Master of Arts Degree

in

Teaching and Learning in Higher Education

'The Effects of Learner Self-Confidence on Competence in Mathematics'

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i Dedication

This research Dissertation is dedicated to my wife, Deborah, whose constant support and encouragement permitted its completion. This is as much her effort as it is mine.

"Who can find a virtuous and capable wife? She is more precious than rubies. Her husband can trust her, and she will greatly enrich his life."

Proverbs 31:10-11 NLT.

I also dedicate this Dissertation to our baby daughter, Eva, whose presence in my life has helped me see all things with fresh eyes and who teaches me much about myself.

"Children are a gift from the LORD; they are a reward from Him…how happy is the man whose quiver is full of them!"

Psalm 127:3, 5 NLT

I love you both with all my heart.

ii Acknowledgements

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iii Declaration

This Dissertation is presented in partial fulfilment of the requirements for the Master of Arts Degree in Teaching and Learning in Higher Education, from the Waterford Institute of Technology.

It is entirely my own work and has not been submitted to any other university or higher education institution, or for any other academic award in this Institute. Where use has been made of the work of other researchers it has been fully acknowledged and fully referenced.

Signature:_____

Michael Lanigan

25th June, 2007

Chapter 1 Introduction

1.1 Introduction

This research study investigated the prevalence of mathematics-anxiety in return-to-education adult learners on a tertiary preparatory course. From experience and anecdotal evidence, it was observed that mathematics intimidation was rife in this cohort, with the power to paralyse the learners educationally, thereby preventing their access of and progression to tertiary education and achieving ultimately, professional careers. Research questions were formulated and reformulated as the research readjusted to various stimuli.

1.2 Context of Study

The Waterford Institute of Technology's Certificate in Foundation Studies Course exists to empower return-to-education adult learners access tertiary education. It inducts them into academia in such a way that allows them to change their attitudes, increase their knowledge, and develop new skills so they can become self-directed learners capable of progression within higher education and third level research across all domains – including those with a mathematics content.

In 2002 the researcher became Course Leader and at short notice took charge of the annual induction of new students in September. The issue of devising a sensitive yet accurate numeracy assessment arose. Armed with a practical numeracy assessment, grounded in everyday experiences, the researcher embarked upon the sensitive assessment of return-to-education adult learners. Examinations are problematic for these cohorts traditionally; mathematics examinations even more so. Although the assessment appeared non-threatening, and was not conducted under so-called 'examination conditions', there was always a danger it may have been perceived as an actual mathematics examination by some participants.

Subsequently, the researcher observed a manifestation of mathematics trauma that affected him immensely. He became extremely concerned for the human dignity of those before him. Never before had he been faced with such a powerful manifestation of mathematics trauma. Their reactions so strongly affected the researcher that it led to

readjustments in his paradigm of mathematics education. Thus began a professional quest to research mathematics anxiety in general, and in this cohort particularly. Ultimately, it has led to this current research study.

Over a number of years, the researcher experimented with various new assessment and teaching modalities, including introducing a student learning journal for mathematics education, and a peer-assessed PowerPoint audiovisual mathematics presentation. Anecdotally, these modalities appeared somewhat successful in terms of the sensitive and accurate assessment of this cohort. The researcher chose to include the evaluation of these modalities in his research study to ascertain what benefits, if any, accrue to these learners.

1.3 Aims and Objectives

The aim of this research is to answer the questions: "With respect to adult learners: what effect has learner self-confidence on mathematics competency?" and "With respect to adult learners: what effect have less traditional teaching and assessment modalities on the learner's self-confidence and mathematics competency?"

The objectives of this research are:

- To investigate any relationship that may exist between mathematics anxiety and competence in adult learners;
- To examine mathematics anxiety in terms of adults' previous experiences, beliefs, attitudes and philosophies of mathematics;
- To research adults' attitudes towards learning and engaging with mathematics;
- To explore any affects of gender and age on confidence and learning of mathematics;

- To research adults' communication skills in terms of discussing mathematics, asking and answering questions on mathematics, and attitudes towards correctness of answers in mathematics;

- To research the effects of the mathematics instructor on adults' learning of mathematics, as well as adult students' attitudes towards their instructor;

- To research adult learners' learning habits in terms of team-working, preferences for collaboration, and ability to manage their learning (self-directedness);

- To research adults' mathematics competency in terms of problem-solving skills, numbers skills, awareness of mathematics around us, and adults' self-reported competency versus test-score validated competency;

- To investigate the effects on adults' learning of mathematics in terms of new and non-traditional assessment and teaching modalities in the form of a mathematics learning journal, and an audiovisual mathematics presentation;

1.4 Scope of Study

The research study focused on one course within the Department of Adult and Continuing Education, School of Education and Professional Development, Waterford Institute of Technology. The Certificate in Foundation Studies course is a one-year adult tertiary preparatory course and is one of only a small number of such courses operating in Ireland; it was the first of its kind in this country. The study surveyed students of the mathematics module over four of the previous five academic years. Classes of 2005 to 2007 were exposed to newer assessment and teaching methodologies; the classes of 2003 and 2004 followed identical, traditional modalities. For the purposes of the study, the classes of 2005 to 2007 were grouped together and compared against the class of 2003, the control group.

1.5 Originality of Study

Insofar as it is known, no similar research study has been undertaken within WIT. Research exists regarding adult learners in a mature or tertiary context however, not exclusively in a preparatory context. Furthermore, research exists on fear and anxiety, however not in relation to mathematics-anxiety or similar context. Therefore, at a local level, it may be concluded, this study is fully original.

This research is to some degree original due in part to the fact the researcher was unable to source a similar body of research during the literature review. Studies abound regarding education of mathematics-anxious traditional students both at secondary and tertiary levels. These mainly originated in the US, and the UK; only one piece reviewed was from Ireland. The closest research identified during the literature review was of a tertiary preparatory course for Australian adult learners. Although there are some similarities between the Australian study and this current study in terms of investigating confidence and competency in mathematics, the Australian study focused much attention to the area of motivation, whereas this study focused on researching the phenomena of mathematics-anxiety's effect on competence, from an Irish perspective.

1.6 Limitations of Study

The research is limited potentially by a slightly skewed respondent bias. For example, of a total number of 58 respondents, 22 were from the class of 2007 and 18 were from the class of 2003 (the control group). The typical population of students from each year is consistently between 25 and 30. (From the remaining 16 respondents, 10 were from the class of 2006, while 6 were from the class of 2005). With so many respondents from these two classes (and so few from the others, especially from 2005) the data may have been unintentionally skewed. The researcher had no control over this potential limitation. In addition, the researcher was unable to access all students of the course (total population) in order to survey them. This was out of the researcher's control.

The sample of respondents used for evaluating the new assessment and teaching methodologies was relatively small compared with other, larger course samples. However, the population from which the sample is derived was smaller relative to other courses. In spite of this fact, the smaller sample size may have, to some degree, limited the full evaluation of the modalities. This was out of the researcher's control.

This was a study to be conducted within nine months and naturally due to such limited time constraints, the study was limited to what could actually be achieved. The study has gone some way towards answering the questions, however further research is implied.

Each of the respondent classes was taught mathematics by the researcher for one academic year. The 2003 group may have responded more positively to the research investigation due to the amount of time passed since their involvement. They may have viewed their experiences retrospectively with some nostalgia, thereby biasing to some extent their responses. This is a hypothesis that was not conclusively proven. Conversely, the more contemporary impact of academia on the class of 2007 may have affected them less positively than 2003's class due to the more immediately recallable nature of their experiences. These factors have the potential to limit the research study to some degree.

The researcher was involved to a large extent with the research groups and this may have limited the scope of the study somewhat in terms of reactivity and respondent bias. These potential limitations are discussed in chapter 3.

1.7 Value of Study

The Report of the Task Force on Physical Science (Drury and Allen, 2002) was commissioned to examine the decline in student numbers choosing mathematics (and science) at second level. This has consequences for participation, research and innovation in these disciplines at third level. Interestingly, the Department of Education and Science (DES) statistics for passing mathematics at Leaving Certificate level are not

encouraging, with almost 20% failing Ordinary level mathematics since 1999. Moreover, statistics for passing mathematics at any level (Higher or Ordinary) has declined since the same year (DES, 2001). This trend has continued year on year since.

Some strategies need to be developed to deal with teaching and learning mathematics at all levels including, significantly, second-chance 'rehabilitation'. The conclusions from this study will inform practice for other stakeholders in the Adult Education arena, most notably, Adult Education Centre (AEC) Numeracy Officers, and the National Adult Literacy Association (NALA). With the massification of tertiary education in this country over the last decade, previously educationally disadvantaged adult learners are accessing third level education in ever greater numbers. Therefore this research will inform course developers of all first year third level courses of which mathematics is a constituent part, that is, Science, Engineering, Computing, and Business courses. Furthermore, this research will inform student support services such as mathematics 'drop in' centres in universities and other colleges around the country, and particularly, the CHART student support centre at WIT.

From a purely parochial perspective, the research will have implications for the researcher's practice in terms of the amount of student support (and perhaps counselling) available for weak students; this will have a knock-on effect within the Department and School, to some degree, and across WIT, generally.

The School and Department will be interested in the evaluation of the mathematics module and of its influence on learners ultimately as they access mainstream tertiary education at WIT. From this perspective, the research will provide evaluative information and may offer political arguments for the continued existence and ongoing support of the course within the Institute. Cooperating with the School and Department, CHART will be informed of specific mathematics difficulties and possible remedial strategies to be employed or other rehabilitation strategies.

Nationally, there exists a small but growing debate within this country of stakeholders concerned by the decreasingly poor mathematics ability of our students at all

levels, and the consequences this will have on our ability to be a competitive economy in years to come. This study and its findings will contribute to that debate in a new and constructive way, from the perspective of adults returning to education in a tertiary preparatory context, and will point to further research opportunities in the area.

Ultimately, the research will influence the way mathematics is taught pre-third level; research showed learners are already mathephobic by the time tertiary education is accessed. Therefore, this research will influence intervention measures to be taken at secondary and primary levels particularly.

1.8 Composition of Research Study

The following chapter describes the literature reviewed for this research study and outlines the researcher's reading in the area. Chapter 3 describes the researcher's methodology for the study. It discusses the choice of a mixed-methods approach to the research and provides justification for the researcher's methodology paradigm. Chapter 4 analyses the quantitative data (in the form of numerically coded responses to a questionnaire) and triangulates them in terms of qualitative data (in the form of various forms of reflexive student accounts). Chapter 5 discusses the findings from these data offering hypotheses for observed phenomena in the light of previous and current research in the area. Chapter 6 describes the researcher's conclusions drawn from the research findings. Recommendations for future research opportunities are suggested where applicable.

Chapter 2 Literature Review

2.1 Introduction to Literature Review

This review targets adult learners suffering from mathematics anxiety, examines possible causes and effects, and draws from literature from many sources. Higbee and Thomas (1999) reviewed the literature concerning important factors pertaining to a learner-centred environment, and how they relate to achievement in mathematics. The literature is reviewed using a similar method of enquiry using four separate themes: Mathematics Anxiety and Self-Confidence; Adult Learners, Mathematics Competency; and Assessment & Teaching Methodologies. The review concludes with a discussion and reformulation of research questions, where minor and secondary questions are posed.

2.2 Mathematics Anxiety and Self-Confidence

Fiore (1999), as well as Tobias and Weissbrod (1980) defined mathematics anxiety as the panic, helplessness, paralysis, and mental disorganisation arising among some people when required to solve a mathematical problem. It is both an emotional and cognitive dread of mathematics. While some anxiety can be motivating or even exciting, too much anxiety can cause 'downshifting' in which the brain's normal processing mechanisms begin to change by narrowing perceptions, inhibiting short term memory (McKee 2002, p2).

Ashcraft and Faust, (1994) described it as feelings of tension, apprehension, or even dread interfering with the ordinary manipulation of numbers and the solving of mathematical problems. Jones (2001) in Sheffield and Hunt (2006) conducted a study of over 9,000 American students and found just over a quarter (25.9%) had a moderate-to-high need of help with mathematics anxiety. Sheffield and Hunt (2006), found no clear indication of the prevalence of mathematics anxiety in the UK; there would seem to be similar lack of awareness of its prevalence in Ireland due to the dearth of research in the subject area. What is not in doubt, however is that mathematics anxiety exists in Ireland (see Lanigan, 2006, p39).

Mathematics anxiety has the most pronounced detrimental effect on arithmetical performance when the problems are relatively complex (Ashcraft and Faust, 1994;

Ashcraft and Kirk, 2001, in Sheffield and Hunt, 2006). Worry could pre-empt actual task processing, consequently inhibiting the effectiveness of working memory. Moreover, it may act as a distractor (Ashcraft and Kirk, 2001) with failure to prevent worrisome thoughts loading working memory and detrimentally affecting performances.

Preis & Biggs (2001) described a cycle of mathematics avoidance (see Appendices): In phase one, the person experiences negative reactions to mathematics situations. These may result from past negative experiences with mathematics, and lead to a second phase in which a person avoids mathematics situations. This avoidance leads to phase three, poor mathematics preparation, which brings them to phase four, poor mathematics performance. This generates more negative experiences with mathematics and brings us back to phase one. This cycle can repeat so often mathephobes become convinced they cannot do mathematics and the cycle is rarely broken.

Arem (2003) equated much of mathematics anxiety with mathematics test anxiety, which is three-fold: poor test preparation, poor test-taking strategies and psychological pressures; it is exacerbated by poor health habits, especially diet and sleep. Hopko, Ashcraft, Gute, Ruggerio, and Lewis, (1998), found explicit memory performance was poorer for high-anxious individuals, with no relationship between competence and mathematics anxiety.

In a similar study, Ashcraft and Kirk (2001) found it was not necessary to use conventional arithmetic and mathematics problems to trigger the mathematics-anxiety reaction; it only needs to be a counting-like process. The anxiety reaction involves attention to or preoccupation with intrusive thoughts or worry. According to the researchers (Ashcraft and Kirk, 2001, p236), students who do poorly on exams claim they become confused, are unable to focus on the task at hand, or keep thinking about how poor they are at mathematics.

Another source of mathematics anxiety in adults are the so-called ‘mathematics myths’ like:

- *"Women can't do mathematics"*
- *"Some people can do mathematics, others can't"*
- *"My father/mother couldn't do mathematics, either"*
- *"I'm good at English – that's why I'm so bad at mathematics"*
- *"Insights into mathematics have to come to you instantly; and if you can't solve a problem instantly, you should just quit"*"

(Preis & Biggs, 2001)

According to Burns (1998) two-thirds of Americans fear and loathe mathematics. Zaslavsky (1994) showed people of all races and economic backgrounds fear mathematics, but women and minorities are most hindered by it. She reported research conducted in America which points out that around the seventh grade girls begin to doubt their ability to do mathematics. Moreover, she claimed self-confidence and mathematics performance are closely related based in part on the major role self-confidence plays in girls' choices to continue mathematics into high school (Burns, 1998).

Carmichael and Taylor (2005) conducted an analysis of student beliefs in a tertiary preparatory mathematics course in the University of Southern Queensland, Australia. Their aim was to investigate motivational effects on the performance of students in a tertiary preparatory context with particular focus on student self-confidence in ability to succeed in mathematics as the primary motivational effect (Carmichael and Taylor, 2005, p713). They attempted to predict strengths of mathematics confidence measured at three levels of speciality: confidence to succeed in the course, confidence to succeed in a mathematics topic and confidence to succeed in a specific mathematics question. They found motivation has an effect on student performance and confidence and the effect of mathematics confidence on performance was far more complex than first thought (Carmichael and Taylor, 2005, p718).

Carmichael and Taylor's (2005) research built upon Bandura's research (1997) and is based upon his social cognitive theory, maintaining even if a student has received reinforcement in the past for displaying a certain desirable behaviour, they must believe

in the value of this behaviour if they are to continue displaying it. Student beliefs about the value of a learning activity, their expectation of success and their enjoyment of it will motivate them to undertake it. They examined the effect of motivation on student achievement through twin lenses of anxiety and self-efficacy.

Anxiety regarding consequences of failure is known to motivate undesirable learning behaviours, resulting in diminished academic performance (Ironsmith, Marva, Harju and Eppler, 2003; Bandura, 1997; Pintrich & De Groot, 1990; Sloan, Daane, and Giesen, 2002; Tobias, 1980). Furthermore, belief in their confidence to succeed in a given task (self-efficacy) is known to motivate desirable learning behaviours in students leading to subsequent academic success (Pintrich & De Groot, 1990, and Pajeres & Miller, 1994, in Carmichael and Taylor, 2005). Bandura (1997) argued anxiety is known to correlate with performance due to the motivational effect of self-efficacy. This research is contradicted by Higbee and Thomas (1999) and Hopko et al (1998), but substantiated by Sheffield and Hunt's (2006) research.

Moreover, self-efficacy is known to predict achievement in mathematics (Bandura, 1997), however Carmichael and Taylor (2005) hypothesise that student beliefs on the nature of intelligence may in fact mediate this relationship. Their hypothesis is supported by Stodolsky (1985) who suggested mathematics is an area in which student views on intelligence play a dominant role in performance. Research by Multon, Brown and Lent (1991) investigated the mediating effects of age and previous achievement on mathematics self-efficacy and mathematics performance; examining the effects of gender on both of these issues. They suggested the effect on performance of self-efficacy would be greater for older and low achieving students.

Parker (1997) noted overcoming mathematics anxiety involves making a transition of major magnitude, that there is an identifiable six-stage process for overcoming mathematics anxiety (see Appendix) and a support network is necessary for overcoming mathematics anxiety as an adult. With an understanding of how beliefs might affect outcomes, learners could increase perceived self-efficacy and thus increase the likelihood of success in achieving desired goals.

2.3 Adult Learners

Researchers (Campbell & Hackett, 1986; Hackett, Betz, O'Halloran, & Romac, 1990 in Hall, 2002 and Higbee and Thomas, 1999) have determined previous mathematics performance and perceived ability are key elements for success in mathematics. Meltzer's (2002) research showed a significant relationship existed between levels of previous mathematics education and conceptual learning gains in a physics course. Zopp (1999) found unrelated life events, 'trigger events' in education and a lack of support contributed to mathematics anxiety in adult learners. Mathephobic parents 'infect' their children; mathephobic teachers 'infect' their students (Fiore 1999).

Jackson and Leffingwell (1999) researched 157 above-average, highly motivated adult learners. Only 7% had positive mathematics experiences from kindergarten through college. Otherwise, there were clusters of times when problems occurred. Main difficulties experienced were gender bias, insensitive/uncaring instructors, unrealistic expectations of parents and students, or age discrimination (showing insensitivity to older anxious students). The main content problem seems to have been with fractions.

Ernest (2004) compared absolutism and fallibilism - the two primary and opposing philosophies of mathematics teaching and learning. Absolutism suggests an image of mathematics as rigid, fixed, logical, absolute, inhuman, cold, objective, pure, abstract, remote and ultra-rational. An absolutist-like view may be communicated in class by giving students mainly unrelated routine mathematical tasks which involve the application of learnt procedures, and by stressing that every task has a unique, fixed and objectively right answer, coupled with disapproval and criticism of any failure to achieve this answer (Buerk, 1982). Preoccupation with getting right answers is at the root of many problems. Adults especially do not wish to appear 'stupid' or ignorant in group settings, hence knowing the correct answer is important. Gathering data about perceptions/beliefs around utilising mistakes as learning opportunities (Lanigan, 2006, p41) is one goal of this research.

Recently new waves of 'fallibilist' mathematical philosophies have gained ground, proposing a different and opposing image of mathematics as human, corrigible, historical and changing (Davis and Hersh 1980, Ernest 1994b, Lakatos 1976, Tymoczko 1986). Fallibilism views mathematics as the outcome of social processes. Mathematical knowledge is understood to be eternally open to revision, both in terms of its proofs and its concepts. Consequently this view embraces the practices of mathematics, its history and applications, the place of mathematics in human culture, including issues of values and education as legitimate philosophical concerns. The fallibilist view does not reject the role of logic and structure in mathematics, just the notion there is a unique, fixed and permanently enduring hierarchical structure. Instead it accepts the view mathematics is composed of many overlapping structures which, over the course of history, grow, dissolve, and then grow anew, like trees in a forest (Steen 1988, in Ernest, 2004).

If mathematical knowledge is constructed rather than given, where does this leave notions of mathematical truth? (Coben, 2000) From the adult absolutist's viewpoint, mathematics is viewed as a set of absolute truths determined by authority and 'doing mathematics' means following the rules correctly. Skemp (1971) distinguished between so-called 'instrumental understanding' (i.e. following the rules without necessarily understanding the reasoning behind them) and 'relational understanding' (i.e. knowing what to do and why). In the absolutist view only Skemp's instrumental understanding is necessary. By comparison, the fallibilist viewpoint is polar opposite: mathematics is seen as an entirely human construct and therefore is value-laden, culturally determined, and open to revision (Lakatos, 1976, in Coben, 2000). For the fallibilist, Skemp's relational understanding is the 'theory of choice'

Mezirow took learning in adulthood to be the social process of constructing and appropriating a new or revised interpretation of the meaning of one's experience as a guide to action. He constructed a critical theory of adult learning which has at its heart the idea of 'perspective transformation' (Benn, 2004). It is an emancipatory process of becoming critically aware of how and why the structure of psycho-cultural assumptions has come to constrain the way we see ourselves and our relationships, reconstituting this

structure to permit a more inclusive and discriminating integration of experience and acting upon these new understandings. It is the learning process by which adults come to recognise their culturally-induced dependency roles and relationships, and the reasons for them, and to take action to overcome them. The most significant learning involves critical reflection. Indeed, Mezirow identified the prime role for adult educators as assisting adults to learn in a way that enhances their capability to function as self-directed learners (Benn, 2004, p12).

Quoting Mezirow, Benn (2004, p13) highlighted that educators have an ethical commitment to help learners learn to think for themselves rather than consciously striving to convert them to their views. This commitment forbids us to indulge in indoctrination; we can foster learner awareness of the need for change through transformative learning (Mezirow 1994, p230). William Perry's research (1970) into learners' expectations in college (discussed later) proves interesting reading when examined from an adult education perspective. To put Perry's research in context requires a brief examination of Malcolm Knowles' theory of andragogy, which assumes four characteristics of adult learners, they:

1. are self-directed learners;
2. have accumulated experience which is a rich learning source;
3. are ready to learn when learning will help them cope with tasks and problems of their life;
4. need practical competence rather than theoretical knowledge

(Knowles, 1980, 1984, in Benn, 2004, p10)

This view of adult learners is somewhat idealised – in practice it could not be claimed that *every* adult learner possesses all or even any of these characteristics. Where does this leave the theory of andragogy then in terms of practice and in developing learners into critically aware, self-directed individuals? Perry's (1970) research found numerous characteristics of college students which illustrate a generalised developmental process of becoming critically aware (see Appendices). This provides a more accurate description of the characteristics of these adult learner cohorts. Moreover, utilising

Perry's and Mezirow's research provides a solid theoretical basis from which to help adult learners transform their learning expectation from didactic to self-directed, developing critical awareness in the process. Viewing Knowles' work through Perry's lens can provide a workable, practical, theory-of-use.

Abraham Maslow's (1943, 1954, 1971, and 1998) research into the area of psychology and human behaviour has shown reinforcement is important. Particularly relevant is his 'hierarchy of needs' which shows positive reinforcement in the form of constructing a safe environment (lower tier of hierarchy) for learning is necessary before higher tiers in the hierarchy can be attained. Ultimately, self-actualisation is the pinnacle of the hierarchy, therefore one needs to have in place the necessary prerequisite tiers before supporting the learners' attainment of self-actualisation.

Higbee and Thomas (1999) noted there is an increasing shift from a focus on learner characteristics to a more integrated and holistic approach, incorporating the role of teacher and course content, including different types of tests, grading systems, use of mathematics applications, and collaborative learning. The effects of creating a safe class room environment, analysing its effect on anxiety and competency, while evaluating the effectiveness of reflexive practice will be investigated.

2.4 Mathematics Competency (Self-Reported & Test Score Validated)

The Mathematical Association of America's (2001) publication *CUPM Discussion Papers about Mathematics and the Mathematical Sciences in 2010: What Should Students Know* (in Nyman and Berry, 2002) and the NCTM's *Principles and Standards for School Mathematics* (2006) both highlighted the importance of competency for success in students' later careers. The Principles and Standards state

> *…by learning problem solving in mathematics, students should acquire ways of thinking, habits of persistence and curiosity, and confidence in unfamiliar situations that will serve them well outside the mathematics classroom. In*

> *everyday life and in the workplace, being a good problem solver can lead to great advantages* (emphasis added), (NCTM, 2006)

Perception of ability to perform tasks and accomplish goals is defined by Bandura (1997) as perceived self-efficacy. Bandura asserted that this personal belief influences action, effort, perseverance, resilience to adversity, and realisation of goals. Therefore, beliefs associated with individual capability often determine outcomes before any action occurs. In addition, Bandura suggested a triadic reciprocal relationship between environment, interpersonal factors, and behaviours influence human functioning. Understanding how beliefs might affect outcomes, individuals can increase perceived self-efficacy and thus increase the likelihood of success in achieving desired goals (Bandura, 1997).

Sheffield and Hunt (2006) concluded mathematics anxiety directly affects mathematical task performance: in some cases very similar to the neuropsychological condition termed 'phobia'. Their research would seem to indicate the absence of self-confidence has a bearing on mathematics performance. They researched traditional, undergraduate students so an examination of the impact of mathematics anxiety on competence of pre-entry tertiary adult learners would seem appropriate.

Relating to mathematical achievement, Higbee and Thomas (1999) noted the following affective variables are important: student's academic self-concepts, attitudes toward success in mathematics, self-confidence in ability to learn mathematics, mathematics anxiety, test anxiety, perceptions of the usefulness of mathematics, motivation, self-esteem, and locus of control (see Appendices). They found, on average, students experienced a reduction in mathematics and test anxiety (due to intervention), but the reduction in anxiety was not correlated with greater mathematics competency, as measured by a variety of course outcomes. This research, conducted over a relatively short term of two three-month periods, seems to imply possessing less mathematics anxiety does not necessarily imply greater proficiency. This research will investigate this phenomenon further using data from a number of years to increase reliability.

Meyer and Eley (1999) in a study into development of the affective experiences of studying mathematics in higher education noted students' attitudes toward mathematics exhibited reliable, consistent patterns of beliefs concerning the nature of mathematics (Meyer and Eley, 1999). Moreover, in concluding discussions they cited their findings are consistent with other findings demonstrating how course experiences impact quite negatively on general study approaches, and in turn related learning outcomes (Meyer and Eley, 1999).

Kieran (1994) highlighted the shift in ideas about learning mathematics over the last generation. Kieran (in Coben, 2000) contended that previously learning mathematics was equated with immediate recall, retention and transfer, and understanding was equated with achievement in tests or the performance of tasks. Currently, however, learning mathematics is regarded as 'learning mathematics with understanding'.

In an increasingly more technical society, mathematics proficiency is a necessity. A study by Blackington, (McKee, 2002), examined graduation rates for students who entered university at a remedial level. In the ten-year study of Pre and Elementary Algebra students, 11.4% and 22% completed their degrees respectively. Students who did not take mathematics continuously throughout high school fell increasingly behind in college. Entering college with a fundamental knowledge of Algebra meant they were 44% more likely to graduate. Clearly, if mathematics anxiety is limiting a student's success in mathematics, their career and life options may be severely diminished.

Furner (2004) made the argument for the importance of having mathematical confidence to compete globally in a high-tech world relying heavily on mathematics, science, and technology, encouraging students to be confident in their ability to solve problems, understand mathematical concepts, and see mathematics as a human endeavour. Furner believed there is a connection between mathematics anxiety and student performance (competence) in mathematics

2.5 Assessment and Teaching Methodologies

Higbee and Thomas (1999) examined the relationship between performance in mathematics and cognitive factors, such as preferred learning styles, visual and spatial ability, use of specific cognitive strategies, and critical thinking skills. Using this research, educators have begun researching various techniques to reduce or eliminate some of the barriers so far identified, including the use of collaborative learning and verbalisation during the problem-solving process.

Writing can also be a powerful tool in overcoming mathematics anxiety. Tobias (1987) suggested practicing 'self-monitoring' while doing homework or studying by dividing up one's page vertically. One side is used for mathematics work, the student records feelings and thoughts on the opposite side leading to an understanding of the obstacles put up to success. With practice, alternative thoughts can be suggested, and this process allows the student to keep working, breaking somewhat, the paralysis of mathematics anxiety.

Writing a 'mathematics autobiography' and encouraging positive mathematics self-talk can also be helpful (Preis & Biggs, 2001). The mathematics autobiography is a personal story of a student's mathematics educational history. In those read by Fiore (1999, p405), several of the students reported a teacher or parent had called them 'stupid'.

Dodd (1999) encouraged instructors to have students work together, citing Vygotsky's 'zone of proximal development'. Some students feel more comfortable speaking in small groups obtaining emotional support and academic assistance. More structured group activities reduce mathematics anxiety: students with high mathematics anxiety distrust themselves to obtain answers, often preferring not to work alone and dislike discovery learning (Preis & Biggs 2001). Clute's study (1984) found low mathematics-anxious students were more successful when discovery (exploratory) methods were employed, while high mathematics-anxious students benefited more from expository (routine, pseudo-behaviourist) methods.

Furthermore, instructors can emphasise that learning mathematics is partially like learning a foreign language, with its own vocabulary and symbols. In writing they encourage self-monitoring as described above, or they can ask students to explain in writing how they solved a given mathematics problem (Preis & Biggs 2001). They can encourage students to keep journals where students privately write to instructors to share their difficulties. Instructors can then address the concern long before the assessment. Journals can be motivating, providing direct and private links to the instructor (Dodd 1999). Carefully thought-out journal prompts can help uncover areas of mathematics anxiety and allow the instructor to work more effectively with the student (see Curry, 2000, and Lanigan, 2006).

The other side of this discussion is that learners must take responsibility for their own learning. Mathematics anxiety rarely goes away by itself; it must be addressed as a primary concern by the sufferer to see improvement. Learners must be participants in mathematical problem solving. Most importantly, instructors must believe each student can learn mathematics (Preis & Biggs, 2001) and must help students come to believe they can do mathematics (Dodd, 1999).

Selfe et al (1996) described an experiment designed to identify the effects of journal writing assignments on students in a college-level mathematics class. Ultimately the researchers wanted to ascertain if writing skills and attitudes to writing in journals improved. Specific advantages of journal writing were found similar to research by Lanigan (2006). Students exhibited increased confidence in their ability to solve problems and participate in in-class discussions about problems and concepts. Moreover, journals provided a record of individual learning styles, a written account of students' progress as seen not only by the instructor, but by the student as well.

Based on Higbee and Thomas' (1999) research, educators have begun to research various techniques to reduce or eliminate some of the barriers so far identified, including the use of collaborative learning (including study groups) and verbalisation (including reflexive journals) during the problem-solving process. Brookfield (2004), featured effective strategies for facilitating critical thinking/reflexivity, illustrated qualities of

skilled facilitators, and outlined some approaches for helping others examine assumptions underlying their thoughts and actions. Supporting and showing one's support for learners' efforts to become critical thinkers is necessary. This was consistent with Higbee & Thomas' (1999) research.

The literature suggests instructors can have a large hand in reducing mathematics anxiety in their classrooms. Some recommendations by Jackson et al (1999) are for instructors to disclose their own mathematics anxiety and how it was overcome, project interest and enjoyment in mathematics, offer positive-reinforcement and help to the mathephobic and make respect dwell in the classroom. Instructors can also demonstrate to students that competency and even proficiency in mathematics is developed over time.

2.6 Discussion

The literature on mathematics anxiety and mathematical competence (e.g. Bandura, 1997) seems to suggest that with an understanding of how beliefs might affect outcomes, learners can increase perceived self-efficacy and thus increase the likelihood of success in achieving desired goals. The literature would seem to suggest, therefore that it is very important for learners to examine their beliefs system in terms of their self-efficacy towards a point where they attain proficiency in critical reflection and re-examine their philosophy of mathematics. Therefore this research will investigate the part reflexivity plays in promoting self-efficacy by examining student journals.

Moreover, self-efficacy is known to predict achievement in mathematics, Multon et al (1991) suggested the effect on performance of self-efficacy will be greater for older and low achieving students. They investigated the mediating effects of age and previous achievement on mathematics self-efficacy and mathematics performance, examining the effects of gender on both. The questionnaire was designed with this in mind.

From observation, students rarely if ever consciously recognise their beliefs as a philosophical stance, however all are in possession of a view – typically absolutist. Ernest (2004) touches on issues pertinent to this research. To engage in any investigation

of the relationship between mathematics anxiety and competency, mathematics philosophy must be considered. Each individual possesses a set of beliefs, attitudes, prejudices and presuppositions with respect to mathematics – a philosophy of mathematics in effect. This philosophy, internalised by both those learning and teaching mathematics can have a long-lasting negative influence. Such phenomena are extremely relevant to this research. The questionnaire was designed to elicit Skemp's (1971) 'mathematical understandings' data as well as philosophical viewpoints.

Challenging adults' perceptions and beliefs by utilising mistakes as learning opportunities is one goal of the teaching methodologies employed. The questionnaire was designed to extract appropriate evidence of philosophical attitudes/beliefs towards mathematics.

The literature suggests there is a significant relationship between the level of previous mathematics education and conceptual learning gains. This study will investigate what bearing previous education has on confidence (and self-efficacy) versus competency (both self-reported and test-validated) in mathematics.

The literature also suggests school-mathematics is not useful or practical in everyday life (see Coben, 2000). This study hopes to identify whether mathematics is pigeon-holed by learners such that school/college mathematics is decoupled from so-called 'street' mathematics; further examination will investigate so-called 'invisible' mathematics (Coben, 2000).

As discussed earlier, Higbee and Thomas (1999) noted there is an increasing shift from a focus on learner characteristics to a more integrated and holistic approach. This study researches the effects of learning journals and audio-visual presentations on learners' self-efficacy and competence. This study also hopes to identify what if any improvements might be incorporated going forward. Test scores and a questionnaire operating on the Likert scale will be a means of providing quantitative evidence.

Brookfield (2004) stated plainly that encouragement and confidence-building is effected by means of helping others to develop critical thinking skills – this goes to the heart of the research question around reflexivity – and about how instructors might go about affirming adult learners' self-worth. The questionnaire was designed to elicit information from learners around these issues. Facets such as trust and confidence in their tutor, attitude towards mathematics, self-concept and philosophical viewpoint, amongst others are exposed in the data and these are highly important affective factors in one's development into a critical thinker/reflector.

Therefore, the following further and reformulated questions emerge:

- Does possessing mathematics anxiety imply lower mathematics competency (and conversely)?

- Can mathematics anxiety be reduced? If so, how?

- Can reflective practice, in the form of a mathematics learning journal, facilitate the learners' development of confidence/competence in mathematics?

- How have learners' philosophies of mathematics been affected by past experiences? In what manner do learners' philosophies of mathematics influence learning and ability to cope with mathematics anxiety? What role exists for the teacher of mathematics?

Chapter 3 Research Methodology

3.1 Introduction to Research Methodology

For my research I have asked the question: What effect has learner self-confidence on mathematics competency? Answering this question involves examination from a particular research paradigm (in this case the pragmatic paradigm), formulation of a research analysis (mainly ethnographical enquiry), and research design (flexible, mixed methods making use of both qualitative and quantitative analysis). To begin with, I want to contextualise my research question, and that of my overall approach to the research by explaining how and what circumstances brought about the original research question, and prior to that, the development and introduction of newer assessment modalities in my mathematics classroom.

As outlined in chapter 1, I have co-ordinated the WIT Certificate in Foundation Studies course since 2002. During my very first week on the job I had what is sometimes termed a 'critical incident' concerning mathematics assessment of vulnerable, adult learners. From that earlier milieu emerged the genesis, ultimately, for this piece of research. I believed at that time it was my responsibility to investigate other, non-traditional, not-threatening modalities of assessing groups of vulnerable, sometimes traumatised adult learners in a dignified and learner-oriented manner. In doing so I could also achieve my own aims of diagnosing pre-course mathematics levels, and providing insights into adult learners' attitudes and beliefs with respect to learning mathematics post-schooling.

I had anecdotal evidence from my own experiences as an adult learner and more recently as a teacher of mathematics that early intervention with weaker students meant a more hopeful prognosis in terms of successful completion of the module. Therefore the learning journal was introduced into my mathematics classroom. Later on that year, I decided to utilise a second assessment modality in the form of the audiovisual mathematics presentation. At the outset my main concern was to facilitate learning of mathematics in ways other than the so-called '3-Rs' – reading, writing, arithmetic. I was exposed to new learning and teaching theories by Howard Gardner relating to the so-called 'multiple intelligences' (MIs) and endeavoured to examine their effectiveness as a

working theory-in-use by introducing the presentation modality. It was because of journal entries and comments made to me by the adult learners relating to confidence mainly, that made me first consider some form of relationship between confidence and competency in mathematics existed; hence this current research.

3.2 Context

It is incumbent upon me to state that, of all the enquiry groups, the class of 2007 had an atypical formative experience at the beginning of the academic year, which in my opinion needs to be highlighted and explained for purposes of objectivity and reliability. Over the years, my scheme of work used in teaching these cohorts annually is executed in a very specific and cumulative manner. At the beginning of October 2006, when the course was in its first month, I was absent on special leave for three months. In my absence two colleagues replaced me and for unknown reasons a deviation occurred from the scheme of work. Traditionally, Linear Programming is introduced at or near the end of the academic year, when a firm mathematical foundation supports it, but it was covered while I was absent. The introductory, formative modules were covered much faster than usual and the Linear Programming module subsequently started. As a direct result, I believe this had a negative-reinforcing, effect on the cohort's learning of mathematics.

Moreover, the process of reflective practice (mathematics learning journals) that began prior to my departure was neglected by students to such a degree that a new approach was required. Without encouragement and consistent feedback, the students unilaterally and unanimously neglected their responsibility to themselves to reflect on their learning of mathematics.

As a result of the students' lack of motivation for engagement with the reflexive process and particularly to address the benefits of reflection within the learning journal (30% Continuous assessment mark being a large incentive) I decided to run a workshop on reflection, in cooperation with my 'critical friend'. This workshop was a new departure from previous years. Traditionally, this cohort is introduced to the journaling

process in a gradual and formative manner over the course of the first term. Due to my leave of absence this did not happen for the current cohort, and as such, I felt they were disadvantaged and to a degree, disillusioned with the process. I invited my colleague to part-take in the workshop so that I could step back somewhat from the initiative, as I did not want to compromise my objectivity with respect to this research and my current enquiry. Borrowing from Jenny Moon (2006), one of the UK's leading experts in reflective practice, we adapted some of her ideas into a one-off reflection workshop, showing the class of 2007 the difference between descriptive writing and reflexive writing. I feel it is important for me to state these occurrences were atypical and one-off in nature. As a result, I was forced to rethink my research question(s) and objectives, as I believed that the limited time available to me, would not allow me be as broad in dealing with the issues.

Naturally I have approached the research with my own presuppositions, prejudices, theories and experience that will colour the research to a degree. That said however, I do not approach this research coming from any one particular research paradigm. Stated simply, I wish to answer the research question in the most appropriate manner using the most appropriate paradigm, analysis (method), and design available to me, as objectively as possible.

3.3 My Research Paradigm

In a positivist analysis or enquiry, much credence and importance is placed on the so-called 'scientific method'. In his book on real world research Robson (2002, pp17-18) emphatically rejects this approach as a basis for social forms of research and offers reasons for this. Nevertheless, he recommends approaching social research with a 'scientific attitude'. The positivist paradigm is rejected in favour of a more pragmatic approach.

The relativistic paradigm holds that reality is represented through the eyes of participants and is pertinent to my research. Robson (ibid) highlighted the limitations of research involving human beings. I have incorporated this relativistic approach into my

overall research paradigm because much of my data relies on human beings' underlying ideas, their presuppositions, prejudices and experiences of mathematics. The relativistic paradigm holds that scientific accounts and theories are equivalent with other accounts – even lay ones, and that no one theory is given a position of privilege (Robson, 2002, p 25).

The successor to relativism is constructivism and it too, although ultimately discounted as my research paradigm, possesses fundaments appropriate to my research. For example, my research data was collected primarily by means of learning journals, questionnaires, and in some cases, interviews. A hallmark of a constructivist paradigm is this format of data collection to allow for the observation of multiple perspectives, which ultimately help construct 'reality'. My research seeks to poll the viewpoints of stakeholders over a number of years to examine any convergence or divergence in findings.

Because the group being researched are educationally disadvantaged, my research might also be seen as an emancipatory and indeed, if using the terminology technically, a feminist paradigm. Consistently, women populate my classroom more so than men, thus the feminist paradigm allusion.

As I have stated earlier, my over-arching research paradigm is the pragmatist paradigm which emerged from the realist paradigm movement. Before explaining its appropriateness to my research question, I think it necessary and pertinent to contextualise and situate my paradigm within realism by explaining what realism has to offer me in terms of a fully functioning research paradigm and synthesise my reasons for choosing the pragmatist paradigm ultimately.

In a strange way, the question I am attempting to research seems at home within positivism; it asks a question that involves two attributes (in this case confidence in mathematics and test-score validated competence in mathematics), each possibly affecting the other – this requires further research prior to any conclusion. Positivism would suggest I should look for a 'constant conjunction' (change in one variable reliably

leading to a change in the second variable), thus constituting a 'law' and as a result allowing a form of predictability. Remarkably, this is one of the things I wish to investigate and hope to prove, to whatever degree I can. Yet, I have already rejected positivism because it is impossible for me to investigate such variables in a closed system.

Fundamentally I am researching a causal phenomenon of confidence and validated competency in mathematics, and as pointed out by Robson, my hypothesis is *'…that there are one or more mechanisms at work which will trigger these outcomes, and that there are other mechanisms which will interfere so that the outcome does not occur'* (Robson, 2002, p40). Predictability may be uncertain or impossible from this study, however, I may be able to explain what my data analysis for the last 4-5 years indicates, reasons for this, and what this might mean going forward.

In my examination of research paradigms within the realistic paradigm I noted that critical realism is yet another facet offering appropriate assistance with answering my research question. Noticeable is its fundament that, according to Bhaskar (1986) in Robson (2002), if false understandings, and actions based on them, can be identified, this provides an impetus for change. Hence, Robson argues, adopting a critical realist stance not only provides a third way between positivism and relativism, but might also help fulfil the emancipatory potential of social research (Robson, 2002, p41). Examination of a misunderstanding of the nature of mathematics (e.g. philosophical viewpoint) and that of its place in society (e.g. cultural or societal viewpoint), I believe, is an appropriate place to begin answering the question "*What effect has learner self-confidence on mathematics competency?*" From the critical realist's position, this is perhaps *the* place to begin answering it and is my starting place. Ultimately, I have chosen the pragmatic paradigm as my over-arching research paradigm. I am confident that this choice, emerging from the critical realist and relativistic paradigms is the most appropriate paradigm at my disposal, to best answer my research question. The pragmatic paradigm consists of using whatever philosophical or methodological approach that works best for

a particular research problem at issue, leading to mixed-method studies where both quantitative and qualitative approaches are adopted (Robson, 2002, p43).

3.4 Method of Enquiry

I have chosen to conduct my research by means of an ethnographical enquiry. I have not approached this portion of my research methodology with any a priori standpoint on analysis. Moreover, in keeping with my pragmatist research paradigm, I require the most appropriate and flexible method of enquiry available to me in order to answer my research question. Although my primary method of research analysis is the ethnographical enquiry, secondary methods such as phenomenology, case study, and even grounded theory of enquiry (utilising thick description) have featured, when appropriate, in my overall research method.

My research is new and experimental: I am testing the benefits of using non-traditional mathematical assessments with adult learners in order to ascertain any benefits accruing to the learners in terms of confidence and competency. I am examining any relationship therefore that may exist between learners' confidence in mathematics and validated competency in the subject. The non-traditional assessment modalities consist of a learning journal that is compiled by the learner and used partly as a form of tutor-learner dialogue; and a peer-assessed class presentation on how mathematics has impacted on society. I plan to investigate the effects these modalities exert on the learners by surveying all those learners whom I have assessed in this manner.

Because I am in effect performing a type of student tracking, going back a number of years, my analysis is a case study; Robson points out that in one sense all enquiries are such, (2002, p185). The groups under study are unique and somewhat of a rarity these days (foundation course, pre-entry third level mature students). The enquiry examines their experiences and perspectives of learning mathematics as adults. The method of enquiry must also be then a form of phenomenology. The philosophy behind phenomenology has influenced the development of interpretative research strategies, such

as are needed in my enquiry, like ethnomethodology. It is out of this philosophical and social research milieu that my own research analysis emerges.

I chose ethnography as my research method because, as Robson noted, it is a feature of ethnography that people are studied for a long period of time in their own natural environment (Robson, 2002, p186). He highlighted critics of the approach being concerned about researchers getting over-involved with the people being studied, perhaps disturbing and changing the natural setting, and hence compromising the quality of the research (ibid). These points are valid with respect to my research. In order to explain this I must contextualise my approaches to teaching and learning mathematics as well as my experiences as an adult learner as I believe they bias my research, but provide advantages in researching such questions.

As a school-goer in secondary school I was gravely intimidated by a teacher, to the point where I was convinced that something was wrong with me – that I just could not do mathematics. My own trauma with leaning mathematics has influenced my approach to teaching mathematics, but particularly with regard to the teaching of mathematics to adult learners. Adult learners who historically pursue the mathematics module have little or no faith in mathematics teachers (as evidenced from numerous learning journal entries). Furthermore, their levels of confidence and/or competence are historically, low to non-existent.

From an ethnographical perspective, it could be argued that I am not just involved with those I am studying; I used to be one of them – this is true to some degree. Does it imply then that I have 'gone native' (Robson, 2002, p187) before I have started my research? It is a question that I must consider. I do not believe that my acute empathy with this group hinders my capacity for objectivity. Instead my unique perspective as one-time traumatised mathematics student provides understanding, not to mention a fantastic opportunity to impact on how mathematics is taught pre-third level. Critics of ethnography point out that the very fact I am engaged with the group being studied, that a relationship pre-exists, is unscientific, causing disturbances in the natural setting. I realise that I must not only be involved with the groups being studied, but be immersed in

their natural setting with them as is the case typically. To be any other way is to make the study of these groups unnatural. In order to conduct this enquiry, that is, to conduct an ethnographic study means I must not only be an observer of phenomena, studying the groups in their natural setting, I must be a part-taker in whatever goes on.

Ethnography as a research analysis is useful in another respect: the production of so-called 'thick description' - descriptive data free from imposed external concepts and ideas (Geertz, 1973 in Robson, 2002, p186). This allows others to understand the culture from inside in the terms that the participants themselves used to describe what is going on. Robson points out how useful this is, that it is valuable in cases where there is little known about the enquiry group or culture, or where misunderstandings, presumptions or prejudices about the group exist. I believe this applies even in the situation where the group possess such preconceptions about themselves possibly because of inherited traits from wider society about the privileged position of mathematics in our culture. I must obtain descriptions of what is happening in these groups not only from my own perspective, but from the groups' own perspectives and more importantly, in their own words Therefore I have invited the groups to volunteer information in the form of 'thick description'.

Moreover, utilising the ethnographical enquiry approach to research analysis provides me with the necessary and appropriate flexibility required when research questions emerge and/or evolve, when revisiting the research question necessitates revisiting the literature review, and where the data tells a story that requires further analysis. Enquiring about behaviours and attitudes stretching over a time span of years necessitates my using ethnography as the primary means of analysis.

3.5 My Research Design

I have chosen to use a mixed method of research for this study. It incorporates qualitative research as well as quantitative statistical data analysis. This offers much flexibility in the design, as I anticipate the design will evolve over the course of the research, particularly with respect to the data collection stage.

Selecting a flexible design such as the mixed method approach allows me develop and modify my research question, sampling methods and data collection. Primarily the design of this research is driven by my research questions such that I am hopeful of gathering supporting evidence to expose new theory for noted phenomena. According to MacDonald (1994): '*the findings of flexible method research can be seen as no more or less legitimate than those of any other type of study'* (in Robson, 2002, p167).

At one stage I considered sampling only those students who had successfully completed the mathematics module but revised this to include all those who simply completed the mathematics module in any of the last five years to ensure 'saturation'.

In coming to terms with my research question I realised that I needed to survey the groups who had been exposed to the newer assessment modalities (learning journal and class presentation) to gather data on what was happening to them in terms of their confidence levels in mathematics versus their validated competency in the subject. There are three distinct groups who were exposed to these modalities and each of them were involved in this study, along with a so-called 'control group' for comparison. I chose a questionnaire as my primary data gathering tool. For those groups who were exposed to the newer modalities I made use of their learning journals, post-presentation guided reflections, and any other unsolicited material such as electronic mail, correspondence, and even 'thank you' cards received from students. In addition to these data sources I made use of test results over a number of years.

3.5.1 The Questionnaire

The questionnaire was quite comprehensive in seeking to elicit data from respondents regarding their experiences of learning mathematics. The respondents were asked to agree or disagree with various statements on the questionnaire. Similar to a Likert scale, the levels of agreement or disagreement were indicated as: 1 (Strongly Agree); 2 (Agree); 3 (Neither Agree nor Disagree); 4 (Disagree); 5 (Strongly Disagree). In the data analysis, when comparing average scores, a value less than 3 is taken to imply overall agreement with a statement; a value greater than 3 implies overall disagreement.

In order to improve the rigor of the data, similar statements were included on the questionnaire, appearing randomly throughout. Included also, were eight general and overarching research categories, comprising a number of statements within each. The eight categories were labelled: A (Problem solving skills); B (Numbers skills & universality of mathematics); C (Team working skills); D (Affective learning domain, confidence, self-esteem, mathematics anxiety, attitude, emotion); E (Communication skills); F (Managing own learning skills); G (Learning in other ways, learning journal, non-"3-r's" learning); H (Effect of tutor, students' attitudes towards tutor).

A certain amount of recoding of data was necessary after the data collection stage had finished. For example, statement C8, as it appeared on the questionnaire read: "*Study groups are a waste of my time"*. A diligent and collaborative student typically would not agree with this statement, hence s/he would be required to disagree. However this raised a problem when attempting to code the data. Ultimately, this statement and those composed similarly, were recoded during the data analysis phase of the study. For example, in the data analysis C8 read: *"STUDY GROUPS ARE NOT A WASTE OF MY TIME"*. This meant that any disagreement to C8 originally (either a 4 or a 5 on the Likert scale) was recoded to the corresponding level of agreement (either a 2 or a 1 respectively). These recoded statements appear throughout the research study and are distinguishable from ordinarily coded statements by use of capital letters throughout, as illustrated above.

Using SPSS r14.0, frequency tables were produced for a majority of primary and secondary data sources on the questionnaire (see Appendices). Subsequently, comparative cross-tabulations were effected between variables and t-tests conducted for means comparisons. Ultimately, statistically consistent data were chosen as being representative of the overarching categories. These data were also used for discussion purposes in chapter 5.

Exclusively qualitative data in the form of learning journal extracts and other reflective extracts were used for comparative purposes to triangulate findings elsewhere. These data were also discussed in chapter 5.

3.6 Reliability & Validity

According to Robson, claiming that a piece of qualitative research is valid, that it has validity is to do with it being accurate, or correct, or true (Robson, 2002, p170). It is necessary to examine my research for any so-called threats to validity and reliability.

3.6.1 Validity and Threats to Validity:

According to Maxwell (1992) in Robson (2002, p40) there exists a typology of the kinds of understanding involved in qualitative research. The main types are description, interpretation, and theory and each has particular threats to its validity. I have used Maxwell's typology to examine any threats to the validity of my own research.

Description *(threat - inaccuracy/incompleteness of the data)*: when piloting the questionnaire, feedback from students and staff was recorded and incorporated into the questionnaire. Any data collected is supplemented with information from journals, guided reflections, and if necessary, from previous related research.

Interpretation *(threat – imposition of meaning on phenomena)*: I began this research with a preconceived idea/theory that some relationship exists between confidence and competency with respect to learning mathematics. I will show that the phenomena have been allowed to tell their story, free of researcher bias.

Theory *(threat – not considering alternative explanations for phenomena)*: I have specifically asked questions in my questionnaire that ask for information not consonant with my own theory.

Lincoln and Guba (1985) in Robson (2002) have raised other possible threats to the validity of flexible design research – reactivity, respondent biases, and researcher biases. I have countered reactivity by removing myself as researcher as much as possible from the data gathering process. For example, all journals are written solely by the students – in my absence – although I engage in dialogue I do not believe this is a form of reactivity as defined, in this instance. Furthermore, questionnaires were also completed

in my absence, as were post-presentation guided reflections, and emails from students. Threats posed by respondents' biases were potentially more difficult to handle however, I attempted to limit its effects by sampling as many students as possible across all levels of competency. Regarding researcher bias I had to proceed carefully; my contact with the research groups was extremely limited for the duration of the research, with only one group (2007) having weekly contact for classes.

Research involving people is sometimes problematic, due to respondents' possible close relationship with the researcher. I am potentially biased therefore. However, strategies and tactics exist that I made use of to combat the potential bias. My research paradigm is mainly an ethnographical enquiry. Ethnographical research usually means researcher involvement over a prolonged period of time. In my case, I have been involved with the respondents' course since 2001, and with the actual respondents themselves since 2002, however, duration of prolonged contact is typically one academic year. Such limited involvement with a respondent group helps reduce both reactivity and respondent bias. As researcher I am accepted by the respondent groups, as I have a track record with some of them in this regard, therefore any initial reactivity is reduced. According to Robson this permits the development of a trusting relationship between the researcher and respondents where the latter are less likely to give biased information. Although there is no way to be absolutely certain, I believe that the respondents were truthful, bearing in mind that some have been involved with other on-going research, culminating in a number of publications over the time period. I believe in such an environment of collaboration, or co-research, the respondents' would adopt appropriate attitudes to this current research. Due to the annual turnover of respondents each year I believe that any personal, researcher bias is minimised.

Triangulation is another useful strategy employed in this piece of research. I have used more than one method of data triangulation in the form of questionnaires, journals, guided reflections, and other, unsolicited materials. Traditionally triangulation helps counter all threats to validity (Robson, 2002, pp174-175).

3.6.2 Reliability and Threats to Reliability

My study is of a hugely fluid and human social experience that exists in an open system, which de facto rules out any scientific reliability. The form of social research to be outlined here depends on observational evidence, human experience, interpretations, belief systems, prejudices and so on. Therefore, I am dealing with what Robson describes as *'…tendencies and probabilities…leading to particular outcomes'* (Robson, 2002, p40).

Eliminating threats to reliability in flexible, mixed methods research is notoriously difficult to achieve. Studies involving observation of human beings or surveys involving human beings are extremely time specific and are difficult to standardise and replicate. I am capturing data at a specific time and place. Responses to statements by respondents may change due to any number of complex factors that comprise humanity. The only strategy a researcher can have in such a fluidic and complex situation is to ensure the rigor of the data collection method and to use more than one method. For this study I designed a comprehensive questionnaire as my primary data collection method and have incorporated data collected by other secondary means such as student learning journals, guided reflections, and unsolicited materials such as emails and cards from students.

Chapter 4 Data Analysis & Findings

4.1 Introduction to Data Analysis

These results are presented under the eight headings used in the original questionnaire supplied to respondents. The results are comprised from four distinct groups of adult learners who studied mathematics between the year 2003 and 2007. From 2005 to 2007 as part of a new continuous assessment modality learners were requested to produce a mathematics learning journal and to part-take in a collaborative audio-visual presentation on some aspect of the impact of mathematics on society. Previous years' groups did not undertake these new modalities. The groups from 2005 to 2007 are grouped together for the purposes of these results and are also compared against the so-called 'control' group, namely the year 2003 group. The year 2004 group are not included in the study. Both the 2003 and 2004 groups pursued the same course including identical assessment modalities. Due to the large response and ease of access to this group, the year 2003 group was selected as a representative control group.[1]

Groups	Population Size	Respondent Sample Size	Response Rate
Year 2003 Control Group	*40*	*18*	*45%*
Year 2007	*31*	*22*	*71%*
Year 2006	*24*	*10*	*42%*
Year 2005	*20*	*6*	*30%*
Totals	*115*	*56*	*49%*

Table 1

From a total possible population of 115 adult students, 56 responded to the survey by completing and returning questionnaires. This equates to a response rate of 49% overall. The original questionnaire comprised over one hundred statements to which the

[1] *Significance between groups is demonstrated by p< .05 (Sig. 2-tailed) and any reference to significance in this chapter is in this context.*

respondents agreed or disagreed on a scale[2] of 1 to 5 respectively. Some statements had similar related statements within the questionnaire to ensure validity and for triangulation purposes. In this chapter, the data are presented in such a way that only those statements which were statistically consistent are utilised, and are therefore a representation of an overall research topic or sub-topic. The entire frequency table of responses to the questionnaire is located in the Appendices.

4.2 Category A: Problem Solving Skills

On average, 73% of respondents agreed they were more persistent now at mathematics, treated problems more logically, and were ultimately pleased with their cognitive development and levels of curiosity.

Utilising consistently representative results from the groups, statements A3, A5, and A6 were analysed. The 2005-2007 combined group was compared with the 2003 control group:

Group Statistics (all 2 d.p.)	YEAR	No.	$\bar{x}$	σ
(A3) Persistant in maths	2005-2007	38	2.24	1.10
	2003	18	1.94	0.94
(A5) Treat Problems more logically	2005-2007	38	2.13	0.88
	2003	18	1.89	0.83
(A6) Approach is more logical	2005-2007	38	2.39	0.82
	2003	18	2.22	0.81

Table 2

These data show conclusively the control group (Year 2003) 'agreed' slightly more with the statements than their counterparts (Year 2005-2007). These data showed no significant differences between groups. The following table of cross-tabs showed agreement with *both* statements.

[2] *1=Strongly Agree; 2=Agree; 3=Neither Agree nor Disagree; 4=Disagree; 5=Strongly Disagree. A value greater than 3 implies "disagreement"; a value less than 3 implies "agreement".*

CROSS TAB OF AGREEMENTS TO BOTH	***D16 I AM A CONFIDENT LEARNER WHEN IT COMES TO MATHEMATICS***
D16/A3 I am persistent in maths,staying at a problem until the problem is resolved	**50%**
D16/A5 I treat problems in maths more logically now than before	**41%**
D16/A6 I approach generic problems more logically since studying maths	**35%**

Table 3

D16/A3: 27 respondents (50%) agreed with both statements; 5 respondents disagreed (9%) with both statements. 7 who disagreed (13%) with D16 agreed with A3. No respondents who agreed they are confident learners (D16), disagreed with A3.

D16/A5: 22 respondents (41%) agreed with both statements, 14 who disagreed (26%) with D16 agreed with A5. 2 respondents (4%) who agreed with D16 disagreed with A5, meaning they are confident learners but they do not treat problems more logically now. Only 2 respondents (4%) disagreed with both statements.

D16/A6: 19 respondents (35%) agreed with both statements.

Comparing A5 with A6: 63% of respondents agreed that they treat problems in mathematics more logically now than before while approaching generic problems more logically since studying mathematics; only 7% disagreed with both. This illustrates a positive trend in logical ability related to mathematics.

4.3 Category B: Number Skills; Universality of Mathematics

On average, 89% of respondents, agreed they were now more aware of the universality of mathematics as part of normal daily life, citing their participation in the audio-visual presentation as one reason for their awareness. The fact the control group did not participate in such presentations for mathematics means no comparison is possible.

4.3.1 Competency: Self-reported and Test-score Validated

This data showed significant difference between the groups for Final Exam Mark. No significant differences exist for Christmas Exam Mark.

Group Statistics (all 2 d.p.)	YEAR	No.	$\bar{x}$	σ
Final Exam Mark	2005-2007	38	67	25.88
	2003	16	87	10.82
Christmas Exam mark	2005-2007	37	65	24.57
	2003	14	74	20.99

Table 4

Furthermore, comparing D38 *(Prior to studying mathematics on this course, I believed I was competent at mathematics)* with D39 *(I am more competent at mathematics after studying mathematics on this course)*: 17 respondents agreed with both statements; only 1 disagreed. Noticeably, 32 respondents who did not agree they were competent at mathematics prior to this course now agreed they are more competent at mathematics having taken it on this course.

An average of 88% of respondents reported they were more competent at mathematics after taking the mathematics module.

Christmas test scores were cross-tabulated with Final test scores from the entire population of students to note any improvement in validated competency scores (as opposed to self-reported competency above).

XmasGrade * FinalGrade Crosstabulation

		FinalGrade					
		1-20	21-39	40-60	61-80	81-100	Total
XmasGrade	0	0	0	1	2	0	3
	1-20	1	3	1	0	0	5
	21-40	0	0	2	1	3	6
	41-60	1	2	4	5	10	22
	61-80	0	2	2	5	21	30
	81-100	0	1	6	3	22	32
Total		2	8	16	16	56	98

Table 5

It appears from these grouped frequency data that from 98 students (*17 missing*), 56 (equivalent to approximately 57% of sample) increased test scores (and therefore validated competency) between Christmas and Finals.

The following cross-tab illustrates perceived competency corresponds with external measurements. 48 respondents (89%) who claimed to be more competent subsequent to the course achieved passing scores (validated competency measure) in their finals.

[D39] I am more competent at mathematics after studying mathematics on this course * FinalGrade Crosstabulation

		FinalGrade					
		1-20	21-39	40-60	61-80	81-100	Total
I am more competent at mathematics after studying mathematics on this course	Strongly Agree	0	0	3	3	19	25
	Agree	1	4	6	4	10	25
	Neither Agree Nor Disagree	0	0	0	1	1	2
	Disagree	0	1	0	0	1	2
Total		1	5	9	8	31	54

Table 6

4.3.2 Invisible Mathematics

79% agreed with B3 (*Although mathematics is not a major portion of my chosen third level course, I still need to understand* it).

B3 was compared with responses to *Subject/Area where mathematics is useful* of SECTION III of the questionnaire. Participants stated a subject or area where mathematics is useful to them: 8% disagreed mathematics is useful outside the classroom. 77% agreed mathematics is useful to them either in other subjects or in their personal life; 26% agreed mathematics is useful in both settings.

4.4 Category C: Team Working Skills

On average, 86% of respondents agreed they work well as part of a team; 90% agreed they work well as part of a study group. An average of 64% agreed they worked well either as part of a team or study group.

Regarding meetings with study groups, on average 83% of respondents agreed they attended voluntarily with 49% meeting on a weekly basis at least.

Group Statistics (all 2 d.p.)				
	YEAR	No.	$\bar{x}$	σ
(C5) Study group meetings weekly	2005-2007	38	2.92	1.40
	2003	15	2.60	1.35
(C6) Study group meetings bi-weekly	2005-2007	38	4.03	0.85
	2003	15	3.87	0.74
(C7) Study group meetings infrequently	2005-2007	38	3.47	1.29
	2003	15	3.20	1.32

Table 7

These data demonstrate no significant difference between the two groups.

4.4.1 Preferences for Collaboration

	YEAR	No.	x	σ
(C1) I prefer to collaborate with others on projects or assignments	2005-2007	37	2.35	0.98
	2003	17	1.76	0.83
(C2) I work well with others in a team	2005-2007	37	1.97	0.83
	2003	18	1.67	0.69
(C3) I work well with others in my study group	2005-2007	35	1.91	0.78
	2003	18	1.61	0.61

Table 8

These data demonstrate no significant difference between the two groups, apart from C1 illustrating a significant difference between groups.

Agreement statistics

Collaboration/Teamwork	*Classes*	*Tutorials*	*Study Groups*
Confidence to Ask Questions - Where?	64%	80%	*not defined
Like Discussing Answers - Most Comfortable Where?	85%	89%	85%

**Comprises Infrequently & Neutral responses to statement*

	Weekly	*Fortnightly*	*Infrequently*
Study Group Meetings - Attendance How Often?	50%	6%	34%

Table 9

CROSS TAB OF AGREEMENTS TO BOTH		***I prefer to collaborate*** **with others on** ***projects or assignments***
C1/C3	**I work well with others in my study group**	**90%**
C1/C5	**I attend study groups at least weekly**	**81%**
C1/F5	**I WOULD RATHER COLLABORATE THAN WORK ON MY OWN**	**61%**
C1/G7	**I learn maths best when collaborating with others**	**59%**
C1/C4	**I ATTEND STUDY GROUPS BECAUSE I WANT TO**	**57%**
C1/C8	**STUDY GROUPS ARE NOT A WASTE OF MY TIME**	**55%**
C1/C7	**I attend study groups infrequently**	**34%**
C1/C6	**I attend study groups at least every 2 wks**	**6%**

Table 10

C1/C5: Of the 26 respondents who attended study group on a weekly basis at least, 21 (81%) had a collaborative preference.

C1/F5: 33 respondents (61%) agreed with both statements, while only 1 disagreed (2%) with both.

C1/G7: Significantly, 32 respondents (59%) agreed with both statements, while none disagreed with both. Only 3 respondents (6%) who learn best when they collaborate state they do not have a preference for collaborating with others.

C1/C4: 57% of respondents agreed with both statements. A total of 83% attend voluntarily; the remaining respondents are neutral. Importantly though, none reported disagreement with statement C4 "*I attend study group meetings because I want to"*.

C1/C8: 55% of respondents agreed with both statements. Asked if they thought study groups were a waste of their time, 86% of all respondents disagreed. Only 5% agreed they wasted time attending study groups. Of the 21 infrequent attendees none cited 'waste of time' as a reason for not attending more regularly. In fact, 19 (91%) agreed that study groups are not a waste of time.

Group Statistics (all 2 d.p.)	YEAR	No.	$\bar{x}$	σ
(C3) I attend study group meetings infrequently	2005-2007	38	3.47	1.29
	2003	15	3.20	1.32
(C8) STUDY GROUPS ARE NOT A WASTE OF MY TIME	2005-2007	38	1.82	0.98
	2003	17	1.59	0.71

Table 11

These data demonstrate no significant difference between the two groups.

C1/C7: There are 35 with a collaborative preference; of this number 12 met infrequently, while 20 did not.

C1/C6: The data showed that of the 35 respondents who claimed to have a collaborative preference only 2 met at least every two weeks.

4.5 Category D: Affective Learning Domain, Confidence, Self-Esteem, Mathematics Anxiety, Attitude, Emotion

4.5.1 Mathematics Intimidation

These data demonstrate respondents' views from before and after they embarked upon the mathematics module.

Group Statistics (all 2 d.p.)	YEAR	No.	$\bar{x}$	σ
(D1) Not intimidated by maths previously	2005-2007	37	3.49	1.33
	2003	18	3.50	1.38
(D2) Not intimidated by maths currently	2005-2007	38	2.34	1.19
	2003	18	1.78	0.55
(D16) I am a confident maths learner	2005-2007	38	2.84	1.28
	2003	16	2.63	1.26

Table 12

The modal term for D1 is 5 (*Strongly Disagree*) and for D2 is 2 (*Agree*)[3]; thus, illustrating that most respondents were intimidated by mathematics prior to the course, but were not intimidated subsequently. The D1 data demonstrated no significant differences between the two groups, however they are significant for D2. It would appear the 2003 control group exhibit less mathephobia than their counterparts in 2005-2007.

FINAL GRADE	*D16*	*D2*
1 - 20	**0**	**1**
21 - 39	**0**	**0**
40 - 60	**4**	**5**
61 - 80	**3**	**5**
81 - 100	**20**	**27**

Table 13

[3] *1=Strongly Agree; 2=Agree; 3=Neither Agree nor Disagree; 4=Disagree; 5=Strongly Disagree. A value greater than 3 implies "disagreement"; a value less than 3 implies "agreement".*

This table illustrates respondents' final grade ranges compared against their agreement with D16 (*I am a confident learner when it comes to mathematics*), and D2 (*I remain unintimidated by mathematics at this point*). Note the consistency between FinalGrade vs. D16 and FinalGrade vs. D2. With the exception of one, no respondents who agreed with D16 and D2 failed to achieve a passing score in their final test.

Regarding intimidation by calculator (D34 to D37), 25% believed an answer given by a calculator should not be challenged; 22% agreed they were intimidated by their calculator and 36% agreed they avoided certain areas of mathematics because of calculator intimidation.

Overall, 52% of respondents agreed they were confident learners in mathematics, although 33% disagreed. However, a total of 89% of respondents agreed they had noticed a positive change in their attitudes towards mathematics since taking the course (D30). 65% agreed they possessed confidence to assist their children with mathematics homework (D29).

4.5.2 Mathematics Anxiety's Affect on Confidence

CROSS TAB OF AGREEMENTS TO BOTH		**D16 I AM A CONFIDENT LEARNER WHEN IT COMES TO MATHS**
D16/D1	**I WAS NOT INTIMIDATED BY MATHS PRIOR TO THIS COURSE**	**30%**
D16/D2	**I REMAIN UNINTIMIDATED BY MATHS**	**50%**
D16/D20	**MATHEMATICS IS NOT A DIFFICULT SUBJECT**	**15%**
D16/D21	**My self-confidence increased as a result of my participation in the presentation**	**46%**
D16/D27	**I BELIEVE THE MATHS I'VE LEARNT AS AN ADULT HAS THE SAME RULES AS THE MATHS I LEARNT AS A CHILD**	**31%**
D16/D29	**Because of this module I have the confidence to help my children with their maths homework**	**33%**
D16/D40	**My confidence level in maths affects my competency and ability to do maths**	**37%**

Table 14

D16/D1: These data compare respondents' confidence with mathematics in general. 30% of those claiming to be confident learners were not intimidated by

mathematics prior to the course. This means 70% of those who claim to be confident learners currently, were intimidated prior to the course.

D16/D2: A total of 27 (50%) agreed with both statements, only one was neutral regarding currently being intimidated. Of those 38 respondents who agreed they were not intimidated, 6 claimed not to be confident learners (16%). Only 7 respondents (13%) consider themselves to not be confident learners and remain intimidated by mathematics currently.

D16/D20: Of the 28 respondents who agreed they are confident learners in mathematics 16 agreed (57%) mathematics is a difficult subject. Furthermore, 2 respondents (4%) agreed mathematics is not a difficult subject yet they did not agree they are confident learners in mathematics. 15 respondents (28%) disagreed with both statements, meaning they perceived mathematics to be a difficult subject while they are not confident learners in mathematics. By comparison, this means that irrespective of confidence level in mathematics, 31 respondents (86%) agreed mathematics is a difficult subject.

D16/D21: In all 32% of respondents agreed they were confident learners and increased self-confidence as a result of the presentation. D21 frequency data show that 60% of respondents agreed their confidence increased as a direct result of the presentation. 19% disagreed with this statement.

D16/D27: 17 respondents (32%) did not agree they are confident learners in mathematics and believed the rules of mathematics learnt in adulthood differ from childhood. 8 who agreed they were confident learners in mathematics also believe the mathematics learnt in adulthood differs from childhood. This is a total number of 25 from 54 respondents (46%) who believe the mathematics they learned as children has been superseded.

D16/D29: 17 respondents (33%) agreed with both statements and consider themselves confident in both settings. A further 11 (21%) who did not agree they are

confident learners in mathematics however, agreed they have the confidence to help their children with mathematics homework.

D40/D16: 20 respondents (37%) agreed with both statements, while none disagreed with both. 6 respondents (11%) agreed they are confident learners did not agree their confidence level affects competency. A total of 18 respondents (33%) who are not confident learners with mathematics agreed that their confidence level affects competency. Overall, 70% believed confidence affects competency.

4.5.3 Previous Mathematics Experience

D1 and D2 were put to the respondents to elicit more time-specific data of the respondents' level of intimidation before and after the module commenced.

CROSS TAB OF AGREEMENTS TO BOTH		***D1 I WAS NOT INTIMIDATED BY MATHS PRIOR TO THIS COURSE***
D1/A4	**I am confident in situations where the maths is unfamiliar**	**20%**
D1/D2	**I REMAIN UNINTIMIDATED BY MATHS**	**29%**

Table 15

D1: 31 respondents (56%) agreed they were intimidated by mathematics prior to taking the mathematics module. These data were compared against A4 to discover the extent mathephobia pervaded the respondents who admitted to being mathematics anxious prior to the commencement of the module.

D1/A4: 11 respondents (20%) agreed with both statements. Of the 31 previous mathephobia sufferers (from D1 above), 15 are currently confident in situations where the mathematics is unfamiliar. This indicates a positive trend. 12 students (22%) disagreed with both statements and remain in mathephobia's grip.

D1/D2: 16 respondents (29%) agreed with both statements meaning they were not intimidated previous to the course nor are they now intimidated. 19 respondents (35%) who disagreed with D1 agreed with D2, meaning they were intimidated prior to the

course but are not currently. 5 respondents (9%) disagreed with both statements, meaning they were and are still intimidated by mathematics.

4.5.4 Adults' Beliefs, Attitudes to, and Philosophies of Mathematics

Prior to undertaking the mathematics module, a total of 55% agreed they had a predilection for an instructional understanding; only 16% had a predilection for a relational understanding. 72% agreed they now preferred to understand both how mathematical processes work and why – a holistic predilection.

Group Statistics (all 2 d.p.) *(Based on Skemp, 1971)*	YEAR	No.	$\bar{x}$	σ
(D7) Prior pref.: Instructional Understanding	2005-2007	38	2.87	1.02
	2003	18	2.50	1.20
(D8) Prior pref: Relational Understanding	2005-2007	38	3.61	1.05
	2003	17	3.53	0.87
(D9) Current pref: Holistic Understanding	2005-2007	38	1.87	0.84
	2003	17	1.94	0.83

Table 16

These data demonstrate no significant difference between the two groups.

D7/D8: This data showed that prior to them embarking upon the mathematics module, 8 respondents (15%) had an exclusively relational preference for understanding mathematics. 26 respondents (47%) had an exclusively instructional preference, with another 6 respondents (11%) with a somewhat neutral preference.

These data were further compared by means of cross-tabulations with respondents' current philosophical mathematics teaching/learning paradigm.

D7/D9: A total of 27 previous preferences for the instructional paradigm (49% of total) reported they now prefer a more holistic understanding of mathematics, including both the instructional and relational paradigms. There are 16 (29%) who did not prefer the instructional paradigm who also prefer the more holistic paradigm now. A total of 45 out of the 55 respondents irrespective of previous preferences now prefer the more holistic paradigm – this equates to 82% of respondents.

D8/D9: The data illustrated 9 respondents (16%) who previously had a relational preference also now have a holistic preference. A total of 32 respondents (58%) who did not agree they had a relational preference reported they now preferred a holistic paradigm.

Consistently, there are a total of 45 respondents out of 55 who, regardless of previous preferences, now prefer the more holistic paradigm.

4.5.5 Adults' Personal Belief Systems

Group Statistics (all 2 d.p.)	YEAR	No.	$\bar{x}$	σ
(D23) I see mathematics as being a subject with many inter-related areas adhering to general rules	2005-2007	36	2.00	0.68
	2003	17	1.76	0.75
(D31) Maths is a collection of knowledge that may be added to, amended, or updated from time to time	2005-2007	38	1.92	0.82
	2003	18	2.17	1.34
(D27) I BELIEVE THE MATHS I'VE LEARNT AS AN ADULT HAS THE SAME RULES AS THE MATHS I LEARNT AS A CHILD	2005-2007	38	3.63	1.20
	2003	18	3.00	1.61

Table 17

These data were slightly different for D27, however were not significant in the other instances.

D27: 52% of respondents believed the mathematics they learned in adulthood had different rules to the mathematics they learned in childhood.

Overall, 66% of respondents agreed with both D23 (*Mathematics is a collection of knowledge that may be added to, amended, or updated from time to time*) and D31 (*I see mathematics as being a subject with many inter-related areas adhering to general rules*).

4.5.6 Attitudes to Learning and Engaging with Mathematics

These data illustrate the adults' attitudes towards their mathematics studies.

CROSS TAB RECORD OF AGREEMENT TO STATEMENTS		D3 SIMPLY GETTING THROUGH THE COURSE IS NOT MY MAIN MOTIVATION FOR DOING MATHS
D3/D17	DOING WHAT IS REQUIRED FOR THE SET TASKS IS NOT THE MAIN EXTENT OF MY ENGAGEMENT WITH MATHS	39%
D3/D33	CONSIDERING THE DURATION OF THE ACADEMIC YEAR, TRYING TO UNDERSTAND MATHS DOES NOT SEEM LIKE TOO MUCH HARD WORK	49%

Table 18

Of those respondents who agreed with D3, 21 (39%) agreed with D17 also; and 27 (49%) agreed with D33 too, thus illustrating a good work ethic and motivation for engagement with mathematics. A total of 8 disagreed with D17, meaning their motivation to do mathematics is not simply to get through the year however they just want to do the minimum amount possible to get through. No respondents who agreed with D3 disagreed with D33.

4.5.7 Confidence, Gender and Age

[GENDER/D16] Gender * I AM A CONFIDENT LEARNER WHEN IT COMES TO MATHEMATICS

		I AM A CONFIDENT LEARNER WHEN IT COMES TO MATHEMATICS					
		Strongly Agree	Agree	Neither Agree Nor Disagree	Disagree	Strongly Disagree	Total
Gender	Female	3	15	3	8	5	34
	Male	5	5	5	4	1	20
Total		8	20	8	12	6	54

Table 19

These data illustrate the gender breakdown of the respondents[4]: 34 are female, 20 male. Overall, this equates to a gender balance of 63%:37% in favour of female. Of the 34 females who responded to both of these statements, 18 agreed to both, meaning 53% of female respondents agreed they are confident learners when it comes to mathematics.

[4] Of the 56 respondents, 54 responded to both of these statements.

Of the 20 males who responded to both, 10 agreed with both, meaning 50% of male respondents agreed they are confident learners when it comes to mathematics. There seems to be consistency between the genders on the issue of confidence in mathematics.

The respondents' ages were cross-tabulated with D16 (*I am a confident learner when it comes to mathematics*) with the following results:

Age Bracket	Agreed with D16	Total Respondents	Percentage
24-30	8	12	67%
31-40	7	15	47%
41-50	8	10	80%
51-60	4	12	33%
60+	1	2	50%

Table 20

This shows each of the age brackets of the respondents to the questionnaire. The second column shows how many respondents in each age bracket agreed with D16 (indicating they are confident learners in mathematics). The third column shows the total number of respondents in each age bracket, which provides the last column detailing percentage of total in each age bracket who agreed they are confident learners in mathematics.

4.6 Category E: Communication Skills

4.6.1 Discussing Mathematics

These data, representing preferences for discussing mathematics answers in various settings, show an average of 87% of respondents was in agreement with the four statements. The data seem to illustrate a trend whereby respondents agreed with the statement the more intimate the discussion forum.

Group Statistics (all 2 d.p.)				
	YEAR	No.	$\bar{x}$	σ
(D12) I LIKE DISCUSSING MY ANSWER WITH	2005-2007	38	2.03	0.94
MY COLLEAGUES IN CLASS	2003	16	1.81	0.98
(D13) I LIKE DISCUSSING MY ANSWER WITH	2005-2007	37	1.92	0.86
MY COLLEAGUES IN TUTORIALS	2003	17	1.82	1.01
(D14) I LIKE DISCUSSING MY ANSWER WITH	2005-2007	38	1.92	0.97
MY COLLEAGUES IN STUDY GROUPS	2003	17	1.71	0.85
(D15) I LIKE DISCUSSING MATHEMATICS	2005-2007	38	1.87	0.91
	2003	17	1.53	0.80

Table 21

These data demonstrate no significant difference between the two groups.

The statements followed a quasi-hierarchical pattern: discussing mathematics in CLASS, in TUTORIAL, in STUDY GROUP. These units possess progressively fewer and fewer students in their make-up.

	I like discussing …	Agreed	Disagreed
D12	...my answer with my colleagues in class	85%	11%
D13	...my answer with my colleagues in tutorials	85%	7%
D14	...my answer with my colleagues in study groups	89%	7%
D15	...maths	87%	5%

Table 22

Agreement scores are consistent across these four statements, while disagreement scores are consistently dropping.

4.6.2 Asking and Answering Questions

From learning journal entries, a majority of students cite asking questions as a large fear they possess.

Group Statistics (all 2 d.p.)	YEAR	No.	$\bar{x}$	σ
(E1) I POSSESS THE CONFIDENCE TO ASK EFFECTIVE QUESTIONS IN CLASS	2005-2007	38	2.74	1.35
	2003	18	1.94	0.94
(E2) I POSSESS THE CONFIDENCE TO ASK EFFECTIVE QUESTIONS IN TUTORIALS	2005-2007	37	2.27	1.07
	2003	18	1.61	0.50
(E7) MAINLY, I DO NOT RELY ON OTHERS IN MY CLASS/ STUDY GROUP TO ASK THE QUESTIONS I WANT TO ASK	2005-2007	38	2.55	1.22
	2003	18	1.89	0.68
(E9) I am not intimidated by raising my hand in class to ask a question	2005-2007	37	2.59	1.19
	2003	18	2.17	1.15

Table 23

These data (E1, E2 and E7) showed significant differences between groups. Although, 64% of respondents agreed with E1, 70% agreed with E2, illustrating their predilection for a more intimate group learning environment. Consistently, the 2003 control group displayed less mathephobia than their counterparts in 2005-2007 group.

SCENARIO #2[5] included four possible options (A[6], B[7], C[8], or D[9]) regarding students' questioning behaviours. Option D is recommended as the preferred choice.

[5] *Scenario #2: You are attending a mathematics lecture when at some point during it you feel you don't quite understand the point your lecturer is making or you are not quite getting the flow of the argument. Your lecturer then decides to move onto a newer area. Which one of the following statements best describes you? A; B; C; D*

[6] *A: Feelings of anxiousness rise in you as you consider raising your hand to ask a question and gain clarification. However, in the time it's taken you to decide what to do your lecturer has moved on and by thinking about what to do you've now also missed the beginning of the newer area. Dejected you simply accept the situation, and hope to catch what you missed from a colleague or a tutorial. You don't ask or try to ask any further questions during the class.*

[7] *B: You nervously raise your hand to stop your lecturer from moving on before you've understood the current topic. You ask your question and feel 'every' eye in the class on you. Your lecturer answers your question very clearly and asks if you understand. You are still not sure but to avoid any awkwardness you simply smile and nod in agreement with your lecturer who, thinking you understand things now, moves on. There are feelings of tension inside of you and you don't ask any further questions in that class.*

CROSS TAB OF AGREEMENTS TO BOTH		*E1 I POSSESS THE CONFIDENCE TO ASK EFFECTIVE QUESTIONS IN CLASS*
E1/E2	**I POSSESS THE CONFIDENCE TO ASK EFFECTIVE QUESTIONS IN TUTORIALS**	**64%**
E1/E7	**MAINLY, I DO NOT RELY ON OTHERS IN MY CLASS/STUDY GROUP TO ASK THE QUESTIONS I WANT TO ASK**	**61%**
E1/E8	**I am not intimidated by raising my hand in class to ask a question**	**58%**
E1/E9	**Before I ask a question in maths class I am not considering what others may think of me**	**48%**
E1/Sc#2	**SCENARIO #2**	**53%**

Table 24

E1/E2: 35 respondents agreed with both statements, 5 disagreed with both, meaning these possess confidence in neither setting. None who agreed with E1 disagreed with E2, showing consistency. Only 7 who agreed with E2, disagreed with E1, meaning they possess only confidence to ask questions in tutorials.

E1/E7: 34 respondents agreed with both statements, 9 disagreed with both, meaning these do not possess confidence to ask questions in class and mainly rely on others to ask questions for them. 3 respondents who disagreed with E1 (confident), agreed with E7, meaning they do not rely on others to ask questions.

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[8] *C: As soon as it hits you that you are not getting it, your hand shoots up or you announce verbally to your lecturer that you are 'lost'. To assist you further, your lecturer enquires as to what part you don't understand. You are not sure, having not taken enough time to examine just exactly where it's not making sense for you. Feeling a bit silly, and hoping to stall your lecturer's enquiries, you answer that you aren't understanding anything of what has been explained so far and could s/he go over it once again. Your lecturer frowns at the prospect of having to review the previous topic from the top. Due to his/her reaction and your embarrassment, you don't ask any further questions during that class.*

[9] *D: You consider what part of your lecturer's argument you are not catching and decide on an appropriate question. You raise your hand, putting your question to your lecturer as clearly and as simply as you can so as not to confuse yourself and everyone else. You may feel nervous but are undeterred, persevering with your question. You gain some understanding from your lecturer's explanations and confidently ask further minor, clarifying questions if appropriate on this topic. You continue to ask questions during the class if required.*

E1/E8: 32 respondents agreed with both statements; 9 disagreed with both meaning these possess confidence in neither situation. 3 who agreed with E1 disagreed with E8, meaning there may be a slight inconsistency to the responses.

E1/E9: 27 respondents agreed with both statements; 5 disagreed meaning these possess no confidence to ask questions in class and are considering others' thoughts about them before asking a question. 7 respondents who agreed with E1 (confident) disagreed with E9, meaning they are considering others' thoughts about them before they ask questions.

E1/Scenario #2: 26 respondents agreed they are confident in class to ask questions and chose option D in Scenario #2 (the preferred option). This means the respondents would ask their question and if necessary ask further clarifying questions during the explanation or the lecture going forward.

4.6.3 Attitudes Towards Correctness Of Answers

CROSS TAB OF AGREEMENTS TO BOTH		***D10 PROVING THE ANSWER CORRECT IS SOMETHING I ENJOY ABOUT MATHEMATICS***
D10/D4	**WHEN I ARRIVE AT A POSSIBLE SOLUTION TO A MATHS PROBLEM I BELIEVE I AM PROBABLY CORRECT**	**40%**
D10/D5	**When I arrive at a possible solution to a maths problem I double check my answer**	**42%**

Table 25

D10: Data showed 71% of respondents enjoy proving the answer in mathematics; a relatively large minority of 18% do not, with almost 11% neutral.

D10/D4: Data showed 21 respondents (40%) agreed with both statements. 7 (13%) disagreed with both statements. 15 respondents (27%) agreed with D10 (enjoyment from proving the answer) but disagreed with D4 (not accepting the answer and moving on.

D10/D5: 23 respondents (42%) agreed with both statements; 6 (11%) disagreed. 12 (22%) agreed with D10 disagreed with D5.

This data showed that of the 39 respondents who enjoy proving the answer in mathematics, only 23 were confident it was correct. A total of 12 out of the remaining 16 respondents claim to believe they are incorrect.

D10/D11: 33 out of 55 of respondents (60%) both enjoy proving the answer correct and do not mind making mistakes as long as they discovered their errors. 5 respondents (9%) disagreed with both statements.

4.7 Category F: Managing own Learning (in Mathematics)

Nearly half of all respondents (46%) agreed they were comfortable managing their own learning in mathematics, while 68% agreed they had the ability to supplement their mathematics learning by other self-directed means.

Group Statistics (all 2 d.p.)	YEAR	No.	$\bar{x}$	σ
(F1) Comfortable managing own learning	2005-2007	38	2.97	0.94
	2003	18	2.83	1.25
(F3) Ability for self-directed learning	2005-2007	38	2.45	1.01
	2003	18	2.28	1.23

Table 26

These data demonstrate no significant difference between the groups, note the control group agreed slightly more with the statements than did the other group.

F1/F3: These data show that 21 respondents (38%) agreed with both statements, while 9 disagreed (16%), meaning these are neither comfortable managing their own learning in mathematics nor are they able to supplement learning by other self-directed means. A further 9 respondents (16%) who are not comfortable managing their own learning agreed they can supplement learning by self-directed means.

4.8 Category G: Learning in other Ways, Learning Journal, Non-"3R's" Learning

The control group did not produce a mathematics learning journal or PowerPoint presentation means no comparison is possible. As regards learning mathematics, 90% of respondents agreed they learn mathematics best in a practical/hands-on type of classroom environment.

Group Statistics (all 2 d.p.)	YEAR	No.	$\bar{x}$	σ
(G2) Learn best from practical/hands-on class	2005-2007	38	1.89	0.51
	2003	15	1.67	0.72

Table 27

4.8.1 Learning from Participation in the PowerPoint Presentation

CROSS TAB OF AGREEMENTS TO BOTH		***G2 I learn best in a practical, hands-on type of class room environment***
G2/G4	**I learned about maths during the presentation element of the course**	**50%**
G2/G5	**I noticed my ability to do maths improved in the time after I presented my presentation**	**21%**

Table 28

G2/G4: 19 (50%) agreed with both statements, while 5 disagreed (13%). These data illustrate the practical nature of the presentation assisted those learners with a practical preference.

G2/G5: 8 (21%) agreed they learn best in a practical environment and noticed an increase in mathematics ability in the time after the presentation. 13 respondents (34%) did not notice any improvement.

4.8.2 The Mathematics Learning Journal

Due to the fact the control group did not participate in the newer teaching and assessment modalities, statement G9 was included on the questionnaire to elicit the group's predilection for expressing feelings about mathematics in writing. This is the only window into the potential reflexive capabilities of the control group and is therefore included in this section as a means of comparison. It is worth noting that some of the control group are or were pursuing third level degrees in the Humanities area, including Social Care, Nursing, and Legal Studies. They indicated verbally that reflexivity is or was an integral part of their course and this fact is reflected to some degree in the overall responses from this group.

G9/D16: 50% of respondents agreed they like writing how they feel about mathematics, while 23% disagreed; noticeably, a considerable 27% of respondents are neutral on the issue. 14 respondents (26%) agreed with *both* statements, while 6 disagreed (11%), suggesting these dislike writing how they feel about mathematics and are not confident learners in mathematics. 10 respondents (19%) consider themselves not to be confident however they like writing how they feel about mathematics. Only 7 respondents (13%) who consider themselves confident learners in mathematics, dislike writing how the feel about mathematics. Furthermore, 19 respondents (35%) agreed mathematics is a difficult subject for them (D20), however they like writing how they feel about mathematics.

4.8.2.1 Regularity of Journal-Keeping

Only 19% of respondents agreed they write in their journal on a daily basis at least; 78% of respondents disagreed with this statement, meaning that less than a fifth of respondents journal on a daily basis.

61% of respondents agreed they journal at least on a weekly basis, while 36% disagreed with the statement. The data suggested most respondents journal on a weekly basis.

Synthesis of responses to statements:

Agreement statistics

The Learning Journal	Daily	Weekly	Infrequently
(G11-13) Regularity of Journal-keeping	19%	61%	20%
(G19) Reflection Quality over Quantity	17%	44%	39%
(G15) Deeper Reflections Now Than Previously	0.1%	40%	*not defined
(G10) Incorporating Others' Views	6%	17%	14%
(G20) Motivation not for Tutor	8%	36%	42%
(G22) Learning Strategies Defined	17%	25%	*not defined
(D16) Confident Learners	17%	36%	11%

**Comprises Infrequently & Neutral responses to statement*

Table 29

Agreement statistics

The Journal & Confidence Level	*% of Respondents Who Are Confident*	*% of Respondents Who Are Not Confident*
D16/G14 Reflects More Often Now Than Previously	45%	41%
D16/G15 Reflections Deeper Now Than Previously	52%	38%
D16/G16 Recognise Difficulties & Struggles	38%	43%
D16/G17 Recognise Increasing Ability	48%	36%
D16/G18 Recognise Improving Confidence	64%	27%
D16/G19 Reflection Quality over Quantity	38%	42%
D16/G20 Motivation not for Tutor	55%	40%
D16/G21 Continue Journal if not Assessed	64%	27%
D16/G22 Learning Strategies Defined	54%	38%
D16/G23 Tutor Insights Provided	56%	33%

Table 30

4.8.2.2 Effectiveness of the Journal in the Learning Process

[G16/G18] I find my journal tells the story of my struggles with the subject of mathematics *

From my journal, I can recognise when my confidence began improving in mathematics

		From my journal, I can recognise when my confidence began improving in mathematics					
		Strongly Agree	Agree	Neither Agree Nor Disagree	Disagree	Strongly Disagree	Total
I find my journal tells the story of my struggles with the subject of mathematics	Strongly Agree	2	1	1	0	0	4
	Agree	1	12	3	1	0	17
	Neither Agree Nor Disagree	0	5	6	0	0	11
	Disagree	1	0	0	2	0	3
	Strongly Disagree	0	0	0	0	1	1
Total		4	18	10	3	1	36

Table 31

16 respondents (44%) agreed with both statements, while only 3 disagreed (8%). There is a relatively large neutral view here (11 respondents or 31% of total).

4.9 Category H: Effect of Tutor, Students' Attitudes to Tutor

Group Statistics (all 2 d.p.)	YEAR	No.	$\bar{x}$	σ
(H3) My tutor is someone I trust	2005-2007	36	1.97	0.91
	2003	18	1.72	0.75
(H5) I place much confidence in my tutor	2005-2007	37	2.03	0.69
	2003	18	1.50	0.51
(H6) I believe my tutor has confidence in me	2005-2007	37	2.03	0.64
	2003	18	1.78	0.55
(H8) Important my tutor believes in me	2005-2007	37	2.32	0.75
	2003	18	1.94	0.73

Table 32

These data show significance for H5; H8 shows slight difference between groups. This means the control group agreed more with the statements H5 and H8.

Agreement statistics

Effect of Tutor	*% of Respondents Who Are Confident*	*% of Respondents Who Are Not Confident*
D16/H1 Successes NOT Attributable to Tutor	83%	0%
D16/H2 Tutor Not Irrelevant to Learning	50%	33%
D16/H3 Learner Places Trust in Tutor	52%	38%
D16/H4 Learning Unaffected by Substitute	78%	22%
D16/H5 Learner Places Much Confidence in Tutor	52%	36%
D16/H8 VIP to Know Tutor Believes in Learner	58%	39%
D16/H11 Does NOT Prefer Strict Class Environment	50%	36%

Table 33

Irrespective of confidence, 81% of respondents agreed they trust their tutor; 84% agreed they placed much confidence in their tutor; 84% agreed they believed their tutor had confidence in them; and 71% agreed it was important for them to know their tutor believed in them.

Chapter 5 Discussion of Findings

5.1 Introduction to Discussion of Findings

This discussion chapter focuses on interpreting the data findings in the light of research reviewed in chapter 2 (Literature Review) and draws upon the triangulation data from students' learning journals and other reflexive materials to support interpretations and evaluations. Where this research overlaps, supports or contradicts other research, this is clearly stated. Data is drawn from the eight questionnaire research categories and discussed under appropriate headings taken from the literature review.

Two groups of students were researched: a combined group from 2005-2007 who studied mathematics and participated in newer assessment and teaching modalities as adult students and a control group from the same course from 2003 who pursued traditional assessment and teaching modalities.

5.2 Mathematics Anxiety and Self-Confidence

5.2.1 Mathematics Anxiety and Intimidation

The hypothesis is that there is some relationship between mathematics anxiety and mathematics competence responsible for a transformation in learners' intimidation levels and validated competency. There also appears to be some phenomenon whereby belief affects confidence and/or competency (this is known elsewhere as self-efficacy).

The data showed clearly the majority of both groups were intimidated by mathematics prior to beginning the course; however a substantial majority were not intimidated afterwards. Clearly, a metamorphosis occurred in terms of mathematics intimidation with both groups. Noticeably, it appeared the control group possessed less mathephobia than their counterparts which required further explanation.

There appeared to be supporting evidence for respondents' claims to be confident learners in mathematics. When final grades were compared against confidence the data was conclusive: almost no one who claimed to be confident and free of intimidation achieved a failing score. This is an important discovery in any attempts to find

relationships between mathematics competency and mathematics anxiety. These data illustrate a correlation and would seem to be consistent with research by Zaslavsky (1994) in Burns (1998), where it was claimed self-confidence and mathematics performance were closely related. These results also find consonance with research by Pintrich and De Groot (1990); Sloan et al (2002); Tobias (1980); Pajeres and Miller (1994); and Carmichael and Taylor (2005); where self-efficacy (belief in confidence to succeed at a given task) was found to have a motivational affect on learning mathematics. Further common ground was highlighted in the work of Bandura (1997) and Sheffield and Hunt (2006), who argued anxiety is known to correlate inversely with performance due to the motivational effect of self-efficacy. On the contrary however, research by Higbee and Thomas (1999) and Hopko et al (1998) is contradicted by these findings.

Intimidation manifests in many forms; from experience calculator intimidation is a potential sign of mathematics anxiety in students and data illustrated some startling findings. Regardless of confidence, over one-fifth were intimidated by the calculator; one-quarter would not challenge answers given by the calculator, and over one-third of all respondents avoided some mathematics due to calculator intimidation. Clearly, calculator intimidation is a problem for these groups.

The data for confidence levels showed that 70% of respondents believed their confidence in mathematics affected their competency and mathematics ability. This is a clear demonstration of the power of self-belief on learner self-image, and motivation - ultimately self-efficacy. There would appear to be consonance with the research of Carmichael and Taylor (2005) and Bandura (1997). Moreover, Carmichael and Taylor's research found motivation affected student performance and confidence.

Mathematics confidence levels were affected in several ways, for example nearly 90% of confident respondents believed mathematics to be a difficult subject, possibly a throwback to their schooldays. However, nearly half of all confident respondents agreed their confidence increased as a result of their participation in the mathematics presentation.

It appeared from the data that lack of confidence in mathematics does not hinder respondents from rendering assistance with children's mathematics homework. Over one-fifth of non-confident respondents agreed they had confidence to do this. Clearly there is something more going on in this context than a simple binary relationship between confidence and ability. These data showed declared mathephobic parents put aside anxiety to assist with children's mathematics homework. If mathematics anxiety can be put aside in this context, perhaps it can be similarly put aside in others? These data are all the more remarkable when viewed against further data regarding adulthood mathematics and childhood mathematics: nearly half of all respondents (and a substantial non-confident majority) believe their childhood mathematics to be superseded.

5.2.2 Previous Mathematics Experience

The hypothesis is that previous negative mathematics experiences impact negatively on current mathematics learning. A majority of respondents began their mathematics module intimidated to some degree from previous experiences. Journals detailed insidious treatment mainly by school mathematics teachers. For example, this student had a particularly vindictive mathematics teacher suffering ongoing public humiliation by him:

> *"…this is where my 'fear' surrounding mathematics comes from…because it's the one thing that always sticks out in my mind. It later carried on into secondary school, where I always performed badly at mathematics. In the end I opted to take Foundation mathematics paper for the Leaving Cert. because I HAD NO CONFIDENCE ABOUT MATHEMATICS."*

Another student reflected:

> *"I know a lot of my fear stems from primary school; I never understood what the teacher was saying. When I asked a question I was made the butt of his jokes for that particular lesson, that was bad enough, but he also had a sweeping brush handle and for every sum we got wrong he used to whack us really hard across the palms of our hands. By the time I got to secondary school I had lost*

all interest in mathematics and failed every exam I ever did. It was because of this that I bottled out of doing my Leaving Cert…"

These quantitative and qualitative data showed clearly the effect of previous negative mathematics experiences on current learners of mathematics. There is consonance with the research of Higbee and Thomas (1999), which showed previous mathematics education and perceived ability are key elements for success in mathematics. Further research by Campbell and Hackett (1986); Hackett et al (1990); Meyer and Eley (1999) and Hall (2002) concurred with Higbee and Thomas' findings.

5.2.3 Adults' Beliefs, Attitudes to, and Philosophies of Mathematics

The hypothesis is that altering one's philosophical paradigm transforms attitudes and perceived self-efficacy, and perhaps even confidence.

The data showed conclusive evidence the majority (55%) of respondents began their course preferring an 'instructional understanding' mathematics paradigm (knowing how) over 'relational understanding' (knowing why). By the end of their course however, 72% preferred a more holistic paradigm, incorporating the relational understanding paradigm - knowing what to do and why. This included almost half the number of previously 'instructional understanding' respondents, demonstrating a trend towards a more holistic paradigm. Any move away from the instructional paradigm could be interpreted as positive in terms of mathematics teaching and learning.

Skemp (1971) distinguished between instructional and relational understanding, highlighting that from an instructional viewpoint mathematics is viewed as an absolute set of truths, where rules must be followed carefully and correctly in order to achieve the correct answer. However, Ernest (2004) amongst others, highlighted the benefits of the opposing view to absolutism – fallibilism – as a human construct, corrigible, and open to revision. The data illustrated two-thirds of respondents believe mathematics to be corrigible. Anecdotally, experiences of inducting these cohorts for several years, indicates such figures would be much less at the beginning of the mathematics module due in part to negative previous educational experiences.

By altering philosophical paradigms, these learners seem to have been well-placed to transform their attitudes and improve their self-efficacy. To what extent self-confidence has been improved, or for that matter, mathematics anxiety decreased, was not fully revealed by these data.

5.2.4 Attitudes to Learning and Engaging with Mathematics

The hypothesis is that persistence affects competency, and a proper work ethic for engagement with mathematics impacts positively on mathematics competency.

A sizeable minority (39%) of respondents displayed a good work ethic and motivation for engagement with mathematics. Overall, 49% with proper engagement motivation appeared not averse to undertake hard work should it be necessary to understand mathematics. For example, a student who had difficulty keeping his momentum up over holidays and midterms wrote:

> *"After today I realise mathematics needs to be practised, it's like going to the gym – you're fit while you're training but once you stop you go into reverse and get rusty. I need to go to the 'gym' more often."*

On another occasion this student was very candid in his reflections around understanding mathematics, he wrote: *"…I don't know exactly how to explain it but it's as if I feel I've no right to learn mathematics".* This dramatic insight into his attitude towards mathematics illustrates a significant benefit of the journal to teachers of mathematics. Due to his candour his tutor was able to help him confront this attitude, expose it and show him he was worthy. This same attitude manifested in a small number of students.

Another student reflected on his attitude to mathematics now the course was almost over. Originally from the UK he utilised an icon from his culture to derive an analogy of his attitude to mathematics:

> *"I'm no longer afraid of mathematics; I just know I will have to work at it harder than most other subjects. But then in the words of Margaret Thatcher, she supposedly said 'if it isn't hurting it isn't working!'"*

One can see the similarities in both analogies here: hard work and working out. Both of these students believed mathematics is something akin to exercising – *"if you don't use it, you lose it"*, as another student put it.

Research by Kieran (1994) found that contemporary thinking regarding learning mathematics has shifted away from rote learning/instant recall and changed to include learning mathematics with understanding. From the journal extracts it can be seen how difficult learning mathematics with understanding might be for adult learners with little or no mathematical foundations. It would seem from these representative data from journals some of the learners were prepared to work as hard as necessary to learn mathematics with understanding.

5.2.5 Confidence, Gender and Age

The hypothesis is that perhaps gender and/or age affected confidence and/or competence in mathematics. No significant differences appeared from these data, either between genders or groups. Preis and Biggs (2001) found that, amongst others, a mathematics 'myth' existed which claimed 'women can't do mathematics'. These findings also contradict that statement. Zaslavsky's research (1994) examined schoolgirls' progression with mathematics and noted negative gender differences in that context, however, none were revealed in this current study's findings.

Regarding age and confidence, the data seemed to show the most confident age group was 41 to 50 years, followed by 24-30 years. The least confident group was 51 to 60 years. Perhaps due to the length of time since traditional schooling, confidence in mathematics is low; also, this group may believe their mathematics has been superseded as illustrated previously. These findings seemed to fit with findings from Multon et al (1991) who found the effect on performance of self-efficacy would be greater for older and low achieving students.

5.2.6 Communications Skills

5.2.6.1 Discussing Mathematics

The hypothesis is that more intimate settings are more conducive for discussion especially for low-confidence learners. Respondents were asked to show how they felt discussing mathematics in different situations: class, tutorials, study groups, and generally. At least 85% of respondents liked discussing mathematics generally and in class, rising to 89% in the study group forum. These data seem to describe a trend whereby respondents agreed with the statement the more intimate the discussion forum. For example, agreement scores across the four statements regarding discussing mathematics increased, while disagreement scores fell, illustrating a downward trend, and a move away from disagreement generally. Moreover, the data showed respondents preferred discussing mathematics in smaller, more intimate and apparently less intimidating surroundings. Their preferences were: study group, tutorial, and classroom. For example, one student wrote about how her study group offered benefits beyond the academic:

> *"...I've put the effort in and can do the graphs but [it] really does not float my boat! Perhaps this will cause me problems in September ... if I don't learn how to deal with stuff I don't like. A matter of figuring out how, I think, maybe getting together and chatting with study group might help?"*

Later the same student noted:

> *"But my learning strengths so far are definitely through listening! Especially within the study group I can remember a lot more of what's said through discussion and so on!"*

These findings seem to concur with those of Dodd (1999) who found some students feel more comfortable speaking in smaller groups, obtaining emotional and academic support.

5.2.6.2 Asking and Answering Questions

The hypothesis was to ascertain whether more intimate settings provide low-confidence learners particularly, with increased opportunities to ask and answer questions. These data exhibited significant differences between the groups regarding confidence to ask questions in class, tutorials, and study group. Consistently the 2003 control group exhibited more confidence in each setting. As observed previously, the data showed the preference trend for more intimate fora, and these data showed clearly some respondents felt more able to ask questions in tutorials rather than classes. These data were triangulated and showed a sizeable minority of respondents relied on others to ask questions in class because of intimidation or low self-confidence. Preis and Biggs (2001) found high mathematics-anxious students distrust themselves to obtain answers, preferring to collaborate instead of working alone. These findings were supported by this current study.

It could be argued that by providing tutorials respondents were in some way enabled to withdraw from classroom questioning; this requires further investigation. Conversely, tutorials provide low-confidence students with a less intimidating environment and a much smaller discussion forum in which to ask questions. There may be a perceived lack of threat to self-image under these circumstances enabling them to be somewhat freer than in the normal classroom.

These hypotheses are given further relevance when additional data regarding questioning is examined. A majority (58%) were not intimidated by raising their hand to ask questions, however nearly one-half of respondents consider what others think of them before asking their question. Lynch et al (2003) found similarly. For example, one student reflected often of his frustrations around his lack of courage to ask questions. On one such occasion he wrote:

> *"I could feel the questions on the tip of my tongue, I just needed that one more bit of courage – I couldn't find it. It was like being a child confronting a fear like jumping into a swimming pool for the very first time."*

5.2.6.3 Attitudes towards Correctness of Answers

The hypothesis is that attitude towards correctness and persistence in answering questions indicates underlying confidence. These data showed that of those respondents who enjoyed proving the answer correct in mathematics, almost two-thirds were confident it was actually correct, meaning over one-third were not. There seems to be some consonance with the findings of Dodd (1999) who found some mathematics-anxious learners distrusted themselves to answer questions correctly.

Previous research by Selfe et al (1996) and Lanigan (2006) showed students increased confidence in ability to problem-solve and participate more in class; mistakes were valuable if utilised in learning mathematics. For example, a student reflected on remedying mistakes:

> *"...went over fractions on the weekend…Trial and error, but it worked. Now when I get something wrong I go back to see where and why!"*

After presenting on the impact of mathematics on society another student reflected on new learning from the process:

> *"…I realised I did learn something from the whole experience and that is: if I ever have to give a presentation in the future I should get other people's opinions and take on their points while giving myself plenty of time to make all the adjustments that might need doing."*

Another student reflected: *"Don't know what to say about last week's exam; I'm half dreading the results. I know I'm going to find out my weaker points and from there I can revise it all again…"*

The data showed 60% both enjoyed proving answers, and did not mind making mistakes so long as the error was discovered. These data illustrate a paradigm shift in these cohorts who previously would have perceived mistakes as de-facto incompetence. Their concepts of competency seem to have been readjusted or to some degree redefined.

5.2.7 Effect of Tutor, Students' Attitudes to Tutor

The hypothesis is that student attitudes to tutor affect confidence and competence and the safe environment created by the tutor enables effective, competent and confident learning. Research by Maslow (1943, 1954, 1971, and 1998) and Jackson et al (1999) have shown generally the provision of a safe environment and positive reinforcement is conducive to productive learning engagement. For example in school, students cited lack of safe environment and negative reinforcement as culpable in precipitating their withdrawal from mathematics and developing mathephobia. Mathematics teachers were referred to in negative terms mostly from those with some degree of mathephobia.

The data illustrated some significant differences between the groups, for example, *I place much confidence in my tutor* and *It is extremely important for me to know my tutor believes in me*, however the control group agreed more with these statements. Possibly one reason for this may be down to their relationship to their mathematics tutor. It is possible there was a perception of more mutual belief/trust with their tutor. Preis and Biggs' (2001) research showed the importance of instructors believing in each student's ability to learn mathematics; Dodd (1999) discovered this can assist learners develop self-belief they can do mathematics. These findings may have some consonance with the current findings: irrespective of confidence, significant majorities of respondents cited trust and confidence in tutor, and tutor's belief in respondents as being extremely important.

The data showed categorically the majority of respondents' learning was unaffected by substitution of regular tutor. However, it seems long-term (over one month) substitution caused some anxiety to learners through readjustment to new tutor. Different teaching methods, classroom manner, question-answer techniques on tutor's behalf may precipitate uncertainty in the learner causing growing anxiety or anxiousness. For example, research on mathematics anxiety by Ashcraft and Kirk (2001) found failure to prevent worrisome thoughts loaded working memory and detrimentally affected performances. This may possibly have been a factor in the reported anxiousness of the 2007 group.

Moreover, they had least time to bond with their tutor. It consequently affected trust and attitudes towards their tutor. It may have coloured responses regarding trust and confidence in their tutor. It may also be indicative of their lower confidence scores when compared to the control group. The control group experienced no tutor substitutions, were facilitated with an extra tutorial per week, and the tutor was more available for one-to-one sessions. They had more exposure to their tutor and more time to bond and build trust with him. These mitigating factors may have coloured the control group's responses, in a similar but opposite fashion to the 2007 group. This may explain the consistently higher confidence and validated competency scores evidenced throughout the data. It may also go someway towards explaining why there is not a more emphatic case for confidence-building from either learning journal or mathematics presentation.

5.3 Adult Learners

5.3.1 Team Working Skills

Were respondents not attending study group meetings or attending infrequently for reasons other than the fact the meetings were a waste of time? What reasons might these be? Overall, data showed team working had high agreement with no significant difference between groups. The data showed clearly respondents' willingness to part-take in collaborative learning. By far the most popular frequency was weekly.

The respondents appeared divided on the issue of frequency of meetings. However, there seemed to be many unable to meet frequently, indicative perhaps of social, domestic or other demands. For example, some respondents were employed as well as studying; some were homemakers and/or carers. The majority have children, some are still dependents. With a somewhat fluidic lifestyle, it is little wonder study group meetings took place infrequently. It is worth noting no respondents cited 'waste of time' for non-attendance or infrequent attendance. Zopp (1999) found unrelated events and a lack of support, amongst other things contributed to mathematics anxiety in learners. There would seem to be some consonance between Zopp's findings and this current study.

5.3.2 Preferences for Collaboration

The hypothesis is that learners prefer smaller group settings in which to learn mathematics and collaboration benefits learning in mathematics. The data showed clearly those with a collaborative preference collaborated for mathematics; significant because traditionally, mathematics is taught and learned in isolation, or with minimal collaboration between learners. These findings would seem to agree with those of Lynch et al (2003) and Higbee and Thomas (1999) who found benefits to collaborative learning and a safe classroom environment.

Respondents preferred tutorials for collaborative exploration, and for questions and answers. Noticeably, all those who attended study groups did so voluntarily, including, remarkably, those without a collaborative preference (at most 9%). This is a significant finding in that these adult learners exhibited clear self-directedness in pursuing study groups despite their personal collaborative shortcomings. They may have chosen to embed themselves in a study group to appropriate the associated academic, social and personal benefits of study groups. Learners typically cited their academic improvements to participation in study groups; further benefits included mutual support of learners by learners, in many cases this included some form of socialising, shared child-minding and shared transportation. For example, one student wrote:

> *"Going to ask my friend to pick up the kids from school tomorrow so I can go to the tutorial."*

The needs of the participants were met in a similar way to those Maslow (1943, 1954, 1971, and 1998) identified as being necessary prerequisites for learning to be effective; once lower order needs were met students were freed to coalesce with their group. Another reason why some did not or were unable to meet with study groups possibly was their needs were not met. A very small minority of students reported negative experiences in groups claiming they did not feel safe exposing their vulnerability due to insensitive behaviours from other group members.

5.3.3 Managing Own Learning

The hypothesis is that ability to manage own learning indicates competence. Decreasing stress levels (due to good time management for example) may allow growing confidence to develop; this was one finding made by Zopp (1999). Although a large majority of respondents agreed they were capable of self-directedness, less than half overall were comfortable managing their own learning. There appears to be a dichotomy emerging between those able to manage self-directedness and those unable. A dichotomy emerged previously relating to confidence in mathematics. What is not clear however is whether the dichotomies overlap with the same respondents; that is for further research and investigation.

> *"…I've just lost my spark somewhere along the way…It's just my whole life is taken up with everything: if it's not the work we have to do for college it's someone on the phone asking me if they can come over to study with me. My husband barely talks to me anymore, my kids don't see me and on top of all that I have to work. I just feel like screaming, everyone wants some of my time and I don't even have any for myself. I have asked myself so many times why I don't just give up now; it would make everyone's life so much easier. But I can't do that and yes maybe I am being selfish but this means so much to me and I want to make it through the whole year."*

The data showed there were a sizeable minority of respondents who claimed to be uncomfortable managing their own learning as well as being unable to supplement own learning through self-directed means. This finding is worrying because it highlights a learner group who were 'at risk'; they may be mathematics-anxious learners or perhaps low competence learners. They may also have answered the statement negatively for example due to limited access to the Internet, or perhaps felt intimidated by the college libraries. The most significant point to note is they seemed to be disenfranchised further in terms of learning mathematics.

There were no significant differences between the control group and their counterparts on this issue.

5.4 Mathematics Competency

5.4.1 Problem Solving Skills

The hypothesis is that mathematics develops logical, problem-solving skills in the learner providing spin-off benefits to other subjects and areas of life, thereby increasing learner confidence through awareness. Nearly three-quarters of respondents, irrespective of confidence agreed they were more persistent at mathematics than previously. This finding demonstrates the development and exhibition of stamina/tenaciousness in the learner, backed up by numerous journal accounts. For example:

> *"I have heard nothing but nightmare stories on this subject [statistics]"*

However having finished the module she wrote:

> *"It's all about understanding what's being asked (words like 'deviation'), finding averages. I'm no longer scared of starting something new (what you sow you reap)."*

Another stated:

> *"It's just not sinking in, I wish it would click with me but it's just not happening…I have to keep telling myself to stop feeling sorry for myself. To be honest if I'd stop feeling sorry for myself and spent that time trying to figure out linear programming I'd probably do a lot better! I'm not letting myself give up just yet…where there's a will there's a way."*

Apparently, learners now take time to dwell over problems, strategising and deducing their next moves. This behaviour is a paradigm shift and is, to some extent evidence for their transformations into self-sufficient learners.

The NCTM (2006) recommended students should acquire scholarly characteristics that will serve them well outside of the classroom. Skills such as

persistence, curiosity, and confidence amongst others were identified. This current research study showed some students achieved these characteristics to some degree.

In the majority of comparisons, the control group agreed more with statements than did their counterparts from 2005-2007. A possible explanation for this may lie in the previous mathematics levels of respondents from different years. However, the groups' level of study showed no significant differences. The control group had slightly higher grades, although the overall average grade was 'C'. Therefore, it appears some other reason exists to explain this phenomenon.

Overall the data showed a trend in the development of scholarly characteristics such as confidence, logicalness, and persistence with approximately 40% treating problems more logically, and 50% persisting with problems until resolved. The development of such problem solving characteristics – a form of mathematics competency – impacts positively on learners' self-confidence and self-efficacy as can be seen from the following journal entries.

> *"…now I know more mathematics than I have ever known in my lifetime of mathematics at school. This happened in just 7 months, which just goes to show that how it's taught has a lot to do with how it's revised. I am no longer afraid of mathematics. I'd have more confidence in myself to tackle [mathematics] or apply for jobs or courses that involve mathematics, a road on which I would have never travelled before."*

Another wrote:

> *"…just hope I get more confident with numbers because they still frighten the life out of me", "…fractions! Algebra! I can't believe I can understand them let alone do them! It's great I really feel good about it, like I have achieved something already!"*

These data provided further evidence for a tentative link between confidence and competence in mathematics.

5.4.2 Number Skills; Universality of Mathematics

The hypothesis is that de-mystifying mathematics increased awareness, thereby positively impacting upon confidence and competence. By the end of the module there was near complete awareness of the universality of mathematics, of its everyday use. Mathematics was no longer mysterious – 89% of 2005-2007 sample cited their participation in the presentation as one reason for this transformation. (The mathematics presentation is dealt with separately in a following section).

5.4.2.1 'Trophy' Mathematics and Invisible Mathematics

More than three-quarters of respondents felt they need to understand mathematics even if it was not a major portion of their chosen course in third level. Why would such a majority of respondents feel this way? One potential reason may be the fact that, in their psyches mathematics remains the yardstick by which incompetence and so-called 'stupidity' are measured (perhaps another throwback to compulsory education). There may be reluctance to relinquish mathematics after achieving validated levels of competency. Moreover, learners may have felt achieving such mathematics competency akin to a 'trophy' subject, something to boast in, regardless of its prevalence in their college courses.

Regarding the perceived usefulness of mathematics to the respondents' daily lives, a large majority apparently recognised mathematics' usefulness either in college life or other walks. Over one-quarter recognised it in both walks; for example, to quote a number of respondents' questionnaires:

> *"Business: Gave me confidence to work with numbers. Areas in life: In general I feel that I can think more logically and I now question before I act."*

"All areas; knowing in myself that I can come to terms with understanding complicated mathematics has lifted my confidence in all my subjects and has made me a more confident person generally."

"Percentages/APR: I now understand what it means (mortgage/bank); Fractions: having the general knowledge of them; All of it: I love the confidence to help my son with his homework."

"Banking: now know what APR is! Children's mathematics: have 2 children in secondary school; can help them with their mathematics. Have been able to break it down so they understand."

As indicated in another context earlier in this chapter, anecdotal evidence would suggest such a large awareness of the prevalence of mathematics in everyday life would not be indicated prior to the mathematics course; to a large extent the prevalence of mathematics would appear to be 'invisible', only becoming visible through a process of 'coming-to-know' – awareness.

5.4.3 Competency: Self-reported and Test-score Validated

The hypothesis is that although learners indicated so, were they actually more competent after the course? The control group had slightly better scores in terms of Christmas Exam marks; however there were significant differences between groups in terms of Final Exam marks. This seems best explainable in the context of the effect of tutor on the groups (see section previously).

Almost two-thirds of respondents claimed to be more competent after the course – these were formerly incompetent students by their own admission, illustrating further evidence for the students' competency transformations in mathematics as a subject.

When taken into account with the data regarding intimidation and self-confident mathematics-learners, and considering the data regarding validated competency improvements it would appear some form of inter-relationship exists. The data

highlighted a potential link between mathematics confidence and mathematics competence. This finding is quite important as it has the potential to answer the primary research question. Data presented earlier highlighted the correlation between self-reported competency and actual test scores, thereby validating them. Taken together with data regarding pre-course and post-course mathematics anxiety, and reported confidence levels with mathematics, a potential link between learner self-confidence and mathematics competency was identified.

5.5 Assessment and Teaching Methodologies

5.5.1 Learning in other Ways, Learning Journal, Non-"3-R's" Learning

The hypothesis that assessment and teaching methodologies assisted learners develop competence and confidence in mathematics is discussed. As declared previously, the control group did not part-take in the new assessment and teaching methodologies, so no direct comparisons between groups was possible. However, some questionnaire statements[10] were useful for comparison in terms of attitudes towards reflexivity in mathematics. It must be stated that some control group respondents who were in their final year or who had graduated the previous year pursued humanities courses where reflexivity went hand-in-glove with their academic studies. Some of these respondents provided further insights verbally and by means other than the questionnaire that were useful for discussion.

5.5.1.1 Learning from Participation in the PowerPoint Presentation

The hypothesis is that newer assessment and teaching modalities enabled the learners to learn mathematics and by using PowerPoint helped learners become more aware of everyday mathematics thereby increasing confidence and competence. Overall, 90% of respondents agreed they learn best in a practical, hands-on type of classroom environment. However, these data may have involved biases. For example, with so

10 Statement G9 is such a representative statement from the questionnaire: "I like writing how I feel about mathematics". This statement was directed at ALL respondents alike.

many respondents suffering under mathephobia to some degree, and with many turned off the traditional 'chalk and talk' lecturing style of mathematics education, is it any wonder such a majority felt this way about practicality in the mathematics classroom? A possible consequence of this point may be respondents' disbelief in the practicality of mathematics. The data could be highlighting such underlying phenomena.

The exercise of participating in the mathematics presentation may have reintroduced learners to the practicality of mathematics, demonstrating through their own presentation and that of their colleagues' the very practical nature of mathematics. It would seem from the data the presentation was very effective in assisting learners transform their opinions concerning the practicality of mathematics. Evidence from journals and guided reflections, in addition to quantitative data showed 89% of respondents cited the presentation as directly changing their views about the practicality of mathematics and its everyday use. This may also be indicative of a transformation in self-efficacy leading to an increase in confidence perhaps.

5.5.1.2 The Mathematics Learning Journal

The hypothesis is that the learning journal assists learners transform to some degree from intimidated learners to unintimidated learners of mathematics; that it helped build confidence and identify learning strategies. Half of all respondents liked writing about how they feel about mathematics; with nearly one-quarter disliking it. These data showed some low-confidence learners, who found mathematics difficult, liked using the journal. Why was this the case? Perhaps these learners identified benefits with journaling, possibly to communicate with their tutor and share their problems and difficulties with mathematics. By journaling regularly, perhaps these learners were able to 'deal' with their problems by making them explicit rather than allowing them to remain internalised, perhaps alleviating stress or anxiety. Findings by Selfe et al (1996) and Lanigan (2006) may provide insights in this context. They found journals provided a written account of the students' progress as seen not only by the instructor but by the student as well.

Conversely, the data also showed the dislike some competent and/or confident learners had for such endeavours. Perhaps, in some cases, learners felt the journal was somehow 'below' them; others may have felt unable to expose their vulnerability in such a forum. These points highlight a significant shortcoming of the learning journal – it does not suit every learner. Some learners chose to keep their feelings to themselves and decided purposefully not to explore their learning of mathematics in any expository fashion.

As a case in point: moderate-to-high confidence/competence respondents' journals clearly showed their frustrations coming to terms with the journal as a learning tool. For example, entries were 'fabricated' rather than expressed from actual events or so-called 'critical moments'. This is evidenced from at least one respondent's journal where he complained about others in the group discussing how they were going to borrow journals to fabricate their own to achieve continuous assessment credits. The learning benefit to such learners is minimal at best. (Although, it could be argued these learners have learnt how to 'play the academic game' to some degree, in terms of submitting for continuous assessment credits. This too, is a valid form of learning, albeit an unintentional one in this experiment).

5.5.2 Regularity of Journal-keeping

Keeping a regular journal assists mathematics learning; was there any evidence confidence increased as a result of journal-keeping? The learning journal concept in mathematics was to assist learners in various ways to become more confident, more competent, and more discriminating and critically aware in mathematics class. The data highlighted a trend in respondents' preferences for journaling. The majority journaled weekly, meaning they did not journal after each mathematics class, as encouraged by their tutor. A possible reason for this behaviour may lie in their unwillingness or inability to part-take in the learning journal. This may have occurred because of the time involved in reflecting, writing and the general upkeep of the learning journal. Quite a number of the adult learners had poor levels of written English, including poor grammar and punctuation. Some did not have English as their first language. Embarrassment may

have played a part in their lack of enthusiasm for keeping a more frequent journal. A number of learners may have felt unworthy of providing opinion and comment in the pages of a journal due to past negative-reinforcing experiences.

Comparisons were effected between confidence and various other accrued benefits of the journal (based on Lanigan, 2006). These data were illuminating in terms of exposing the benefits to the 2005-2007 group. For non-confident respondents, 41% reflected more often in the second semester than in the first; 38% reflected more deeply; 43% recognised their difficulties with the subject played out within its pages; 36% recognised increased ability over time; 27% recognised improvements to confidence over time; 42% preferred quality over quantity of reflective accounts. For 40%, motivation to please tutor was not their main reason for journal production, 27% would continue it even if it was not credited for assessments; 38% discovered learning strategies from its pages; and 33% agreed it provided their tutor with insights into their learning which in turn assisted with learning mathematics. The benefits to confident learners were as good or better in most instances.

Tobias (1987) found that writing or 'self-monitoring' broke the paralysis of mathematics anxiety which would seem to agree with the findings from this current research study. Further consonance is seen in the findings of Preis and Biggs (2001) who found that a mathematics autobiography helped learners positively by encouraging them. Increased confidence due to journal-keeping was found by Selfe et al (1996), however, correlation between regularity and confidence was not identified explicitly. Although not conclusive here in this study, it would seem that by journaling weekly confident learners remained confident and low-confidence learners were assisted to become more confident. There would appear to be some link between frequency of journal-keeping and confidence in mathematics.

Although these data did not provide categorical evidence for the role the journal played in the confidence-building process, they did however illustrate a major benefit of the journal to the learners, namely the personal historical record of interactions with learning mathematics: over time, a series of 'snapshots' develop into an overall personal

historical record. They were also able to recognise when their confidence began improving in mathematics. It is entirely possible that based upon these records confidence is derived by the learners from reflexivity. Successes are recorded to be replayed at a later date perhaps when the learner is not so successful. Comfort may be derived from the fact the learner made it through their previous bout of 'failure'; for example, on numerous occasions the phrase 'this too, shall pass' appeared in journals. There is much scope in this area particularly for further research.

5.6 Summary

Based on Higbee and Thomas' (1999) research, educators have begun to research various techniques, including the use of collaborative learning (including study groups) and verbalisation (including reflexive journals) during the problem-solving process.

The data demonstrated lack of confidence in mathematics does not hinder respondents from rendering assistance with children's mathematics homework. There is a similar phenomenon in the data for those who experience intimidation regarding asking questions in class. Clearly there is something more going on in this context than a simple binary relationship between confidence and ability. Declared mathephobes willingly put aside mathematics-anxiety under certain circumstances. If mathematics anxiety can be put aside in this context, perhaps it can be similarly put aside in others? This is perhaps the most important finding of this research. There would seem to be a non-linear relationship therefore between competency and confidence in mathematics, under these circumstances. It would seem that human nature is a large variable in the competency-confidence equation. Further research on this specific issue is required.

Respondents were categorical in their preference for smaller, more intimate settings in which to learn and explore mathematics. The provision of a safe and 'vulnerable-friendly' atmosphere was preferred to the traditional mathematics classroom.

Most students used the journal to pose questions, both mathematical and non-mathematical in nature. This allowed engagement in a dialogue and helped build a

mutual bond that endured until the conclusion of the term. In other respects, students mentioned their fear of asking questions in case they appeared 'stupid' – a large hangover from compulsory schooling; and of being asked questions by their tutor; some felt this approach made them uneasy. By utilising the journal in this way their tutor was informed of their preferences immediately, particularly useful in the case of a shy or unassuming student who would not approach their 'mathematics teacher' due to the connotations of power that go with that title.

Most notable throughout the findings is the lack of significant differences between the control group and their counterparts. So-called 'advantages' were identified, marking out the control group as having an especially close bond to their tutor. These may to some degree explain the consistently higher confidence and validated competency scores evidenced throughout the data.

Chapter 6 Conclusions & Recommendations

6.1 Introduction to Conclusions & Recommendations

The aim of this research was to answer a two-part research question:

"With respect to adult learners: what effect has learner self-confidence on mathematics competency?" and *"With respect to adult learners: what effects have less traditional teaching and assessment modalities on the learner's self-confidence and mathematics competency?"*

Examining the first part of the question indicates the involvement of factors such as Mathematics Anxiety and Self-Confidence, Adult Learners, and Mathematics Competency. These are discussed below. Examining the second part of the question involves an examination of Assessment and Teaching Methodologies, and this also, is discussed.

6.2 "With Respect To Adult Learners: What Effect Has Learner Self-Confidence on Mathematics Competency?"

6.2.1 Mathematics Anxiety and Self-Confidence

There is a relationship between mathematics anxiety and mathematics competency that is responsible to some degree for causing a transformation in learners' intimidation levels and validated competency. Nearly all confident learners successfully passed the course. However, a number who claimed to be non-confident learners passed also. In addition, there were a number who were non-confident who did not pass. This might lead one to conclude prematurely, perhaps, the influence of mathematics anxiety on competency in mathematics is not linear.

Unquestionably, there were a number of self-confessed non-confident learners who passed the course. For these learners especially, the relationship is not linear. Some other influence seems to have been affecting their self-assessment of confidence/math-anxiety levels. Therefore, it could be construed from these findings that, although the relationship is not always linear, linear characteristics are exhibited for the majority of

learners. The effect of human nature on the apparent breakdown in linearity for non-confident, competent mathematics learners requires further investigation.

There can be no argument about the effects of previous mathematics experiences on current learning. In addition to the reviewed literature on the subject, the findings from the data were clear: previous negative experiences of mathematics education, particularly compulsory education, were culpable in the withdrawal of learners from mathematics and their development of mathephobia. It appears this reason alone is responsible for such high pre-course intimidation.

Moreover, evidence for the effect of mathematics instructor on learners' confidence and competence were identified. In addition, somewhat surprising findings in terms of trust and belief at the interface between learner and instructor, lead one to conclude the environment created by the mathematics instructor is of huge significance to learners' self-confidence and self-efficacy. Learner confidence was affected by mathematics instructors. Further research is indicated.

Transforming philosophical paradigms and attitudes towards mathematics seems to have been instrumental in the learners' metamorphoses identified earlier. Large numbers of respondents noted benefits mainly to self-efficacy. It might be concluded from these findings, and those of others in the literature reviewed in this area, that motivation, self-efficacy, and philosophical paradigm are powerful instruments in positively transforming non-confident learners' attitudes toward mathematics. Although confidence-building might be inferred from these findings, it is not possible to conclude conclusively in this regard. Therefore it is recommended further research in this area be undertaken to measure the effects on confidence-building.

Furthermore, findings regarding discussing mathematics, asking and answering questions, and attitudes towards correctness of answers, were conclusive: learners preferred smaller, more intimate settings – the less intimidating and more collaborative, the better. Moreover, conclusive evidence indicated respondents' preferred collaboration to isolation. Benefits accruing to them from study groups encouraged their continuation.

However, some experienced negative stress due to their inability to attend, thereby foregoing the associated benefits of group collaboration. The provision of a safe environment for learning mathematics is an important conclusion to be drawn from this research.

6.2.2 Adult Learners

The belief by some older adult learners that their 'school' mathematics had been superseded was remarkable. Their beliefs affected their confidence and competence in mathematics, agreeing with findings by other researchers. Although not conclusively proved by this current research, it might be concluded older age affects mathematics learning. Furthermore, this study found no conclusive evidence for gender bias in terms of confidence or competence. There appears to be much research opportunities in these areas.

Inability to manage own learning emerged, however any relationship to competence or confidence needs further investigation.

6.2.3 Mathematics Competency

It was hypothesised persistence and proper work ethic for engagement with mathematics impacted positively on competency. To some degree this was demonstrated in the findings. Although potentially difficult for some adult learners, working as hard as necessary to comprehend mathematics, in addition to persisting and engaging fully with the subject, seems to have paid dividends for many learners. Learning mathematics with understanding was new to most learners and was the cause of some difficulties for them. Readjusting to this new approach to learning may have more suited those with less demands on time, for example. This requires further research.

It may be concluded from this research that problem-solving behaviour improved in these cohorts generally. It can also be concluded that previous mathematics levels or grades are not a reliable indicator of future competence in these cohorts. It appears effect of previous experiences, particularly of tutor, hold greater influence over future

competency and confidence levels. The researcher recommends further research in this area.

The majority of learners are more competent post-course, indicating the beneficial effect of the module on learners. Validated competency correlates to self-confidence/mathematics-anxiety claims for these respondents. There exists further scope for research into this area.

6.3 "With Respect To Adult Learners: What Effects Have Less Traditional Teaching And Assessment Modalities On The Learner's Self-Confidence And Mathematics Competency?"

6.3.1 Assessment and Teaching Methodologies

Almost 90% of those respondents who participated in the PowerPoint mathematics presentation had their awareness of mathematics, its practicality, and usefulness readjusted to the point where mathematics was demystified. This impacted upon learners' self-efficacy and may have led to increased confidence in some cases. This requires further research.

Journal-keeping seems to have positively benefited those learners who honestly engaged with it. The benefits of journaling to learners of mathematics ensured its continuation, particularly for low or non-confident learners; this despite others' ulterior motivations to fabricate journals for assessment credit. Weekly journal-keeping seems to have built confidence although this was not shown conclusively. There is scope for further research in this area also.

Conclusive evidence was found to encourage the continuation of newer assessment and teaching modalities.

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Appendices

8.1 Appendix – Chapter 2: Literature Review

8.1.1 Preis & Biggs (2001)…

…describe a cycle of mathematics avoidance:

- In phase one, the person experiences negative reactions to mathematics situations. These may result from past negative experiences with mathematics, and lead to a
- Second phase in which a person avoids mathematics situations. This avoidance leads to
- Phase three, poor mathematics preparation, which brings them to
- Phase four, poor mathematics performance. This generates more negative experiences with mathematics and brings us back to phase one.

This cycle can repeat so often the mathematics anxious person becomes convinced they cannot do mathematics and the cycle is rarely broken.

8.1.2 Parker, (1997)…

…found a six-stage process for 12 formerly mathematics-anxious adults in overcoming mathematics anxiety. In her conclusions, she noted

1. In the first stage, the adults perceived a need to overcome their mathematics anxiety
2. While in the second stage they made a commitment to address the problem
3. In the third stage they took specific actions, such as:
    i. refining study techniques
    ii. using learning tools like workbooks
    iii. attending tutoring sessions
    iv. applying relaxation techniques; and
    v. accepting that each of these actions required sacrifices.

4. At stage four they recognized that they were at a turning point and were no longer mathematics anxious.
5. The fifth stage was when their mathematics perspectives changed, and
6. Stage six was becoming part of a support system for others

8.1.3 Perry's (1970)…

…characteristics of college students, not necessarily adult learners in the usual meaning of that term:

1. Learner seeks and expects right answers for everything
2. Learning perceives diversity as distraction
3. Learner accepts diversity as temporary
4. Diversity is accepted but therefore 'everyone has a right to know'
5. Learner perceives all knowledge as contextual and relative
6. Learner perceives the necessity of making a personal judgement as opposed to simple belief
7. Learner makes such a judgement and personal commitment
8. Learner explores implications of commitment
9. Learner experiences issues of personal identity in undertaking commitment

8.1.4 Higbee and Thomas (1999)…

…important factors pertaining to a learner-centred environment, and how they relate to achievement in mathematics (noting that affective variables are important)

1. student's academic self-concepts,
2. attitudes toward success in mathematics,
3. confidence in their ability to learn mathematics,
4. math anxiety,
5. test anxiety,
6. perceptions of the usefulness of math,
7. motivation,
8. self-esteem, and
9. locus of control.

8.2 Appendix – Chapter 4: Analysis of Learning Journals

This Appendix contains the full analysis of learning journals from the class of 2007. Some of these findings overlap with other findings from 2006 and 2005.

8.2.1 Identification of Tensions between Domestic or Personal Responsibilities and Academic Aspirations

Some learners highlighted this emotive issue in their accounts over the year. Predominantly reported as an issue by females, however one male also identified it as having significant impact. Typically this issue stems from the experience of frustration with one's life situation outside of the classroom impacting negatively upon one's continuation on the course and/or progression. Examples included: tension between learner (mostly female) and learners' domestic partner (mostly male); negative self-image on behalf of learner resulting in negative self-talk culminating in reinforcement of negative self-image *"…I was never any good at mathematics in school and I never will be…"* Some learners had battled with addiction previously and were experiencing new emotions/feelings from facing the realities of life in academia with sobriety for the very first time.

For example, one student wrote:

> *"My head is 'melted'…I've sat here for over an hour and all I've managed to do is snap at anyone who spoke to me. Going to ask my friend to pick up the kids from school tomorrow so I can go to the tutorial. Hopefully then I will be able to make sense…"*

The same student's domestic situation deteriorated to such a degree she required counselling ultimately, in addition to more frequent meetings with me. Nearer the end of the course she reflected on how things were affecting her both inside and outside of the classroom, particularly why she felt a lack of motivation:

> *"…I've just lost my spark somewhere along the way…It's just my whole life is taken up with everything: if it's not the work we have to do for college it's someone on the phone asking me if they can come over to study with me. My husband barely talks to me anymore, my kids don't see me and on top of all that I have to work. I just feel like screaming, everyone wants some of my time and I don't even have any for myself. I have asked myself so many times why I don't just give up now; it would make everyone's life so much easier. But I can't do that and yes maybe I am being selfish but this means so much to me and I want to make it through the whole year."*

Some learners placed huge responsibility upon themselves attempting to fulfil their full domestic responsibilities/duties without third party domestic assistance resulting in missed classes, assignments, and assessments. There was evidence that in some cases these learners demonstrated considerable reflexivity around their issues in attempting to produce viable solutions to their situations. In the majority of cases reviewed for the purposes of this research it would appear that learners were able to extract their priorities from their reflective journals and prioritise their academic aspirations. Strategies for moving their situations forward were identified by some and third party opinion, guidance and input were requested.

As a consequence some learners experienced a 'freezing' in terms of their relationships with partner or significant other. However, in other cases, long-held beliefs around negative self-image were challenged for the first time, a process that is on-going and will need to continue going forward into college, in my opinion. College was seen to be an achievable outcome from their year on the course; indeed one learner commented in one account *"…the goals I set are the goals I get…"*

One student wrote: "*Really got the mathematics in class today!!! And I felt really good, it's mad, I'm sitting here thinking I've got so much going on in my life and a simple thing like getting a sum correct can actually put a smile on my face."*

Another reflected on missing a class and a submission deadline:

> *"Unfortunately I couldn't make it to class today. So without doubt I've missed out on something important and I'll fall behind, but I have a plan…spoke to Michael, he told me when I get an assignment, work backwards from the day it's due. The assignment that's due next is already completed, is in a presentation folder with a cover page and ready to be presented. I just hope it's done correctly."*

8.2.2 Transformation from a Didactic To Self-Directed Attitude to Learning

Reading the learners' accounts on this issue I was struck by how diverse they were. For the majority this involved acquiring suitable text books to take them through the course.

One student wrote:

> *"…I had to make a decision; I purchased a Leaving Cert. book along with one or two more and set about learning the subject along with what Michael was teaching in class. This, alongside the excellent tutorials and plenty of practice into the very late hours and early mornings has got me to where I want to be…"*

However, in other accounts learners sought out students from the previous year's mathematics class and utilised their experience in an informal 'study buddy' system – totally excluding me as tutor from the process. This struck me as very self-directed. At the time I was unaware of the students' identities until I read this particular student's journal of her reflections on that exercise: *"…I knew last night precious time was running out. I arranged to meet F___ in the canteen to assist me. She was great help. She has the patience of a saint!"*

In other cases, I read about how I had mentioned the title of a book or an author just in passing during a class or as an aside with a student. The student had noted such information and sourced the book and was utilising it successfully on an on-going basis.

In one case, a student recounted how he was helping his niece with her mathematics homework from time to time. He remarked in humorous terms about how he had assumed my role as tutor in the relationship with his niece, interrogating her reasons for executing certain mathematics to solve her homework. He remarked:

> *"…imagine me asking 'how did you get it?'…I never thought I'd be asking the same questions as Michael asks us in class…but it works – my niece is proof!"*

He had, in that somewhat humorous account learned the value of interrogating oneself either audibly or by internal monologue, when faced with a mathematics problem. Typically I acted as the internal monologue in class while the learners came to terms with interrogating themselves. I would invariably ask questions like that above, of more than one learner, on more than one occasion in a session. Personally, it is very satisfying to see my teaching methods used outside the classroom by my students.

On another occasion a student reflected on a session when I had addressed the group's negative attitude and lack of work ethic. She listed the issues as raised during the dialogue with the group and dealt with each point. She took responsibility for her lack of motivation around solving mathematics homework and admitted she needed to do this for her own good.

> *"Michael had a stern enough talk with us today about how much we rely on him…to work out problems, and he was right…if I can't work something out I just say to myself 'sure all will be revealed in class'…in a way I feel like I am cheating myself out of learning mathematics properly because I'm being too lazy in my approach to it…"*

Another student commented on a calculus class when I had given her group some pre-reading to do for an upcoming session the following day. She stated

> *"…had an opportunity to look at these [differential calculus] before they came up in class which gave me some kind of concept of knowing what they were kind of about when they came up in class. So it's not all about what the tutor hands out, it's about learning for yourself as well."*

8.2.3 Effects of Mathematics Anxiety and Personal Remedial Strategies

In her final entry for the year, looking back over her experiences and comparing them with previous experiences this student wrote:

> *"…now I know more mathematics than I have ever known in my lifetime of mathematics at school. This happened in just 7 months, which just goes to show that how it's taught has a lot to do with how it's revised. I am no longer afraid of mathematics. I'd have more confidence in myself to tackle or apply for jobs or courses that involve mathematics, a road on which I would have never travelled before."*

This same student earlier had written in large, bold, block capitals across her page the following statement: *"MATHEMATICS DOESN'T SCARE ME ANYMORE…Hip hip hurrah!"* On another occasion when her group were about to embark upon statistics she commented *"I have heard nothing but nightmare stories on this subject"*, however having finished the module she wrote this: *"…It's all about understanding what's being asked (words like 'deviation'), finding averages. I'm no longer scared of starting something new (what you sow you reap)."*

Another student who was having difficulty wrote:

> *"Got hold of DVD's [MathTutor™] with mathematics tutorials on them, some of it was great but some [went] over my head. But even hearing someone chat about mathematics makes it easier. Happier with*

> *trig[onometry] now - a little more work and I should be good! Staying positive is the best policy even though [I am] daunted by the quantity of work…from lecturers…"*

Later the same student, still suffering difficulties wrote:

> *"…I've put the effort in and can do the graphs but [it] really does not float my boat! Perhaps this will cause me problems in September [beginning a new course in college] if I don't learn how to deal with stuff I don't like. A matter of figuring out how I think, maybe getting together and chatting with study group might help?"*

One female student who had been severely traumatised by a male mathematics teacher during school wrote the following in the very early days of the course:

> *"…just hope I get more confident with numbers because they still frighten the life out of me", "…fractions! Algebra! I can't believe I can understand them let alone do them! It's great I really feel good about it, like I have achieved something already! Thanks Michael, I keep looking at the mathematics and smiling, thinking 'I did that' WOW!"*

Some months later while experiencing a low point, she wrote:

> *"It's just not sinking in, I wish it would click with me but it's just not happening for me. I'm starting to get all negative again and I have to keep telling myself to stop feeling sorry for myself. To be honest if I'd stop feeling sorry for myself and spent that time trying to figure out linear programming I'd probably do a lot better! I'm not letting myself give up just yet remember [Name] where there's a will there's a way."*

Nearer the end of the year, with interviews for college and final exams looming she wrote:

> *"…I really want to pass. I know I can if I stop panicking, Michael even told me today I need to stay calm. It's funny though because when Michael pointed out to me that I needed to stay calm I finally realised the reason why I keep freaking out, I just have no confidence in myself. I keep telling myself 'I'm going to fail' and 'I can't do it' and that's the reason I keep getting this block and forgetting everything!!"*

Remarkably, illustrating just one benefit of using journals for mathematics students she identified a strategy to help herself:

> *"Now that I know the problem I just have to try to find a way to beat it. Start to believe in myself because if I have managed to make it this far I can't be [entirely] useless can I? At least that's what I'm going to tell myself from now on."*

A little while later she wrote: *"I know I've a much better understanding of mathematics today than I ever thought was possible for me. This in itself is an achievement and if I could just start believing in myself I'd probably blossom and maybe start to feel like I am capable of doing anything."*

On another occasion after she had consulted me about an issue, we jointly agreed the student would leave her usual sitting place at the rear of the class and relocate to the front, albeit to the side so as not to unsettle her too much. She reflected on her experiences:

> *"…even though numbers still frighten the hell out of me I have come to realise sitting down the back of the class won't make them go away, that the best thing to do is sit right up the front and face them, because if you sit there and look at them, I mean really look at them and not just think 'Oh no, I can't do these!!', they're not as scary as they first seemed! I'm not going to run away any more, when the going gets tough I'm just going to get tougher. Thanks Michael for making me believe in myself."*

Her transformation into a confident mathematics learner is evidenced by her final reflection when she wrote:

> *"…I have achieved so much in these last few months. Facing up to my fear of mathematics has changed my life in so many ways!!! It's hard to believe but it's made me a much more confident person. I'm no longer that shy person trying to hide at the back of the class so Michael won't see me. I can even look him in the eye now when he asks me a question instead of at the floor."*

Another student used a novel method to overcome his mathematics anxiety in class. Prior to the beginning of class he was relaxed and chatting to others and he reflected:

> *"…when I asked myself how I feel about mathematics today the answer was in my actions before class started. I was free of stress; I wasn't playing out scenarios of how things may go horrible in class for me. Some days I leave my worries outside the classroom and this frees up my mind allowing more learning to be achieved. Today I used the [overhead] projector to take the place of someone in the front seat [this student sat at the front normally] so as to somehow pretend to myself that I wasn't in the front seat."*

However, his strategy on this occasion had its limitations for the student and he wrote: "*…we'd been given questions to solve in class and I knew there was plenty of time. Panic stations all around; I got completely tangled up in fear and confusion."*

Earlier in the year this gentleman, who outwardly seemed confident and self-assured reflected on one class in particular when some of his answers to questions were incorrect: *"…oh, one very important thing to remember [Name]: you gave answers today that weren't correct and it was OK. You're not stupid, nobody laughed and I'll try to be sharper next time."*

This particular student reflected often of his frustrations around his lack of courage to ask questions. On one such occasion he wrote:

> *"I could feel the questions on the tip of my tongue, I just needed that one more bit of courage – I couldn't find it. It was like being a child confronting a fear like jumping into a swimming pool for the very first time."*

Another student commented on her progress so far: "I feel it's a bit late in the year to only be getting into the mathematics and enjoying them. I think it's because I am seeing progress. It's a great source of encouragement."

After she had performed her mathematics presentation the same student wrote:

> *"I really enjoyed mathematics today, we moved onto Geometric sequences. We didn't go into it too deep as of yet but I know where we are up to. For some strange reason I am enjoying the class. I really feel like it's since the presentation and the first assignment in Linear Programming"*. Later she wrote: *"...and I learned when I was under pressure and I knew I'd no choice but to learn if I wanted to complete the task. I think it made me realise anything is possible if I try. Today I felt I was participating more openly."*

On another occasion, near the end of the year this student had consulted her colleagues on some homework she need feedback on:

> *"I consulted my friend; she said I had done it incorrectly. Guess what? I hadn't! I learned today it's possible for me to be on the right track. Don't always presume someone is right just because they are normally. I found that my contribution to the class has increased."*

Another student reflected on his learning of mathematics through a poem he wrote. It would be his last entry prior to submitting it for assessment at the end of the

academic year. It would be the first time this type of reflective account appeared from this cohort. He wrote:

> *"I'd like to keep it now I have it*
> *And hold onto it with both hands*
> *Nourish it and keep cultivating it*
>
> *That is, the ground beneath it*
> *If I feel it needs deeper care*
> *Deeper cultivation,*
> *I'm no longer afraid to care*
>
> *Digging deeper to reach the in-depth roots*
> *Where life begins*
> *Where understanding is!*
> *Where reason can be found*
>
> *And with the help of my new found friends*
> *Books, lecturers, study buddies*
> *Cultivation is a joy"*

Earlier on in the year he remarked about a linear programming assignment:

> *"Nice but a tough assignment to start with. However the one that convinced me that I can do mathematics again after so many years away from structured study. I knew before I came onto this foundation year that I would have to get to grips with mathematics as continuing on for me would mean that I needed to be reasonably effective with this subject. My memory has let me down; what I have learned two weeks ago takes time to rethink but then again it has been over 30 years since I left school."*

In the same account he highlighted the 'turning point for me'; I took this to mean his turning point for the entire year. It occurred when a more accomplished female student enquired of him as to what the solution to a particular problem was. He wrote:

> *"Well, I could not believe my ears – you are coming to me when really I should be asking you. My confidence shot through the ceiling when she said 'we all thought you would know'. Quickly, I told her I'd look at it that night and get back with my thoughts the next day. I had no idea that others in the class thought so highly of me."*

Finally, a student who went on to achieve the highest mathematics test score in the class for the year overall wrote of her coming to terms with linear programming around half-way through the year. It is included here as it illustrates a seminal example of her attitude and belief in herself and her capacity to achieve:

> *"Everything I've been taught over the last month has just come together; I'm feeling confident about linear programming. When we were given an example, I went home that night and tried to work it out for myself (using my notes as a guide). I wasn't confident about it, so I decided to wait and see how it was worked out in class. Lo and behold I had gotten it right, I couldn't believe it. For something that looked so difficult and for me to give it a try and work it out and get it right was a major achievement for me."*

This account and the one to follow demonstrate not only the student's confidence level with respect to mathematics, but also show her non-didactic approach to learning. Continuing she wrote:

> *"Just to prove it wasn't a fluke I decided to try and work another question out and wow! I'd done it again and gotten it right. The way I see it now, if I can get linear programming, I should be able to get anything else they throw at me."*

8.2.4 Strategies for Learning Mathematics Identified

One student who was preparing to do final exams wrote: "*You need to keep on top of stuff. That way it doesn't get on top of you."*

Another student who was notoriously bad at organising himself with respect to notes etc. yet quite confident and competent at mathematics reflected on the effects of his scattered approach:

> *"A part of what set me off was worry about not being organised enough. I think this is part of a tendency I have to think of things in very polarised, black and white terms. My organisation isn't exactly brilliant but it's definitely improved (and improving), however instead of thinking on the positives of the situation I think it's completely hopeless – I'll never get on top of it. The simplest and best solutions to this is…sitting down each evening and filing away my notes. That I'm doing this makes me feel so much more secure, and it doesn't take 5 minutes to do, so really I've no excuse!"*

From this account it can be seen that the student was able to provide himself with a strategy that assisted him with learning mathematics, although a mundane strategy, concerning self-organisation, it was of significant magnitude to the student.

Coming to terms with mathematics exams was another area identified by students from their journal entries. One student who had stressed herself out prior to her exam at midterm reflected on why she was so stressed out and discovered the reason: *"My trouble with mathematics I think is being able to decipher one element of mathematics from another. For instance, in class I can do whatever element on an ongoing base one after another but when taken out of context like in the exam, when there were different questions, I choked."* A little while later, she reflected on the aftermath of her midterm exam and wrote: *"I have begun to question myself a lot with regard to what I need to do [to learn mathematics]. Last mathematics exam gave me a fright; I will be more prepared for December's Christmas exam."*

After she had returned to college following the Christmas break she had made a startling discovery: *"…metacognition…I think it's a great word. Trying to think about how I think and learn lately in some hope of figuring out the best way for me to learn. As far as I can make out, to this point I pick a lot up from listening or doing a lot more so than labouring over text books. I think this is something to do with the turn around in mathematics for me. As mathematics is like a puzzle for me now, I enjoy trying to get it to work. But my learning strengths so far are definitely through listening! Especially within the study group I can remember a lot more of what's said through discussion and so on!"*

Another student who, with her colleague had agonised over algebra wrote: *"Done it! Thank God. Spent nearly two hours on the phone to V____ last night and we worked it out; felt much better. Didn't need to go tutorial after; by the time Michael had ended the class today I felt so much more comfortable with algebra – don't even mind writing the word now."*

A few weeks later, with an upcoming midterm exam looming, and after a particularly emotionally charged account written the day before, she wrote: *"Feeling a little better again! Understanding the mathematics a bit better now. E____ went over it with me today and that helped me a lot. Done some revision work myself tonight and seem to be getting on ok. Just hope I don't go blank again on Wednesday, fingers crossed and all that!"*

Almost at the end of the year this student, who was gradually and steadily gaining confidence with mathematics reflected on something I had warned the students against a number of times during the year – storing mathematics in compartments in their minds where they never mingle together, and inhibit the informing of learning from one area of mathematics to another – 'pigeon-holing' I called it.

She wrote:

> *"…I've managed to do most of the homework…but I can't remember how to turn fractions into whole numbers…they're gone into the pigeon holes and I'm going to have to sit down over the weekend and root them out! I have to say if there is one thing I have learnt from this whole year it is you really need to get your time management right and never put off doing revision work!!! It's just so important because I felt tonight that if I had kept on top of my revision those bloody fractions wouldn't be so far inside those pigeon holes that I'm probably going to need a shovel to get them out. Mental note to oneself: next year allocate at least one night a fortnight just for revision work!! I'm going to try keeping the pigeon holes empty instead of my brain cells."*

A very tongue-in-cheek reflection on a most significant aspect of self-directed learning.

8.2.5 Effects of Learning Environment and Others on Learning

A self-confident learner remarked on an instance in class that had her second-guessing herself:

> *" Still doing signs and felt confident I was getting the hang of it until during the class some of my fellow students began questioning the 'whys' and 'wherefores' of signs and operators! Got confused and lost my grip! Argh.....!"*

This latter account dates from her earlier journaling; what follows is quoted with around six weeks to go to finals: *"…the end is near and we're all flapping like mad. Tempers are flaring and everyone has an opinion."*

While I was away on extended leave of absence this year two colleagues 'carried the baton' until I returned. This student, on one particular day reflected on her difficulties adjusting to this new situation:

> *"I just don't know what's happening to me; Michael told us at the start of the course not to let the mathematics control us, but my god it's definitely controlling me! I'm just so terrified – [tutor] stood over me today to try explain something to me and I felt like I was going to pass out. I started sweating and felt so sick my mind went totally blank. I thought he would never go away I just felt so sick."*

A number of months later the same student met with me to discuss her ongoing difficulties with mathematics anxiety; her reflections from that event:

> *"Had a chat with Michael today, got some stuff that was worrying me off my chest. He asked me to sit up the front of the class for mathematics from now on. It's a bit scary, like I'll have nowhere to hide anymore!!! Maybe that's a good thing? Funny how something like my fear of numbers can have an effect on my whole life?"*

She took my advice and relocated herself to the front of the class; her reflections of that event:

> *"I sat up at the top of the class today like Michael had asked, it's mad but I was very nervous, felt really tense at first!!! But after a bit I calmed down, I think I even took in more, I actually managed to do the mathematics questions he gave us and got them right!! Can't believe it, and with no one beside [me] I had to trust my own judgement. I came out of mathematics today with a little bulb over my head and I felt very proud. I hope that tomorrow I don't start to clam up again because there's no nicer feeling than when you understand something. It's put a beautiful smile on my face. Normally when I'm in mathematics class I like to feel invisible but when I sat at the front today I had nowhere to hide. Thanks Michael, maybe I have taken my first step in the right direction?"*

Nearly one month later, with a difficult domestic situation uppermost in her mind, she wrote:

> *"Michael called me after class and said 'well done!' Two little words but I'm feeling so low at the minute those two words meant a lot. This year has been a major turning point in my life! Made me face a lot and shown me that no matter what junk life throws at you, if you believe in yourself you will still come out on top."*

One student who had some difficulty motivating himself to actually get to class to be physically present reflected quite considerably about this during the course of the year. Notwithstanding this he had one of the best attendance records of any student. He eventually deduced the reason for his lack of motivation to be present and further, somewhat subtle influences he had not originally been aware of. After a difficult night when he slept very little he wrote:

> *"…I was in conflict with myself as to whether to go to mathematics or not…what was I thinking?…'we have no psychology class this morning so it's OK not to go in for one class of mathematics' as if mathematics had anything to do with psychology. What did I do to counteract this thinking? I had to basically drag myself to class. I told myself if I get in early I could meet people from the class and make a connection. I also purposely and in a positive way gave myself the option of leaving if I felt like it, this way I had an air of freedom going into class. The class itself was grand, it was light-hearted but effective – this is my ideal way of learning – but to have it depends on my input and also the way the lecturer conducts the class. Michael was and is genuinely interested in our class and its progression."*

A hallmark of this student's reflections was his use of the phrase 'make a connection'; he explained it to me personally during one of several dialogues during the

course of the year. Making a connection with others kept him anchored to the group; it kept him grounded and he felt included and a part of the group.

Such was his lack of motivation in the early days that he would not move from his position in class to another during a collaborative phase in the class. He typically received a prompt from me to 'connect' with some of his colleagues elsewhere in the class and always responded positively. However, it was through using his journal he discovered the reasons for his seemingly low motivation. In other areas, not quoted here, he reflected on his predilection for a smaller group in class, claiming he connected better with others, felt engaged more, and possessed a new intent in mathematics within such an environment. He remarked on one occasion about how he felt more connected when class was held on another campus, citing the arrangement of the room helped focus his mind.

8.2.6 Mistakes or Learning Opportunities?

The learning journal is an ideal place for students to reflect on mistakes and remedies. Utilising mistakes as learning opportunities is a sign the learner has matured in terms of self-directedness and illustrates a paradigm shift in attitude and beliefs about mathematics. It may be an indication of the development of confidence and ongoing competence in the learner.

A student reflected on her mistakes in fractions during the early stages of the course and her strategy for remedying mistakes: *"...went over fractions on the weekend…Trial and error, but it worked. Now when I get something wrong I go back to see where and why!"*

After presenting on the impact of mathematics on society another student reflected on the amount of time she had wasted and the fact that she had ignored positive criticism during the preparation stage which would have improved her overall score; while reflecting on these she discovered new learning from the process. She wrote:

> *"...I realised I did learn something from the whole experience and that is: if I ever have to give a presentation in the future I should get other people's opinions and take on their points while giving myself plenty of time to make all the adjustments that might need doing."*

After a particularly bad experience of a midterm exam another student reflected: *"Don't know what to say about last week's exam; I'm half dreading the results. I know I'm going to find out my weaker points and from there I can revise it all again…"*

8.2.7 Positive and Negative Attitudes towards Mathematics

During a so-called 'purple patch' early on in the year this student reflected humorously on her positive attitude towards mathematics: *"Fractions and algebra: surprising myself still. I find it easier than I ever expected. I love mathematics; I may live to regret writing that down on paper!"*

Some months later the same student wrote about her difficulties with trigonometrical functions and displays the opposite attitude:

> *"Just as I was getting confident with mathematics!! WHAT ARE WE DOING? I don't know…sinusoidal motion...well I can't even pronounce this. Time to recoil, I feel tired and this was not the wake up call I needed."*

Another student who had severe difficulties with linear programming as well as domestic difficulties reflected on how it was all affecting her attitude:

> *"OK, I've sat here since I finished work tonight at 9pm and it's now 11pm. I'm tired and fed up because I still don't understand linear programming. I'm at the same point as when I started. I'm beginning to think my brain is not programmed to understand the damn thing! I'm not going to give up though, because if I do that I'll never understand it and I promised*

> *myself I will find a way. I've also just realised that the one person I don't want to leave down is myself."*

In another journal a student reflected on the entire year's goings-on, with particular emphasis on his cognitive and metacognitive development and attitude to mathematics:

> *"In retrospect, mathematics on the course this year has given me the opportunity at times to actually question and define the person that I am, my mentality when problems arose during various topics, and more importantly how I faced them. If nothing else, I have realised that I am not a quitter, that when faced with a particular problem, that I will stand my ground and say 'ok, let's get stuck in here' - get the hands dirty, so to speak. I've never before stood back and tried to define my mentality to situations, asking 'did I give up at the first sign of trouble?' 'How did I deal with it?'"*

Another student who had difficulty keeping his momentum up over holidays and midterms wrote: *"After today I realise mathematics needs to be practised, it's like going to the gym – you're fit while you're training but once you stop you go into reverse and get rusty. I need to go to the 'gym' more often."*

On another occasion this student was very candid in his reflections around understanding mathematics, he wrote: *"…I don't know exactly how to explain it but it's as if I feel I've no right to learn mathematics".* This dramatic insight into his attitude towards mathematics illustrates a significant benefit of the journal to teachers of mathematics. Due to his candour I was able to help the student confront this attitude, expose it and help him to see he was worthy. This same attitude manifested in a small number of students.

The same student who wrote the poetic reflection previously, reflected on his attitude to mathematics now that the course was almost over. Originally from the UK he

utilised an icon from his culture to derive an analogy of his attitude to mathematics (like the student above did regarding the 'gym'); he wrote:

> *"I'm no longer afraid of mathematics; I just know I will have to work at it harder than most other subjects. But then in the words of Margaret Thatcher, the first ever woman Prime Minister of the UK, she supposedly said "if it isn't hurting it isn't working", although she was referring to the economy!"*

One can see the similarities in both analogies here: hard work and working out. Both of these students believed mathematics is something akin to exercising – *"if you do not use it you lose it"*, as another student put it.

Another student who had experienced mixed results in terms of successes reflected on her attitude towards her successes in mathematics. In the first part of her account she wrote about the class work and her mixed results – her attitude here is positive and she displays conscious learning from her mistakes.

> *"…the first problem I was delighted with because I thought I got it without any help. Then we were shown the right way to do it and I realised I hadn't. Anyway, this didn't matter because I know I did get it the second time."*

Subsequently she wrote:

> *"I didn't have to think too much when I was doing the homework, which in turn makes me think I must have them all wrong because mathematics is supposed to be hard."*

This student ended up achieving a very high test result in her final exam. To illustrate further the benefits of reflexivity in mathematics to both teacher and student I offer the example of this next student who constantly wrote negatively about herself and

her abilities entirely. With great difficulty, she has begun to rehabilitate herself but the damage done to her confidence and competence in mathematics was tremendous; she failed nearly all her exams. One key reflection from her journal after she presented in another module illustrated her attitude to mathematics and in some ways towards herself:

> *"I sat in all weekend and worked on it [her presentation], told myself constantly 'I can't do it' and [yet] I did do it, in the end. Tell myself that about mathematics…hopefully it will turn out that really I can do them too!"*

8.2.8 Identification of Learning Blocks

For some, learning blocks remained unseen or unidentified until the students chose to dig deeper into their consciousness, exposing any problem. In the early days of the course it was possible to recognise their identification of learning blocks from students' entries in the journals. Typically they were exclamations of frustration at not being able to remember the mathematics outside of class or from class to class or from term to term. Subsequently, after meetings with specific students the entries became less about frustration and more about strategies for overcoming the learning blocks. Each student who engaged in this process achieved some level of success. For example one student wrote:

> *"…had our first assessment today. I feel like I did really badly. I studied so hard for it, what a waste of time, it happened to me again – my mind just went completely blank…I think I'm going to talk to Michael…because I really need help to find out why my mind seems to wipe out everything I've learned all the time."*

Another student identified the difference between a real live mental block and assessment 'stage fright'. She was representative of a number of students who discovered this about themselves and who had an attitude whereby understanding must come instantly or not at all in mathematics. She wrote:

> *"Oh…I just hate that mental block when you just can't see anything and yet it's right there in front of you…I can't see how I can work problems out for myself if I can't fully understand it, I don't say anything in class because eventually the great mystery of mathematics is revealed to me."*

This student possessed a somewhat overly absolutist paradigm to mathematics and was representative of a number of students.

8.2.9 Effects of Previous Experiences of Mathematics on Current Learning

Higbee and Thomas (1999) suggested previous experiences of mathematics are the single most important influencing factor on current confidence and competence in mathematics. From analysing the students' journals they would seem to concur with this research. For example, one female student who had a particularly vindictive male mathematics tutor in school suffered ongoing public humiliation by him. On one instance when she was reflecting on her current domestic tribulations and difficulties with mathematics on the course she was reminded of her humiliation and wrote:

> *"…I gave up on myself once before in school when a certain teacher told me I would never amount to anything, and I'm not going to make the same mistake twice. So I'm here to stay till the end – tears and anger to go with it all, because I'm so determined to have something to show for it in the end. If all I get is to prove to myself I can achieve something then this whole year has been worthwhile!"*

During the course of the year I was privileged to be taken into the confidence of this student and she shared her story with me in great detail. After one such meeting she reflected on the outcomes for her and what she now faced into in order to get over her trauma:

> *"…I came close to tears a few times while chatting to Michael today and that scared me too and at first I didn't understand why? But now that I've sat down and thought about it I've realised he was, for the first time ever,*

> *making me face my past!!! I don't know why but for some reason I've spent my whole life running from things and hiding - bottling everything up inside and never wanting to face up to anything. My mission now is to start fresh, leave the past where it belongs, because if I can do this then life will open many doors for me."*

Once more, the benefits of the journal for tutor-student dialogue are demonstrated. These feelings and thoughts would never come to the surface in such a natural way unless they were probed and coaxed appropriately. Ongoing journaling keeps the tutor on top of developments in such an intimate way. In the end, this student was able to move beyond her past humiliations and began crediting herself for her confidence and competence in mathematics. Ultimately she achieved very high results in the overall course.

In another journal entry a female student recounted her negative experiences of another male mathematics teacher who made fun of her and called her names when she was unable to perform at the blackboard. Following incident after incident of this behaviour she came to dislike mathematics immensely. In her reflections she also remarked she had discussed this with her older sister who also was taught by the teacher in primary school. To the student's surprise she discovered her sister had been treated similarly and she also had a fear of mathematics. She wrote:

> *"…this is where my 'fear' surrounding mathematics comes from…because it's the one thing that always sticks out in my mind. It later carried on into secondary school, where I always performed badly at mathematics. In the end I opted to take Foundation mathematics paper for the Leaving Cert. because I HAD NO CONFIDENCE ABOUT MATHEMATICS."*

Another student reflected over her experiences of the year compared with those of previous mathematics courses:

> *"I know a lot of my fear stems from primary school; I never understood what the teacher was saying. When I asked a question I was made the butt of his jokes for that particular lesson, that was bad enough, but he also had a sweeping brush handle and for every sum we got wrong he used to whack us really hard across the palms of our hands. By the time I got to secondary school I had lost all interest in mathematics and failed every exam I ever did. It was because of this that I bottled out of doing my Leaving Cert…"*

Having read this account, I realised why this student had such difficulty asking questions in class or sharing knowledge with others during collaborative phases within classes. Higbee and Thomas' (1999) research would seem to have been substantiated by these students' accounts. Subsequently, this student has gone on to actively help her son with his mathematics homework without fear or embarrassment, which was not always the case for her. This case demonstrates conclusively previous experiences affect current learning however as they also demonstrate there is hope of redemption for such students.

These areas identified above were the most popular and frequently voiced in the pages of the students' journals. There were however, a small number of topics that arose in most journals which are noteworthy and mentionable. These are the areas of:

- **Questions – asking them and facing them**
- **Reflecting – pros and cons**
- **The turning point – confidence/competency**

Most students used the journal to pose questions, both mathematical and non-mathematical in nature. This allowed engagement in a dialogue and helped build a mutual bond that endured until the conclusion of the term. In other respects, students mentioned their fear of asking questions in case they appeared 'stupid' – a large hangover from compulsory schooling; and of being asked questions by their tutor; some felt my approach to eliciting information from them made them uneasy. By utilising the journal in this way I was informed of their preferences immediately, particularly useful in the

case of a shy or unassuming student who would not approach me because I was 'the teacher' with all the connotations of power that go with that title.

The journal was useful for highlighting the so-called 'turning point' for some students. Some students reflected on the usefulness of reflecting, however any comments on this issue should be looked at in the context of their responses to statements on the questionnaire about continuing their journal if it was not assessed.

8.3 Frequency Tables and Questionnaire

The following pages contain the frequency tables of responses to statements on the questionnaire. Following this, there is a copy of the actual questionnaire used in the data collection phase of the research study.

	PROBLEM SOLVING SKILLS	SA		A		N		D		SD		Valid	Missing	Total	Mean	Mode	σ
A1	I am pleased with the development of my cognitive ability (i.e. mental processes of thinking or reasoning)	19	34%	33	59%	3	5%	1	2%	0	0%	56	0	56	1.8	2	0.64
A2	I find that I possess more curiosity (wanting to find out about something) now, than before I took this mathematics module	16	29%	31	55%	8	14%	1	2%	0	0%	56	0	56	1.9	2	0.71
A3	I am persistent in mathematics, staying at a problem until the problem is resolved	18	32%	20	36%	11	20%	6	11%	1	2%	56	0	56	2.1	2	1.05
A4	I am confident in situations where the mathematics is unfamiliar	3	5%	26	46%	9	16%	15	27%	3	5%	56	0	56	2.8	2	1.07
A5	I treat problems in mathematics more logically now than before	13	23%	32	57%	7	13%	3	5%	1	2%	56	0	56	2.1	2	0.86
A6	I approach generic (a range of) problems more logically since studying mathematics	6	11%	31	55%	13	23%	6	11%	0	0%	56	0	56	2.3	2	0.82

	NUMBERS SKILLS, UNIVERSALITY OF MATHEMATICS	SA		A		N		D		SD		Valid	Missing	Total	Mean	Mode	σ
B1	I am able to apply numbers to non-mathematical situations	5	9%	26	46%	15	27%	9	16%	1	2%	56	0	56	2.6	2	0.93
B2	By participating in the mathematics presentation I discovered that mathematics is a very diverse subject with many real-life applications	10	27%	23	62%	2	5%	2	5%	0	0%	37	19	56	1.9	2	0.74
B3	ALTHOUGH MATHEMATICS IS NOT A MAJOR PORTION OF MY CHOSEN THIRD LEVEL COURSE, I STILL NEED TO UNDERSTAND IT	18	32%	26	46%	7	13%	5	9%	0	0%	56	0	56	2.0	2	0.90

	TEAM WORKING SKILLS	SA		A		N		D		SD		Valid	Missing	Total	Mean	Mode	σ
C1	I prefer to collaborate with others on projects or assignments	14	26%	23	43%	12	22%	4	7%	1	2%	54	2	56	2.2	2	0.97
C2	I work well with others in a team	18	33%	29	53%	5	9%	3	5%	0	0%	55	1	56	1.9	2	0.80
C3	I work well with others in my study group	17	32%	31	58%	4	8%	1	2%	0	0%	53	3	56	1.8	2	0.74
C4	I ATTEND STUDY GROUP MEETINGS BECAUSE I WANT TO	15	29%	28	54%	9	17%	0	0%	0	0%	52	4	56	1.9	2	0.68
C5	I attend study group meetings at least once a week	12	23%	14	26%	3	6%	19	36%	5	9%	53	3	56	2.8	4	1.38
C6	I attend study group meetings at least every two weeks	0	0%	5	9%	3	6%	33	62%	12	23%	53	3	56	4.0	4	0.82
C7	I attend study group meetings infrequently	1	2%	20	38%	3	6%	15	28%	14	26%	53	3	56	3.4	2	1.29
C8	STUDY GROUPS ARE NOT A WASTE OF MY TIME	26	47%	21	38%	5	9%	2	4%	1	2%	55	1	56	1.8	1	0.91

	AFFECTIVE LEARNING DOMAIN, CONFIDENCE, SELF-ESTEEM, MATHEMATICS ANXIETY, ATTITUDE, EMOTION	SA		A		N		D		SD		Valid	Missing	Total	Mean	Mode	σ
D1	I WAS NOT INTIMIDATED BY MATHEMATICS (EITHER PRIOR TO THIS COURSE AND/OR UP TO THIS POINT IN TIME)	3	5%	15	27%	6	11%	14	25%	17	31%	55	1	56	3.5	5	1.33
D2	I REMAIN UNINTIMIDATED BY MATHEMATICS (AT THIS POINT)	16	29%	24	43%	9	16%	5	9%	2	4%	56	0	56	2.2	2	1.06
D3	SIMPLY GETTING THROUGH THE COURSE IS NOT MY MAIN MOTIVATION FOR DOING MATHS	12	21%	21	38%	3	5%	16	29%	4	7%	56	0	56	2.6	2	1.30
D4	WHEN I ARRIVE AT A POSSIBLE SOLUTION TO A MATHS PROBLEM I DO NOT ACCEPT IT AND MOVE ON	4	7%	21	38%	7	13%	22	39%	2	4%	56	0	56	3.0	4	1.10
D5	WHEN I ARRIVE AT A POSSIBLE SOLUTION TO A MATHS PROBLEM I BELIEVE I AM PROBABLY CORRECT	7	13%	23	41%	8	14%	14	25%	4	7%	56	0	56	2.7	2	1.18
D6	When I arrive at a possible solution to a maths problem I double check my answer	10	18%	19	34%	5	9%	18	32%	4	7%	56	0	56	2.8	2	1.28
D7	Prior to this course I preferred to know the method for working out maths i.e. how to do this or that process	4	7%	27	48%	6	11%	17	30%	2	4%	56	0	56	2.8	2	1.08
D8	Prior to this course I preferred to know the reason why, or purpose for using this or that method in maths	3	5%	6	11%	7	13%	34	62%	5	9%	55	1	56	3.6	4	0.99
D9	Because of this course I like to know the reason or purpose for doing something as well as knowing the method for doing it	19	35%	26	47%	7	13%	3	5%	0	0%	55	1	56	1.9	2	0.83
D10	PROVING THE ANSWER 'CORRECT' IS SOMETHING I ENJOY ABOUT MATHEMATICS	12	22%	27	49%	6	11%	9	16%	1	2%	55	1	56	2.3	2	1.04
D11	I don't mind if the answer I arrive at is incorrect as long as I find out where I made my mistakes	16	29%	31	56%	3	5%	3	5%	2	4%	55	1	56	2.0	2	0.95
D12	I LIKE DISCUSSING MY ANSWER WITH MY COLLEAGUES IN CLASS	17	31%	29	54%	2	4%	5	9%	1	2%	54	2	56	2.0	2	0.95
D13	I LIKE DISCUSSING MY ANSWER WITH MY COLLEAGUES IN TUTORIALS	19	35%	27	50%	4	7%	3	6%	1	2%	54	2	56	1.9	2	0.90
D14	I LIKE DISCUSSING MY ANSWER WITH MY COLLEAGUES IN STUDY GROUPS	20	36%	29	53%	2	4%	2	4%	2	4%	55	1	56	1.9	2	0.93
D15	I LIKE DISCUSSING MATHEMATICS	24	44%	24	44%	4	7%	2	4%	1	2%	55	1	56	1.8	1(a)	0.88
D16	I AM A CONFIDENT LEARNER WHEN IT COMES TO MATHEMATICS	8	15%	20	37%	8	15%	12	22%	6	11%	54	2	56	2.8	2	1.27
D17	DOING WHAT IS REQUIRED FOR THE SET TASKS IS NOT THE MAIN EXTENT OF MY ENGAGEMENT WITH MATHEMATICS	4	7%	21	39%	6	11%	19	35%	4	7%	54	2	56	3.0	2	1.17
D18	I BELIEVE MATHEMATICS IS NOT AN ABSOLUTE SCIENCE - IT IS FALLIBLE	5	10%	23	44%	8	15%	8	15%	8	15%	52	4	56	2.8	2	1.26
D19	Mathematics was always there and mankind simply discovered it	2	4%	3	6%	13	24%	23	43%	13	24%	54	2	56	3.8	4	1.00
D20	MATHEMATICS IS NOT A DIFFICULT SUBJECT	5	9%	7	13%	6	11%	27	49%	10	18%	55	1	56	3.6	4	1.20
D21	My self-confidence increased as a result of my participation in the mathematics presentation	10	27%	12	32%	8	22%	7	19%	0	0%	37	19	56	2.3	2	1.08
D22	PRESENTING TO MY PEERS DID NOT MAKE ME NERVOUS EVEN THOUGH IT WAS ON MATHEMATICS	3	8%	6	16%	11	29%	13	34%	5	13%	38	18	56	3.3	4	1.14
D23	I see mathematics as being a subject with many inter-related areas adhering to general rules	15	28%	27	51%	11	21%	0	0%	0	0%	53	3	56	1.9	2	0.70
D24	My self-confidence improved after I participated in the mathematics presentation	3	8%	18	47%	12	32%	4	11%	1	3%	38	18	56	2.5	2	0.89
D25	MY CHOSEN THIRD LEVEL COURSE CHOICE WAS UNAFFECTED BY HOW I FELT ABOUT MATHS	9	16%	14	25%	11	20%	14	25%	7	13%	55	1	56	2.9	2(a)	1.30
D26	I WAS NOT INTIMIDATED BY GIVING A PRESENTATION ON MATHEMATICS	5	13%	13	34%	7	18%	11	29%	2	5%	38	18	56	2.8	2	1.17
D27	I BELIEVE THE MATHS I'VE LEARNED AS AN ADULT HAS THE SAME RULES AS THE MATHS I LEARNED AS A CHILD	3	5%	17	30%	7	13%	11	20%	18	32%	56	0	56	3.4	5	1.36
D28	THE MAIN PROBLEM WITH MATHS IS NOT THAT RULES HAVE TO BE LEARNED OFF	6	11%	21	38%	17	30%	9	16%	3	5%	56	0	56	2.7	2	1.05
D29	Because of this module I have the confidence to help my children with their maths homework	13	24%	22	41%	16	30%	3	6%	0	0%	54	2	56	2.2	2	0.86
D30	I noticed a positive change in my attitude towards maths since taking this course	24	43%	26	46%	5	9%	1	2%	0	0%	56	0	56	1.7	2	0.71
D31	Maths is a collection of knowledge that may be added to, amended, or updated from time to time	17	30%	30	54%	4	7%	2	4%	3	5%	56	0	56	2.0	2	1.01
D32	I BELIEVE THE DIFFERENT AREAS OF MATHEMATICS ARE NOT SEPARATE BUT ARE RELATED TO ONE ANOTHER	14	25%	37	66%	4	7%	1	2%	0	0%	56	0	56	1.9	2	0.62
D33	CONSIDERING THE DURATION OF THE ACADEMIC YEAR, TRYING TO UNDERSTAND MATHS DOES NOT SEEM LIKE TOO MUCH HARD WORK	7	13%	34	62%	9	16%	4	7%	1	2%	55	1	56	2.2	2	0.84
D34	ELECTRONIC CALCULATORS LIKE THE ONE I USE DO NOT ALWAYS GIVE THE CORRECT ANSWER	6	11%	27	48%	9	16%	14	25%	0	0%	56	0	56	2.6	2	0.99
D35	AN ANSWER GIVEN BY AN ELECTRONIC CALCULATOR SHOULD BE CHALLENGED	12	22%	32	58%	8	15%	3	5%	0	0%	55	1	56	2.0	2	0.77
D36	I AM NOT INTIMIDATED BY MY ELECTRONIC CALCULATOR	7	13%	24	43%	13	23%	11	20%	1	2%	56	0	56	2.6	2	1.01
D37	I DO NOT AVOID SOME AREAS OF MATH BECAUSE I AM UNCERTAIN OF HOW TO USE MY ELECTRONIC CALCULATOR	5	9%	24	43%	7	13%	19	34%	1	2%	56	0	56	2.8	2	1.08
D38	PRIOR TO STUDYING MATHS ON THIS COURSE, I BELIEVED I WAS COMPETENT AT MATHS	3	5%	16	29%	3	5%	18	32%	16	29%	56	0	56	3.5	4	1.32

D39	I am more competent at mathematics after studying maths on this course	25	45%	27	48%	2	4%	2	4%	0	0%	56	0	56	1.7	2	0.72
D40	My confidence level in mathematics affects my competency and ability to do mathematics	16	29%	32	57%	2	4%	6	11%	0	0%	56	0	56	2.0	2	0.87

	COMMUNICATION SKILLS	SA		A		N		D		SD		Valid	Missing	Total	Mean	Mode	σ
E1	I POSSESS THE CONFIDENCE TO ASK EFFECTIVE QUESTIONS IN CLASS	13	23%	23	41%	5	9%	10	18%	5	9%	56	0	56	2.5	2	1.28
E2	I POSSESS THE CONFIDENCE TO ASK EFFECTIVE QUESTIONS IN TUTORIALS	15	27%	29	53%	6	11%	3	5%	2	4%	55	1	56	2.1	2	0.97
E3	I have a good working knowledge of mathematical jargon	0	0%	19	34%	25	45%	12	21%	0	0%	56	0	56	2.9	3	0.74
E4	I WOULD NOT BE PUT OFF ATTEMPTING A MATHEMATICAL PROBLEM BY ITS LEVEL OF JARGON	0	0%	32	57%	9	16%	13	23%	2	4%	56	0	56	2.7	2	0.94
E5	I am able to communicate ideas in writing to others in a step-by-step fashion	5	9%	38	69%	9	16%	3	5%	0	0%	55	1	56	2.2	2	0.67
E6	I am able to communicate concepts and ideas in mathematics	1	2%	31	55%	15	27%	9	16%	0	0%	56	0	56	2.6	2	0.78
E7	MAINLY, I DO NOT RELY ON OTHERS IN MY CLASS/STUDY GROUP TO ASK THE QUESTIONS I WANT TO ASK	11	20%	29	52%	5	9%	8	14%	3	5%	56	0	56	2.3	2	1.12
E8	I am not intimidated by raising my hand in class to ask a question	11	20%	24	44%	8	15%	8	15%	4	7%	55	1	56	2.5	2	1.18
E9	Before I ask a question in maths class I am not considering what others may think of me	12	21%	28	50%	3	5%	10	18%	3	5%	56	0	56	2.4	2	1.17

	MANAGING OWN LEARNING	SA		A		N		D		SD		Valid	Missing	Total	Mean	Mode	σ
F1	I am comfortable managing my own learning in mathematics	2	4%	24	43%	8	14%	20	36%	2	4%	56	0	56	2.9	2	1.04
F2	I am comfortable reflecting on how I learn mathematics	5	9%	25	45%	15	27%	10	18%	1	2%	56	0	56	2.6	2	0.95
F3	When necessary, I am able to supplement my learning by other self-directed means such as Internet, DVD-ROMs or similar	9	16%	29	52%	8	14%	7	13%	3	5%	56	0	56	2.4	2	1.07
F4	I LIKE THE TEACHING METHODS USED TO TEACH ME MATHEMATICS	17	30%	29	52%	9	16%	1	2%	0	0%	56	0	56	1.9	2	0.73
F5	I WOULD RATHER COLLABORATE WITH OTHERS THAN WORK ON MY OWN	9	16%	33	59%	10	18%	2	4%	2	4%	56	0	56	2.2	2	0.88
F6	IT IS NOT THE RESPONSIBILITY OF MY LECTURER TO TEACH ME MATHS	10	18%	22	39%	11	20%	13	23%	0	0%	56	0	56	2.5	2	1.04
F7	MY LECTURER IS INTERESTED IN WHETHER I DO WELL AT MATHS OR NOT	25	45%	26	46%	2	4%	3	5%	0	0%	56	0	56	1.7	2	0.78

	LEARNING IN OTHER WAYS, LEARNING JOURNAL, NON-3'R's LEARNING	SA		A		N		D		SD		Valid	Missing	Total	Mean	Mode	σ
G1	I enjoyed the opportunity to learn more about mathematics by giving a presentation to my peers	6	16%	15	39%	10	26%	5	13%	2	5%	38	18	56	2.5	2	1.08
G2	I learn best in a practical, hands-on type of class room environment	14	26%	34	64%	5	9%	0	0%	0	0%	53	3	56	1.8	2	0.58
G3	I LEARNED SOMETHING NEW BY PARTICIPATING IN THE MATHEMATICS PRESENTATION	10	27%	18	49%	7	19%	2	5%	0	0%	37	19	56	2.0	2	0.83
G4	I learned about mathematics during the presentation element of the course	1	3%	18	47%	13	34%	5	13%	1	3%	38	18	56	2.7	2	0.85
G5	I noticed my ability to do maths improved in the time after I presented my presentation	1	3%	7	18%	14	37%	14	37%	2	5%	38	18	56	3.2	3(a)	0.91
G6	PROGRESS MADE IN ONE AREA OF MATHS HELPS ME LEARN IN OTHER AREAS OF MATH	8	15%	34	64%	5	9%	3	6%	3	6%	53	3	56	2.2	2	0.97
G7	I learn maths best when collaborating with others	14	25%	27	48%	12	21%	1	2%	2	4%	56	0	56	2.1	2	0.93
G8	LEARNING MATHS RULES AND FORMULAES OFF-BY-HEART IS NOT THE BEST WAY TO LEARN MATHS	4	7%	19	34%	15	27%	15	27%	3	5%	56	0	56	2.9	2	1.06
G9	I LIKE WRITING HOW I FEEL ABOUT MATHEMATICS	4	7%	24	43%	15	27%	10	18%	3	5%	56	0	56	2.7	2	1.02
G10	When writing in my journal I incorporate other people's points of view, as well as my own	0	0%	7	19%	12	33%	14	39%	3	8%	36	20	56	3.4	4	0.90
G11	I write my journal on a daily basis at least	1	3%	6	17%	1	3%	22	61%	6	17%	36	20	56	3.7	4	1.03
G12	I write my journal on a weekly basis at least	2	6%	20	56%	1	3%	12	33%	1	3%	36	20	56	2.7	2	1.09
G13	I DO NOT WRITE IRREGULARLY IN MY JOURNAL	5	14%	18	50%	1	3%	11	31%	1	3%	36	20	56	2.6	2	1.16
G14	I find that I reflect about mathematics more often now than in the first semester	3	9%	19	54%	6	17%	5	14%	2	6%	35	21	56	2.5	2	1.04
G15	I find that my reflections are deeper and more meaningful than in the first semester	4	11%	17	49%	10	29%	3	9%	1	3%	35	21	56	2.4	2	0.92
G16	I find my journal tells the story of my struggles with the subject of mathematics	4	11%	17	47%	11	31%	3	8%	1	3%	36	20	56	2.4	2	0.91
G17	Using my journal, I can highlight when I noticed an increase in my mathematics ability	5	14%	20	56%	7	19%	3	8%	1	3%	36	20	56	2.3	2	0.92
G18	From my journal, I can recognise when my confidence began improving in mathematics	4	11%	18	50%	10	28%	3	8%	1	3%	36	20	56	2.4	2	0.91
G19	REGARDING MY JOURNAL, I WOULD SAY THAT THE QUALITY OF MY ENTRIES IS MORE IMPORTANT THAN THEIR QUANTITY	7	19%	19	53%	7	19%	1	3%	2	6%	36	20	56	2.2	2	0.99
G20	PLEASING MY TUTOR IS NOT MY MAIN MOTIVATION FOR DOING MY JOURNAL	6	17%	14	39%	6	17%	10	28%	0	0%	36	20	56	2.6	2	1.08
G21	If my journal was not assessed I would continue writing it	1	3%	10	29%	7	20%	12	34%	5	14%	35	21	56	3.3	4	1.13
G22	My journal has helped me define strategies for coping with learning mathematics	2	6%	11	31%	13	36%	8	22%	2	6%	36	20	56	2.9	3	1.00
G23	Due to my journaling, my tutor was given insights into my difficulties with learning mathematics	4	11%	14	40%	11	31%	6	17%	0	0%	35	21	56	2.5	2	0.92

	EFFECT OF TUTOR, STUDENTS' ATTITUDES TO TUTOR	SA		A		N		D		SD		Valid	Missing	Total	Mean	Mode	σ
H1	MY SUCCESSES IN MATHEMATICS ON THIS COURSE ARE NOT ATTRIBUTED TO MY TUTOR	0	0%	6	11%	7	13%	26	47%	16	29%	55	1	56	4.0	4	0.93
H2	MY TUTOR IS NOT IRRELEVANT TO MY LEARNING OF MATHEMATICS	24	44%	24	44%	4	7%	2	4%	1	2%	55	1	56	1.8	1(a)	0.88
H3	My tutor is someone I trust	19	35%	25	46%	8	15%	1	2%	1	2%	54	2	56	1.9	2	0.86
H4	MY LEARNING IS UNAFFECTED WHEN MY REGULAR TUTOR IS SUBSTITUTED BY ANOTHER	0	0%	9	16%	13	24%	22	40%	11	20%	55	1	56	3.6	4	0.99
H5	I place much confidence in my tutor	17	31%	29	53%	9	16%	0	0%	0	0%	55	1	56	1.9	2	0.68
H6	I believe my tutor has confidence in me	12	22%	34	62%	9	16%	0	0%	0	0%	55	1	56	2.0	2	0.62
H7	I DO NOT BELIEVE MY TUTOR IS 'LET DOWN' WHEN/IF I GET A 'BAD' RESULT	6	11%	20	36%	11	20%	15	27%	3	5%	55	1	56	2.8	2	1.13
H8	It is extremely important for me to know my tutor believes in me	8	15%	31	56%	13	24%	3	5%	0	0%	55	1	56	2.2	2	0.76
H9	I am pleased that my tutor sometimes sees potential in me that I had not noticed	19	35%	27	49%	8	15%	1	2%	0	0%	55	1	56	1.8	2	0.74
H10	I find my mathematics classes have a typically easy going, relaxed atmosphere	13	23%	21	38%	14	25%	7	13%	1	2%	56	0	56	2.3	2	1.03
H11	I DO NOT PREFER MY MATHS CLASSES TO BE STRICT AFFAIRS WITH A MINIMUM OF CLASS-TUTOR DISCUSSION, INTERACTION OR COLLABORATION	19	36%	27	51%	3	6%	3	6%	1	2%	53	3	56	1.9	2	0.90
H12	I LIKE THE WAY MY TUTOR COMPELS ME SOMETIMES TO ATTEMPT TO SOLVE A PROBLEM I FEEL UNPREPARED FOR	8	15%	22	41%	16	30%	8	15%	0	0%	54	2	56	2.4	2	0.93
H13	I WOULD PREFER TO FIGURE OUT AN ANSWER MYSELF RATHER THAN RELYING ON MY TUTOR TO PROMPT OR TELL ME THE ANSWER	18	33%	30	55%	6	11%	1	2%	0	0%	55	1	56	1.8	2	0.70

(a) corresponds to more than one modal term

Tuesday, 27 March 2007

To current and former students of the WIT Certificate in Foundation Studies,

You were or still are a student of the abovementioned course, participating either in a full-time or part-time capacity. You have at least one thing in common with your colleagues – you have taken either the Business Mathematics or Technology Mathematics module in one of the last five years. During the course of your year of study you will no doubt remember that you completed assignments of various kinds as part of the overall continuous assessment for the module. During the last three years two of these assignments concerned 1) the ongoing production of your mathematics learning journal and 2) a peer assessed PowerPoint presentation on the impact of mathematics on society. Both of these assessments came about as a result of my studies and research for a Master of Arts Degree in Teaching and Learning in Higher Education from WIT.

This year sees the completion of this portion of my research in the form of a 20,000 word dissertation research report. A major part of my research is an analysis of students' responses to a questionnaire, students' journals, and students' post-presentation guided reflections from each of the last three years (2004-2007). This is in order to discover any trends and/or evidence of phenomena that may be noteworthy. In particular I am keen to investigate any relationship that may exist between student levels of confidence in mathematics with student levels of competency (effective ability) at mathematics. I am also examining any transferability of skills learned through mathematics to other disciplines or contexts. I hope to influence teaching practices of mathematics teachers as a result, and educate others to the benefits of learning mathematics.

To this end I would gratefully appreciate you filling out the attached questionnaire as fully, carefully and above all, as honestly as possible. All data collected will remain confidential and will be kept securely. No data identifying individual students will be made available. The analysis of the data you supply will be general and absolutely anonymous, and will be published as an integral part of my research dissertation for the award of Masters of Arts Degree in Teaching and Learning in Higher Education, and will be available from the 'Thesis Room' of the Luke Wadding Library, at WIT.

Completed questionnaires should be returned after a maximum of 2 days from receipt.

Your assistance is most gratefully appreciated and I thank you in advance for your help.

_____

Michael Lanigan

Please indicate your agreement with participating in this research project by indication below and by your signature. Thank you.

(Please circle)

I agree to participate in this research project as outlined above. Yes No

Signed:_____ **Date:**_____

Questionnaire Instructions

1. If you are in doubt about any instruction, any statement or anything related to this questionnaire please seek clarification.

2. You should attempt to complete the questionnaire in one or two sittings. Please feel free to take a break in between sittings. Please do not attempt this questionnaire if you are tired or in a hurry. Your responses to the statements are extremely important and it should not be rushed or improperly completed.

3. Please read each statement carefully, making sure you understand it before you record your agreement or disagreement with it. If in doubt, please seek clarification.

4. Each statement offers you a scale of agreement-disagreement. You should record only one per each statement. For example:

I believe the world is round	***SA***	***A***	***N***	***D***	***SD***

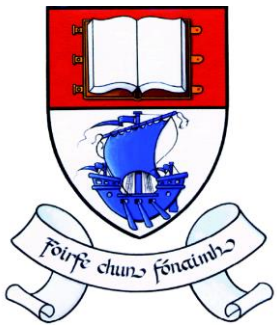
In this example SD has been selected; this means that you STRONGLY DISAGREE with the preceding statement. Other preferences are recorded in a similar way depending on the individual completing the questionnaire. If in doubt, please seek clarification.

5. Record your agreement-disagreement with each statement as you would today, not in the past. The only exception to this would be in agreeing-disagreeing with a statement specifically about a time in the past. If you are a previous student of the Foundation Course you should indicate your agreement-disagreement as you would today. Most statements are written with the current year in mind so use of the present tense and recent past is used throughout. You should bear this in mind when completing the questionnaire. This will be clear from the context of the statement. If in doubt, please seek clarification.

6. If you are a member of the class which did not have the continuous assessments consisting of the PowerPoint presentation on maths and the Mathematics Learning Journal, you may disregard and ignore any statement related to those elements. If in doubt, please seek clarification.

7. If you are in doubt about any instruction, any statement or anything related to this questionnaire please seek clarification. Michael Lanigan is available on mobile: 086-2025611.

Thank you for your assistance in this endeavour.



Note: Please return completed questionnaires within 2 days of receipt

QUESTIONNAIRE

FOR
MASTERS OF ARTS IN TEACHING AND LEARNING IN HIGHER EDUCATION

COMPILED BY
MICHAEL LANIGAN

Waterford Institute of Technology
DEPT. OF ADULT & CONTINUING EDUCATION

Section I Personal & Academic Details

Name: _____ Age:_____ Gender M/F_____

WIT Foundation Course year ☐ First year ☐ Second year ☐

Third year ☐ Fourth year ☐ Post Graduate ☐

Course Title _____

Section II Previous Mathematics Education

Did you sit the Leaving Certificate (or equivalent) Mathematics examination?

Please Circle Yes / No

If no, please explain _____

If yes, please specify year completed:_____

At what level did you study Leaving Certificate (or equivalent) Mathematics?
Please tick one of the following:

Foundation Level ☐ Ordinary Level ☐ Honours Level ☐

Grade achieved: _____

Did you sit the Junior/Intermediate Certificate (or equivalent) Mathematics examination?

Please Circle Yes / No

If no, please explain _____

If yes, please specify year completed:_____

At what level did you study Junior/Intermediate Certificate (or equivalent) Mathematics?
Please tick one of the following:

Foundation Level ☐ Ordinary Level ☐ Honours Level ☐

Grade achieved: _____

Section III WIT Certificate in Foundation Studies Experience

What has been your favourite mathematics topic you have studied in the Mathematics Module at WIT?

_____

What has been your least favourite mathematics topic you have studied in the Mathematics Module at WIT?

_____

Have you attended any of the mathematics tutorial sessions that are available?

Please Circle Yes / No

If yes, did you find them useful? Please explain. _____

_____

_____

If not, what is the main reason:

Don't need any extra mathematics help
Timing of sessions
Got grinds / outside tuition
Worked with other students
Picked it up in other subjects
Other – Please specify _____

Do you find the mathematics covered on this course to be useful in your other subjects or other areas of your life?

Subject/Area where maths is useful	Please explain why

SA=Strongly Agree; A=Agree; N=Neither Agree Nor Disagree; D=Disagree; SD=Strongly Disagree

Please tick each row only once

		1	2	3	4	5
	CATEGORY A: PROBLEM SOLVING SKILLS					
A1	**I am pleased with the development of my cognitive ability (i.e. mental processes of thinking or reasoning)**	SA	A	N	D	SD
A2	**I find that I possess more curiosity *(wanting to find out about something)* now, than before I took this mathematics module**	SA	A	N	D	SD
A3	**I am persistent in mathematics, staying at a problem until the problem is resolved**	SA	A	N	D	SD
A4	**I am confident in situations where the mathematics is unfamiliar**	SA	A	N	D	SD
A5	**I treat problems in mathematics more logically now than before**	SA	A	N	D	SD
A6	**I approach generic *(a range of)* problems more logically since studying mathematics**	SA	A	N	D	SD
	CATEGORY B: NUMBERS SKILLS & UNIVERSALITY OF MATHEMATICS					
B1	**I am able to apply numbers to non-mathematical situations**	SA	A	N	D	SD
B2	**By participating in the mathematics presentation I discovered that mathematics is a very diverse subject with many real-life applications**	SA	A	N	D	SD
B3	**As mathematics is not a major portion of my chosen third level course, I don't need to worry about understanding it**	SA	A	N	D	SD
	CATEGORY C: TEAM WORKING SKILLS					
C1	**I prefer to collaborate with others on projects or assignments**	SA	A	N	D	SD
C2	**I work well with others in a team**	SA	A	N	D	SD

C3	I work well with others in my study group	SA	A	N	D	SD
C4	I attend study group meetings because I am obligated to	SA	A	N	D	SD
C5	I attend study group meetings at least once a week	SA	A	N	D	SD
C6	I attend study group meetings at least every two weeks	SA	A	N	D	SD
C7	I attend study group meetings infrequently	SA	A	N	D	SD
C8	Study groups are a waste of my time	SA	A	N	D	SD
	CATEGORY D: AFFECTIVE LEARNING DOMAIN, CONFIDENCE, SELF-ESTEEM, MATHS ANXIETY, ATTITUDE, EMOTION					
D1	I was intimidated by mathematics (either prior to this course and/or up to this point in time)	SA	A	N	D	SD
D2	I remain intimidated by mathematics (at this point)	SA	A	N	D	SD
D3	My main motivation for doing mathematics is just to get through the course	SA	A	N	D	SD
D4	When I arrive at a possible solution to a maths problem I accept it and move on	SA	A	N	D	SD
D5	When I arrive at a possible solution to a maths problem I believe I am probably wrong	SA	A	N	D	SD
D6	When I arrive at a possible solution to a maths problem I double check my answer	SA	A	N	D	SD
D7	Prior to this course I preferred to know the method for working out maths i.e. how to do this or that process	SA	A	N	D	SD

D8	**Prior to this course I preferred to know the reason why, or purpose for using this or that method in maths**	**SA**	**A**	**N**	**D**	**SD**
D9	**Because of this course I like to know the *reason or purpose for doing something as well as knowing the method for doing it***	**SA**	**A**	**N**	**D**	**SD**
D10	**Proving the answer 'correct' is something I do not enjoy about mathematics**	**SA**	**A**	**N**	**D**	**SD**
D11	**I don't mind if the answer I arrive at is incorrect as long as I find out where I made my mistakes**	**SA**	**A**	**N**	**D**	**SD**
D12	**I don't like discussing my answer with my colleagues in class**	**SA**	**A**	**N**	**D**	**SD**
D13	**I don't like discussing my answer with my colleagues in tutorials**	**SA**	**A**	**N**	**D**	**SD**
D14	**I don't like discussing my answer with my colleagues in study groups**	**SA**	**A**	**N**	**D**	**SD**
D15	**I don't like discussing mathematics at all**	**SA**	**A**	**N**	**D**	**SD**
D16	**I am not a confident learner when it comes to mathematics**	**SA**	**A**	**N**	**D**	**SD**
D17	**The main extent of my engagement with mathematics is to simply do what is required for the set tasks**	**SA**	**A**	**N**	**D**	**SD**
D18	**I believe mathematics is an absolute science - infallible**	**SA**	**A**	**N**	**D**	**SD**
D19	**Mathematics was always there and mankind simply discovered it**	**SA**	**A**	**N**	**D**	**SD**
D20	**Mathematics is a difficult subject**	**SA**	**A**	**N**	**D**	**SD**
D21	**My self-confidence increased as a result of my participation in the mathematics presentation**	**SA**	**A**	**N**	**D**	**SD**

D22	**Presenting to my peers made me nervous, particularly in mathematics**	**SA**	**A**	**N**	**D**	**SD**
D23	**I see mathematics as being a subject with many inter-related areas adhering to general rules**	**SA**	**A**	**N**	**D**	**SD**
D24	**My self-confidence improved after I participated in the mathematics presentation**	**SA**	**A**	**N**	**D**	**SD**
D25	**My chosen third level course choice was affected by how I felt about maths**	**SA**	**A**	**N**	**D**	**SD**
D26	**I was intimidated by giving a presentation on mathematics**	**SA**	**A**	**N**	**D**	**SD**
D27	**I believe the maths I've learned as an adult has different rules from the maths I learned as a child**	**SA**	**A**	**N**	**D**	**SD**
D28	**The main problem with maths is: the rules have to be learned off but they change from time to time**	**SA**	**A**	**N**	**D**	**SD**
D29	**Because of this module I have the confidence to help my children with their maths homework**	**SA**	**A**	**N**	**D**	**SD**
D30	**I noticed a positive change in my attitude towards maths since taking this course**	**SA**	**A**	**N**	**D**	**SD**
D31	**Maths is a collection of knowledge that may be added to, amended, or updated from time to time**	**SA**	**A**	**N**	**D**	**SD**
D32	**I believe the different areas of mathematics are separate and unrelated to one another**	**SA**	**A**	**N**	**D**	**SD**
D33	**Understanding maths seems like too much hard work especially considering the duration of the academic year**	**SA**	**A**	**N**	**D**	**SD**
D34	**Electronic calculators like the one I use always give the correct answer**	**SA**	**A**	**N**	**D**	**SD**
D35	**An answer given by an electronic calculator should not be challenged**	**SA**	**A**	**N**	**D**	**SD**

D36	**I am intimidated by my electronic calculator**	**SA**	**A**	**N**	**D**	**SD**
D37	**I avoid some areas of maths because I am uncertain of how to use my electronic calculator**	**SA**	**A**	**N**	**D**	**SD**
D38	**Prior to studying maths on this course, I believed I was not competent at maths**	**SA**	**A**	**N**	**D**	**SD**
D39	**I am more competent at mathematics after studying maths on this course**	**SA**	**A**	**N**	**D**	**SD**
D40	**My confidence level in mathematics affects my competency and ability to do mathematics**	**SA**	**A**	**N**	**D**	**SD**
	CATEGORY E: COMMUNICATION SKILLS					
E1	**I do not have the confidence to ask effective questions in class**	**SA**	**A**	**N**	**D**	**SD**
E2	**I do not possess the confidence to ask effective questions in tutorials**	**SA**	**A**	**N**	**D**	**SD**
E3	**I have a good working knowledge of mathematical jargon**	**SA**	**A**	**N**	**D**	**SD**
E4	**I would not be put off attempting a mathematical problem by the level of jargon**	**SA**	**A**	**N**	**D**	**SD**
E5	**I am able to communicate ideas in writing to others in a step-by-step fashion**	**SA**	**A**	**N**	**D**	**SD**
E6	**I am able to communicate concepts and ideas in mathematics**	**SA**	**A**	**N**	**D**	**SD**
E7	**I mainly rely on others in my class/study group to ask the question(s) I want to ask**	**SA**	**A**	**N**	**D**	**SD**
E8	**I am not intimidated by raising my hand in class to ask a question**	**SA**	**A**	**N**	**D**	**SD**
E9	**Before I ask a question in maths class I am not considering what others may think of me**	**SA**	**A**	**N**	**D**	**SD**

	CATEGORY F: MANAGING OWN LEARNING SKILLS					
F1	**I am comfortable managing my own learning in mathematics**	SA	A	N	D	SD
F2	**I am comfortable reflecting on how I learn mathematics**	SA	A	N	D	SD
F3	**When necessary, I am able to supplement my learning by other self-directed means such as Internet, DVD-ROMs or similar**	SA	A	N	D	SD
F4	**I don't like the teaching methods used to teach me mathematics**	SA	A	N	D	SD
F5	**I would rather work on my own than collaborate with others**	SA	A	N	D	SD
F6	**It is the responsibility of my lecturer to teach me maths**	SA	A	N	D	SD
F7	**My lecturer has no interest whether I do well at maths or not**	SA	A	N	D	SD
	CATEGORY G: LEARNING IN OTHER WAYS/LEARNING JOURNAL/NON-3RS LEARNING					
G1	**I enjoyed the opportunity to learn more about mathematics by giving a presentation to my peers**	SA	A	N	D	SD
G2	**I learn best in a practical, hands-on type of class room environment**	SA	A	N	D	SD
G3	**I did not learn anything new by participating in the mathematics presentation**	SA	A	N	D	SD
G4	**I learned more about mathematics during the presentation element of the course**	SA	A	N	D	SD
G5	**I noticed my ability to do maths improved after I presented my presentation**	SA	A	N	D	SD
G6	**Progress made in one area of maths does not help me learn in other areas of maths**	SA	A	N	D	SD

G7	**I learn maths best when collaborating with others**	**SA**	**A**	**N**	**D**	**SD**
G8	**Learning maths rules and formulae off-by-heart is the best way to learn maths**	**SA**	**A**	**N**	**D**	**SD**
G9	**I do not like writing how I feel about mathematics**	**SA**	**A**	**N**	**D**	**SD**
G10	**When writing in my journal I incorporate other people's points of view, as well as my own**	**SA**	**A**	**N**	**D**	**SD**
G11	**I write my journal on a daily basis at least**	**SA**	**A**	**N**	**D**	**SD**
G12	**I write my journal on a weekly basis at least**	**SA**	**A**	**N**	**D**	**SD**
G13	**I write irregularly in my journal**	**SA**	**A**	**N**	**D**	**SD**
G14	**I find that I reflect about mathematics more often now than in the first semester**	**SA**	**A**	**N**	**D**	**SD**
G15	**I find that my reflections are deeper and more meaningful than in the first semester**	**SA**	**A**	**N**	**D**	**SD**
G16	**I find my journal tells the story of my struggles with the subject of mathematics**	**SA**	**A**	**N**	**D**	**SD**
G17	**Using my journal, I can highlight when I noticed an increase in my mathematics ability**	**SA**	**A**	**N**	**D**	**SD**
G18	**From my journal, I can recognise when my confidence began improving in mathematics**	**SA**	**A**	**N**	**D**	**SD**
G19	**Regarding my journal, I would say the quantity of my entries is more important than their quality**	**SA**	**A**	**N**	**D**	**SD**
G20	**My motivation for doing my journal is to please my tutor**	**SA**	**A**	**N**	**D**	**SD**

G21	If my journal was not assessed I would continue writing it	SA	A	N	D	SD
G22	My journal has helped me define strategies for coping with learning mathematics	SA	A	N	D	SD
G23	Due to my journaling, my tutor was given insights into my difficulties with learning maths	SA	A	N	D	SD
	CATEGORY H: EFFECT OF TUTOR, STUDENTS' ATTITUDE TO TUTOR					
H1	My successes in mathematics on this course is attributed to my tutor	SA	A	N	D	SD
H2	My tutor is irrelevant to my learning of mathematics	SA	A	N	D	SD
H3	My tutor is someone I trust	SA	A	N	D	SD
H4	My learning is affected when my regular tutor is substituted by another	SA	A	N	D	SD
H5	I place much confidence in my tutor	SA	A	N	D	SD
H6	I believe my tutor has confidence in me	SA	A	N	D	SD
H7	I believe my tutor is let down when/if I get a 'bad' result	SA	A	N	D	SD
H8	It is extremely important for me to know my tutor believes in me	SA	A	N	D	SD
H9	I am pleased that my tutor sometimes sees potential in me that I had not noticed	SA	A	N	D	SD
H10	I find my mathematics classes have a typically easy going, relaxed atmosphere	SA	A	N	D	SD

H11	**I prefer my maths classes to be strict affairs with a minimum of class-tutor discussion, interaction or collaboration**	**SA**	**A**	**N**	**D**	**SD**
H12	**I dislike the way my tutor compels me sometimes to attempt to solve a problem I feel unprepared for**	**SA**	**A**	**N**	**D**	**SD**
H13	**I would prefer if my tutor told me the answer rather than I figuring it out myself**	**SA**	**A**	**N**	**D**	**SD**

Please feel free to add any other appropriate statements regarding your experiences of learning mathematics – use other pages if necessary. Thank you.

Hypothetical Scenario 1:

You are faced with a mathematical problem that is initially unfamiliar to you; which one of the following statements would best describe your personal reaction or attitude to that problem: [please circle the appropriate letter]

A. ***Since you are not familiar with this exact problem you therefore have no idea where to begin dealing with it or what to do next, so you have no alternative and abandon trying;***

Or

B. ***You attempt to make sense of the problem but once your initial attempts run into trouble you decide to 'bail out' and leave the problem unfinished;***

Or

C. ***You examine the problem looking beyond the initial unfamiliarity and take your time to possibly break the problem into smaller, more manageable and familiar problems;***

Or

D. ***You seek assistance from a third party (e.g. a mathematics text book, a tutorial class, fellow students, lecturer or other) and examine the problem as per C above;***

Depending on which scenario corresponds best with you, could you describe briefly an actual instance or instances when this occurred?

_____

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Hypothetical Scenario 2:

You are attending a mathematics lecture when at some point during the lecture you feel you don't quite understand the point your lecturer is making or you are not quite getting the flow of his/her argument about a particular topic. Your lecturer then decides to move onto a newer area. Which one of the following statements best describes you:

A. ***Feelings of anxiousness rise in you as you consider raising your hand to ask a question and gain clarification. However, in the time it's taken you to decide what to do your lecturer has moved on and by thinking about what to do you've now also missed the beginning of the newer area. Dejected you simply accept the situation, and hope to catch what you missed from a colleague or a tutorial. You don't ask or try to ask any further questions during the class.***

Or

B. ***You nervously raise your hand to stop your lecturer from moving on before you've understood the current topic. You ask your question and feel 'every' eye in the class on you. Your lecturer answers your question very clearly and asks if you understand. You are still not sure but to avoid any awkwardness you simply smile and nod in agreement with your lecturer who, thinking you understand things now, moves on. There are feelings of tension inside of you and you don't ask any further questions in that class.***

Or

C. ***As soon as it hits you that you are not getting it, your hand shoots up or you announce verbally to your lecturer that you are 'lost'. To assist you further, your lecturer enquires as to what part you don't understand. You are not sure, having not taken enough time to examine just exactly where it's not making sense for you. Feeling a bit silly, and hoping to stall your lecturer's enquiries, you answer that you aren't understanding anything of what has been explained so far and could s/he go over it once again. Your lecturer frowns at the prospect of having to review the previous topic from the top. Due to his/her reaction and your embarrassment, you don't ask any further questions during that class.***

Or

D. ***You consider what part of your lecturer's argument you are not catching and decide on an appropriate question. You raise your hand, putting your question to your lecturer as clearly and as simply as you can so as not to confuse yourself and everyone else. You may feel nervous but are undeterred, persevering with your question. You gain some understanding from your lecturer's explanations and confidently ask further minor, clarifying questions if appropriate on this topic. You continue to ask questions during the class if required.***

Cont'd overleaf…

Depending on which scenario corresponds best with you, could you describe briefly an actual instance or instances when this occurred?

_____

_____

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