formulas and methods to do different kinds of problems are mind boggling."

In the same vein, Perry has referred to John Allen Paulo's' book, "Innumeracy",

"Some of the blame for the generally poor instruction in schools must lie with the teacher who is not sufficiently capable and has too little interest in mathematics."

One can also suggest that parents may also be partly if not fully responsible for a child's math anxiety if they make statements to the effect of,

“When I was your age, I was useless at mathematics. It is such a difficult subject. We must make sure you attend extra math classes to ensure you succeed in math. After all, it is crucial for your future career, you will have such limited options if you do not have math as a Matric subject.”

In reviewing this research study, one must take heed of the fact that besides the ability to reason deductively and besides a math anxiety, gender, race and possible prior poor education may also influence a future career choice. Such issues have also been addressed in the results of this study and discussion of them will be left to the relevant chapter in this thesis.

This study also will demonstrate the fact that in terms of career appraisal, it is interesting to note how the careers that were posed to the students are perceived so differently, attributed with either requiring a high/low math skill or having a high/low status in society. The discussion chapter of this thesis will also address this issue for one may assume that students may feel worthless if they themselves have low math ability and engage in a career that requires little math skill, one which they may associate with having low status in society.

As this phenomenon of math anxiety has been proven to exist through various authors, researchers and studies, the literature review that will now follow will also deal with preventing the phenomenon or suggesting methods for coping with it or eventual elimination of the anxiety. This in turn would facilitate the encouragement to reason deductively and thus may influence a child to choose the correct career that compliments his or her ability and fulfills his or her maximum potential in life. At this stage it is vital to mention that math anxiety can distort career attributes and lead to false closure of career opportunities. It is the relationship between math anxiety and deductive reasoning and the effect these variables may have on career attributes and appraisals that is measured in this study, not career choice.

CHAPTER 2: ANXIETY AND MATH ANXIETY

When a psychologist states that a person is anxious, one can interpret this in two ways. Firstly, that the person is an anxious person (constant condition with no time limitation) or secondly, that the person is anxious at that particular moment in time and thus the anxiety is immediate (Levitt, 1967).

Anxiety may also be defined as, “The tense anticipation of a threatening but vague event; a feeling of uneasy suspense” (Rachman, 1998). One must not confuse fear with anxiety, as they are very different. Fear involves a specific focus of threat and there is an understandable connection between threat and fear. Fear is episodic and declines with the removal of the threat. Bodily sensations of an emergency are evoked and the offset of fear is detectable (Rachman, 1998). Anxiety on the other hand involves an elusive source of threat and has an uncertain connection between anxiety and threat. It is prolonged and has an uncertain onset. Anxiety is persistent and has no clear borders. One experiences a threat that is seldom imminent and bodily sensations of vigilance are evoked (Rachman, 1998).

An individual who experiences a certain anxiety such as “math anxiety” may be said to experience acute anxiety as this is a situational anxiety and thus the anxiety may occur when the person is exposed to situations of having to work with numbers. This is vastly different to an individual with chronic anxiety, who would experience anxiety in many different situations and more frequently than his/her peers (Levitt, 1967). Thus the math

anxiety prone individual would experience a situational anxiety or transitory state, which occurs in response to a stimulus and is likely to vary in intensity as a function of the stimulus, characterized by a variety of associated physiological reactions (Levitt, 1967).

There are many ways that people who face any anxiety can deal with this anxiety. Such defense mechanisms have been investigated by Freud, who spoke of keeping the feeling of anxiety from coming into consciousness (Levitt, 1967). The reason why people may adopt such defense mechanisms is to preclude the awareness of thoughts or impulses that would be anxiety provoking (Levitt, 1967). In terms of mathematics anxiety, defense mechanisms such as avoidance and somatization could be operationalized. Avoidance would occur as a means of avoiding stimuli and circumstances that arouse it (Levitt, 1967). If a student studying mathematics, acknowledges the anxiety-provoking properties of the stimulus or situation, this may inhibit his/her ability to work with numbers (Levitt, 1967). Rachman (1998) stated that, if an individual uses avoidance, this is indicative of a certain type of anxiety – panic. This type of anxiety can occur with or without agoraphobia (the fear of the market place and now used as the fear of being around people). However, in terms of this study, one would assume that a student with a math anxiety would experience panic without agoraphobia. Somatization may occur in a basic sense in terms of emotional reactions (anxiety), being reflected in physical symptoms (Levitt, 1967). This may explain why in some circumstances, individuals partaking in a mathematics test may not perform as well as they wished to. In addition, it may explain why certain individuals who are highly prone to mathematics anxiety may be absent on the day that a math test needs to be written.

The Yale Theory

The Yale theory of Mandler and Sarason (1952) can substantiate the literature of Rachman (1998) and Levitt (1967) as they express that anxiety is a strong learned drive, which is situationally evoked. A particular circumstance or class of circumstances may be stressful for a person though he/she is not made anxious by other situations. Individuals may react differently to the same circumstance. Secondly, the individual has learned or developed characteristic responses to anxiety, which is brought with the individual to the current situation. These reactions may be task-irrelevant and thus tend to disrupt performance. Such an example is the fear of failure. This may also be task-relevant as the individual may experience a reduction of anxiety by completing the task successfully. The effects of anxiety may also be a function of the educator's attitude and the meaning of the task as perceived by the individual. Such factors are said to be of greater significance than the difficulty of the task or the like. Lastly, it is proposed that one must first study and place emphasis on situational anxieties before investigating a general trait of anxiety (Levitt, 1967).

In accordance with the Yale theory, Oner (1977) has provided literature. Oner provides one with insight into teaching anxious children and the educator's role and technique as impacting on the learning process of such children. Several studies have been carried out that observe the interpersonal relationship between anxious students and educator behaviour. Through this research, it has been proposed that the most effective educator

behaviours for facilitating learning are personal warmth, regard for the student, freedom and flexibility in the learning situation and clarity in academic and social expectations (Oner, 1977). In many circumstances, the pupil's anxiety level was a function of how they perceived their educator (Oner, 1977).

Schwartz (2000) has also proposed ways to minimize or even eliminate math anxiety in students. Some of these techniques that Schwartz proposes is working on attitude. The educator should put him or herself in the students place and try to remember how intimidated some pupils may feel about learning math (Schwartz, 2000). An obstacle that Schwartz mentions is the fact that students may not have been taught to think critically or deductively and may be able to memorize formulas but may not understand the underlying concepts or basic structure on which to build a foundation for mathematical reasoning (Schwartz, 2000). One must bear in mind that the process of developing critical and mathematical analysis is often more important than being able to deduce the correct solution to a math problem.

Secondly, Schwartz has stated that mathematics is the universal language. The students must learn the language of math, which involves not only definitions and vocabulary but also symbols and notations. The educator must facilitate this learning by finding a way to present the math terminology in the language of the student (Schwartz, 2000). If students cannot verbalize their way through a mathematics procedure, they cannot apply the necessary techniques for problem solving. In the South African context, the notion of language is of vital importance as students whose home language is not English, may

experience a heightened anxiety as the educator, teaching in English (if the school is English), would provide the students with rapid and complicated explanations of procedures (Schwartz, 2000). This does not affect this research-both schools are English.

Lastly, the notion of “taking tests” is mentioned as a means of reinforcing math anxiety in students, who are tested on math skills that they may think they are fluent at but still score average marks. This may lead to frustration and reinforcement that they are not good at math (Schwartz, 2000). However, one must bear in mind that on the part of the student, it would be counterproductive to blame a teacher or textbook for their math anxiety. The student should rather look to a second source for assistance (Perry, 2004). At this stage, one must take the concept of math anxiety into account as a variable that could affect preconceived ideas of careers and thus the child’s future career decision.

Math Anxiety

Tobias (1978) defines math anxiety as a feeling of “sudden death” (Stuart, 2000). Stuart (2000), states that math anxiety is an obsession with the idea that “everyone knows that I do not understand and I should not draw attention to myself by asking questions” (Stuart, 2000, p.330). Math anxiety usually arises from a lack of confidence when working in mathematical situations. After observing several very math-anxious students, Stuart conducted a survey to identify where her fifth graders fit into the continuum of math confidence. She researched how their own attitudes and those of the people around them

affected her student's confidence levels and maybe their view of the world and career opportunities.

Her aim was also to investigate what teaching methods worked best for her pupils and turn math into an enjoyable activity and help students overcome their math anxiety. She conducted this research qualitatively through surveys and quantitatively through questionnaires. The survey questions allowed the students to select an answer and justify their choice, judge their parents feelings about mathematics and other tools looked at the effectiveness of manipulative and comparative groups as learning tools. She used a sample of twenty-two female and twenty-five male students from nine to twelve years of age and separated the results of her analysis in terms of gender as most research on mathematics competence focuses on gender. Eleven of the students were gifted in this sample and seven qualified for special education services. This may be a flaw in her research as she had the knowledge of the educational levels of a large portion of the sample, which could skew results, as the competence of all of the participants should rather have been unknown. She found that students, who believed they were not good at mathematics, performed poorly and visa versa. Manipulatives as a learning tool were reported to be helpful among the majority of respondents and most appreciated the opportunity to work in cooperative groups. Stuart also reported that most students viewed their experience of mathematics separately from any influence their parents may have on them and their perceptions of the discipline. Stuart was also able to help the pupils focus on their strengths rather than weaknesses and realize the wide variety of the use of math in all spheres of life. Her research resulted in substantiation of the following Chinese

proverb and is relevant to the context of this research study as it substantiates the fact that when math anxiety is eliminated, pupils will be more receptive to the discipline on the basis that they understand math and thus have a good deductive reasoning, boding well for future careers that they may chose that allows them to achieve their maximum potential in life and be involved in a career that they love rather than being persuaded away from it due to a math anxiety. The Chinese proverb says, “Tell me mathematics and I forget, show me mathematics and I may remember; involve me... and I will understand mathematics. If I understand mathematics, I will be less likely to have math anxiety and if I become a teacher of mathematics, I can thus begin a cycle that will produce less math anxious students for generations to come” (Stuart2000).

Buckley and Ribordy (1982), defines math anxiety as “An inconceivable dread of mathematics that can interfere with manipulating numbers and solving mathematical problems within a variety of everyday life and academic situations” (Furner and Duffy, 2002,p.68). Perry (2004), defines math anxiety as, “An inability by an otherwise intelligent person to cope with quantification, and more generally mathematics.”

Bower (2001) has found that by the age of 12 years, children who feel threatened by mathematics start to avoid math courses and if they do partake in mathematics, their performance is rather poor. Many people think that children, who have a small math aptitude, dread dealing with numbers but Ashcraft and Kirk reported that this is not the case as peoples intrusive worries about math temporarily disrupt mental processes needed for doing arithmetic and decreases math competence (Bower, 2001). It is proposed that

math anxiety exerts this effect by making it difficult to hold new information in mind, while simultaneously manipulating it. This capacity is known as working memory and is responsible for dealing with numbers (Bowers, 2001). This statement begins to draw a link to the cognitive aspect of this research in terms of deductive reasoning. Earlier studies by Geary have also linked math anxiety to physical symptoms of increased heart rate and worry (Bower, 2001).

Oberlin (1982) found that several common teaching techniques cause math anxiety. Such techniques included assigning the same work for everyone, teaching the textbook problem by problem and insisting on only one correct way to complete a problem (Furner and Duffy, 2002). Many math educators have also agreed that a student's math anxiety is often as a result of fears of failure and feelings of inadequacy (Perry, 2004). However, math anxiety may not only stem from a classroom situation in terms of what the educator does but also from the student's home life. This is substantiated by Furner and Berman (2003), who state that the child's parents may have a negative attitude about math or limited experience with math and this may be projected on to their children. In addition, it is stated that socioeconomics may play a role if the parents come from a low socioeconomic background and may not have had sufficient exposure to math or sufficient experience with it to promote a positive math attitude within their children (Furner and Berman, 2003).

Many researchers view math anxiety as a subject-specific manifestation of test anxiety (Ho, Senturk, Lam and Zimmer, 2000). Two theoretical models of test anxiety exist – the

interference model and the deficit model. The interference model propose that examination anxiety interferes with students' recall of prior learning, whereas the deficit model deduces that poor performance is attributed to poor study habits or test-taking skills and this in turn leads to a high anxiety (Ho et al, 2000). Test anxiety also incorporates a dimensionality aspect in terms of work completed by Liebert and Morris (1967), who state that test anxiety has two factors. These are "emotionality" and a cognitive worry dimension of test anxiety. Affective test anxiety refers to the emotional component of anxiety and thus feelings of nervousness, tension or fear to testing situations and cognitive anxiety would refer to the worry component of anxiety in terms of preoccupation of thoughts about an anxiety-causing situation (Ho et al, 2000). Students may also be confident when they are being taught the work but when having to apply the theory in a test, they may tend to forget most of the concepts and as a result, panic may occur (Perry,2004).

Gardner and Math Anxiety

As mentioned by Schwartz (2000), mathematics is termed as the universal language and as a result, at this juncture, Gardner's (1979) model of second language learning should be mentioned as he views math as a second language that is learnt by an individual according to an attitudinal-motivational construct. Gardner identifies four individual difference variables that are expected to directly influence the degree of success that one will have in acquiring a second language (math in this context): intelligence, language aptitude, situational anxiety and motivation (Lalonde and Gardner, 1993). In this model,

there exists an obviousness that intelligence would influence the extent to which any subject matter is learned, be it math or anything else. The other components should be looked at more intensely. Language aptitude is the ability that allows for language learning and thus also mathematical aptitude would be a special ability, influencing the understanding of math (Lalonde and Gardner, 1993). Gardner has described situational anxiety as anxiety reactions that are evoked in situations involving the second language. Math anxiety is a form of situational anxiety and math may be seen as the “second language”. In terms of motivation and attitude, this refers to the student’s motive as an attitudinal-motivational construct, including the student’s motivation to learn. (Lalonde and Gardner, 1993).

To draw a comparison between math anxiety and learning a second language, one must keep in mind the limitations that exist in terms of anxiety playing a greater role in the prediction of performance in math than in a second language. In addition, math anxiety most likely begins in childhood and may only be aroused when beginning math classes and till then remain dormant. The distinction to be made is that Gardner’s model of second language learning and the proposed model of learning math is that Gardner treats situational anxiety as independent from aptitude, while the opposite is true in terms of the math model being proposed here. Situational anxiety is expected to be negatively related to math aptitude if math anxiety is due in part to an individual’s performance history in mathematics (Lalonde and Gardner, 1993). Although this theory will not form part of this research study, a component of it, being that of situational anxiety is discussed further in this chapter as a factor that may provoke and produce math anxiety in school children.

One also expects that situational anxiety will be related to attitudes and motivation, involved in learning math, as well as to performance in math (Lalonde and Gardner, 1993). This statement has received some empirical evidence in research on second language learning by Gardner (Lalonde and Gardner, 1993).

Gender, Race and Math Anxiety

Students may have a math anxiety that has been provoked by negative racial or gender stereotypes that may lead them to believe that as a result, they cannot perform in mathematics (Perry, 2004). Perry (2004) stated that studies have shown however, that males and females are equal in terms of intrinsic mathematical ability. It would be absurd to propose the notion that race or gender results in one being mathematically incompetent. It could be beneficial to students if both parents and educators remind them of this fact. As will be noted in this research study, no relationship existed between math anxiety and gender, supporting this notion but interestingly enough, in the South African context, race plays a part in math anxiety levels as black students are less anxious than Caucasians. One could attribute this to culture.

Tapia and Marsh II (2004) investigated the relationship of math anxiety to gender, using the Attitudes towards Mathematics Inventory (ATMI), which consisted of forty items designed to measure student's attitudes towards mathematics. They used 134 undergraduate students, enrolled in mathematics at a state university. Seventy-one subjects were male and fifty-eight were female. Their age ranged from 17 to 34 years of

age and 80% of the sample was Caucasian, only 20% were African-American. Their results also yielded that no relationship existed between gender and math anxiety and their claim substantiates the results that follow in this research study. Interestingly enough they found that in terms of attitude, those who performed better in mathematics exhibited more positive attitudes towards the discipline. Differences were noted though in terms of attitudes of girls as younger girls (age 13 and below) were more negative regarding mathematics than older girls. Attitudes such as these are concomitant to Marzano's Dimensions of Learning Model (1992) that is based on the premise that students must have good attitudes and perceptions toward learning before real learning can occur (Furner and Berman, 2003). As a result, students with a good attitude regarding math will be more likely to truly understand the concepts and develop confidence in their ability to perform mathematical operations (Furner and Berman, 2003). Age thus may have a significant effect on math anxiety as opposed to gender.

Some suggestions may be put-forward for educators to prevent or reduce math anxiety. Firstly, educators should accommodate for different learning styles of pupils and create for a variety of testing environments. Positive experiences should be designed in the math class and the educator should refrain from associating self-esteem with success in math. An emphasis should be made that everyone makes mistakes in mathematics and that math is relevant in daily life. An emphasis should also be placed on the importance of original, quality thinking rather than rote manipulation of formulas. Math should be characterized as a human endeavor (Furner and Berman, 2003).

Furner and Berman (2003), state that educators have to almost take on the role of counselor to help lower or overcome math anxiety. This can be done by systematic desensitization, or even relaxation techniques in conjunction with repeated positive messages and visualizations. Educators need to help the student identify how their math anxiety began and as Tobias (1987) suggests, one must recognize when the panic starts, identify the inactiveness in their analytic and retrieval systems and clear up the static without ceasing to work on the problem (Furner and Berman, 2003).

Parents also must play a part in this process by being empathic towards their children and encouraging them in terms of their mathematical ability. Parents should also ensure homework is done and try not to help their children to solve problems but rather guide them to the correct procedure of tackling the problem, being more concerned with the process of doing math rather than achieving the correct answer (Furner and Berman, 2003).

In Summary

This chapter has dealt with anxiety in terms of viewing the phenomenon as an anxious person or someone who is anxious in a certain context or situation. Fear and anxiety have been covered and distinguished on the basis that fear is due to focusing on a threat and is episodic, declining when the threat is removed. Anxiety on the other hand is due to an elusive threat and is a prolonged experience, occurring from an uncertain onset and is persistent in nature. Math anxiety has been introduced as a type of situational anxiety.

Methods of coping with anxiety have also been alluded to in terms of avoidance and somatization as defense mechanisms. Mandler and Sarason's (1952) Yale theory has also been discussed in terms of anxiety as a strong learned drive that is situationally evoked.

Furthermore, the educator's role in provoking and eliminating math anxiety has been reviewed. This has been detailed in terms of the educator projecting his or her own incompetence of math by not being able to answer a pupils question or solving a problem. The notion has been put across that educators should offer more freedom in the math classroom and put forward clear expectations of the pupils. Test taking has also been discussed as a factor that may provoke a math anxiety. Schwartz's (2000) propositions of eliminating math anxiety were discussed in terms of having a positive attitude and teaching pupils to think deductively and critically as well as understand the work as math is proposed as a universal language and one has to learn the symbols and notation, not only the vocabulary and definitions. Math anxiety has been defined by Perry (2004), as an inability to cope with math and this chapter has discussed the research conducted by Stuart (2000) in terms of attitudes towards math, parental perception, enjoyment of math and teaching techniques. Causes of math anxiety have been stipulated by referring to Oberlin (1982) regarding textbooks that always insist on one correct answer to a math problem or teachers and their influence on pupils. Although Stuart's research states that parental influence on children regarding their perceptions and experience of math is unrelated, Furner and Berman have discredited this in their own work.

Ho et al (2000), have pointed-out the difference between the two models of test anxiety in terms of the deficit model and interference and Gardner has been referred to as proposing math as a second language whereby intelligence influences the extent to which subject matter is learned. Gender and race have also been mentioned as having no effect on math ability and Tapia and Marsh II's work has been documented in this regard. Prevention and reduction of math anxiety has also been covered in terms of the educator's role in accommodating different learning styles, offering different environments for testing to take place and not associating math ability with a pupil's self-esteem. Furner and Berman (2003) have stated that the educator must act in the capacity of a counselor and aid the pupil to reduce or eliminate his or her math anxiety through systematic desensitization. Tobias (1987) has proposed that one ought to identify how the anxiety began and recognize when the panic starts as well as identify inactiveness and clear up the static without pausing to work on the problem at hand.

This chapter's literature is of the utmost relevance to this research study as all of these factors and theories help to explain the notion of math anxiety and its causes and effects on the child. This is vital to allow the reader of this thesis to have a solid grounding and comprehension of one of the most vital variables of this study. Now that this has been achieved, the next chapter will look at the second variable of the study- deductive reasoning because of the relation that is assumed to exist between math anxiety and mathematical deductive reasoning, leading to the fact that high math anxiety may result in low deductive reasoning and visa versa. It is at this stage that the link should also be made known that due to math anxiety, one's perception of career attributes may be highly distorted and as a result, individuals with a math anxiety may shy away from any and all

careers that involve math and may perceive such careers in a negative light, leading to a premature misconception that those careers may just not be an option for them to engage in, in the future. This statement though should be seen in a speculative light and this research study should provide some clarity in terms of this statement as the study is investigating the appraisals of various careers by school children and whether their math anxiety or lack of anxiety has some weight in affecting such appraisals of careers to guide future career choice. This also provides reason as to why deductive reasoning is to follow this chapter as this reasoning is vital for one to learn math and perform well in this discipline.

CHAPTER 3: DEDUCTIVE REASONING

One can state that without deductive reasoning, mathematics would not exist. It is this vital that one understand that in order to have the ability to do math, deductive reasoning is necessary as a tool to allow the individual to have the math ability. Reasoning is a process of thought that yields a conclusion from percepts, thoughts or assertions (Poltzer and Bourmaud, 2002). Reasoning is also a systematic process and thus, by deductive reasoning, one refers to deduction as yielding valid conclusions, which must be true given that their premises are true (Poltzer and Bourmaud, 2002). An example as stated by Johnson-Laird is that of a test that is reliant on a turbine to rotate fast enough for the test to continue. If the turbine is not rotating fast enough, the test is not to continue.

To measure deductive reasoning, which is necessary for mathematical reasoning, verbal as opposed to non-verbal reasoning has been proposed by Vosloo, Coetzee and Claasen (2000) and as a result, the proposed instrument- DAT test 2, has been utilized to measure this. Verbal reasoning investigates the ability of one to complete word analogies and solve general problems requiring logical thought, which is a valid indication of one's general reasoning. Non-verbal reasoning on the other hand rests on the assumption that the ability to see relationships between figures and by analogy, to identify an appropriate missing figure is a valid indication of an aspect of non-verbal reasoning ability. A distinction should also be made between deductive and inductive reasoning.

Deduction as opposed to induction can be defined as the direct application of knowledge in the production of new knowledge but the new knowledge does not represent any new semantic information (AI, 2004). Deductive reasoning is also a valid form of proof and allows one to make conclusions based on previously known facts (Spark Notes, 2003). Within a mathematical framework, explanation –based learning is a means of teaching deductively as this is a means of analytic learning that has an integral deductive mechanism, requiring only one single training example of a concept before the individual grasps that concept. Although this concept of deductive reasoning seems rather simple, it does have faults. When deductive reasoning leads to faulty conclusions, the reason is often attributed to the fact that the premise was incorrect. This is significant as the premise is the most important part of the entire process of deductive reasoning (Spark Notes, 2003). If the premise is faulty, the foundation of the whole line of reasoning is faulty and nothing can be reliably concluded- even if one conclusion is incorrect, those that follow are unreliable and may very well be incorrect too (Spark Notes, 2003). Furthermore, deductive reasoning may prove faulty if it is not executed properly (Spark Notes, 2003). Deductive reasoning is operationalized in mathematics as one always is proving that certain rules/ generalizations always hold true – such as using rules or theories or even formulas for calculating surface areas of objects and the like (Annenberg, 2004).

Inductive reasoning however, results in the addition of semantic information (AI, 2004). Annenberg (2004) defines inductive reasoning as a process of generating data from specific cases of a problem, keeping an organized list and looking for patterns in the data,

thereby making a generalization. Inductive reasoning thus simply put, is a process of making and justifying a conjecture based on what we have observed (Annenberg, 2004). This means of reasoning however, is not a valid method of proof – a person may observe a number of situations in which a pattern exists but this does not mean that the pattern is true for all situations (Spark Notes, 2003). As far back as John Stuart Mill (1843), a philosopher, proposed a paradigm whereby positive instances of some phenomena that have a common trait identify that trait as indicating some larger commonality and similarly, negative instances that differ for some trait from the positive instances are also indicative of a crucial feature (AI, 2004). Within inductive reasoning, acquisition as a technique can be used but this technique is limited in a mathematical context as it generates labels for objects and labels objects so one can associate the object with the relevant operation (AI, 2004).

As deductive reasoning is a means of drawing conclusions from premises, if one looks at a mathematical proof, this is exactly what they are – deductions, strung together into long chains (Reid, 2002). The kind of deduction that educators are most likely to come across is that of specialization. Specialization is determining something about a specific situation by applying a general rule that pertains to the situation (Reid, 2002).

Deductive reasoning though can be divided into certain categories, each of which illustrates the necessity of deductive reasoning in order to have the ability to do math confidently and avoid a math anxiety.

Simple deductive reasoning is one of these categories. This is a one- step deductive reasoning, in which the reasoning is a single deduction from two or more premises and differs from specialization as this involves only one premise (Reid, 2002). Simple one-step deductions are the building blocks of proving but need to be assembled into chains to make a proof (Reid, 2002). Reasoning with chains of deductions is called simple multistep deductive reasoning (Redid, 2002). Due to the emphasis of mathematics in the child's education, from early elementary mathematics, the child will display simple multistep deductive reasoning while solving problems involving math (Reid, 2002).

However, it is not always possible to reason from mathematics proofs, leading to category two of deductive reasoning, the use of hypotheses instead- something that is not known to be true (Reid, 2002). This reasoning is done to show that something cannot be true or that if it were true for one number it also would be true for the next number (Reid, 2002). As this reasoning involves hypotheses, so it is termed as "hypothetical-deductive reasoning". Although this is a more advanced type of reasoning, one can also observe it from elementary school in both one-step and multistep forms (Reid, 2002).

Rationality and Deductive Competence

Rationality has a fundamental paradox in that naïve individuals may err in tests of deductive reasoning yet achieve their goals in daily life, provided that they have no prior training in logic (Johnson-Laird, 1999). One reaction to this paradox is that psychological tests do not reflect a human's competence even though they may be wholly

rational. Deduction though is not tractable and as the number of premises increases, any system of reasoning will eventually run out of time and memory before it reaches a conclusion (Johnson-Laird, 1999).

Logic may also be termed as the wrong normative theory as it may permit inferences that no sane individual is liable to draw. Such inferences are valid although their conclusions are less informative than their premises. In logic, if a conclusion follows a premise, no subsequent premise can invalidate it but in terms of human reasoning, subsequent information can undermine a deduction (Johnson-Laird, 1999).

A further reaction to the paradox of rationality is dichotomizing rationality into a tacit competence for coping with life's problems and a conscious mechanism for normative reasoning (Johnson-Laird, 1999). Sloman (1996), links this dichotomy to associative and rule-based thinking and by doing so, this allows for sense to be attributed to both competence and incompetence in life and the laboratory but as a weakness, it may accommodate too much (Johnson-Laird, 1999). Throughout this chapter one should bear in mind that the importance of this literature in terms of the research study at hand is to provide for a clear understanding as well as a broad overview of deductive reasoning as it was stated in the beginning of the chapter that deductive reasoning is vital for math ability and the ability to learn math to take place.

Theories of Deductive Performance

The notion that deductive performance depends on formal rules is pervasive and goes back to the ancient doctrine that laws of logic are the laws of thought (Johnson-Laird, 1999). Such a statement was championed by Piaget and underlies many current psychological theories such as Rips (1994) and Martin Braine (1998). Rips's theory is implemented through a computer programme called Psychology of Proof (PSYCOP) and has rules for sentential connectives, such as "if" and "or" and for quantifiers such as "all" and "some". This theory is based on a method in logic known as natural deduction, having rules for elimination of sentential connectives such as: If A then B $\rightarrow$ A therefore B (Byrne, 1996). What is interesting to make mention of here is the inference-rule hypothesis that would have a large bearing on deductive reasoning in mathematics as a student calculating a mathematical equation would perform the task, having a set of rules for the task in his/her mental logic (Byrne, 1996). Testing for the presence of such rules in one's logic is difficult as a student may fail to make inferences of the mathematical equations and the reasons can be numerous. Either the student may not know how to apply the rules or he/she may be using alternative rules or the rules may be unavailable and the student cannot gain access to the rule (Byrne, 1996). The problem is that due to the ambiguity of distinguishing between whether a person possesses the rules and the availability of the rules, may undermine the falsifiability of reasoning and this is a problem in terms of deductive reasoning (Byrne, 1996). It is through PSYCOP that Rips proves that deductive reasoning is the core of cognition (Byrne, 1996).

A further theory of deduction is based on mental models that postulate that reasoning is based on manipulations of mental models representing situations as opposed to syntactic derivations from logical forms (Johnson-Laird, 1999). If deduction depends on models, then the process is semantic because their construction from discourse depends on meaning and knowledge. Each model represents a possibility, and its structure and content capture what is common to the different ways in which possibility may occur. Such an example may be when individuals understand a conjunction such as “There is a triangle and there is a circle”, they represent its meaning from which they can construct a mental model of the situation to which it refers- o represents a circle and A represents a triangle (Johnson-Laird, 1999). This theory gives a unified account of deductions about what is possible, probable and necessary. A fundamental assumption of the theory is that of the principle of truth as individuals minimize the load on working memory by tending to construct mental models that represent explicitly only what is true and not what is false (Johnson-Laird, 1999).

The two dominant accounts of deductive reasoning underlying mechanisms are based on the rules and on models, which allows for distinction that demonstrates the contrast in logic between “proof” and “model” theory (Johnson-Laird, 1999). Rule theorists are impressed by the automatic ease with which one makes inferences and they formulate rules that correspond to these elementary deductions. In contrast, model theorists state that reasoning is just the continuation of comprehension by alternative means and they notice that arguments are seldom laid out as proofs and that public reasoning is often

dialectical (Johnson-Laird, 1999). Both theories have protective advantages and both have testable consequences and in principle, rules and models are not compatible. Yet, advanced reasoners may learn to construct formal rules for themselves – a process that ultimately leads to the discipline of logic (Johnson-Laird, 1999). This literature has been explained as the current research study is investigating whether there is a relationship between math (that inherently requires logical thought and processes) and deductive reasoning as well as whether having a math anxiety as a result of low deductive reasoning potential or not having a math anxiety as a result of high deductive reasoning potential, has a direct effect on the school child's appraisal of careers that will directly effect the child's future career that he or she will ultimately engage in.

At this stage, one can now introduce literature that relates to mathematical learning difficulties as the above-mentioned theories of RIP and literature provided by Johnson-Laird (1999) has illustrated that deductive reasoning is integral with logical thought and logical thought is an inherent characteristic of math as a discipline. By now, explanation has been given as to why deductive reasoning is necessary for mathematics. However, as reasoning in general is encompassed within one's cognition, a difficulty in learning mathematics may be attributed to poor deductive reasoning. Naglieri and Das (1997) proposed the use of the "PASS" processes to correlate with specific types of achievement in mathematics. "PASS" is the Planning, Attention, Simultaneous, Successive theory of cognitive processing (Kroesbergen, Van Luit and Naglieri, 2003). Although related to achievement, particular aspects of "PASS", such as planning, are related to math

calculation as planning is required to make a decision on how to solve a math problem, recall and apply certain math facts and evaluate one's answer (Kroesbergen et al, 2003).

Successive processes are also relevant for solving math problems as they often consist of different and interrelated elements that must be integrated into a whole to attain the answer (Kroesbergen et al, 2003). Attention is also vital to selectively attend to the components of an academic task, for following sequences and memorizing basic math facts (Kroesbergen et al, 2003). Successive processing may also be important for reading of words that are not known by sight, yet may be necessary for solving a math word problem (Kroesbergen et al, 2003).

Although the "PASS" theory will not be tested in this research study it builds ground for this study as overall cognition, necessary for mathematics may thus be a factor that may even cause math anxiety or even influence vocational choice if the individual's cognition and deductive reasoning is of a poor nature. This links to the notion that a math anxiety may result in a low deductive reasoning and no math anxiety may result in a high deductive reasoning.

3.7) In Summary

This chapter has viewed deduction in terms of Politzer and Bourmaud (2002), as a process that yields valid conclusions and these conclusions must be true as long as the premise is true. Verbal and non-verbal reasoning has been discussed and the differences

have been clearly alluded to. Verbal reasoning has been documented as the ability to complete word analogies and solve problems that require logical thought. Non-verbal reasoning has been defined as the ability to see relationships between figures. In the same vein, deductive and inductive reasoning has been defined and their differences discussed. Deduction has been viewed as the direct application of knowledge to produce new knowledge but no new semantic information is generated. It is a form of valid proof and allows one to make conclusions based on previously known facts. However, deduction may lead to faulty conclusions if the premise is incorrect, which is significant as the premise is the most important part of the entire process. Deduction may also prove faulty if it is executed incorrectly. However, induction according to Annenberg (2004), results in the addition of semantic information and generates data from specific cases of a problem as well as makes and justifies a conjecture, based on what is observed.

Deductive reasoning has been described in terms of specialization, simple deductive reasoning (one-step and multistep) as well as, hypothetical deductive reasoning, which is carried out to prove something true or untrue and results in the fact that what is true for one number would be true for the next number (Reid, 2002). Rationality and deductive competence has been reviewed and it has been stated that as the number of premises increases, any system will run out of time and memory before it reaches a conclusion. Logic may permit inferences that nobody is liable to draw and is the wrong normative theory. A further reaction to paradox rationality has been discussed by dichotomizing rationality into tacit competence and conscious mechanisms for normative reasoning.

Theories of deductive performance have also been proposed in terms of Rips and PSYCPOP. Johnson and Laird's (1999) notion of mental models have been discussed as they have stated that reasoning is based on manipulation of mental models representing situations as opposed to syntactic derivations from logical forms. The two dominant accounts of deductive reasoning have been overviewed in terms of rules and models. Lastly, the connection between deduction and math anxiety is stipulated clearly in looking at math learning difficulties as a difficulty to learn math may be attributed to poor deductive reasoning in terms of Naglieri and Das's (1997) work of PASS theory of cognitive processes- Planning, Attention, Simultaneous, Successive theory. The point should be made clear at this stage that an individual with a high math anxiety and a low deductive reasoning will start to distort their appraisal of career attributes. One could thus expect the opposite to occur for individuals who have a low math anxiety as they would have a high deductive reasoning and as a result will not experience distortion of their appraisal of career attributes.

This chapter has aided in explaining the concept of deductive reasoning and why it is this reasoning that is used for reasoning mathematics as well as how such reasoning is linked to mathematics and the importance of deductive reasoning in one's ability to do math competently and thus have less of a math anxiety if any math anxiety what so ever. Chapter four will deal with the dependent variable of the study – career appraisal and attributes.

CHAPTER 4: CAREER ATTRIBUTES, APPRAISAL & CHOICE

Mitchell (1988) has stated that adolescents are often overwhelmed and disillusioned by the monumental and momentous task and risk of making a career choice. Some students may have “always known” what they would like to do when leaving school and others who may not, may make use of guidance or career counselors. The core of this research though is embedded in the fact that due to a high math anxiety, this emotion can over ride the cognitive aspect of deductive reasoning and thus results in the student appraising careers in this light, influenced by their math anxiety and thus being steered away from making a career choice that in some or other form, includes a large amount of math skills and working with numbers.

Influencing Factors of Career Choice and the Influence on Attributes

In the United States, adolescents may be able to steer their careers in exactly this manner due to the vast amount of literature that is readily available to them that describes the various occupations, ability and preparation requirements, future supply/demand and job responsibilities for that particular career (Mitchell, 1988). Once the adolescent has made his or her career choice, they may change their major subjects at university if they dislike the course they are doing or feel it involves math and they would rather steer away from it. However, even though it may involve math and the student has a math anxiety, he or she may stick with the course due to economic reasons (Mitchell, 1988). Examples of such phenomenon may be that particular fields may become over-flooded, limiting job

opportunities and in certain areas, there may be less job mobility so people stick to the jobs that they may already have (Mitchell, 1988). Even though the student may enjoy the course in university, the reality of the job may alter their career choice as they may find the realities of the job to be disappointing and not be willing to commit to the long working hours or any unexpected drawbacks that may come their way (Mitchell, 1988).

The manner by which students appraise careers may also be attributed to their parents. Birk and Blimline (1984), have researched this topic and their results have yielded that parents are primary determiners of their children's career choices (Sher, 2000). Steinke and Kaczowski (1961) already showed that adolescents listed their parents (usually the same-sex parent) as most responsible for their career choice (Sher, 2000). Such parental involvement may have an immense effect on the appraisal of careers for the child may do this according to what his or her parent deems the best career path for him or her.

Rowsey (1997) mentions yet another factor in terms of educators that may influence children's career appraisals. Teachers make youngsters aware of careers that are related to their specialization in teaching (Math, science and the like) and the educator also informs the pupil of the proper academic preparation needed to reach that career goal (Rowsey, 1997). This is a very important point to be addressed as in such a circumstance, an individual with a high math anxiety and a low deductive reasoning may begin to distort his or her appraisal of the career attributes of the teacher and this would result in that individual or those particular individuals refraining from entering the career of

teaching as they already have a preconceived idea of the career and distorted attributes of that career.

Stereotypes

Stereotypes can be defined as a set of beliefs and expectations about members of a group that are held solely because of the membership in the group (Feldman, 2001). Stereotypes should also not be disregarded in this respect as Tapia and Marsh II (2004) have stated in their research on gender and math anxiety that stereotyping in boys and girls and societies expectations are exceptionally prevalent as factors that would influence the manner in which careers are appraised- boys have a tendency towards engineering and the like whereas girls would have a tendency towards designing, nursing and so on. The notion of gender roles as a set of expectations defined by society that indicate what is appropriate behaviour for men and women (Feldman, 2001), also plays a part in male and females perceptions of careers and certainly would influence their appraisal of careers and future career choice. However, for the future, this may prove interesting to note as gender roles are ever changing with women breaking traditional expectations and entering non-traditional roles such as military or business. The same shift can be noted regarding men as some may shift to more feminine occupations or may not be the “bread winner” in the household. In the same vein as stereotyping and gender roles, society has inherently placed value on careers by attributing status to each one – a “Doctor” is of value, important and respected, a “waiter” is not. These notions have undoubtedly been transferred from generation to generation and alter people’s perceptions of the varying

status of careers according to the societal norm and outlook, almost overshadowing one's ability to think, perceive or decide for one's self. Such notions may be noted as influencing the appraisal of career attributes of the high math anxiety, low deductive reasoning individual.

In addition, O'Brien and Fassinger (1993) found that girls, who attended prestigious schools, pursued tertiary education more than those who attended less prestigious schools. In addition, Wulff and Steitz (1997), through a sample of forty girls and the use of a short form of the Bem Sex-Role Inventory, found that adolescent girls who valued their career pursuits had liberal gender-role attitudes and were instrumental and efficacious with regards to math and careers (Wulff and Steitz, 1997). These factors should also be taken into account as possible extraneous factors in a female's future career path and the appraisal thereof. As a result, current and future recruitment patterns in organizations may be explained (Wilkinson, 1996). Wilkinson (1996) has proposed that when one looks to the future of gender as an issue in career appraisal, other factors may result in affecting that career appraisal and the kind of job a male or female may accept and market him or herself for. It may be a long shot to suggest that a female and male may choose careers for the future that not only encompass or are absent of math but also social factors of family, location of the job and future possible travel requirements of a job may influence the manner by which a career is appraised and ultimately chosen and further more, the kind of job one would market him or her self for, in the future.

An aversion towards mathematics was even noted in research conducted by an anonymous author in the St. Joseph Journal of July 2003. This researcher showed how in the United States, the percentage of high school graduates who showed an interest in pursuing engineering dropped to 6 % in 2002 from the 9% in 1992. Out of the potential engineering majors in the class of 2002, one out of ten had taken no more than basic mathematics courses in high school and just over half had taken calculus (Anonymous, 2003). This proves excellent supportive evidence for this research study in that it again illustrates and substantiates the fact that individuals with a high math anxiety and low deductive reasoning will have distorted appraisals of career attributes and shy away from those careers, as this particular study has proven true. As a result of this trend becoming ever prevalent and increasing, not only in engineering but also in accounting, Hargadon and Lordi (2001) proposed the introduction of a “Junior Achievement Programme”. This programme aids in educating young people and students about business by changing their perceptions about the accounting profession and marketing the career as fun and exciting so as to attract them to the profession, hopefully, combating the pre-existing perceptions and possible math anxiety that some of these students may already have and any aversions they may have towards accountancy due to its mathematical nature (Hargadon and Lordi, 2001). Such notions are implicit in the following theory, as proposed by Gottfredson, a key theorist that underpins this research study and particularly, the variable of career attributes and choice as Gottfredson provides one with even more factors that may distort the appraisal of career attributes of individuals with high math anxiety and low deductive reasoning.

Gottfredson

Gottfredson's life-stage theory of career development, is primarily concerned with the development of occupational aspirations among individuals, and as such, attempts to provide a detailed description of the ways in which individuals are said to be attracted to certain occupations (Zunker, 1994). This theory places a special focus upon the self-concept, because individuals are known to have a tendency to select jobs or careers that are compatible with their self-image. Gottfredson expands upon other theories involving the self-concept, by noting that the development of the self-concept is determined by "one's social class, level of intelligence, and experiences with sex-typing" (Zunker, 1994, p.41). That is to say that both gender roles and social class backgrounds greatly influence the career perceptions that individuals are likely to make. It is perceptions that precede choice and this study is not about choices but rather perceptions.

Gottfredson's stages of development are vital to mention now as Gottfredson highlights other factors that are introduced through one's life stages that may also influence people's perceptions of careers later in life. Gottfredson listed four main stages through which individual development is said to progress. These stages include orientation to size and power, orientation to sex roles, orientation to social valuation and orientation to the internal, unique self. From age 3-5 years, the orientation to size and power is said to occur. In this stage, the thought processes of the child becomes concrete and they become aware of what it means to be an adult, in terms of the differences in the dimensions of size and power between them and their elders (Zunker, 1994 and Osipow and Fitzgerald,

1996). Children at this stage become aware of the noticeable physical differences between men and women, but are unable to recognize the differences in the gender roles held by these groups of individuals (Swanson and Fouad, 1999).

Orientation to sex roles then occurs from age 6-8 years. The child now becomes aware of the different gender roles of men and women. Gottfredson refers to this as “The development of sex-role identity and notes that it has a significant influence on the specific occupations considered through the rest of the child’s life” (Osipow and Fitzgerald, 1996,p.155). Swanson and Fouad (1999) note that it is common for children at this stage to view their sex as being superior to the other sex, and define their occupational aspirations in terms of what is commonly seen as appropriate for their sex-type.

By age 9-13 years, the orientation to social valuation stage then occurs. The child becomes aware of social class, and takes prestige and status into account when making a career choice. The child therefore begins to distinguish between occupations by observing and comparing the value that each occupation offers them (Sharf, 2002). Gottfredson notes that the child develops certain boundaries, to assist them in eliminating occupations that are either unacceptably low in prestige, or overly difficult to attain (Swanson and Fouad, 1999).

By age 14 and older, the stage of orientation to internal, unique self sets in. Now, introspective thinking is engaged in, which not only raises self-awareness, but also allows

the child to develop perceptions of those around them (Zunker, 1994). This stage is vital as it allows the individual to connect their occupational aspirations and choices with their personal interests, abilities and values (Zunker, 1994). This stage focuses on identifying which of the acceptable alternatives are preferred by the individual, who is then said to engage in a form of compromise, which involves accepting less appealing alternatives. This is usually the result of inaccessibility into the career of their choice (Swanson and Fouad, 1999).

Gottfredson states that sex-type, prestige and field of interest are the three elements that will be considered by the individual in the process of compromise. The most common element to be considered is the field of interest, followed by prestige, with very few individuals being willing to compromise their sex-type (Swanson and Fouad, 1999). It is vital to take into account that the individuals with a high math anxiety and low deductive reasoning will result in being influenced in terms of “prestige” and “interest” judgments based on systematic changes of career attributes.

Gottfredson’s theory is particularly relevant to the South African context with continuous references to notions of social class, level of intelligence and experience with sex typing of which all of these factors may play a role in influencing the appraisal of career attributes for the highly math anxious and low deductive ability individual. Gottfredson places emphasis on the fact that one’s gender roles and social class background have a great effect on career development and are therefore likely to influence one’s choice of career. Gottfredson places emphasis on external factors that are imposed on the

individual. This is of particular importance in the South African context, as the process of career development tends to present a great deal of obstacles.

4.4) In Summary

The final chapter of this literature review has dealt with factors that may influence one's appraisal of careers and ultimately one's career choice such as a supply and demand of graduates for the job market and the important influence a salary may have on one's future career appraisal. The job market may also be notorious for being flooded by certain careers, detracting students from electing such careers for fear of not being able to obtain work. Some individuals may not want to commit to demands that certain careers may entail (long working hours). In addition, Sher (2000) has stated how adolescents list parents as the most responsible for their career choice. However, it must not be forgotten that in fact math anxiety and deductive reasoning shape career attributes. This point must be noted with great emphasis in this study.

Rowsey (1997) has proposed that educators make youngsters more aware of careers that fall within their specialization of teaching (math and science careers if a math and science educator). Stereotypes have been mentioned in terms of gender roles and careers that are stereotypically associated with certain genders such as Engineering for a boy and Nursing for a girl. Such claims are substantiated by Tapia and Marsh II (2004). The notion that pupils at prestigious schools have a higher tendency of pursuing tertiary education is also put forward as well as, adolescents who valued their career pursuits, possessing liberal

gender role attitudes. Future determinants of careers may also be reliant on proximity of a job to one's family and travel requirements that are involved to commute to and from work on a daily basis. The St. Joseph Journal (2003) illustrates the point that so few pupils engage in more than a basic math course and this substantiates this research study so well as it highlights the existence and prevalence of math anxiety. Hargadon and Lordi's proposition and idea of a Junior Achievement Programme (JAP) has been discussed and the benefits it offers to create a larger pool of candidates for jobs that entail math ability and skills. Lastly, the theory of Gottfredson is discussed in terms of the stages of development he proposed. This is detailed in terms of orientation to size and power, orientation to sex roles, orientation to social valuation and orientation to an internal and unique self.

It is vital to bear in mind though that this research study is not measuring career choice but rather the appraisal of careers that will ultimately result in a career choice being made. One must also remember that such appraisals are highly dependent not only on the factors that have been mentioned in this chapter but in terms of this research study, math anxiety and its relationship with deductive reasoning that plays such an enormous role in influencing the means by which one appraises careers on the basis of having a math anxiety with a resultant low deductive reasoning or not having a math anxiety with a resultant high deductive reasoning as well as whether the career at hand to be appraised has an inherent characteristic of being math oriented or not.

Now that the three variables of math anxiety, deductive reasoning and career appraisals and attributes have been theoretically and conceptually reviewed, the operationalization of them within the context of this research study will now be detailed in the chapters to follow. The chapter five will draw these points together and make an argument for the research questions.

PRESENT RESEARCH – CHAPTER 5: PROCEDURE

Research Rationale

This research investigates math anxiety that is present in South African schools and whether such anxiety, combined with the ability or inability of reasoning deductively, could be major factors that influence an adolescent's appraisal of careers that ultimately would guide him or her on a career path. The distortion of career attributes as a result of high math anxiety and low deductive reasoning is also taken into account in this study.

This research study will contribute to knowledge that has already been gained in the field of cognitive psychology in terms of deductive reasoning as well as in occupational psychology in terms of career choice and social psychology in terms of math anxiety. In performing searches through databases such as Proquest, there seems to be a paucity of research in the South African context that is related to this topic. Although extensive research has been done on the variables that comprise this study, no research has taken place to examine the relationship of these variables to one another, which has its own set of implications, to be discussed in chapter 7. Furthermore, many studies have been carried out that investigate whether gender plays a role in what career a male or female would opt for. All research that has been documented in the literature review of this thesis suggests that gender does not play a role and this research will either support or disprove this notion.

In terms of the literature that has been covered in the previous chapters – the introduction, math anxiety, deductive reasoning and career appraisal, attributes and choice, this study will be a source of additional knowledge and act as a means to substantiate research claims that other studies have put forward. Such examples would be the Yale theory as mentioned in chapter two as this research will illustrate the situationally evoked anxiety of math anxiety by a focus on a school and classroom setting. In addition, this study will be able to gauge the degree of math anxiety present in girls and boys as well as note if there is a difference among the genders, adding to and substantiating claims of Tapia and Marsh II (2004). In the case that this research does elicit a notion that math anxiety does influence deductive reasoning and career appraisal and choice, Furner and Berman's (2003) notions of reducing and preventing math anxiety may be operationalized in the schools that have participated in this study. This would also highlight the work by Ho et al (2000) as mentioned in chapter two in terms of drawing schools attention to the fact that a math anxiety does exist and test taking can be a major factor that contributes to this anxiety.

This research also stands to underpin the notion of the importance of deductive reasoning and in particular, verbal reasoning in order for one to have a fluent mathematical ability, as alluded to in chapter three. This would also serve to justify the use of theories of deduction in terms of Rip's theory and PSYCPOP as well as mental models. This research also stands to substantiate claims that math-learning difficulties may be as a result of poor deductive reasoning, which in turn may be due to math anxiety. This vital link between the two variables stands to be proven and thus substantiate the work of

Naglieri and Das (1997) in terms of their Planning, Attention, Simultaneous, Successive theory of cognitive processing as discussed in the chapter on deductive reasoning.

Furthermore, this research may highlight that due to math anxiety and a poor deductive reasoning, fewer school children are electing to enter into math -oriented careers and as a result, the pool of future potential employees for such jobs will be limited. This acts as a means of substantiating the study in the St Joseph journal of 2003 as mentioned in chapter four that depicts a situation of a lack of youngsters taking more than a basic math course. This too lends itself to the importance of Horgadan and Lordi's idea of a "Junior Achievement Programme" (JAP) as detailed in chapter four that could be used so successfully in South Africa to ensure this phenomenon is curbed if not ideally, eliminated. Although Gottfredson's theory does not need substantiation, the claims of his theory will also be justified and substantiated by this research in terms of social status and careers.

In addition, it would be narrow- minded to think that this study is only a source of additional knowledge in a secondary school context. This research is valuable to educational psychology as one's appraisals of careers ultimately effects the choice of secondary school subjects of a child, these choices will shape the career path that he or she may follow in the future.

Research Aims

This study aims to investigate the relationship between math anxiety and deductive reasoning in concomitance with the appraisal of attributes of careers options to be made by grade nine pupils. The study will be based in the South African context and the relationship between math anxiety and deductive reasoning will be investigated as well as whether these two variables influence the basis upon which careers are appraised by grade nine pupils, which will ultimately lead to their future career choice.

Research Questions

- ❑ Is there a relationship between math anxiety and deductive reasoning?
- ❑ Is there a relationship between math anxiety and deductive reasoning versus the appraisal of career attributes?

Sample and Sampling

The initial sample proposed for this study aimed to comprise of forty male and forty female English school children in grade nine. This sample size was reduced to forty females and thirty-four males as six male volunteers did not arrive to participate. Grade nine is chosen, as this is the stage in one's secondary school career that subject choices need to be made that will mold one's matric year and future career choice. The ages in

this sample ranged from fourteen years old to sixteen years old. Sixteen participants were fourteen years of age, fifty-five were fifteen and three were sixteen years old. In terms of home language, forty-three participants spoke English, twelve spoke Afrikaans, nine spoke Sotho, three were Zulu speaking and lastly, seven spoke a language other than was given as an option on the biographical questionnaire (Refer to Appendix F). Racially, 32% of the pupils were black, 62% were white, 5 % were Indian and 1% Coloured. Only 7% of participants had not attended the two schools from grade 8 and of those 7%, three percent did not think that their previous school offered them as good an education as their current school.

The sample is taken from the South African population and is limited in generalisability in South Africa on the basis that not every school child from any South African school may experience math anxiety or similar levels of deductive reasoning that could influence appraisal of careers. This would be due to the fact that South Africa is still recovering from the apartheid legacy and not every school is on the same standard as the two schools that will be used for this study. Thus, math anxiety and lack of deductive reasoning could possibly be attributed to lack of proper education or lack of resources in alternative schools in South Africa.

This research is only applicable in the South African context as the school systems abroad and on the African continent is not the same. Pertinent characteristics of the sample is that it is purposive as all children must be in grade 9 and 15 years or older to avoid ethical considerations of ascent. However, in one school, ascent was required and

thus gained. This is non-probability sampling and is a volunteer sample, taken from Pretoria schools for the convenience of the researcher and thus convenience sampling has been used.

Procedure

Access was gained from two English, gender specific, secondary schools in Pretoria to access the sample required for the study (Appendix A and B). The boy's school required a more detailed letter (Appendix B). As the girl's school required parental ascent, a letter was drafted for that purpose and handed to the school to distribute among volunteers (Appendix C). These letters were then returned to the school, signed by the parent of each participant and that participant was used for the study. In terms of the girls, this allowed the researcher to use fourteen and fifteen year old pupils as parental ascent was gained in terms of ethical procedures, required in such a situation.

A date and time was arranged between the researcher and the guidance teachers at each school for the research to be conducted, once letters were gained that permitted the researcher to access the schools. The guidance educators, on the researcher's behalf, asked students to think about volunteering. On arriving at the schools, each of the 74 pupils was given a brown, numbered envelope (1-74) that contained the relevant documentation for the study. These envelopes were numbered for the convenience of the researcher to make sure that all participants had returned the envelopes by the end of the research. A subject information sheet (Appendix D) that explained the study to him or her

was given to each volunteer. They then had the option of participating in the study or not. If a subject agreed to participate, each pupil was issued with a consent form (Appendix E). A biographical questionnaire was provided that he/she completed (Appendix F). In addition, three instruments were administered to each pupil – The Math Anxiety rating Scale (MARS) by Fennema and Sherman (1976), The verbal reasoning test as a component of the Differential Aptitude Test- Form S (DAT-S) by Vosloo, Coetzee and Claasen (2000) and a graph and list of careers, formulated for the purposes of this research and based on the theory of Gottfredson. Refer to Appendices G-I for the above-mentioned instruments.

Before each instrument was administered, the researcher explained what was required of the participants and explained how to complete the instruments. The MARS was explained by showing the boys and girls were to place their cross in the relevant box. In terms of the verbal reasoning test, this was done by taking the volunteers through examples and showing them how to enter their answer on the DAT-S answer grid. The career appraisal graph was explained by means of demonstrating an example as attached to appendix H and this was also explained to the subjects by means of an overhead projector. As the schools had offered their own time to the researcher, all of these instruments had to be completed in one hour. No time limit was placed on any instrument and when completed, the subjects were allowed to leave the classroom.

The researcher ensured, by prior explanation to participants, that all students knew exactly how to complete each instrument. On completion of the research, these envelopes

were handed back to the researcher in the envelope and each participant ensured that his/her envelope was sealed. All questionnaires remained confidential and respondents, anonymous. The responses were used to generate data for this research and were captured to elicit results, using the SAS system. Data was recorded in an excel spreadsheet that consisted of all the biographical variables, math anxiety, in terms of each item and a total of the scale. This scale was also reverse scored. The verbal reasoning test was also scored in terms of correct and incorrect answers and a total for each individual. The career appraisal graph was scored according to the quadrant that comprised the highest number of plotted careers. This was done clockwise in terms of low math skills and high status (4), high math skills and high status (3), high math skills and low status (2) and low math skill and low status (1) (Appendix H). This graph is measuring the perception that the sample has of certain careers in terms of the amount of math skill required for each career and the status that this career holds in society. This is indicative of the samples appraisal of careers and the extent to which, (if any) individual's perceptions of career attributes have been distorted as a result of their math anxiety and lack of deductive reasoning. Further analysis of the research will be discussed in the chapter to follow.

The research took place in September 2004 and was cross-sectional. The study comprises of two independent variables – math anxiety and deductive reasoning and one dependent variable – career attributes. Gender has also been used as a factor in the research. This is a quantitative, non-experimental study. There was no manipulation of the independent variable, no control group and no random assignment. This supported the proposed method of data analysis- correlation, implicit in non-experimental research. However,

correlation will only be used to investigate the relationship between math anxiety and deductive reasoning. The remainder of the research study will take on a descriptive, qualitative approach.

The measuring instruments and scales used in this study will now be outlined in some detail to enable future replication or expansion of this study.

Measuring Instruments

Math Anxiety Rating Scale (MARS)

The Maths Anxiety Rating Scale (MARS) used for the purposes of this research consists of 27 items. The MARS scale is measured from A- “Not at all” to E-“Very much”. B represents “A little”, C- “A fair amount” and D- “Much”. This is a constantly revised scale. High scores are indicative of high anxiety and low scores, low anxiety. This scale has been developed by Fennema and Sherman (1976) and has a good test-retest reliability coefficient of 0,85. The validity for the MARS was generated by correlating the MARS total scores with that of the Differential Aptitude Test (DAT) and a correlation of $-0,35$ ($p < 0,05$) and $-0,64$ ($p < 0,01$) was recorded (Richardson and Woolfolk, 1980). In terms of this research study, the MARS yielded descriptive statistics in terms of a mean of 104,73 and a standard deviation of 21,79. These values are indicative of a mean in terms of the average level of anxiety in the entire sample and the amount or deviation above or below this mean of 21,79 that the scores were captured at, thus $104,73 \pm 21,79$. Fennema and

Sherman (1976) used the MARS as a measurement of determining different attitudes and feelings about mathematics. Appendix G should be referred to for viewing the MARS.

Differential Aptitude Test- Form S (DAT-S)

The DAT-S is one of a series of differential aptitude tests constructed to assess various facets of intellectual functioning. Included among the aptitudes assessed is the one component that has been extracted for the purposes of this research – the verbal reasoning test. The DAT-S can produce information that is indicative of future career success. The DAT-S is the advanced form of the DAT and is aimed at those students who enjoy relatively good educational opportunities, as is the case in the sample for this study (Vosloo, Coetzee and Classen, 2000). The DAT-S is used for grade 7-10 pupils and is thus perfect for this study.

The aim of the verbal reasoning test is to measure an aspect of general reasoning on the basis of verbal material. The test rests on the assumption that the ability to determine relationships, to complete word analogies, to solve general problems requiring logical thought, as well as a person's vocabulary background is a valid indication of an aspect of general reasoning. The test consists of 25 items that require the learner to understand the verbal material that he/she reads, to process it logically, and to find a solution to that particular problem. The test should give a reasonably satisfactory indication of the general level of cognitive functioning and general reasoning (Vosloo ET al, 2000). The test will take 25 minutes and answers will be recorded by colouring in the correct letter

on the answer sheet, provided to the pupil (Appendix I). The test has been standardized for the South African context.

Reliability coefficients of 0,78 has been given for this test and an intercorrelation score of 0,70 has been given for the test for 513 grade 7 learners tested in four schools (Vosloo et al, 2000). These figures are significant for alpha at the 0,05 level. Content validity and construct validity has been provided. Limited information though is noted in terms of predictive validity of the DAT-S. The verbal reasoning, test 2 of the DAT-S, in this study, yielded a mean value of 33,3 and a standard deviation of 5,64. Thus the average score of the participants in this research study was 33,3 and differed by +/- 5,64 in deviation

Career Appraisal List and Graph

This instrument has been developed for the purposes of this study and is based on the career choice theory of Gottfredson, as previously mentioned and explained in the literature review. A list of 25 random careers has been listed in no particular order and will be given to each participant of this study. Every career is coded (Appendix H). It is important to note though that there is no right or wrong answer. Each career has a stereotype of high or low status attached to it and a certain level of math skills and ability is required (high or low) for entering into these professions. Each pupil is asked to make judgments of each career on the graph provided (Appendix H). This is to be done in terms of how the pupil, subjectively, views the career in terms of high or low status and

in terms of high or low math ability that is required for the career or job. All areas of the graph are important and will be used in this study.

Validity is implicit in the study in terms of content validity; construct validity and face validity in terms of Gottfredson's theory and concurrent validity in terms of the criterion data that will be obtained during the administration of the instrument.

Using all of these instruments and the procedure as detailed in this chapter, data could be generated that is interval (one can speak legitimately of differences between scale points) and continuous in nature (can assume any values between the lowest and highest points on a scale) as rating scales are used and data from a graph. The graph features here as a means of generating proof of how different careers are appraised by different individuals depending on whether they have a high math anxiety and low deductive reasoning or high deductive reasoning and low math anxiety or low math anxiety and low deductive reasoning or even high math anxiety and high deductive reasoning. The respondent must appraise all of the careers provided to him or her by plotting each one on the graph according to their unique and individual perception of whether the career has a high or low status attributed to it or whether the individual perceives a high or low math skill necessary for the job or not. The respondents tasks in the context of this study is thus to complete the MARS, DAT-S test two and the career graph.

The following chapter will detail the data that was generated and provide results of the conducted analyses

CHAPTER 6: DATA ANALYSIS AND RESULTS

As this is quantitative non-experimental research, correlation will be used as a means of data analysis. However, this study is not just limited to quantitative analysis as a descriptive qualitative approach is also to be taken in terms of analysis of the data elicited by the career graph, used in this study. The sample size for this study is 74 individuals and correlations will be used to observe whether the independent variables correlate with one another or not so as to assess the relationship between the variables. This will allow for the research to generate results as to whether high or low math anxiety and deductive reasoning are related and are affected by appraisal of career attributes or not. Howell (1999) proposes in his text that Pearson's correlation is an appropriate technique to be used for a study of this nature.

Each independent variable will be correlated with one another, tested for significance at the alpha level of 0,05. If the correlation were less than 0,05 or greater than 0,05, this would result in rejecting or failing to reject the null hypothesis of the variables being related. The correlation would allow for deducing which variables have strong or weak relationships with one another. Scatter plots may also be used to view and interpret the results (Howell, 1999).

In looking at the results, the researcher assumes the following criteria for the correlation's strength or weakness:

0-0,3 → weak

0,3-0,5 → moderate

0,5-0,7 → Strong

0,7 and above → very strong

In accordance with this procedure, the following results were generated through the SAS programme:

6.1) Sample Statistics

Table 1: Descriptive Statistics Of The Biographical Variables

		GENDER	LANGUAGE	RACE	AGE	GRADSIN	ASGDEDU
N	Valid	74	74	74	74	74	74
	Missing	0	0	0	0	0	0
Mean			-	-	-	-	-
Std. Error of Mean			-	-	-	-	-
Median			1.00	-	2.00	-	-
Mode			1	2	2	1	0
Std. Deviation			-	-	-	-	-
Variance			-	-	-	-	-
Skewness			-	-	-	-	-
Std. Error of Skewness			-	-	-	-	-
Kurtosis			-	-	-	-	-
Std. Error of Kurtosis			-	-	-	-	-
Range			5	4	2	1	2
Minimum			1	1	1	1	0
Maximum			6	5	3	2	2

When interpreting the table above, one must take into account that this table is producing data that has been coded before the time into an excel spreadsheet and as a result to make sense of the table, it is vital to bare the following information in mind. In terms of Language, race, whether participants had been in the same school since grade 8 (Gradsin) and if they had not, whether they received as good an education in their previous schools (AsGdEdu), means and the like are of no use as one is not able to talk of an average race or language. The only descriptive statistics that are of use in this study due to the nature of the data being coded is that of the median, mode, range and minimum and maximum.

The modes indicate that English (coded 1) is the language of the majority of participants. Most participants were 15 years old (coded 2). The majority of participants were Caucasian (coded 2) and most respondents had been in the same school since grade eight (coded 1).

6.2) Correlations

Pearson's Correlation Coefficient for the Research Variables

Table 2: Correlation coefficients for the relationship between the respective independent variables in the study followed by a scatter plot of the results.

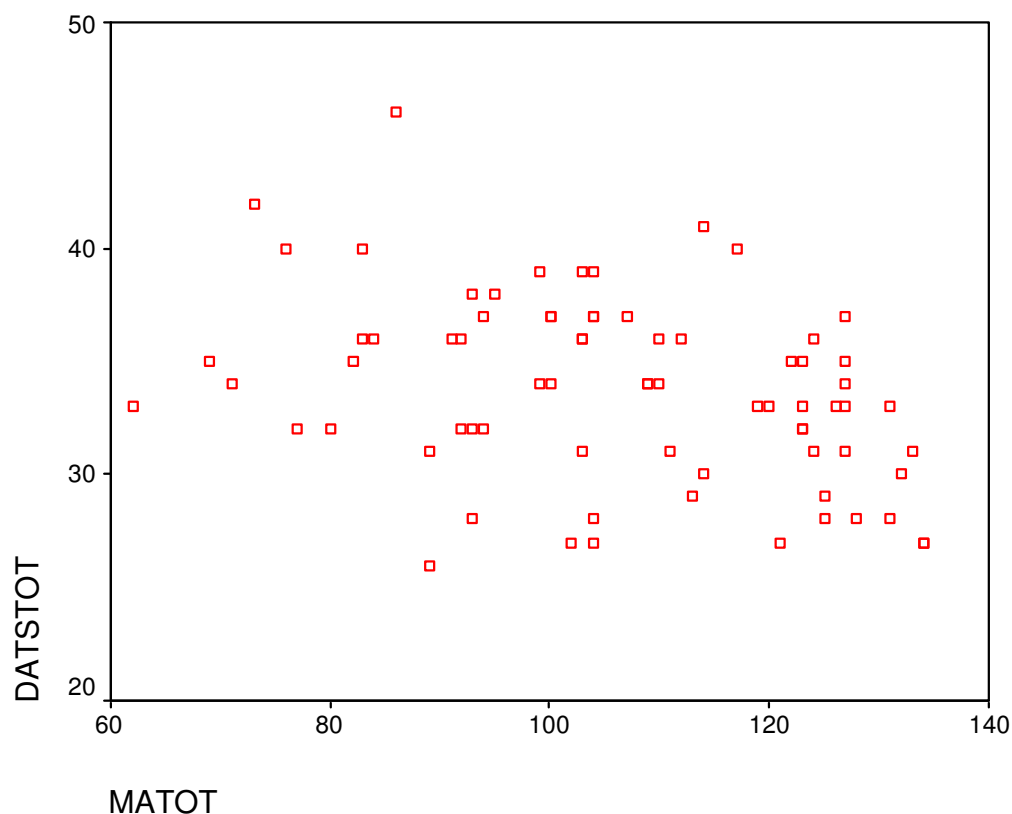
	Math Anxiety	Deductive Reasoning
Math Anxiety	1,00	-0.363***
Deductive Reasoning	-0.363***	1,00

*** Correlation significant at 0,01 level

This table is interpreted as meaning that deductive reasoning and math anxiety have a negative correlation ($r=0.363$, $p=0,01$), which is not a strong correlation with only 36.3% of the variance explained by the relationship. However, the relationship between these two variables is negatively correlated. This means that if an individual is highly math anxious, he or she will not have a high deductive reasoning but rather a lower deductive reasoning. In other words, when math anxiety as a variable increases, deductive reasoning will decrease and if math anxiety decreases, deductive reasoning will increase. If the one variable experiences a change, the other variable will also change but in the

opposite direction. This can also be seen in the scatter plot below that portrays this phenomenon clearly and concisely.

A Scatter Plot Of Math Anxiety And The Indirect-Proportional Relationship That Exists Between The Two Variables



Hypothesis 1: There is a relationship between math anxiety and deductive reasoning.

The results of this hypothesis, in terms of the figures from table 2, indicate that there is a relationship between math anxiety and deductive reasoning as measured by r , as r is indicative of the fact that there is always a relationship being measured.

This Pearson's correlation was carried out to investigate whether a relationship in fact existed between math anxiety and deductive reasoning. As can be seen by table 2, there was a significant relationship between these two variables at the alpha level of 0,01 and this relationship was negatively correlated. In other words, if math anxiety would increase, deductive reasoning would decrease, what the one experiences, the other experiences the opposite.

6.3 Coefficient Alpha's for Measuring Instruments

Table 3: Coefficient Alphas for Measuring Instruments

Instrument	Coefficient Alpha Value	Reliability Strength
MARS	0,68	Strong
DAT-S: Test 2- Verbal Reasoning	0,786	Very Strong
Graph	No reliability generated	/

Table 3 should be interpreted as indicating the coefficient alpha values that were generated for each of the measuring instruments so as to show the strength of their internal consistency reliability. As can be noted from the table, the MARS scale proved to have a strong reliability and the DAT-S had a very strong reliability. What is vital to mention though is that the career graph that was used for this research was of a non-linear

nature and as a result, reliability in terms of internal consistency could not be generated for this instrument. This means that the axis of status vs. the axis of math skills on the career appraisal graph were not varying linearly and thus there was a range restriction that occurred in terms of this graph, altering the correlation from what it would have been if the range had not been so restricted. Thus no internal consistency for the graph has been calculated.

Qualitative Descriptive Data

Career Attributes vs. Math Anxiety and Deductive Reasoning

In terms of the following tables, this data has been generated from the career graph as referred to in the appendix of this study. Each table that follows is identical in terms of the components. Each looks at career attributes of perceived status and perceived level of math skill necessary for a particular career. The sample for the study has been categorized as to whether he or she has a high or low math anxiety and high or low deductive reasoning ability, based on the data elicited by the DAT-S sub-test two and the MARS. This has been done so as to note the pattern that emerges in terms of each of the twenty-five careers that the respondents were asked to plot on the graph. This is of vital importance in this study as one now knows that there is an indirect proportional relationship between math anxiety and deductive reasoning so now, one can note whether in fact being anxious or not or having a high deductive reasoning ability or not does in fact play a role in affecting the appraisal of careers in terms of the attributes of perceived status and math skill for that career. The tables that follow will answer the second

research question by interpretation of the patterns that exist in the tables in terms of how each career has been appraised with specific emphasis on the similarity or dissimilarity of appraisal between the groups of high deductive reasoning and low math anxiety and the group of high math anxiety and low deductive reasoning.

As stated above, each table that follows will look at a specific career. The rows and columns of each table should be interpreted as a relay of information from the sample of this study whereby for each career that was presented, each individual's response for that particular career was recorded. This was done in terms of whether that person attributed a high status and low math skill or a high status and high math skill or a low status and high math skill or a low status and low math skill in their individual appraisal of that career /job as will be seen on the left hand side of the tables that follow. The criteria for categorizing this information as such was devised directly from the graph that the respondents received to plot the allocated careers on, thus depending on what quadrant their plot fell for each career, that quadrant was interpreted into the four categories of high/low deductive reasoning and high /low math anxiety.

However, in capturing this information, the individual respondents were also classified as demonstrating high deductive reasoning and high math anxiety, high deductive reasoning and demonstrating low math anxiety, low deductive reasoning and low math anxiety as well as low deductive reasoning and high math anxiety. These categories can be noted in the top of each table to follow and relate to the respondents in terms of the results obtained from the MARS and the DAT-S test two on deductive reasoning that was

administered on the sample. Whether the respondents scored high or low on these tests formed the criteria to categorize the tables that follow into high/low deductive reasoning and high/low math anxiety and their combinations as mentioned above. Classifying an individual as having a high/low math anxiety and high/low deductive reasoning was done by using the raw scores that each candidate achieved on the MARS and DAT-S test 2 in terms of a median split. The average score any individual could achieve was thus generated and those who scored higher than the average were classified as high and those who scored lower than the average was classified as low. No candidates scored exactly on the average score which meant that “high” and “low” could be used with the absence of an “average” as an additional classification. Norm-based criteria were not used in the interpretation of the MARS and DAT-S as norms exist for the DAT-S for the South African population but norms were not able to be sourced for the MARS for the South African population.

As a point of interest, a qualitative approach to this section of the research has been taken as the information elicited is of more value for interpretation. A quantitative technique such as chi-squared has not been used because the results would not reveal much in the way of interpretation and in accordance with the assumption for the use of chi-squared, as each matrix in this research study, in terms of the tables that follow below, contains a high proportion of cells with less than five observations; many have zero observations. Due to the large number of cells and the sample size and given the marginal totals for each cell, it is likely too that the expected frequency in many of the cells would also be less than five. Under these circumstances Chi squared is not accurate and should not be

used. Similarly Fishers exact probability will give a probability for the matrices but will not allow interpretation of the meaning of array. This thus requires a qualitative explanation of each of the tables that are to follow this explanation.

Before moving on to the results of these tables, the following table will provide a framework to show the order of the tables to follow and thus the order of careers/jobs to be discussed.

Table depicting order of careers to be discussed

<u>Order</u>	<u>Career</u>
1	Bus Driver
2	Lawyer
3	Doctor
4	Psychologist
5	Engineer
6	Pilot
7	Secretary
8	Farmer
9	Typist
10	Actuary
11	President
12	Restaurant Manager
13	Architect
14	Painter
15	Bank Teller
16	History Teacher
17	Electrician
18	Plumber
19	Tour Guide
20	Salesman
21	Travel Agent
22	Chef
23	Model
24	Actor
25	Waiter

Table 1: Patterns of the levels of math anxiety and deductive reasoning of the research sample vs. appraisal of the job of a Bus Driver based on high or low status attributed to the job and perceived high or low math skill required to do the job.

N= 74	<u>Category 1:</u> High Deductive Reasoning/ High Math Anxiety	<u>Category 2:</u> High Deductive Reasoning / Low Math Anxiety	<u>Category 3:</u> Low Deductive Reasoning/ Low Math Anxiety	<u>Category 4:</u> Low Deductive Reasoning / High Math Anxiety	TOTALS
High Status/Low Math Skills	1	2	2	4	9
High Status/ High Math Skills	0	0	1	0	1
Low Status/ High Math Skills	0	2	1	1	4
Low Status/ Low Math Skills	6	31	13	10	60
TOTALS	7	35	17	15	

In terms of the explanation given above for the inclusion of these tables, if one looks at the table above for bus drivers, it can be seen that despite the four different categories of participants, math anxiety and deductive reasoning do not seem to play a role in the appraisal of this career in terms of the attributes of status or math skill required. Sixty participants across all four categories view this occupation as having a low status and requiring low math skills. On the other hand, only one individual perceived a bus driver as requiring high math skills and attributed this job as having a high status in society. Also within this table, zero participants who were classified as being highly math anxious and having a low level of deductive reasoning attributed a high status and high math skill to this career.

Table 2: Patterns of the levels of math anxiety and deductive reasoning of the research sample vs. appraisal of the job of a Lawyer based on high or low status attributed to the job and perceived high or low math skill required to do the job.

N= 74	<u>Category 1:</u> High Deductive Reasoning/ High Math Anxiety	<u>Category 2:</u> High Deductive Reasoning / Low Math Anxiety	<u>Category 3:</u> Low Deductive Reasoning/ Low Math Anxiety	<u>Category 4:</u> Low Deductive Reasoning / High Math Anxiety	TOTALS
High Status/Low Math Skills	5	17	6	4	32
High Status/ High Math Skills	2	17	9	11	39
Low Status/ High Math Skills	0	0	1	1	2
Low Status/ Low Math Skills	0	0	1	0	1
TOTALS	7	34	17	16	

In this table for a lawyer, the pattern seems different than a bus driver as here, an equal amount of participants who have low math anxiety and high deductive reasoning appraise a lawyer as both having a high status but low and high math skills. Participants with a low deductive reasoning and high math anxiety view a lawyer in the same vein. The majority of participants (39) appraised this career as having a high math skill and high status attributed to it. Eleven participants who are highly math anxious and have a low deductive reasoning viewed this occupation as having a high status and high math skills. Due to consensus in this table, math anxiety and deductive reasoning do not influence the appraisal of this career/job.

Table 3: Patterns of the levels of math anxiety and deductive reasoning of the research sample vs. appraisal of the job of a Doctor based on high or low status attributed to the job and perceived high or low math skill required to do the job.

N= 74	<u>Category 1:</u> High Deductive Reasoning/ High Math Anxiety	<u>Category 2:</u> High Deductive Reasoning / Low Math Anxiety	<u>Category 3:</u> Low Deductive Reasoning/ Low Math Anxiety	<u>Category 4:</u> Low Deductive Reasoning / High Math Anxiety	TOTALS
High Status/Low Math Skills	1	1	2	1	5
High Status/ High Math Skills	6	33	15	13	67
Low Status/ High Math Skills	0	0	0	2	2
Low Status/ Low Math Skills	0	0	0	0	0
TOTALS	7	34	17	16	

In terms of a doctor, the perceptions are that sixty-seven participants view this career as having a high status and requiring high math skills whereas zero appraises medicine as requiring low math skill and a low status attached to this profession. This again is evidence that math anxiety and deductive reasoning do not play a role in influencing the appraisal of this career/job.

Table 4: Patterns of the levels of math anxiety and deductive reasoning of the research sample vs. appraisal of the job of a Psychologist based on high or low status attributed to the job and perceived high or low math skill required to do the job.

N= 74	<u>Category 1:</u> High Deductive Reasoning/ High Math Anxiety	<u>Category 2:</u> High Deductive Reasoning / Low Math Anxiety	<u>Category 3:</u> Low Deductive Reasoning/ Low Math Anxiety	<u>Category 4:</u> Low Deductive Reasoning / High Math Anxiety	TOTALS
High Status/Low Math Skills	3	12	10	5	30
High Status/High Math Skills	4	19	7	7	37
Low Status/High Math Skills	0	4	0	2	6
Low Status/Low Math Skills	0	0	0	1	1
TOTALS	7	35	17	15	

If one views this table on a psychologist it is interesting to note that high math anxious and low deductive reasoning individuals appraise this career as requiring low math skill. However the notion that most individuals may have a false perception of what a psychologist's job entails may also feature in this result. Perhaps if the perception that a psychologist's job did entail math in terms of research, was known by the general public, these participants may have all appraised the career as high status and high math skill oriented. This was not the case in this sample as 30 individuals appraised this as a high status low math skill career and 37 as a high status and high math skill career. As a result, some individuals with high math anxiety and low deductive reasoning may appraise the career of psychologist on false perceptions. The one individual who has a low deductive reasoning and high math anxiety appraised a psychologist as requiring low math skill and having a low status in society. Due to the fact though that majority of participants in category 2 and 4 appraised this career in the same vein, math anxiety and deductive reasoning do not have influencing powers in the appraisal of this job/career.

Table 5: Patterns of the levels of math anxiety and deductive reasoning of the research sample vs. appraisal of the job of an Engineer based on high or low status attributed to the job and perceived high or low math skill required to do the job.

N= 74	<u>Category 1:</u> High Deductive Reasoning/ High Math Anxiety	<u>Category 2:</u> High Deductive Reasoning / Low Math Anxiety	<u>Category 3:</u> Low Deductive Reasoning/ Low Math Anxiety	<u>Category 4:</u> Low Deductive Reasoning / High Math Anxiety	TOTALS
High Status/Low Math Skills	0	0	1	2	3
High Status/ High Math Skills	7	28	13	10	58
Low Status/ High Math Skills	0	5	3	3	11
Low Status/ Low Math Skills	0	1	0	1	2
TOTALS	7	34	17	16	

In terms of this table, the perception, as with the job of a doctor is_ that this career requires high math skill and has a high status attributed to it with 58 individuals appraising it as such. Again, math anxiety and deductive reasoning do not come across as factors that would influence the appraisal of this career due to the consistency in the pattern of appraisal as seen in this table that appraises the job of a doctor.

Table 6: Patterns of the levels of math anxiety and deductive reasoning of the research sample vs. appraisal of the job of a Pilot based on high or low status attributed to the job and perceived high or low math skill required to do the job.

N= 74	<u>Category 1:</u> High Deductive Reasoning/ High Math Anxiety	<u>Category 2:</u> High Deductive Reasoning / Low Math Anxiety	<u>Category 3:</u> Low Deductive Reasoning/ Low Math Anxiety	<u>Category 4:</u> Low Deductive Reasoning / High Math Anxiety	TOTALS
High Status/Low Math Skills	0	4	1	2	7
High Status/ High Math Skills	6	23	14	11	54
Low Status/ High Math Skills	1	6	2	2	11
Low Status/ Low Math Skills	0	1	0	1	2
TOTALS	7	34	17	16	

As was mentioned in the table above, the majority (54) perceives a high status and high math skill necessary for a pilot. This again portrays that math anxiety and deductive reasoning do not influence the appraisal of this job/career.

Table 7: Patterns of the levels of math anxiety and deductive reasoning of the research sample vs. appraisal of the job of a Secretary based on high or low status attributed to the job and perceived high or low math skill required to do the job.

N= 74	<u>Category 1:</u> High Deductive Reasoning/ High Math Anxiety	<u>Category 2:</u> High Deductive Reasoning / Low Math Anxiety	<u>Category 3:</u> Low Deductive Reasoning/ Low Math Anxiety	<u>Category 4:</u> Low Deductive Reasoning / High Math Anxiety	TOTALS
High Status/Low Math Skills	3	4	4	4	15
High Status/ High Math Skills	0	5	1	3	9
Low Status/ High Math Skills	1	9	3	2	15
Low Status/ Low Math Skills	3	16	9	7	35
TOTALS	7	34	17	16	

Here one sees a new pattern emerging as although majority of people (35) view a secretary as having low status and low math skill, there is a greater dispersion amongst people as to how they view a secretary as can be seen above. This is indicative of the fact that this job is less targeted to a particular individual on the basis of math anxiety or deductive reasoning. However between the two categories of high math anxiety and low deductive reasoning and low math anxiety and high deductive reasoning, majority of participants in each category concede to the appraisal of a secretary as having a low status and low math skill thus math anxiety and deductive reasoning do not play a role in influencing the appraisal of the job of a secretary.

Table 8: Patterns of the levels of math anxiety and deductive reasoning of the research sample vs. appraisal of the job of a Farmer based on high or low status attributed to the job and perceived high or low math skill required to do the job.

N= 74	<u>Category 1:</u> High Deductive Reasoning/ High Math Anxiety	<u>Category 2:</u> High Deductive Reasoning / Low Math Anxiety	<u>Category 3:</u> Low Deductive Reasoning/ Low Math Anxiety	<u>Category 4:</u> Low Deductive Reasoning / High Math Anxiety	TOTALS
High Status/Low Math Skills	1	4	3	5	13
High Status/ High Math Skills	0	6	2	1	9
Low Status/ High Math Skills	1	1	2	2	6
Low Status/ Low Math Skills	5	24	9	8	46
TOTALS	7	35	16	16	

Again in this table, the majority of participants (46) see a farmer as low status and low math skills but again the pattern is dispersed and it can be seen how different people perceive a career so differently. It is interesting to note though that this pattern is rather varied between the two groups of high math anxiety and low deductive reasoning and low deductive reasoning and low math anxiety. The other two categories of high deductive reasoning and low math anxiety and high deductive reasoning and high math anxiety are more definitive in terms of what the consensus of appraisal is in terms of this specific career. However, majority of people in category 2 and 4 appraise this job with attributes of low math skill and low status and this again is evidence that math anxiety and deductive reasoning do not play a role in influencing the appraisal of a farmer.

Table 9: Patterns of the levels of math anxiety and deductive reasoning of the research sample vs. appraisal of the job of a Typist based on high or low status attributed to the job and perceived high or low math skill required to do the job.

N= 74	<u>Category 1:</u> High Deductive Reasoning/ High Math Anxiety	<u>Category 2:</u> High Deductive Reasoning / Low Math Anxiety	<u>Category 3:</u> Low Deductive Reasoning/ Low Math Anxiety	<u>Category 4:</u> Low Deductive Reasoning / High Math Anxiety	TOTALS
High Status/Low Math Skills	2	1	1	2	6
High Status/ High Math Skills	0	4	1	4	9
Low Status/ High Math Skills	1	6	1	1	9
Low Status/ Low Math Skills	4	24	13	9	50
TOTALS	7	35	16	16	

The typist is also interesting to note, as 50 people appraised the career as a low status low math skill job but individuals who are highly anxious about math and have a low deductive reasoning view this career very differently as a group compared to the other categories of individuals in this study. Math anxiety and deductive reasoning though do not play a role in influencing the appraisal of this job as consensus between the majority of participants in category 2 and 4 was reached in appraising the job as low status and low math skill. It seems strange to think that people's perceptions of attributes of careers are so varied, no matter what their ability in terms of math or deductive reasoning.

Table 10: Patterns of the levels of math anxiety and deductive reasoning of the research sample vs. appraisal of the job of an Actuary based on high or low status attributed to the job and perceived high or low math skill required to do the job.

N= 74	<u>Category 1:</u> High Deductive Reasoning/ High Math Anxiety	<u>Category 2:</u> High Deductive Reasoning / Low Math Anxiety	<u>Category 3:</u> Low Deductive Reasoning/ Low Math Anxiety	<u>Category 4:</u> Low Deductive Reasoning / High Math Anxiety	TOTALS
High Status/Low Math Skills	1	10	0	1	12
High Status/ High Math Skills	6	21	13	15	55
Low Status/ High Math Skills	0	1	1	1	3
Low Status/ Low Math Skills	0	1	3	0	4
TOTALS	7	33	17	17	

The career of an actuary can again be seen to be a specialized career with clear perceptions by participants across all four groups and is a career that individual's with a math anxiety and low deductive reasoning also perceive as requiring high math skills as appraised by 55 individuals of which they are included in. Again due to consensus, math anxiety and deductive reasoning have not influenced the appraisal of this job. It is interesting to note though that 12 individuals perceive this career as requiring a low math skill but having a high status. This may speculatively be attributed to the fact that not all individuals may have understood what each career entails and may have neglected to enquire on this point while administration of the graph was taking place.

Table 11: Patterns of the levels of math anxiety and deductive reasoning of the research sample vs. appraisal of the job of a President based on high or low status attributed to the job and perceived high or low math skill required to do the job.

N= 74	<u>Category 1:</u> High Deductive Reasoning/ High Math Anxiety	<u>Category 2:</u> High Deductive Reasoning / Low Math Anxiety	<u>Category 3:</u> Low Deductive Reasoning/ Low Math Anxiety	<u>Category 4:</u> Low Deductive Reasoning / High Math Anxiety	TOTALS
High Status/Low Math Skills	3	15	5	6	29
High Status/ High Math Skills	4	18	11	10	43
Low Status/ High Math Skills	0	0	1	0	1
Low Status/ Low Math Skills	0	1	0	0	1
TOTALS	7	34	17	16	

Yet again for a president, the majority (43) perceives this political career as high status and high math skill. As previously, math anxiety and deductive reasoning do not influence the appraisal of this job. Those with a high math anxiety and low deductive reasoning may also strive for such a position in life and society, as there are six such participants who perceive this as a low math skill job. Here as in the example above with an actuary, there are two individuals who attribute a low status to a president and may have done so either because this was indeed their perception but more likely because of a misunderstanding of instructions on how to plot the career or perhaps making a mistake in plotting it or not understanding the job of a president and the stereotypical attributes of that job.

Table 12: Patterns of the levels of math anxiety and deductive reasoning of the research sample vs. appraisal of the job of a Restaurant Manager based on high or low status attributed to the job and perceived high or low math skill required to do the job.

N= 74	<u>Category 1:</u> High Deductive Reasoning/ High Math Anxiety	<u>Category 2:</u> High Deductive Reasoning / Low Math Anxiety	<u>Category 3:</u> Low Deductive Reasoning/ Low Math Anxiety	<u>Category 4:</u> Low Deductive Reasoning / High Math Anxiety	TOTALS
High Status/Low Math Skills	2	9	3	1	15
High Status/High Math Skills	4	11	10	12	37
Low Status/High Math Skills	0	9	2	2	13
Low Status/Low Math Skills	1	5	2	1	9
TOTALS	7	34	17	16	

Restaurant manager has a high status and high math skill attributed by 37 participants to it across all four categories of individuals indicative again that math anxiety and deductive reasoning have not played an influencing role in the appraisal of this job.

Table 13: Patterns of the levels of math anxiety and deductive reasoning of the research sample vs. appraisal of the job of an Architect based on high or low status attributed to the job and perceived high or low math skill required to do the job.

N= 74	<u>Category 1:</u> High Deductive Reasoning/ High Math Anxiety	<u>Category 2:</u> High Deductive Reasoning / Low Math Anxiety	<u>Category 3:</u> Low Deductive Reasoning/ Low Math Anxiety	<u>Category 4:</u> Low Deductive Reasoning / High Math Anxiety	TOTALS
High Status/Low Math Skills	1	0	4	2	7
High Status/ High Math Skills	3	30	9	14	56
Low Status/ High Math Skills	1	4	2	0	7
Low Status/ Low Math Skills	1	0	2	1	4
TOTALS	6	34	17	17	

As with the job of a doctor and an actuary, an architect was attributed a high math skill and high status to this career/job based on 56 individuals' appraisal of this career, which again is evidence of the lack of influence math anxiety and deductive reasoning is playing in terms of the appraisal of this job.

Table 14: Patterns of the levels of math anxiety and deductive reasoning of the research sample vs. appraisal of the job of a Painter based on high or low status attributed to the job and perceived high or low math skill required to do the job.

N= 74	<u>Category 1:</u> High Deductive Reasoning/ High Math Anxiety	<u>Category 2:</u> High Deductive Reasoning / Low Math Anxiety	<u>Category 3:</u> Low Deductive Reasoning/ Low Math Anxiety	<u>Category 4:</u> Low Deductive Reasoning / High Math Anxiety	TOTALS
High Status/Low Math Skills	0	2	3	3	8
High Status/ High Math Skills	1	0	1	2	4
Low Status/ High Math Skills	0	2	1	2	5
Low Status/ Low Math Skills	6	30	12	9	57
TOTALS	7	34	17	16	

In the category of low deductive reasoning and high math anxiety, 2 individuals have attributed a low status/high math skill and 2 attributed a high status/high math skill in terms of this career. 57 individuals overall view this career as a low status career with a low requirement of math and thus again the independent variables have not played a role in influencing the appraisal of this career.

Table 15: Patterns of the levels of math anxiety and deductive reasoning of the research sample vs. appraisal of the job of a Bank Teller based on high or low status attributed to the job and perceived high or low math skill required to do the job.

N= 74	<u>Category 1:</u> High Deductive Reasoning/ High Math Anxiety	<u>Category 2:</u> High Deductive Reasoning / Low Math Anxiety	<u>Category 3:</u> Low Deductive Reasoning/ Low Math Anxiety	<u>Category 4:</u> Low Deductive Reasoning / High Math Anxiety	TOTALS
High Status/Low Math Skills	1	1	1	0	3
High Status/ High Math Skills	1	5	4	7	17
Low Status/ High Math Skills	2	19	4	8	33
Low Status/ Low Math Skills	3	9	8	1	21
TOTALS	7	34	17	16	

A bank teller is a job of which the overall perception is appraised as having low status and high math skill attributes. However 21 individuals also view this job as being a low status and low math skill career, which again is proof of how subjective such perceptions of careers are and how appraisals of career attributes are so varied due to subjectivity and individuality. Due to consensus again between majority of participants in category 2 and 4, math anxiety and deductive reasoning have not played an influencing role in terms of how this career has been appraised by the participants of this research study.

Table 16: Patterns of the levels of math anxiety and deductive reasoning of the research sample vs. appraisal of the job of a History Teacher based on high or low status attributed to the job and perceived high or low math skill required to do the job.

N= 74	<u>Category 1:</u> High Deductive Reasoning/ High Math Anxiety	<u>Category 2:</u> High Deductive Reasoning / Low Math Anxiety	<u>Category 3:</u> Low Deductive Reasoning/ Low Math Anxiety	<u>Category 4:</u> Low Deductive Reasoning / High Math Anxiety	TOTALS
High Status/Low Math Skills	0	10	5	2	17
High Status/ High Math Skills	0	0	1	1	2
Low Status/ High Math Skills	2	4	0	2	8
Low Status/ Low Math Skills	4	22	11	10	47
TOTALS	6	36	17	15	

The job of a history teacher is perceived as having attributes of low math skills. The overall appraisal of this job is that it requires a low math skill and is attributed with a low status in society as viewed by 47 participants again evidence of the fact that math anxiety and deductive reasoning have not influenced the appraisal of this career.

Table 17: Patterns of the levels of math anxiety and deductive reasoning of the research sample vs. appraisal of the job of an Electrician based on high or low status attributed to the job and perceived high or low math skill required to do the job.

N= 74	<u>Category 1:</u> High Deductive Reasoning/ High Math Anxiety	<u>Category 2:</u> High Deductive Reasoning / Low Math Anxiety	<u>Category 3:</u> Low Deductive Reasoning/ Low Math Anxiety	<u>Category 4:</u> Low Deductive Reasoning / High Math Anxiety	TOTALS
High Status/Low Math Skills	0	3	2	5	10
High Status/ High Math Skills	1	7	3	5	16
Low Status/ High Math Skills	5	16	4	1	26
Low Status/ Low Math Skills	2	9	8	3	22
TOTALS	8	35	17	14	

This career comes across as one, which has a dispersed pattern yet again. It is perceived as requiring high math skills as viewed by 26 individuals. Individuals perceive the career differently whether they have a math anxiety or not. 22 individuals have appraised this career as low status and requiring low math skills. What is vital to note here though is that as opposed to all the previous tables, this career has not been appraised in consensus across the categories of high or low math anxiety and high or low deductive reasoning which means that in terms of the appraisal of this career, math anxiety and deductive reasoning do play a role in how this career is appraised.

Table 18: Patterns of the levels of math anxiety and deductive reasoning of the research sample vs. appraisal of the job of a Plumber based on high or low status attributed to the job and perceived high or low math skill required to do the job.

N= 74	<u>Category 1:</u> High Deductive Reasoning/ High Math Anxiety	<u>Category 2:</u> High Deductive Reasoning / Low Math Anxiety	<u>Category 3:</u> Low Deductive Reasoning/ Low Math Anxiety	<u>Category 4:</u> Low Deductive Reasoning / High Math Anxiety	TOTALS
High Status/Low Math Skills	0	3	2	6	11
High Status/ High Math Skills	1	2	1	1	5
Low Status/ High Math Skills	1	11	2	0	14
Low Status/ Low Math Skills	5	19	12	7	43
TOTALS	7	35	17	14	

This is a career where 43 individual's perception is that low math skills are required. And due to such consistency in the pattern in this table of appraisals across the categories of people, math anxiety and deductive reasoning do not play an influencing role in the appraisal of this career/job.

Table 19: Patterns of the levels of math anxiety and deductive reasoning of the research sample vs. appraisal of the job of a Tour Guide based on high or low status attributed to the job and perceived high or low math skill required to do the job.

N= 74	<u>Category 1:</u> High Deductive Reasoning/ High Math Anxiety	<u>Category 2:</u> High Deductive Reasoning / Low Math Anxiety	<u>Category 3:</u> Low Deductive Reasoning/ Low Math Anxiety	<u>Category 4:</u> Low Deductive Reasoning / High Math Anxiety	TOTALS
High Status/Low Math Skills	3	8	4	3	18
High Status/ High Math Skills	0	2	2	1	5
Low Status/ High Math Skills	0	4	2	0	6
Low Status/ Low Math Skills	4	21	7	13	45
TOTALS	7	35	15	17	

The perception by 45 people is that low math skills are required and a low status is attributed to this career and thus again math anxiety and deductive reasoning have not played a role in influencing the appraisal of this job.

Table 20: Patterns of the levels of math anxiety and deductive reasoning of the research sample vs. appraisal of the job of a Salesman based on high or low status attributed to the job and perceived high or low math skill required to do the job.

N= 74	<u>Category 1:</u> High Deductive Reasoning/ High Math Anxiety	<u>Category 2:</u> High Deductive Reasoning / Low Math Anxiety	<u>Category 3:</u> Low Deductive Reasoning/ Low Math Anxiety	<u>Category 4:</u> Low Deductive Reasoning / High Math Anxiety	TOTALS
High Status/Low Math Skills	0	0	4	3	7
High Status/ High Math Skills	1	10	1	7	19
Low Status/ High Math Skills	1	15	4	1	21
Low Status/ Low Math Skills	5	9	8	5	27
TOTALS	7	34	17	16	

Opinion seems varied in terms of a salesman. 21 individuals appraise this career as a low status/high math skill job and 27 appraise it as a low status/low math skill job, the math anxious and low deductive reasoning ability individuals have a close a margin in their perception of the math skill needed (7) or not needed (5) for this job. What is also vital to point out is that in this career as with the electrician appraisal, there was not consensus between the groups of high math anxiety and low deductive reasoning and high deductive reasoning and low math anxiety as the majority of respondents who are less math anxious and have better deductive reasoning appraise the job of a salesman as having high math skill and low status attributed to the job whereas the majority of respondents in terms of high math anxiety and low deductive reasoning appraised this job as high status and high math skills. Again this is indicative that in terms of the appraisal of this job, math anxiety and deductive reasoning have an influencing factor in the appraisal of this job.

Table 21: Patterns of the levels of math anxiety and deductive reasoning of the research sample vs. appraisal of the job of a Travel Agent based on high or low status attributed to the job and perceived high or low math skill required to do the job.

N= 74	<u>Category 1:</u> High Deductive Reasoning/ High Math Anxiety	<u>Category 2:</u> High Deductive Reasoning / Low Math Anxiety	<u>Category 3:</u> Low Deductive Reasoning/ Low Math Anxiety	<u>Category 4:</u> Low Deductive Reasoning / High Math Anxiety	TOTALS
High Status/Low Math Skills	1	7	5	3	16
High Status/ High Math Skills	1	7	3	6	17
Low Status/ High Math Skills	1	8	2	3	14
Low Status/ Low Math Skills	4	12	7	4	27
TOTALS	7	34	17	16	

A travel agent is yet another example of a career which is difficult to pin-point as being a math or non-math-oriented career as the pattern of respondents perceptions are so dispersed. The general consensus among participants though is that 27 individuals feel that this job requires low math skills and is attributed with a low status. Here though consensus was not reached between the groups of high math anxiety and low deductive reasoning, who appraised the career as high status/high math skill and low math anxiety and high deductive reasoning who appraised the career as low status/low math skill. This suggests that again math anxiety and deductive reasoning have influenced this job appraisal.

Table 22: Patterns of the levels of math anxiety and deductive reasoning of the research sample vs. appraisal of the job of a Chef based on high or low status attributed to the job and perceived high or low math skill required to do the job.

N= 74	<u>Category 1:</u> High Deductive Reasoning/ High Math Anxiety	<u>Category 2:</u> High Deductive Reasoning / Low Math Anxiety	<u>Category 3:</u> Low Deductive Reasoning/ Low Math Anxiety	<u>Category 4:</u> Low Deductive Reasoning / High Math Anxiety	TOTALS
High Status/Low Math Skills	2	12	6	6	26
High Status/ High Math Skills	0	1	2	3	6
Low Status/ High Math Skills	1	3	2	1	7
Low Status/ Low Math Skills	4	19	7	5	35
TOTALS	7	35	17	15	

35 individuals appraise that a low math skill is required but what is also interesting to note is the close margin in perception of this career as 26 individuals view this career as requiring low math skill but as having a high status attributed to it. This is yet another result that illustrates so well the subjectivity in appraising careers and the fact that many other factors may come into play in appraising careers other than the given parameters of status and math skill as investigated in his study. In addition, consensus was not reached again in terms of high math anxiety and low deductive reasoning participants who appraised the career as high status/low math skill and low math anxiety and high deductive reasoning participants who appraised the job as low status/ low math skill, indicative that again math anxiety and deductive reasoning play a part in influencing the appraisal of this job. Speculatively, such factors may be that a friend or family is involved in this job and it is thus seen in a favourable and important light by the respondent(s). There may also be different point of reference in appraising careers – In this career of a chef- if one thinks of someone famous such as Jamie Oliver, a well-renowned British chef, he may have a high status and influence respondents that they respond in this fashion but Joe next door may be a chef but not renowned like Jamie Oliver and thus not have a high status.

Table 23: Patterns of the levels of math anxiety and deductive reasoning of the research sample vs. appraisal of the job of a Model based on high or low status attributed to the job and perceived high or low math skill required to do the job.

N= 74	<u>Category 1:</u> High Deductive Reasoning/ High Math Anxiety	<u>Category 2:</u> High Deductive Reasoning / Low Math Anxiety	<u>Category 3:</u> Low Deductive Reasoning/ Low Math Anxiety	<u>Category 4:</u> Low Deductive Reasoning / High Math Anxiety	TOTALS
High Status/Low Math Skills	4	26	9	12	51
High Status/ High Math Skills	0	0	0	0	0
Low Status/ High Math Skills	0	0	0	0	0
Low Status/ Low Math Skills	2	9	8	4	23
TOTALS	6	35	17	16	

An outcome of low math skill required for this career is appraised by 51 participants. The varying in people's perceptions is also noted here with 23 respondents appraising the job as requiring low math skill and having a low status. Due to the consensus of appraisal between category 2 and 4, this career has been appraised without the influence of math anxiety and deductive reasoning.

Table 24: Patterns of the levels of math anxiety and deductive reasoning of the research sample vs. appraisal of the job of a Waiter based on high or low status attributed to the job and perceived high or low math skill required to do the job.

N= 74	<u>Category 1:</u> High Deductive Reasoning/ High Math Anxiety	<u>Category 2:</u> High Deductive Reasoning / Low Math Anxiety	<u>Category 3:</u> Low Deductive Reasoning/ Low Math Anxiety	<u>Category 4:</u> Low Deductive Reasoning / High Math Anxiety	TOTALS
High Status/Low Math Skills	0	1	1	4	6
High Status/ High Math Skills	0	0	0	1	1
Low Status/ High Math Skills	0	6	2	1	9
Low Status/ Low Math Skills	7	28	13	10	58
TOTALS	7	35	16	16	

The perception of low math skill necessary for this job is evident in the table above with the overall outcome indicating that 58 people appraised this job as requiring low math skill and attributed with a low status. Again math anxiety and deductive reasoning do not play an influencing role in the appraisal of this career.

Table 25: Patterns of the levels of math anxiety and deductive reasoning of the research sample vs. appraisal of the job of an Actor based on high or low status attributed to the job and perceived high or low math skill required to do the job.

N= 74	<u>Category 1:</u> High Deductive Reasoning/ High Math Anxiety	<u>Category 2:</u> High Deductive Reasoning / Low Math Anxiety	<u>Category 3:</u> Low Deductive Reasoning/ Low Math Anxiety	<u>Category 4:</u> Low Deductive Reasoning / High Math Anxiety	TOTALS
High Status/Low Math Skills	2	22	7	7	38
High Status/ High Math Skills	4	8	5	8	25
Low Status/ High Math Skills	0	0	2	1	3
Low Status/ Low Math Skills	1	4	2	1	8
TOTALS	7	34	16	17	

It can be seen in the above table that the margin between the perceptions of requiring high (25) and low (38) math skills for this category for individuals is very slim. However, in the appraisal of this career, math anxiety and deductive reasoning seem to have a small influencing role in terms of how the career is appraised as the majority of individuals in category 2 have appraised the job of actor as high status/low math skill and the majority of individuals in category 4 have appraised the job of actor as high status/high math skill. However this is not very good evidence as opposed to that of an electrician, salesman, travel agent or chef of which there was a big discrepancy in terms of how many of the majority of people in category 2 and 4 appraised the career differently. For this job of an actor there is only a difference of one and as a result, it is proposed that this career be seen in the light that math anxiety and deductive reasoning do not play a role as influencing factors in the appraisal of this career.

In summary of this chapter, an overview will now be provided of the patterns that occurred within all 25 careers that have been analyzed. In terms of a bus driver, 81% of participants appraised this career as requiring low math skills and attributed a low status to this career. In terms of a lawyer, 53% attributed a high status and high math skill in their appraisal of this career. Some individuals however, appraised this career as requiring low math skills.

A doctor was appraised as requiring high math skills and a high status with 91% of people appraising this field as such. This is clearly a field that individuals with a high deductive reasoning and low math skill would potentially engage in due to the intense

nature of math and the ability to think deductively in this field. A psychologist had a different pattern in terms of the perception of whether this field requires a high or low math ability as 41% viewed this career as requiring high math ability and 50% viewed psychology as requiring low math ability. This may be attributed to perceptions being varied in terms of the general knowledge that individuals may have of the field of psychology and the actual job description. Engineering on the other hand was appraised by 79% of individuals as requiring high math skills and having a high status attached to it. Consistent appraisal was also noted in term of the career of a pilot requiring high math skill and a high status by 73% of participants. Although a secretary was appraised as a low status and low math skill job, the pattern here was more varied, evidence of how subjective people's views are in the appraisal of careers. An actuary was also appraised as requiring high math skills and attributed with a high status by 74% of the sample. Interestingly enough though, 16% viewed this career as requiring low math skills but perhaps this could be attributed to the fact that the participants had limited knowledge of this job, although this is a speculation, it is a possibility to explain his result.

As with a president, 58% appraised this job as requiring high math skill and having a high status but 6 people viewed this career as requiring low math skill and two people viewed it as a low status job. This just shows how varied peoples perceptions are yet again and this may also be attributed to different outlooks in life and possibly varied point-of-reference as will be mentioned later in terms of the results and patterns of the appraisal of a chef. A restaurant manager was appraised a requiring high math skill and having a high status by 50% of the participants. An architect on the other hand was

appraised as requiring high math skill and attributed with a high status as appraised by 76% of participants. A painter was appraised rather interestingly as the pattern here was different in terms of the fact that although 77% viewed this job as requiring a low status and low math skill ability, two individuals viewed this job as requiring a high math ability and two individuals viewed it as requiring not only a high math ability but also attributed a high status to the job of a painter. A bank teller was appraised by 45% viewed this job as a low status but high math skill job and 28% viewed it as a low status and low math skill job.

A history teacher on the other hand was viewed in the light of a low status, low math skill job as appraised by 64% of the sample. An electrician though was appraised with 35% viewing this job as a low status and high math skill job and 30% viewing this job as a low status and low math ability job. The job of plumber was appraised as requiring low math skill and attributed with a low status by 58% of the sample. The same notion applied to a tour guide appraised as requiring low math skill and attributed with a low status by 61% of the sample. Perceptions of a salesman led to appraisal that was indicative of the fact that 28% of people viewed this job as requiring high math ability and 36% as the job requiring low math ability. A travel agent on the other hand was different in that the appraisals were varied but 36% saw this job in the light of requiring low math skill and having a low status.

The chef was appraised very interestingly and it at this stage, although it is speculation, that one can state that a point-of –reference comes into play here as individuals may think

of a chef in two very different manners. Firstly, one may think of a chef as being famous in terms of Jamie Oliver, a renowned British chef or one may think of a chef as being a unknown entity that works in a restaurant and is known and acknowledged by very few people. This is seen in the dispersion of the appraisal of this career as 47% of individuals appraised this career as having a low status and low math skill but 35% appraised it as having a high status and low math skill ability as a requirement for the job.

A model was appraised as being a high math skill and low status job by 69% of the sample and 31% viewed this job as requiring low math skill but also attributed a low status to this profession. An actor however, was appraised as requiring low math skill and strangely enough attributed with a low status in society by 78% of the participants. Lastly, a waiter was appraised as 34% viewed this career as requiring high math skill and 51% as requiring low math ability.

The finding thus distinctly indicates that the majority of careers are consistently appraised by all individuals regardless of whether they have a high/low math anxiety or high/low deductive reasoning ability. This statement is true with the exception of the careers of electrician, salesman, travel agent and chef whereby the appraisal of these careers was not done in consensus across all four groups of individual and particularly not across the group of high math anxiety and low deductive reasoning and low math anxiety and high deductive reasoning, which are two groups that have been carefully monitored and commented on throughout the result chapter for each table as these are the two groups this study is particularly interested in taking into account and analyzing.

Chapter seven will now look at discussing all of the results found in this study, with reference to and based on the literature review provided in this thesis.

CHAPTER 7: DISCUSSION

Discussion of Results

This research study has generated a numerous amount of potent results that now requires some discussion. The aim of this study was to investigate whether a relationship existed between math anxiety and deductive reasoning. Once this relationship had been clarified, appraisal of career attributes was to be investigated to find out whether math anxiety or lack thereof and deductive reasoning or lack thereof had any weight when the sample of this study appraised specified careers in terms of status and the requirement of high or low math skill as attributes of the careers.

This study has generated results that indicate that a negative correlation exists between the two variables of math anxiety and deductive reasoning. As stated in the results chapter, this translates into the fact that when math anxiety increases, deductive reasoning ability decreases and if math anxiety decreases, the ability to reason deductively then increases. As this relationship has now been cemented as fact, this study then went on to investigate whether these two variables of math anxiety and deductive reasoning played a part in appraising careers in terms of the attributes of status and math skill required when engaging in the career.

This investigation then produced some potent results and interesting patterns in terms of the tables that were generated based on the 25 careers that were given to the participants

of this study to plot on a graph in terms of how they perceived these careers regarding the status attributed to them in society and also their perception of the level of math skill required for each career.

The tables that were generated linked the two variables of math anxiety and deductive reasoning to the attributes of status and math skill for each career. Once each participant's math anxiety had been measured by means of the MARS and once each participant's deductive reasoning had been measured by use of the DAT-S verbal reasoning test, the participants were grouped in to four categories depending on their individual results of these two tests. A participant either fell into the category of high math anxiety/ low deductive reasoning, low math anxiety/ high deductive reasoning, high math anxiety/ high deductive reasoning or low math anxiety/ low deductive reasoning. Each participant's appraisal of each career was then recorded on the tables 1-25 in the qualitative results section in terms of whether the appraised career one – a bus driver as having a high or low status and requiring high or low math skills. If participant X had a low math anxiety and high deductive reasoning and appraised a bus driver as having low status and low math skill required to do the job as attributes of the job, then participant X's result would be recorded in that block on the table that corresponded the participants low math anxiety/ high deductive reasoning and attribution of low status/ low math skill for the bus driver.

By following this procedure for all 25 careers, the patterns that were generated were varied and were tabulated in chapter six, indicating how the careers were appraised and also how each career would be appraised differently by each category of participants.

These results, as stated were extremely varied in pattern and as discussed in the results chapter, yielded the fact that in many cases certain careers were appraised by the majority of participants in the same manner (bus driver, lawyer, doctor, psychologist, engineer, pilot, secretary, farmer, typist, actuary, president, restaurant manager, architect, painter, bank teller, history teacher, plumber, tour guide, model and waiter). This drew the researcher to the conclusion that as there was consensus in appraisals of certain careers, it is not necessarily the case that math anxiety or deductive reasoning would play a role in how an individual appraises a career. Some of the careers though were varied in their appraisal and a lack of consensus existed as a result of this varied means of appraisal. As a result, the appraisal of such careers were influenced by math anxiety and deductive reasoning as particular attention was given to the fact that the majority of participants in the group of high deductive reasoning and low math skill and low deductive reasoning and high math skill did not reach consensus in terms of appraising these careers (electrician, salesman, travel agent, and chef).

Within the results chapter six, each career has been discussed in detail as to the percentage of which category appraised each career according to the attributes of high or low math skill and status. As this was discussed previously, it would be of no value to repeat those results here in detail but what is interesting to mention is that individuals

may have varied reasons for appraising a career in a certain way due to the variety of patterns that emerged in each career. It is speculative but plausible to state that for example in terms of a chef, the degree that this career was appraised so differently in terms of a high or low status could be as a result of a varied point of reference that each individual may have had when thinking of a chef. This was also mentioned in the results chapter and the fact that people are so subjective as individuals was also discussed and is evident in the various ways that each person appraised each career. However the crux of the matter was how the individuals appraised the careers as a result of their own high or low math anxiety and high or low deductive reasoning ability. The weight of these two variables in influencing a different appraisal of careers in terms of the perceived levels of attributes of math skill and status is not evident in that individuals in the different categories had consensus in most careers as to whether the career was appraised as a high/low status career and requiring high or low math skill and only in appraising the career of electrician, salesman, travel agent and chef was consensus not reached between category 2 – high deductive reasoning and low math anxiety and category 4 – high math anxiety and low deductive reasoning. These two groups had to be compared because they are key to what this research is focusing on and reflect the negative correlation that was reported on in chapter six between the two variables as having a relationship that is inversely proportional.

Discussion, Encompassing Theoretical and Practical Implications

In light of the results and analysis that have been presented, a further discussion now aims to highlight the links between the results and the literature that has been presented in this thesis in a broad context.

The results in chapter six table two, have suggested that there is negative, yet significant relationship between deductive reasoning and math anxiety. This is indicative of the fact that math anxiety is inversely-related to deductive reasoning and if individuals have a better deductive reasoning in terms of verbal reasoning, they would have less math anxiety and an improved ability to do mathematics as mentioned in the discussion above in 7.1. This would also be a means of substantiating the work of Hargadon and Lordi in chapter four, in terms of the “Junior Achievement Programme” (JAP) that they propose. Hargadon and Lordi have a basis to carry out their JAP initiative as it would be evident that math anxiety causes more people to shy away from Accountancy, Engineering and the like.

To eliminate math anxiety, one would have to eliminate the causes of it in terms of causes mentioned in the literature review. Educators that may cause the anxiety through projection of their own mathematical incompetence or by associating mathematics with a high or low self-esteem of the student in a school environment should be trained differently to approach the situation in a different fashion as educators, in chapter two, have been documented as being part of the causes of math anxiety in this regard. Parental

causes of enticing a math anxiety would also be decreased or eliminated if this anxiety were removed. The parent would not entice a math anxiety in their child by stating that they found math so difficult or by placing an unnecessary strong emphasis on the child to perform well in the subject or provoke a fear in the child of how limited his or her future career options would be without mathematics. Although this was not mentioned in the literature review, this notion is assumed in paradox to the research that Stuart (2000) carried out as in her study, she found that there was no link to parental influence of children's experience of math as this proved to be an individual and unbiased experience on the child's part. Parents do however influence career choice as alluded to in chapter four by Birk and Blimline (1984) and Steinke and Kaczowski (1961). As a result, the pupils would display better self-esteem and confidence in performing mathematics and would have reduced if not no anxiety when taking mathematical tests, thus again, benefiting them by improving their mathematical performance, otherwise hindered by a math anxiety.

The Yale theory in chapter two is substantiated here too as it proposes that pupils would react differently to the same situation- some would be more or less anxious than others when it comes to coping in a math environment. Characteristic responses of these pupils would be seen by a fear of failure as one example. This research study also goes on to support the work of Ho et al (2000), by supporting their notion of the two proposed models – interference vs. deficit. Their interference model proposed that anxiety affects performance, which is true to this research as without anxiety, ability to reason deductively is improved. As Ho et al (2000) have stated, this notion holds more ground

than the deficit model that proposes that performance in terms of mathematics is due to poor preparation or adverse study habits. Gardner also proves true in his work as his notion of learning a second language- mathematics, does provoke anxiety.

As these results have suggested the absence of math anxiety, as improving deductive reasoning, one would assume that in terms of the theory covered, pupils without a math anxiety would be better deductive thinkers and thus have superior verbal reasoning and logical thought, so vital for excelling in mathematic fields. Educators could thus capitalize on this by conducting their lessons through suggested notions of explanation-based learning, which encompasses an integral deductive mechanism. Pupils who reason well deductively would naturally then exhibit fluent simple and multistep deductive reasoning and hypothetical deductive reasoning, which would not only be noticeable from elementary school and onwards but be a skill that he or she could acquire and maintain, to pursue a mathematically-oriented career in the future.

These results have also supported the literature that has been mentioned in terms of career appraisals and attributes.. In accordance with the theory of Gottfredson's stages of development and in particular, orientation to sex roles and social valuation, society has shaped one to view certain careers as male or female-oriented. This links well with the findings in terms of the career appraisal graph that was operationalized for this study as the result for this graph was indicative of the fact that pupils viewed careers as requiring varying levels of status and math skills with some careers seeming to be more inviting to math anxious and low deductive reasoning individuals and others not an option for such

individuals due to the high math skill that is required in these careers and the perception of this as being so integral in that particular career of which a doctor is an example. One should take into account the links to Gottfredson and the notion of social valuation as certain careers have been imprinted on individual's in terms of what social class they belong to as they are developing and growing-up as attributes that may influence an individual's career appraisal, as documented in chapter four.

One can thus gather that as the majority came to the same conclusion in terms of skill and status level, required for each career, societal influence on people and their perceptions of careers is an ever-dominant feature. The fact that the majority of participants viewed the careers as requiring high math skills, with a math anxiety implicitly noted in the sample, supports the study mentioned in the St. Joseph Journal that states how there are less applicants and graduates in the discipline of Engineering (requiring math). This also suggests that Horgadon and Lordi (2001) are on the right track by introducing their Junior Achievement Programme (JAP) so as to encourage students towards careers that encompass mathematics as opposed to following the trend of less students being pooled for mathematically oriented careers. This again being so important in a world that is now a global village, so technologically advanced and requiring more and more competent individuals to contribute to the field of technology that without any doubt, requires math skill and ability.

These notions also add substance to the rationale for this research study being conducted in the first place in terms of the future of organizations and their limited recruitment and

selection of whom to employ, if so few individuals are mathematically competent. This may be interpreted in the light that the subject choices grade nine children make in secondary school for their matric year, shapes their future career path and this lends one to draw the conclusion that if a math anxiety were to exist and these subject choices were made to avoid math subjects, these pupils would not engage in math careers and thus the job pool for jobs that are math-oriented would be very small for organizations to recruit and select from- a problem in a world that is now a global village and so technologically advanced, demanding of math and math competence even more than in the past.

In addition, the theory that supports career appraisal in this study, being that of Gottfredson, is supported by this research study. When the child reaches nine to thirteen years of age, social class awareness becomes apparent. As a result, one can deduce that the link to this research study is through the notion that the majority of participants plotted careers in terms of high status, indicative that through societal values, norms and perceptions, most viewed the majority of careers as being associated with a high class status, suggesting each one of the pupils conforming to the notion of being aware of their social class and openly exhibiting this through the career graph. This may have also been the case as these individuals attend prestigious schools, in line with their social status or even that of their parents, friends and the like.

Theoretical and Practical Limitations

This study is limited in terms of the sample that was used. Both sets of pupils were taken from two prestigious institutions. As a result, the sect of South African society that of a less privileged background, was not encompassed in this research. This research would thus be applicable to middle and upper class South Africans only. If it were to have incorporated children from less privileged backgrounds, due to the legacy of apartheid, the level of math anxiety may have been greater and attributed to a poor level of education. In addition, the research would be limited to applicability within the South African context only.

In addition, the data generated by this study may have been affected by the time that was allocated for the pupils to complete the instruments that were operationalized. The fact that they were given an hour to complete all three instruments may or may have not affected the pupils performance and accuracy in this regard.

Ethical Considerations

This research, although having made use of a vulnerable sample has ensured that all ethical considerations have been met and addressed. The children that were used for this study, under the age of fifteen years were made use of only once parental ascent had been gained. Those pupils who were fifteen and over were able to provide their own consent to participate in the research. At no stage were any of the pupils coerced into participating in this study. They were all given an option as to whether they would like to participate or not. All those who volunteered to take part in the research were given a subject information sheet that explained what the research was about and why they were participating as well as what they could expect when participating in the study. At no point was any material objects (in terms of rewards or the like) used to encourage participation. All the participants were guaranteed anonymity and all documentation was kept confidential, only collected and viewed by the researcher himself. None of this documentation is in existence any longer. The only remnant of the research is the coded data set that it yielded, which will be passed on to the University of the Witwatersrand along with this thesis. Only one of the schools that participated in the research required anonymity and this was provided and guaranteed. Feedback will be given to both schools in the form of this thesis.

As this research does not pose any threat to the participants and has been conducted to the highest standard in terms of ethical procedures and considerations, this research can be concluded to be ethically sound and secure.

Conclusion

Through conducting this research, substantiation for theory and implications in practice have been elicited. This research, although limited, as previously mentioned has addressed the research questions and met the aims as stipulated in the methodology. Relatedness of the variables of math anxiety, deductive reasoning and career appraisal have been reviewed in terms of substantial literature in the literature review and investigated through quantitative and qualitative techniques in the results and analysis chapter of this dissertation. These results and analyses have been interpreted and elaborated on within the discussion, presented in chapter seven and links to theory have been covered as well. In addition, this research has been stipulated to be ethically sound.

It is the hope of the researcher that the results of this research infiltrate into schools and homes within South Africa and portray the important role that parents and educators alike should fulfill by encouraging a world for the child that is math friendly and builds human beings that have a fluent ability to reason deductively. The importance of this cannot be stipulated more at this point in time on a global scale. Mathematics is becoming more of a vital skill as the world becomes more technological. The reduction and possible elimination of math anxiety in school going children, should be looked at in a serious light so as to provide a future for the children of South Africa to embrace any career that he or she may wish to, a career that encompasses their interests and goals but most importantly, one that allows them to reach their potential in life and not be limited by societal norms, values and perceptions or anxiety of math, evoked by parental or teacher

projection. In my final comments, I would like to draw attention to the fact that this research study has proved, as discussed and presented in chapter six, that a level of math anxiety and deductive reasoning does not really play a part in influencing a child's appraisal of a career and whether such appraisals are valid or based on false perceptions or not enough exposure of the world of work and occupations that are available will not be known in the context of this study. However, this does imply that if these two independent variable of math anxiety and deductive reasoning do not have weight in influencing the appraisal of a career, students should have the notion that they would be capable of pursuing any career. However, due to our inherent competencies and abilities as individuals, this will ultimately limit one to certain fields and dispel the notion of being able to engage in any career. Despite being math anxious or not and thus despite having a high or low deductive reasoning, appraisals of careers are not effected or influenced by these factors. This may be a worry in an educational context as it could be an explanation as to why at university level, so many students change courses or why so many adults are dissatisfied with their careers and jobs in the long term but such an assumption is better left for a different study to pursue further.

Suggestions for Future Research

A study to investigate the effect of race on math anxiety and career appraisal could be investigated as a suggestion for future research or even a study to investigate whether a poor level of education results in greater math anxiety in less privileged South Africans, due to the legacy of apartheid. Another area of interest may be to investigate the extent that math anxiety effects organizational recruitment and selection in terms of limited individuals with math skill and competence or the extent that parental and teacher influence exerts on pupils to succeed mathematically and pursue math careers. As a final suggestion, one may also launch a study to investigate society and how it shapes individuals perceptions of math and career appraisals.

CHAPTER 8: REFERENCE LIST

<http://ai.eecs.umich.edu/cogarch0/common/capa/reason.html>. Inductive and Deductive Reasoning. Retrieved from the worldwide web on 19 November 2004.

Annenberg/CPB and Learner. Org. Teaching Math: Defining Reasoning and Proof. http://www.learner.org/channel/courses/teachingmath/grades6_8/session_03. Retrieved from the worldwide web on 19 November 2004.

Anonymous (2003). Fewer Students Plan Engineering Careers. St. Joseph Journal, 10 (7), 3.

Bower, B. (2001). Maths Fears Subtract from Memory, Learning. Science News, 159 (2), 405.

Byrne, R. (1996). The Core of Cognition. The American Journal of Psychology, 109 (2), 318-323.

Feldman, R.S. (2001). Fitting the Task to the Man, A Textbook of Occupational Ergonomics (4th ed).

Furner, J.M. and Berman, B.T. (2004). Building Math Confidence for a High-Tech World. Academic Exchange Quarterly, 8(2), 214-217.

Furner, J.M. and Duffy, M.L. (2002). Equity for All Students in the New Millennium. Intervention in School and Clinic, 38 (2), 67-73.

Gardner, R.C. and Lalonde, R.N. (1993). Statistics as a Second Language: A Model for Predicting Performance in Psychology Students. Canadian Journal of Behavioural Science, 25 (1), 108-125.

Hargadon, J.M. and Lordi, F.C. (2001). Junior Achievement can make Accounting Attractive to High School Students. Pennsylvania CPA Journal, 72(2), 22.

Ho, H-Z, Senturk, D., Lam, A.G. and Zimer, J.S. (2000). The Affective and Cognitive Dimensions of Math Anxiety: A Cross-National Study. Journal for Research in Mathematics Education, 31 (3), 362-378.

Howell, D.C. (1999). Fundamental Statistics for the Behavioral Sciences (4th ed.). Johannesburg: Duxbury Press.

Johnson-Laird, P.N. (1999). Deductive Reasoning. Annual Review of Psychology, 50, 109-135.

Kroesbergen, E.H., Van Luit, J.E.H. and Naglieri, J.A. (2003). Mathematical Learning Difficulties and PASS Cognitive Processes. Journal of Learning Disabilities, 36(6), 574.

Levitt, E.E. (1967). The Psychology of Anxiety. New York: The Bobbs-Merrill Company, Inc.

Mitchell, C.E. (1988). Preparing for Vocational Choice. Adolescence, 23 (90), 331-334.

Oner, N.P. (1977). Impact of Teacher Behavior and Teaching Technique on Learning by Anxious Children. In C.D. Spielberger and I.G. Sarason (Eds), Stress and Anxiety (Pp.171-186). Washington: Hemisphere Publishing Corporation.

Osipow, S.H. and Fitzgerald, L.F. (1996). Theories of Career Development. (4th ed.). Boston: Allyn and Bacon.

Perry, A.B. (2004). Decreasing Math Anxiety in College Students. College Student Journal, 38(2), 321-324.

Politzer, G. and Bourmaud, G. (2002). Deductive Reasoning from Uncertain Conditionals. British Journal of Psychology, 93 (3), 345-381.

Rachman, S. (1998). Anxiety. East Sussex: Psychology Press.

Reid, D.A. (2002). Describing Reasoning in Early Elementary School Mathematics. Teaching Children Mathematics, 9(4), 234.

Richardson, F.C. and Suinn, R.M. (1973). The Mathematics Anxiety Rating Scale: Psychometric Data. Journal of Counseling Psychology, 19 (6), 551-554.

Richardson, F.C. and Woolfolk, R.L. (1980). Mathematics Anxiety. In I.G. Sarason (Ed), Test Anxiety: Theory Research and Applications. (Pp. 271-258). Lea: Hillsdale New Jersey.

Rowsey, R.E. (1997). The Effects of Teachers and Schooling on the Vocational Choice of University Research Scientists. School Science and Mathematics, 97 (1), 20-26.

Schwartz, A.E. (2000). Axing Maths Anxiety. The Education Digest, 65 (5), 62-64.

Sharf, R. (2002). Applying Career Development Theory to Counseling. (3rd ed.). United States of America: Brooks/Cole Publishing Co.

Sher, D.P. (2000). The Influence of Parental Career Interests on Adolescents' Career Choices. A Master of Arts Dissertation. University of the Witwatersrand: Johannesburg.

Spark Notes- Barnes and Noble (2004). Geometry- Inductive and Deductive Reasoning. <http://www.sparknotes.com/math/geomtery3/inductiveanddeductivereasoning/section1.html> Retrieved form the worldwide web on 19 November 2004.

Stolpa, J.M. (2004). Math and Writing Anxieties. Phi Kappa Phi Forum, 84(3), 3.

Stuart, V.B. (2000). Maths Curse or Math Anxiety? Teaching Children Mathematics, 6 (5), 330-335.

Swanson, J.L. and Fouad, N.A. (1999). Career Theory and Practice: Learning through Case Studies. United States of America: Sage Publications, Inc.

Tapia, M. and Marsh II, G.E. (2004). The Relationship of Math Anxiety and Gender. Academic Exchange Quarterly, 8(2), 130-135.

Toeke, D.J. (1998). Effectiveness of a Mathematics Methods Course in Reducing Math Anxiety of Preservice Elementary Teachers. School Science and Mathematics, 98 (3), 136-139.

Vosloo, H.N., Coetzee, N. and Claasen, N.C.W. (2000). Manual for the Differential Aptitude Test- Form-S (DAT-S). Pretoria: Human Sciences Research Council.

Wilkinson, S. (1996). Factors Affecting the Career Choices of Male and Female Civil Engineering Students in the UK. Career development International, 1(5), 45-50.

Wulff, M.B. and Steitz, J.A. (1997). Curricular Track, Career Choice, and Androgyny among Adolescent Females. Adolescence, 32 (125), 43-50.

Zunker, V.G. (1994). Career Counseling: Applied Concepts of Life Planning. (4th ed.).
California: Brooks/Cole Publishing Co.

APPENDIX

APPENDIX A

University of the Witwatersrand
Department of Psychology
Private Bag 3
Johannesburg
2050

The Headmaster/Headmistress

Permission to Access the School for Research

My name is Brent Herman; I am currently studying my master's degree in industrial psychology at the University of the Witwatersrand. As a prerequisite for fulfilling this degree, I am required to present a research dissertation to the psychology department at the university.

My topic is based on math anxiety and deductive reasoning and how these variables affect career appraisal in grade 9 pupils. Please would you allow me access to a sample of 40 grade 9 pupils at your school in order for me to conduct this study and generate results?

Please would you contact me as soon as possible on: 072 480 2968 to inform me of your decision. If you have any further questions regarding the study, I would be more than glad to answer these.

Thanking you

BRENT HERMAN

APPENDIX B

18-08-2004

To whom it may concern

Permission to Access the School for Research

My name is Brent Herman and I matriculated at Pretoria Boys High School in 1999; I am currently studying my master's degree in industrial psychology at the University of the Witwatersrand. As a prerequisite for fulfilling this degree, I am required to present a research dissertation to the psychology department at the university.

My topic is based on math anxiety and deductive reasoning and how these variables affect career appraisal in grade 9 pupils/form 2. I am using this sample as it is at this stage that these pupils would make subject choices to take them through to their matric year and beyond into a career. Please would you allow me access to a sample of 40 grade 9 pupils/form 2 pupils at your school in order for me to conduct this study and generate results? They must all be 15 years or older so that I can gain their consent and do not their parents assent. I will be providing each pupil with a subject information sheet, explaining the research to them and only volunteers will participate, to avoid coercion. They will be required to sign a consent form, which I require for ethical purposes.

At least 30-45 minutes is required with them to gain all the information necessary, even if this can be done during a Guidance class. I will be administering 3 instruments- The Math Anxiety Rating Scale (MARS), The Differential Aptitude Test- Form S: Test 2 – Verbal Reasoning (DAT-S) and a graph that they need to plot careers on axes of status versus math skills required, based on Gottfredson's theory and developed by myself. In no way does this research provide any ethical dilemmas and neither does it pose any harm to the students. If you are comfortable, allowing me to go ahead with this project, I will require a letter on behalf of the school stating that you allow me access. You do not have to provide me with a letter on your letterhead if you wish to stay anonymous

throughout the research. I am have chosen your school as it is convenient for me as I am based in Pretoria and have a history at Pretoria Boys High.

Please would you contact me as soon as possible on: 072 480 2968 or brenther@mweb.co.za to inform me of your decision. If you have any further questions regarding the study, I would be more than glad to answer these. Please fax all documentation to me at (012) 46-06771.

Thanking you

BRENT HERMAN

APPENDIX C

August/September 2004

My name is Brent Herman and I am conducting research for the purposes of obtaining a master degree in Industrial Psychology at the University of the Witwatersrand. My area of focus is that of math anxiety and deductive reasoning and how this affects career appraisals, in the South African context. I will be using a sample of 40 male and 40 female grade 9 pupils. I would like to invite your child to participate in this study. This research will occur at the school during one of your child's Guidance classes.

Participation in this research will entail completing a form in which your child must also consent to taking part in this study as well as a biographical questionnaire. In addition, your child will be required to complete three tests- one on math anxiety, another on deductive reasoning and the third on career appraisal. Participation is voluntary and your child will not be advantaged or disadvantaged in any way for choosing to complete or not to complete the tests. The documentation that is required will be handed out to him/her in an envelope and all envelopes will be numbered from 1-80 so that anonymity is ensured. The completed tests will not be seen by anyone in the school and only be processed by myself. It should take no longer than 45 minutes to complete all the documentation. The responses will only be looked at in relation to all other responses, thus feedback will be given to the school as a group and not as individuals.

This research will contribute both to an additional set of knowledge on math anxiety and deductive reasoning as factors that may influence career appraisal. The study will also add knowledge to the discipline of psychology as well as generate information for the school to note how to improve aspects of your child's school life and to facilitate more confident attitudes towards mathematics.

BRENT HERMAN

I hereby consent to my child participating in this research.

Signed _____ at _____ on the _____

Day of _____ 2004.

APPENDIX D

August/September 2004

My name is Brent Herman and I am conducting research for the purposes of obtaining a master degree in Industrial Psychology at the University of the Witwatersrand. My area of focus is that of math anxiety and deductive reasoning and how this affects career appraisal, in the South African context. I will be using a sample of 40 male and 40 female grade 9 pupils. I would like to invite you to participate in this study.

Participation in this research will entail completing a form in which you consent to taking part in this study as well as a biographical questionnaire. In addition, you will be required to complete three tests- one on math anxiety, another on deductive reasoning and the third on career appraisal. Participation is voluntary and student will be advantaged or disadvantaged in any way for choosing to complete or not to complete the tests. The documentation that you require will be handed out to you in an envelope and all envelopes will be numbered from 1-80 so that anonymity is ensured. The completed tests will not be seen by anyone in your school and only be processed by myself. It should take no longer than 45 minutes to complete all the documentation. Your responses will only be looked at in relation to all other responses, thus feedback will be given to the school as a group and not as individuals.

If you choose to participate in this study, please complete the tests in the envelope, which you will do under my instruction. Once completed, please place them back in the envelope and seal the envelope and return them to me at the end of your class. This process will ensure that nobody else has access to your completed documentation and thus confidentiality will be ensured.

This research will contribute both to an additional set of knowledge on math anxiety and deductive reasoning as factors that may influence career appraisal. The study will also add knowledge to the discipline of psychology as well as generating information for your school to note how to improve aspects of your school life and to facilitate more confident attitudes towards mathematics.

Kind Regards

BRENT HERMAN

APPENDIX E**Consent for Participation in the Research Study**

Dear pupil

By signing this letter, you are consenting to participating in this research study and you are declaring that you have read the attached subject information sheet that explains the purposes and procedure of this study and that you fully understand this.

Signature

Date

APPENDIX F**Biographical Questionnaire**

Please place a cross (x) over the item that applies to you

- | | |
|---|---|
| 1) My gender is | Male / Female |
| 2) I am ____years old | 14 15 16 Other |
| 3) My home language is | English Afrikaans Sotho
Xhosa Zulu Other |
| 4) My race is (statistic purposes) | Black Caucasian (White)
Indian Colored |
| 5) I have been at this school for since grade 8 | Yes No |
| 6) If No, did your last school offer you as good an
education? | Yes No |

APPENDIX G

Math Anxiety Rating Scale (Revised) (MARS)

For each of the following situations, please choose the **level of anxiety** that best matches the amount of anxiety you would experience in that situation.

E.g. If you would feel a little anxiety, choose level **B** (*A Little*)

	A <i>Not at All</i>	B <i>A little</i>	C <i>Fair Amount</i>	D <i>Much</i>	E <i>Very Much</i>
1. Opening a math book and seeing a page full of problems					
2. Listening to a lesson in a math class					
3. Starting a new chapter in a math book					
4. Signing up for a math course					
5. Picking up the math text book to begin working on homework					
6. Realizing you have to take math until grade 9					

	A <i>Not at All</i>	B <i>A Little</i>	C <i>Fair Amount</i>	D <i>Much</i>	E <i>Very Much</i>
7. Not knowing the formula needed to solve a particular problem					
8. Being given a homework assignment of difficult math problems, due in the next class					
9. Being given a quiz in a math class					
10. Listening to another student explain a math formula					
11. Working on an abstract math problem: "If x = outstanding account and y = total income, calculate how much you have left for recreational expenditure"					

	A <i>Not at All</i>	B <i>A Little</i>	C <i>Fair Amount</i>	D <i>Much</i>	E <i>Very Much</i>
12. Hearing a friend try to teach you a math procedure and not understanding what he/she is telling you					
13. Working around at school and thinking about a math course					
14. Watching a teacher work on an algebraic equation on the blackboard					
15. Walking into a math class					
16. Solving a square root problem					
17. Looking through the pages of a math text book					
18. Walking to a math class					

	A <i>Not at All</i>	B <i>A Little</i>	C <i>Fair Amount</i>	D <i>Much</i>	E <i>Very Much</i>
19. Talking to someone in your class who does well in math and not understanding what he/she is explaining					
20. Being asked how you arrive at a particular solution for a problem					
21. Reading and interpreting graphs or charts					
22. Tallying up the results of a survey or poll					
23. Doing a word problem in algebra					
24. Sitting in a math class and waiting for the teacher to arrive					
25. Being called upon to recite in a math class when you are prepared					

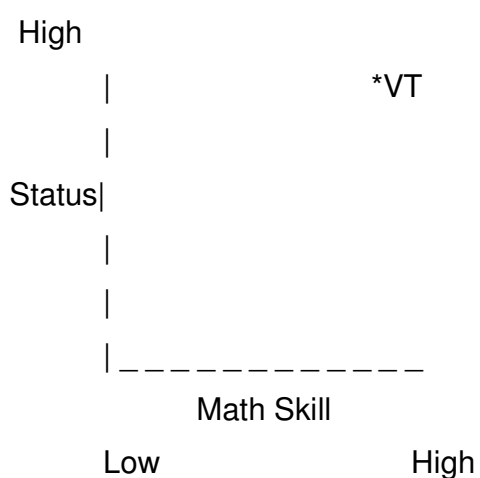
	A <i>Not at All</i>	B <i>A Little</i>	C <i>Fair Amount</i>	D <i>Much</i>	E <i>Very Much</i>
26. Buying a math textbook					
27. Asking your math teacher to help you with a problem that you do not understand					

APPENDIX H

The Career Appraisal Graph Based on Gottfredson

For this task, you will be required to work your way through the list of careers provided and plot each career on the graph provided. This should be done using the career codes in bracket. When plotting the careers you should first think whether that career is stereotypically associated with high or low status and secondly, whether a high or low degree of math skills and ability is needed for each career. Only then should you plot the career on the graph, accordingly.

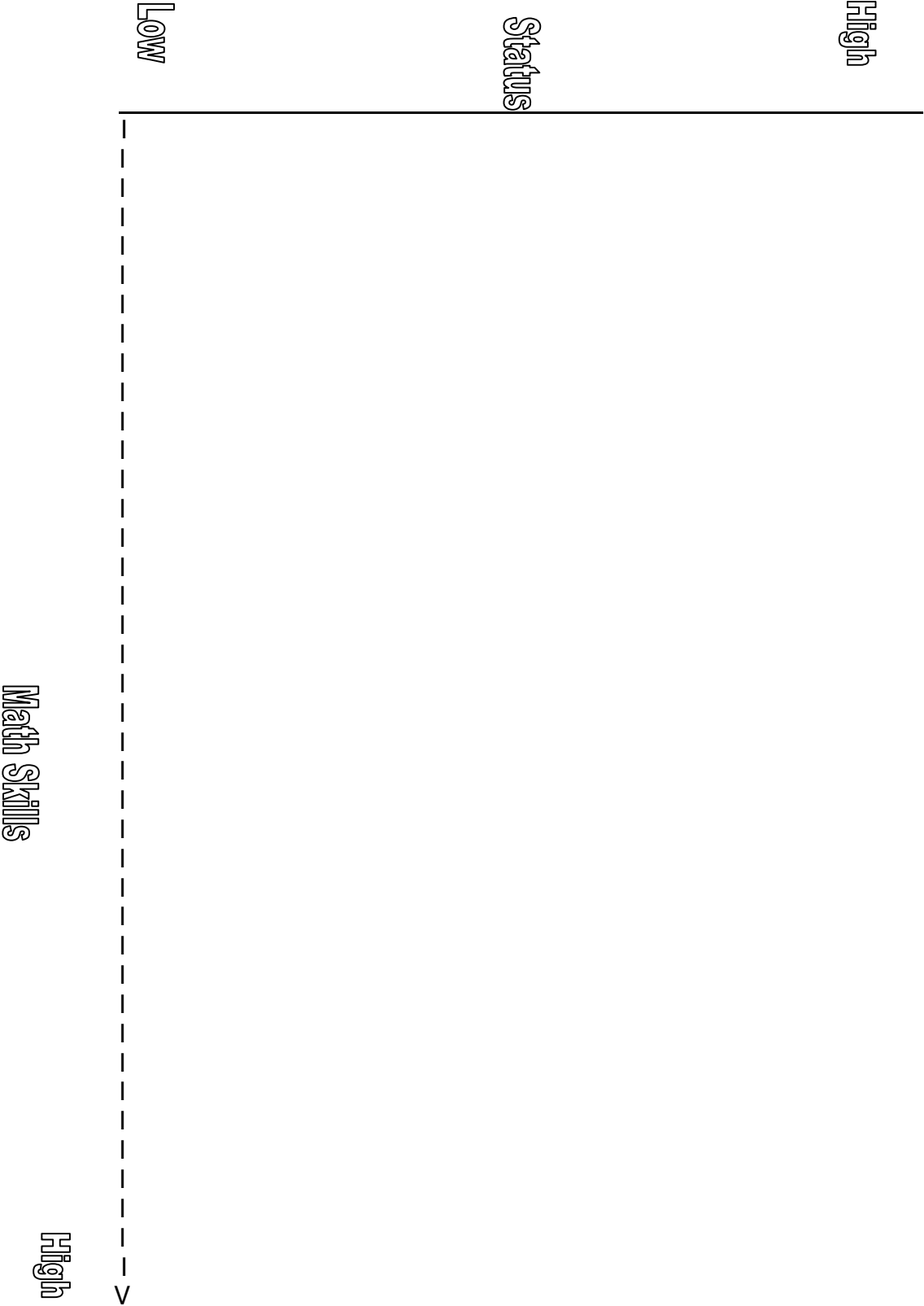
E.g. You may think a Veterinarian (VT) requires high math skills and is a high status career. Thus:



List of Careers:

- ❖ Bus Driver (BD)
- ❖ Lawyer (LR)
- ❖ Doctor (DR)
- ❖ Psychologist (PSYC)
- ❖ Engineer (ENG)
- ❖ Pilot (PT)
- ❖ Secretary (SEC)
- ❖ Farmer (FAR)
- ❖ Typist (TYP)
- ❖ Actuary (ACT)
- ❖ President (PRES)
- ❖ Restaurant Manager (RM)
- ❖ Architect (ARCH)
- ❖ Painter (PR)
- ❖ Bank Teller Assistant (BTA)
- ❖ History teacher (HTEA)
- ❖ Electrician (ELC)
- ❖ Plumber (PLR)
- ❖ Tour Guide (TG)
- ❖ Salesman (SLN)
- ❖ Travel Agent (TAT)
- ❖ Chef (CF)
- ❖ Model (MDL)
- ❖ Waiter (WR)
- ❖ Actor (ACR)

Plot the careers here:



APPENDIX I

Differential Aptitude Test- Form S (DAT-S) Test 2: Verbal Reasoning

Examples:

- a. Chick is to hen as _____ is to _____
- A. child: mother
 - B. son: father
 - C. feathers: skin
 - D. egg: food
 - E. daughter: adult

The relationship between **chick** and **hen** is the same as that between **chick** and **mother**

A, is therefore the correct answer and should be marked next to example a on the answer sheet.

- b. Which word fits in least with the other four?
- A. leaves
 - B. trunk
 - C. roots
 - D. branches
 - E. sunlight

The first four words all describe a tree. Sunlight does not fit in with the others; therefore E is the correct answer.

c. Complete so as to obtain a logical sequence:

Hammer: hit: nail

Axe: _____ : _____

- A. wood: table
- B. chop: wood
- C. sharp: handle
- D. tree: bark
- E. saw: meat

d. What fits in best with ink?

- A. file
- B. pages
- C. paper
- D. pen
- E. book

e. If a girl is carrying a case with books, where is she most probably going?

- A. shops
- B. theatre
- C. school
- D. workshop
- E. sports ground

This test consists of 25 questions. Work as quickly as possible. If you cannot answer a question, go on to the next one.

DO NOT TURN THE PAGE

1. Beautiful is to ugly as big is to _____
 - A. tall
 - B. wonderful
 - C. small
 - D. giant
 - E. old

2. Which word fits in least with the other four?
 - A. think
 - B. swim
 - C. walk
 - D. hit
 - E. run

3. Which word fits in least with the other four?
 - A. flu
 - B. measles
 - C. tuberculosis
 - D. chicken pox
 - E. germs

4. Complete so as to obtain a logical sequence:

egg: ____: ____

- A. fork : bake
- B. nest: rooster
- C. yellow: chicken
- D. hatch: chick
- E. duck: quack

5. _____ is to rand as year is to _____?

- A. Cent: century
- B. Salary: income
- C. Money: history
- D. Cent: period
- E. Cent: day

6. What fits in best with Rhino and Hippo?

- A. Lion
- B. Leopard
- C. Elephant
- D. Giraffe
- E. Crocodile

7. Group: Leader: Follower

Team: Captain: ?

- A. Field
- B. Ball
- C. Player
- D. Referee
- E. Soccer

8. The following codes are assigned to motorcars:

PBS	Large Blue German car
QDW	Small yellow French car
PAS	Large White German car
PFW	Large Black French car
QCS	Small Green German car

What will the code for a Large Yellow German car be?

- A. QDS
- B. PFS
- C. QAW
- D. PDS
- E. PCW

9. Ship is to fleet as bird is to ____?

- A. feathers
- B. flock
- C. fly
- D. sky
- E. egg

10. What fits in best with Driver and Passenger?

- A. Clothes
- B. Suitcase
- C. Licence
- D. Window
- E. Bus

11. What fits in best with Potato and Beetroot?

- A. Mealie
- B. Pea
- C. Bean
- D. Carrot
- E. Tomato

12. Which word fits in least with the other four?

- A. wind
- B. storm
- C. dam
- D. flood
- E. drought

13. Which word fits in least with the other four?

- A. hinder
- B. annoy
- C. help
- D. delay
- E. stop

14. Complete so as to obtain a logical sequence:

tortoise: adder: cheetah

slow: ____:____

- A. poisonous: fast
- B. slithers: bites
- C. small: vicious
- D. long: jump
- E. hiss: roar

15. All the children in a class have numbers on their backs. Five children walk out of the classroom, one behind the other. Number 6 is right in front. Outside the classroom, the very last child goes forward to walk behind the first one. Their order then is 6 9 3 4 1. What order were they in when they left the classroom?

- A. 6 9 3 1 4
- B. 6 3 4 1 9
- C. 3 6 4 9 1
- D. 3 6 4 1 9
- E. 6 4 1 9 3

16. Ruler is to compass as straight is to _____

- A. wheel
- B. turn
- C. circumference
- D. perimeter
- E. round

17. Complete so as to obtain a logical sequence:

owl: mouse: darkness

sheep: ____: ____

- A. graze: sleep
- B. feed: lucerne
- C. soft: sun
- D. grass: daylight
- E. bleat: moon

18. Danger: Fear: Flight

Noise: ? : Scream

- A. Loud
- B. Brave
- C. Calm
- D. Cheerful
- E. Fright

19. Barren is to lush as _____ is to _____

- A. desert: jungle
- B. small: crop
- C. sand: soil
- D. trees: forest
- E. plains: mountains

20. Which word fits in least with the other four?

- A. hum
- B. speak
- C. sing
- D. tune
- E. shout

21. Admiration is to Bravery as Contempt is to _____

- A. Charity
- B. Cowardice
- C. Uneasiness
- D. Negligence
- E. Painful

22. Drop is to rain as spectator is to _____

- A. match
- B. team
- C. someone
- D. stadium
- E. crowd

23. March has 31 days. The first three Mondays in March are the 2nd, 9th and 16th on a calendar. On which day will 1 April fall?
- A. Thursday
 - B. Tuesday
 - C. Monday
 - D. Friday
 - E. Wednesday
24. A person has one 20c coin and a few R2 coins in his pocket. He wants to buy a R2,50 bus ticket. Without looking in his pocket, what is the least number of coins he must take out to be sure he will have enough money to pay?
- A. 4
 - B. 3
 - C. 2
 - D. 5
 - E. cannot say
25. How many times must a square piece of paper be folded for the folded piece to be precisely $\frac{1}{8}$ the size of the original piece?
- A. don't know, the measurements are not given
 - B. 4 times
 - C. 3 times
 - D. twice
 - E. once

STOP HERE

HUMAN SCIENCES RESEARCH COUNCIL/RAAD VIR GEESTESWETENSKAPLIKE NAVORSING

DAT

No.

NUMBER/NOMMER

SURNAME VAN											
INITIALS VOORLETTERS											
CITY/TOWN STAD/DORP											
GENDER GESLAG		Male Manlik		Female Vroulik		SCHOOL SKOOL					
GRADE GRAAD		(6) (7) (8) (9) (10) (11) (12)									
LANGUAGE OF TESTING TOETSTAAL						English ☐		Afrikaans ☐			

TODAY'S DATE VANDAG SE DATUM		YEAR/JAAR		MONTH MAAND		DAY DAG	
DATE OF BIRTH GEBORTE DATUM				AGE OUERDOM			

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