DProf thesis

An exploration of strategies to support non-specialist mathematics and statistics learners in higher education in Mauritius

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An Exploration of Strategies to Support Non-Specialist Mathematics and Statistics Learners in Higher Education in Mauritius

Submitted in partial fulfilment of the requirements

of the degree of

Doctor of Professional Studies
(Education)

by

Bheshaj Kumar Ashley Hoolash

(M00389229)

IPL5360

School of Health and Education

Dedication

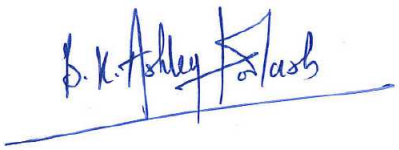
To the loving memory of my mother who, throughout her life, encouraged me to keep pushing the boundaries.

"Education is like Archery. You have your bow and arrows, and you have a target to aim at. You keep shooting the arrows until you succeed. Once you succeed, you feel on top of the world. But what do you do next? You push the target further. Your fresh aim is to hit this new target. And like that, you keep pushing the target further and further, and you keep hitting it. That is what Education is about. It is the target that you have to keep pushing and hitting. It has no end to it. Strive to learn more."

My first teacher, Mrs. Koontee Hoolash.
(1946 - 2015)

Declaration

I hereby declare that except where specific reference is made to the work of others, the contents of this dissertation are original and have not been submitted in whole or in part for consideration for any other degree or qualification in this, or any other university. This dissertation is my own work and contains nothing which is the outcome of work done in collaboration with others, except as specified in the text and Acknowledgements.



(Bheshaj Kumar Ashley Hoolash)

Student No: M00389229

Date: 01-02-2023

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I place on record, my sincere thanks to Dr Karen Pettit, former Campus Director, and Dr Nicky Torrance, former Associate Director Academic at Middlesex University Mauritius, who believed in me and encouraged me to embark on this awesome journey of research, discovery and reflection. They provided all the support I needed throughout my study.

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Last but not least, I would like to thank my students. I would not be where I am without them. They taught me a lot and they made me a better teacher.

B.K. Ashley Hoolash

Abstract

Mathematics anxiety is a prevalent issue which prevents students from choosing undergraduate studies that contain high contents of mathematics and statistics, in higher education. Academics have been trying hard to find ways to support non-specialist mathematics students, through various means, to facilitate the teaching of mathematics and statistics.

This doctoral thesis presents the findings of a study conducted with undergraduate and postgraduate students, in a higher education institution, in Mauritius, namely at Middlesex University Mauritius, an international campus of Middlesex University, UK. The study aimed to explore students' perceptions of mathematics and statistics while taking into consideration their past experiences when learning those subjects. Data were also collected from three teachers who teach those disciplines in their respective programmes.

This study primarily utilises a methodological approach centred on gathering data through interviews with both students and academics, as well as conducting focus groups exclusively with students. The interview process, conducted face-to-face and through focus groups, adopts a Narrative Inquiry approach. Additionally, a limited amount of quantitative data was gathered through an online questionnaire administered to new university students. Thematic analysis was applied to scrutinise the qualitative data. Simultaneously, an examination of the correlation between the perceived "value" of mathematics and factors such as "self-confidence", "enjoyment", and "motivation" was conducted, although measurement of these emotions was not within the scope of this research. In my capacity as an Insider-Researcher, my deep understanding of the research topic played a vital role in guiding the establishment of the investigation, with careful consideration given to the ethical considerations inherent to this role.

Findings from the data collected revealed that students are usually ill-prepared to start studying modules with high quantitative components. Many students have negative emotions towards mathematics and statistics, and this hinders their studies at university. Recommendations include the steps that a higher education institution such as Middlesex University Mauritius, should take to alleviate these negative emotions, at an early stage, and to provide adequate support to non-specialist mathematics students.

TABLE OF CONTENTS

Page

Dedication **ii**

Declaration **iii**

Acknowledgements **iv**

Abstract **v**

List of Figures **xi**

List of Tables **xiv**

List of Abbreviations, Acronyms and Symbols **xvi**

1 Introduction **1**

1.1 Positioning Middlesex University Mauritius 1

1.1.1 "Education Hub" and "Knowledge Hub" in the Mauritian Context 2

1.1.2 Mauritius as a Knowledge Hub 3

1.1.2.1 Successes of an Education Hub 5

1.1.2.2 Mauritius - The Current Status 6

1.1.2.3 Challenges of an Education Hub 7

1.1.3 Responsibilities of an International Branch Campus 7

1.2 My Position at Middlesex University Mauritius 8

1.3 My Motivation 11

1.3.1 A Mathematician Teaching Statistics 11

1.3.2 My Postgraduate Certificate in Higher Education . . . 13
1.3.3 The Rigid Teacher . . . 13
1.3.4 Specious Expectations . . . 14
1.3.5 Unrealistic Anticipation . . . 14
1.3.6 My Responsibilities at MUM . . . 14
1.4 From Applied Mathematician to Researcher in Maths/Stats Education . . . 15
1.5 Project Summary and Introducing the Next Chapters . . . 18
1.5.1 Next Chapters . . . 19

2 Aims, Objectives and Literature Review 22
2.1 Introduction . . . 22
2.1.1 Research Questions . . . 23
2.1.2 Aims and Objectives . . . 23
2.2 Mathematics and Statistics Learning Support in Higher Education . . . 23
2.2.1 Nature or Forms of Support Provided . . . 25
2.2.2 Some Caveats . . . 25
2.2.3 Impact of Mathematics Support . . . 25
2.3 Attitude and Emotions Towards Learning Mathematics and Statistics . . . 27
2.3.1 Developmental Dyscalculia . . . 28
2.4 Introducing the Term "Maths Anxiety" . . . 29
2.4.1 Maths Anxiety at Lower Education Levels . . . 29
2.5 Maths Anxiety in Higher Education . . . 33
2.5.1 Statistics Anxiety . . . 39
2.6 Gender Comparison - Maths Anxiety . . . 43
2.7 Mitigating Maths Anxiety . . . 46
2.8 Positive Emotions - in Mathematics and Statistics Learning . . . 50
2.9 Enhancement in Teaching Strategies in Mathematics and Statistics . . . 51
2.10 Linking Teaching with Learning in Mathematics and Statistics . . . 55
2.10.1 The Constructivist Approach . . . 56
2.10.2 Constructivism in Mathematics Education . . . 58
2.11 Teacher's Maths Anxiety . . . 59
2.12 The Current Situation at Middlesex University Mauritius . . . 61
2.13 Endnote on Literature Review . . . 62

3 Project Design and Methodology 64
3.1 Introduction . . . 64
3.2 Ontology and Epistemology - A Personal Perspective . . . 65
3.3 Research Philosophy . . . 67
3.3.1 Positivism . . . 70
3.3.2 Non-Positivism - Interpretivism . . . 70

3.4 Rationale for Research Approaches . . . 71
3.4.1 Action Research . . . 71
3.4.2 Experimental Research . . . 72
3.4.3 Case Study . . . 73
3.4.4 Grounded Theory . . . 74
3.4.5 Ethnography . . . 74
3.4.6 Narrative Inquiry . . . 75
3.4.6.1 Contrasts between Ethnography and Narrative Inquiry . . . 76
3.5 Rationale for Research Methods . . . 77
3.5.1 Observation . . . 77
3.5.2 Focus Groups . . . 78
3.5.3 Online Questionnaire - For Data Collection Purpose . . . 79
3.5.4 Interviews . . . 80
3.5.5 Document Analysis . . . 81
3.6 Sampling . . . 81
3.6.1 Probability Sampling . . . 82
3.6.2 Non-Probability Sampling . . . 83
3.7 Ethical Issues . . . 91
3.7.1 Informed consent . . . 92
3.7.2 Confidentiality . . . 93
3.7.3 Insider-Researcher . . . 94
3.7.3.1 Teacher-Researcher: A Position of "Power" . . . 97
3.7.4 Ethical Considerations in Narrative Inquiry . . . 98
3.8 Project Design . . . 98
3.8.1 Participants Details - Interviews . . . 101
3.8.2 The Online Questionnaire . . . 102
3.8.3 The Focus Group Interview . . . 104
3.8.4 Face-to-Face Interview with Students . . . 105
3.8.5 Face-to-Face Interview with Staff . . . 106
3.9 Data Analysis . . . 107
3.9.1 Quantitative Analysis - The Online Questionnaire . . . 107
3.9.1.1 Transforming the Variables in SPSS . . . 107
3.9.2 Qualitative Analysis - Thematic Analysis . . . 107
3.9.3 Pitfalls - Thematic Analysis . . . 109
3.10 Validity . . . 109
3.11 Summary . . . 110

4 Project Activity **111**
4.1 Introduction . . . 111

4.2 Why a DProf and not a PhD? . . . 111
4.3 The Research Topic . . . 113
4.4 Value and Feasibility of the Study . . . 113
4.5 The DProf Research Programme and the Research Project . . . 114
4.6 Ethics Approval . . . 115
4.6.1 The Watertight Ethics Package . . . 115
4.7 Ethical Concerns . . . 116
4.8 Equipping Myself with the Best Tools Available . . . 118
4.8.1 Learning Nvivo for Qualitative Analysis . . . 118
4.8.2 Using Qualtrics, an Online Platform, for the Online Questionnaire . 119
4.8.3 Choosing LaTeX over Microsoft Word . . . 119
4.8.4 Mendeley - Reference Manager . . . 119
4.9 Setting Up CeMaSTeL . . . 120
4.10 Area Head, Health Issues and COVID-19 . . . 120
4.11 Write-up of the Thesis . . . 121
4.12 Dissemination of the Study Through Conferences . . . 122
4.13 End Note . . . 123

5 Project Findings 125
5.1 Introduction . . . 125
5.2 Online Questionnaire - An Introduction to its Importance in this Study . . 127
5.2.1 Ordinal Regression: "Value" Against Independent Variables . . . 130
5.2.1.1 Purpose of "Transforming" the Variables . . . 130
5.2.1.2 Test of Normality on the Mean Transformed Variables . . 130
5.2.1.3 Test of Normality on the Log of the Mean Transformed Variables . . . 133
5.2.2 Model Fitting Information . . . 133
5.2.3 The Goodness-of-Fit . . . 134
5.2.4 Test of Parallel Lines . . . 134
5.2.5 Parameter Estimates . . . 135
5.2.6 Findings of Quantitative Analysis . . . 137
5.3 Analysis of Qualitative Data . . . 137
5.3.1 Staff Interviews - Analysis . . . 138
5.3.1.1 Support Mechanisms . . . 138
5.3.1.2 Emotions . . . 139
5.3.1.3 Teacher's Awareness . . . 140
5.3.1.4 Teaching and Learning Strategies . . . 141
5.3.1.5 Resources . . . 142
5.3.2 Students Interviews - Analysis . . . 144

5.3.2.1 Gender . . . 144
5.3.2.2 Teaching & Learning Strategies . . . 146
5.3.2.3 Attitude . . . 147
5.3.2.4 Support Mechanism . . . 149
5.3.2.5 Resources . . . 150
5.3.3 Focus Group Data Analysis . . . 150
5.3.3.1 Resources . . . 151
5.3.3.2 Emotions or Attitudes . . . 151
5.3.3.3 Teaching & Learning . . . 153
5.3.3.4 Support Mechanism . . . 154
5.4 Conclusion of Project Findings . . . 155

6 Discussion **158**
6.1 Introduction . . . 158
6.2 Research Question 1 . . . 158
6.3 Research Question 2 . . . 160
6.4 End Note . . . 163

7 Conclusions and Recommendations **164**
7.1 Introduction . . . 164
7.2 Review of Aims and Objectives . . . 164
7.3 Validity of The Research Study . . . 165
7.4 Limitations . . . 166
7.5 Recommendations . . . 167
7.6 Future Works . . . 168
7.7 End Note - Impact and Significance of the Research . . . 169
7.7.1 Impact as a Researcher . . . 169
7.7.1.1 Future Plan of the Researcher . . . 170
7.7.2 Impact at Middlesex University Mauritius (MUM) . . . 170
7.7.2.1 Future Plan at MUM . . . 171
7.7.3 Impact at Middlesex University (MU-HEN) . . . 171
7.7.3.1 Future Plan with MU-HEN . . . 172
7.7.4 Potential Impact in Mauritius and Beyond . . . 172
7.7.4.1 Recommended Plan for the Government of Mauritius . . . 173

References **174**

Appendix A Ethics Committee Letter with Minor Changes **192**

Appendix B Ethics Approval Letter **193**

Appendix C Participant Information Sheet - Staff and Students Interview 194

Appendix D Participant Information Sheet - Students Focus Groups 199

Appendix E Participant Information Sheet - Online Questionnaire 204

Appendix F Approval Letter by MUM 209

Appendix G Participants Gender Details 210

Appendix H Focus Group Interview Questionnaire 211

Appendix I Staff Interview Questionnaire 215

Appendix J Students Interview Questionnaire 218

Appendix K Online Questionnaire 222

Appendix L Sample Transcription - Focus Group 1 226

Appendix M Sample Transcription - Staff Interview 1 241

Appendix N Sample Transcription - Student Interview 1 250

Appendix O Sample Visual Coding - Staff Manju 255

Appendix P 2019 TEC Conference 257

Appendix Q Cambridge International 258

LIST OF FIGURES

1.1 Main Higher Education Institutions in Mauritius 5
1.2 Trend - International Students Studying in Mauritius 6
1.3 Teaching Career Path 21

2.1 Adapted from Ashcraft and Moore (2009) - Maths Anxiety Cycle Impacting STEM 38

3.1 Research Design - Adapted From: Farrow et al. (2020), Page 26. 65
3.2 Research Onion - Source: Saunders et al. (2019), Page 130. 69
3.3 The Action Research Cycles, based on McNiff and Whitehead (2016) . . . 71

5.1 Summary of Steps in the Analysis of the Data 129
5.2 Likert Scale Questionnaire 131
5.3 Model Fitting Information 134
5.4 Goodness-of-Fit 134
5.5 Test of Parallel Lines 135
5.6 Parameter Estimates of Coefficients 136

A.1 Ethics Committee - Comments by Chair 192

B.1 Ethics Approval Letter 193

F.1 Letter of Approval 209

O.1 Sample Visual Coding - Staff Manju 256

P.1 2019 TEC Conference - Preparing for the Future 257

Q.1 Meeting with Cambridge International 259

LIST OF TABLES

1.1 Main HEIs in Mauritius and their status 4
1.2 LET support provided 9

2.1 Categorising Range of Emotions 28
2.2 Brief Summary of the Above Section on Male/Female Difference with Maths Anxiety 43
2.3 Study on Statistics Anxiety 46

3.1 Contrasting Foundational Considerations of Narrative Research and Ethnography - Adapted from Creswell and Poth (2016) 76
3.2 Teacher/Researcher Ethical Considerations 95
3.3 Recommendations (Nolen and Putten (2007)) and Propositions. 96
3.4 Details of participants 100
3.5 Participants in Focus Group 1 - with Pseudo Names 101
3.6 Participants in Focus Group 2 - with Pseudo Names 101
3.7 Participants in Focus Group 3 - with Pseudo Names 101
3.8 Staff Interviews 102
3.9 Student Interviews 102
3.10 Types of Regression Models Based on Normality Test 107
3.11 Braun and Clarke (2006) Thematic Analysis phases 108

5.1 Online Questionnaire - Participants 125
5.2 Programme - Gender Cross Tabulation 126
5.3 Nomenclature of the Mean Transformed Variables 130
5.4 First Test of Normality 132
5.5 Nomenclature of the Log of the Mean Transformed Variables 133

5.6 Second Test of Normality 133
5.7 Summary of Parameter Estimates obtained from Figure 5.6 136
5.8 Ranking of Estimates 137

LIST OF ABBREVIATIONS, ACRONYMS AND SYMBOLS

Variables

N	Study Population
n	Sample Size

Abbreviations and Acronyms

AL	Authentic Learning
AR	Action Research
BAAF	BA (Hons) Accounting and Finance
BABM	BA (Hons) Business Management
BIC	Business, Innovation and Creativity
BScPsy	BSc (Hons) Psychology with Counselling
CeMaSTeL	Centre for Mathematics & Statistics - Teaching and Learning
DA	Discourse Analysis
DD	Developmental Dyscalculia
DProf	Doctorate in professional Studies

DT	Digital Technology
ER	Educational Research
ESMM	Explanatory Sequential Mixed Methods
FE	Foundation Education
GIS	Government Information Service
GT	Grounded Theory
HE	Higher Education
HEI	Higher Education Institution
IFP	International Foundation Programme
LET	Learning Enhancement Team
MAST	Maths Anxiety Scale for Teachers
MathSoc	Mathematics Society
MCND	MSc Computer Networks and Network Design
MM	MSc Management
MPsy	MSc Applied Psychology
MRU	Mauritius
MU-HEN	Middlesex University, Hendon, UK
MUM	Middlesex University Mauritius
PG	Postgraduate
PGCertHE	Postgraduate Certificate in Higher Education
PhD	Doctor of Philosophy
PIS	Participation Information Sheet
RAL	Recognition and Accreditation of Learning
ROL	Review of Learning
Sc-Edu	Science and Education

SLA	Student Learning Assistant
STEM	Science, Technology, Engineering and Mathematics
TA	Thematic Analysis
TSR	Teacher-Student Relationship
UG	Undergraduate
UoG	The University of Greenwich, London, UK
UoM	University of Mauritius
UTM	University of Technology Mauritius

CHAPTER 1

INTRODUCTION

Operating since early 2010, Middlesex University Mauritius (MUM) is a relatively new Higher Education Institution (HEI) in Mauritius (MRU). It is important to emphasize that MUM is not just an affiliated institution of Middlesex University, Hendon, UK (MU-HEN), but is instead, a full-fledged International Branch Campus (IBC) of MU-HEN. Understanding the context of an IBC is crucial, as it puts the changes suggested in this thesis into perspective. This is further elaborated in Section 1.1.

In my doctoral research, I am looking at the ways we provide academic support to students at MUM, more precisely in the teaching and learning of mathematics and statistics. These changes must be aligned with the existing policies at MU-HEN and MUM. As a private British HEI and the first of its kind on this tiny island on the African continent, in the middle of the Indian Ocean, the stakes are high. There are two main reasons for this, which, together with the motivation behind this research, will be discussed in the following sections of this chapter. It is important that the positioning of MUM and my own professional role at the institution are put in context, to understand the need for this doctoral study fully.

1.1 Positioning Middlesex University Mauritius

As stated above, there are two main reasons why MUM feels that there is a need to lead the way for progressive changes in the education landscape of Mauritius, when it comes to providing support to students in HEI. Those reasons are:

- The Republic of Mauritius is viewed as a Knowledge Hub, in Africa.
- The responsibilities, in terms of teaching and learning, of an International Branch Campus.

1.1.1 "Education Hub" and "Knowledge Hub" in the Mauritian Context

According to Knight (2011) and Knight (2014), **Education Hubs** are categorised into three types:

1. **The Student Hub** emphasizes the teaching and learning aspects, broadening the scope of the higher education system to encompass not only domestic students but particularly those from international backgrounds.
2. **The Talent Hub** focuses on cultivating a proficient (national) workforce.
3. **The Knowledge/Innovation Hub** is intricately linked to the progression of a knowledge-based economy, serving as a pivotal intersection across various policy domains, including science and technology, industry, and education.

The authors further explain that education hubs bring together diverse local and international participants engaged in education, training, knowledge generation, and innovation initiatives. Creating an education hub necessitates a coordinated and strategic effort to foster a substantial presence of both domestic and international educational institutions, students, training organisations, knowledge industries, and science and technology centres. The establishment of an education hub is contingent on the ambition of a country, zone, or city to be acknowledged and function as a reputable centre for higher education, training, and research.

In the Mauritian context, as noted by Knight and Motala-Timol (2022), various terms have been employed to characterise Mauritius' aspiration to establish itself as a renowned hub for higher education. These terms encompass designations such as Knowledge Hub, Education Hub, and Knowledge Industry, among others. The authors also highlight that there has been a lack of uniformity in the terminology employed, leading to occasional confusion among readers and researchers in Mauritius. In this chapter, consistent terminology will be employed, aligning with the language used by various stakeholders, including the Government of Mauritius and researchers.

The idea of transforming Mauritius into a Knowledge Hub was initially introduced by the Ministry of Finance in the National Budget of 2003 (MoF (2003)). During that period, the Finance Minister acknowledged the country's stable economy and recognised the es-

teemed status of the two public HEIs, namely, The University of Mauritius (UoM) and The University of Technology Mauritius (UTM). These institutions had already played a significant role in the economic growth of Mauritius by providing quality education. The Minister also highlighted the government's initiative to attract internationally renowned institutions to establish part of their operations in Mauritius, aiming to capture a portion of the rapidly expanding global education market.

Knight and Motala-Timol (2022) added that in 2001, the Gross Tertiary Enrolment Rate was recorded at 15.7%. With a growing population of educated youth, the demand for higher education was on the rise. Recognising the significant potential, the vision of becoming an education hub gained prominence. Consequently, efforts were initiated to establish supporting institutions, such as the Human Resource Development Council (HRDC). The purpose was to empower authorities to oversee the activities of private training institutions, formulate necessary policies and measures to promote tertiary education, and facilitate the transformation of Mauritius into an education hub. This transformation aimed to contribute to human resource development and economic diversification.

1.1.2 Mauritius as a Knowledge Hub

Over the past 15 to 20 years, there has been a gradual rise in the number of both private and public HEIs in Mauritius, as highlighted by Knight and Motala-Timol (2021). The government's objective is to position Mauritius as a Knowledge Hub for the African region and beyond. This commitment was underscored by the Prime Minister in 2018, emphasizing the importance of this vision on the Republic of Mauritius Government Portal through the Government Information Service, GIS (2018). The aspiration to transform this small island into an Education Hub undoubtedly presents its own set of challenges. Despite the limited body of literature addressing Mauritius as a developing Education Hub, the recent paper by Knight and Motala-Timol (2022) is particularly relevant to this research study. Notably, existing publications tend to focus on countries like Hong Kong, Singapore, Malaysia, and China, with occasional references to nations in the Middle East.

The economy of Mauritius is heavily based on the Agriculture, Exports, Financial Services and Tourism sectors. In his 2010 budget speech, the Minister of Finance talked about the Government's efforts in promoting other pillars of the economy to support its diversification strategy, one of those being the development of the country into a "Knowledge Hub" (Budget (2010)). A year later (2011), the Minister reiterated the Government's vision of establishing Mauritius as a knowledge centre of excellence. The promotion of Mauritius as a knowledge hub was given top priority in the Government's agenda of economic diplomacy to attract more foreign students (Budget (2011), Page 16). As mentioned above, MUM was established in 2010 and the Government's vision and expectations came at

the right time for the institution's survival and expansion on the island. The University World News in 2011, UWN (2011), published an interview with Dr. Rajesh Jeetah, who was then the Tertiary Education Minister, about this ambitious project in redefining the education landscape in MRU. It was clear from the article that the Government was investing a huge amount of money to ensure the success of this project. The focus was clear, and Dr. Jeetah was quoted as saying:

"*Research at the tertiary level is critical to improve the quality of teaching and learning. In this context, we have created five national research chairs and a National Research Fund of some MUR100 million (US$3.5 million) to finance research in our tertiary education institutions.*"

As mentioned above, limited research was done or published on the viability of such a vital project in Mauritius. The intention was noble and politically driven, but the onus was on MUM to make it a success. Being the first British HEI on the island comes with its challenges. Due to a lack of research on the feasibility of the Government's vision of making Mauritius a knowledge hub, we can only rely on the findings of such endeavours in countries stated earlier in this section. In 2017, the Financial Times (FT (2017)) reported that Mauritius has been using Singapore as a template for success in the African continent. Hence the obvious step would be to study the success, as well as the hurdles faced by Singapore when they initiated the "Global Education Hub" project. Table 1.1 below, indicates the status of some of the main HEIs in Mauritius, and Figure 1.1 shows a map of Mauritius with the location of those HEIs. This research project is not only beneficial to me (the researcher), and to MUM, but also to other HEIs who endeavour to contribute towards making the Government's plan a success.

Table 1.1 Main HEIs in Mauritius and their status

Label	Higher Education Institutions	Funding
1	Middlesex University Mauritius	Private
2	Université des Mascareignes	State
3	Open University Mauritius	State
4	Greenwich University Pakistan, Mauritius Campus	Private
5	University of Mauritius	State
6	Curtin University	Private
7	University of Technology	State
8	African Leadership College	Private

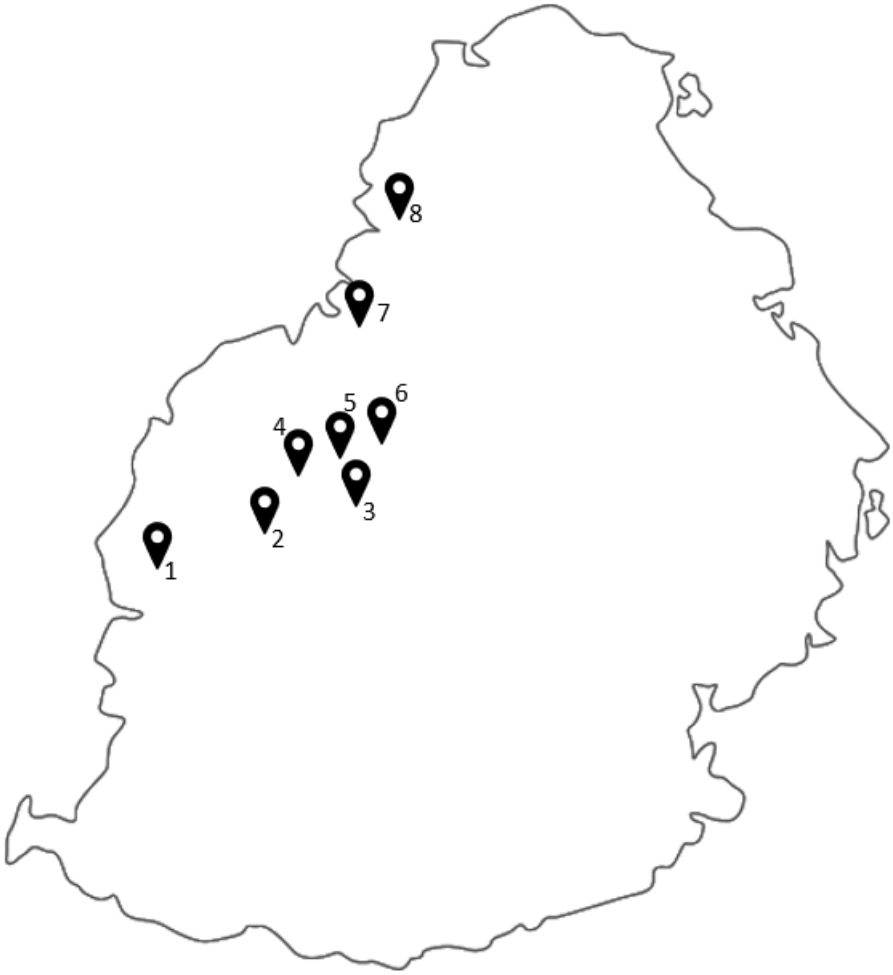

Fig. 1.1 Main Higher Education Institutions in Mauritius

1.1.2.1 Successes of an Education Hub

Knight (2014) defines an education hub as a "*planned effort to build a critical mass of local and international actors strategically engaged in cross-border education, training, knowledge production and innovation initiatives*". The main prevalent rationale, as mentioned by Knight and Motala-Timol (2022), is "Education and Training" and it promotes the alignment of education and training with the industry needs and enhances the overall quality of higher education in the host country. Sidhu et al. (2011) did a thorough investigation in Singapore as a case study. They confirmed that one of the major success stories was the increase of international students in a very short period. It is safe to say that we can see the same trend in Mauritius, as confirmed by The Higher Education Commission of Mauritius, in its report published in November 2022 (HEC (2022)), with numbers compiled in the year 2021. The total number of international students studying in MRU, in 2021, was 2858, with the trend over the years, shown in Figure 1.2, below.

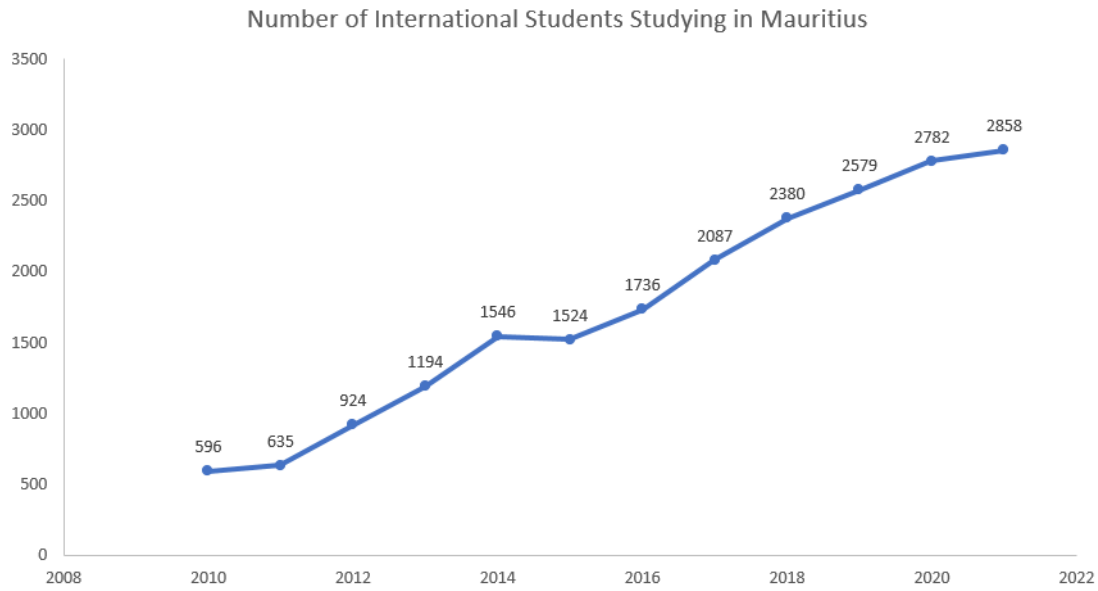

Fig. 1.2 Trend - International Students Studying in Mauritius

This trend has been reciprocated by MUM, and based on the same report, 455 international students were studying at MUM in 2021. With an increase in intakes (February intakes for all programmes will be introduced in 2023, at MUM), and with the re-opening of borders after the COVID-19 pandemic, this number should be closer to 700 by the end of the 2023 calendar year. The report confirms that 1215 students were studying at MUM in 2021, hence international students would represent 37.4% of the total student population. MUM has come a long way since 2010, when it started with only 12 students, out of which only three were international students.

Sidhu et al. (2011) also highlighted two other main successes:

1. Increase the reputation of the universities.
2. High quality of education being provided.

With such an increase in the number of students, local and international, and with the visibility that comes with it, added to the fact that the education level provided is expected to be high and the university to have a good reputation, it is imperative that we, at MUM, maintain a high standard in the delivery of our services.

1.1.2.2 Mauritius - The Current Status

Being the primary source of substantial research in Mauritius, Knight and Motala-Timol (2022) assert that the higher education sector in the country has effectively crafted specific regulations, incentives, and strategies to establish Mauritius as a respected centre for student education. This marks an initial step towards achieving national goals, en-

compassing the shift to a service-oriented and knowledge-based economy, coupled with the development of essential human resources and capacity. Nevertheless, functioning as a regional hub for student education presents an array of challenges. In the face of the dynamic and unpredictable nature of the contemporary world, uncertainties will persist. Mauritius must persevere in adapting to unforeseen constraints and capitalising on opportunities, utilising the robust foundation it is constructing to gain recognition as a regional hub for student education.

1.1.2.3 Challenges of an Education Hub

Knight and Morshidi (2011) did an excellent study on the challenges faced by Malaysia in the country's endeavours to be an education hub. They mentioned two main challenges that the country faced, namely:

1. Potential high rate of unemployment.

2. Brain Drain, as graduates started leaving the country.

Although not in the scope of this research, the Government must realise that these two issues may crop up in the future, in Mauritius. More in line with my study would be the article written by Soong (2020), who claims that there is an increasing need for academics to have a very good educational background and an excellent set of teaching skills to be able to "survive" in the given environment. Academics understand the requirements and they must keep improving to deliver what is expected of them (Åkerlind (2005)). Soong (2020) adds that students now expect to gain a "faultless" education as they have invested a lot and do not necessarily come from a financially sound background. They demand that they get the maximum (better service) from their universities as they need to climb up the social ladder.

1.1.3 Responsibilities of an International Branch Campus

To understand the responsibilities of an IBC, one must first understand the meaning of an Affiliating Institution. Alam et al. (2014) define an Affiliating institution as a degree-awarding body which designs academic content for students studying at affiliated colleges or universities. In simple terms, an affiliated body works independently but in close collaboration with an external and usually bigger institute. Affiliated institutions do not necessarily align their day-to-day operations with the affiliating body. In Mauritius, there are indeed several affiliated institutions, but MUM is not one of them. MUM is strictly governed by the rules and policies set by its home campus, that is, MU-HEN. This means that MUM needs to follow the same teaching criteria set by MU-HEN. Healey (2016) sends a word of caution with regard to managing an IBC. He claims that managing an IBC is extremely challenging and it goes far beyond the comfort zone of even an experienced manager. Wilkins (2013) explains that an IBC should play a key role in the life of its

stakeholders, one of which is the "students".

It is quite clear that, with so much at stake, students expect that they get the best education when they enrol at an HEI. As educators, it is thus our responsibility to provide a good learning environment and experience for our students and we also need to try and challenge ourselves in giving them their money's worth. This study will allow me to improve myself as a teacher, and hopefully, by doing so, students will benefit from it. Understanding what my students want will be a big step towards achieving this goal.

1.2 My Position at Middlesex University Mauritius

My current job, which provides the background and motivation for this research, is as an educator in the Higher Education (HE) sector in Mauritius. I am currently working as a Senior Lecturer at Middlesex University Mauritius. MUM is considered as a "new university" in Mauritius, as it started operating in 2010, and it was the first British university to open its doors in the country. It is a private HEI, with the main campus at Hendon, UK. The Mauritius campus is located at Cascavelle, on the west coast of the island, having moved from Vacoas (in 2017), which is at the centre of Mauritius.

There are about 50 full-time (FT) and 25 part-time (PT) academic staff currently working at the university. I am the only academic staff whose job title is **Mathematics** Senior Lecturer, although there are three other academic staff (Psychology, International Foundation Programme and IT programmes) who teach some mathematics and statistics components to students in their respective departments/schools.

MUM does not run any mathematics or statistics undergraduate (UG) or postgraduate (PG) programmes, but instead, the mathematics and statistics components are part of other programmes, such as:

1. School of Business, Innovation and Creativity (BIC):
    - BA (Hons) Accounting and Finance (Levels 4, 5 and 6).
    - BA (Hons) Business Management (Level 4).
    - MSc Management (Level 7).
2. School of Digital Technology (DT):
    - MSc Computer Networks and Network Design (Level 7).
3. School of Science and Education (Sc-Edu):
    - International Foundation Programme (Level 3).

- BSc (Hons) Psychology with Counselling (Levels 4 and 5).
- MSc Applied Psychology (Level 7).

The common term used to refer to students who are not doing mathematics or statistics undergraduate degrees, but who have to learn these components as part of their undergraduate degree course, is "**non-specialist**" mathematics students. I am currently involved in teaching all the mathematics and statistics modules, in the School of Business, Innovation and Creativity (BIC), whereas other colleagues teach mathematics and statistics in other schools. I also lead the Learning Enhancement Team (LET), in providing numeracy support to students who seek assistance. These students are not necessarily those whom I teach. They can come from any School at MUM.

Before we proceed, it is worth noting that the "Report of the Committee of Inquiry into the Teaching of Mathematics in Schools" by Cockcroft (1982), submitted to the Secretary of State for Education (UK) and the State Secretary for Wales, brings together the terms "Numeracy" and "Mathematical Skills". In this thesis, both terms would mean the same thing.

Table 1.2 LET support provided

Schools	**Programmes**	**Levels**	**Details**
School of BIC	BA (Hons) Accounting and Finance (BAAF)	Level 4	Recap on conversion of fractions to decimals and percentages
	BA (Hons) Business Management (BABM)	Level 4	Recap on basic Probability
	MSc Management (MM)	Level 7	LET sessions on Collection of Data
School of Science and Education	MSc Applied Psychology (MPsy)	Level 7	LET sessions on basic statistics and SPSS software

The support provided can be of any form, and Table 1.2 shows my contribution up to December 2022. It will be seen later in this thesis that the numeracy support has been expanded (since July 2018) and is now part of the Centre of Mathematics and Statistics Teaching & Learning (CeMaSTeL).

As previously mentioned, there are currently **no** students specialising in mathematics or statistics at MUM, as MUM does not offer any undergraduate or postgraduate programmes in mathematics or statistics (BSc Mathematics, BSc Statistics, MSc Mathemat-

ics, and MSc Statistics programmes are **not** available at MUM). The accurate date for the **academic year 2022/23** on the number of non-specialist mathematics students are:

1. **BA (Hons) Accounting and Finance (BAAF): 92 students**
   (a) Year 1 (Level 4): Number of students = 36
   (b) Year 2 (Level 5): Number of students = 29
   (c) Year 3 (Level 6): Number of students = 27
2. **BA (Hons) Business Management (BABM): 150 students**
   (a) Level 4: 46 students
   (b) Level 5: 62 students
   (c) Level 6: 42 students
3. **MSc Management (MM): 24 students**
   (a) Level 7: Number of students = 24
4. **MSc Computer Networks and Network Design (MCND): 10 students**
   (a) Level 7: Number of students = 10
5. **International Foundation Programme (IFP): 180 students**
   (a) Level 3: Number of students = 180
6. **BSc (Hons) Psychology (BScPsy): 76 students**
   (a) Level 4: 32 students
   (b) Level 5: 24 students
   (c) Level 6: 20 students
7. **MSc Applied Psychology (MPsy): 10 students**
   (a) Level 7: Number of students = 10

In summary, there were a total of 542 students not specializing in mathematics at MUM during the academic year 2022/23. It is important to note that some students may choose to seek support from their respective lecturers (those teaching mathematics and statistics components) rather than approaching me. As I primarily teach on the BAAF, BABM,

and MM programmes, I have direct access to 266 of these students. However, there have been instances where students from the BScPsy programme also sought assistance from me.

The admission criteria for the mentioned programmes are largely similar. For UG programmes like BAAF, BABM, and BScPsy, the minimum enrolment requirement at MUM is a Pass in GCSE Mathematics (and English). This holds for the IFP level of study as well. In pursuing a PG programme, students are still required to have a Pass in GCSE Mathematics, but there is no specific mandate for any mathematics and statistics covered at the UG level.

The significant task of offering assistance to a considerable number of students, many of whom may not have a strong academic foundation in mathematics or statistics, falls upon me. As outlined in Section 1.2 on Page 8, I am the sole mathematician at MUM, and there is a substantial expectation for me to deliver the optimal learning experience to students seeking assistance in mathematics and statistics.

1.3 My Motivation

Mathematics and statistics are separate disciplines (Moore, 1988), but it is also understood that statistics is a mathematical science (Moore and Cobb, 2000). My professional journey started in 2000, when I was appointed as a Tutor in Computing at The University of Greenwich (UoG), London, UK. Soon after, I was appointed Lecturer of Mathematics. Part of my role at UoG, was to teach statistics to non-specialist students, although I also taught mathematics to students enrolled in BSc (Hons) Mathematics programme (specialist students), at all undergraduate levels. I was given the responsibility of teaching statistics to students doing chemical sciences (Chemometrics) and psychology (Psychometrics). I initially struggled to teach the statistics components to those students, and I always found myself more excited and better prepared to answer questions when I had to teach mathematics undergraduates. So, the challenge and motivation, from the start of my professional career, was always to improve my teaching skills.

1.3.1 A Mathematician Teaching Statistics

Moore (1988) suggests that only experienced mathematicians, who have worked with data and trained in data analysis, can teach statistics. After so many years of teaching specialist (mathematics) and non-specialist (mathematics and statistics) students, I cannot agree more with his statement. Looking back, I can now relate my lack of interest (definitely not a lack of motivation) in teaching statistics, in the early days of my career. I was keen to prove to myself that I could teach mathematics and statistics, but I could not run a statistics class with the same energy and conviction that I would show in my mathematics class.

The modules that I teach at MUM usually consist of both mathematics and statistics components. Moreover, one could suggest that I should teach only mathematics and someone else could teach statistics. There are three reasons why this might not be convenient:

1. These components are not separated, that is, they could run mathematics in semester I, and statistics in semester II, for example. With regard to the modules taught at MUM or Middlesex University in general, this would not work. The mathematics and statistics taught complement each other to some extent. One simple example, taught to Level 4 (Year 1) BAAF and BABM students, in the first few weeks of the academic year, is the following:

    - A recap of the mathematics chapters, such as Fractions, Decimals and Percentages. These usually take a 3-hour session to cover. The following week, the (statistics) chapter "Probability" would be introduced. "Probability" requires the prerequisite knowledge of the topics, to be successfully taught and learned.

2. The structure of lecture/seminar/lab delivery at MUM, follows that of Middlesex University, Hendon, UK. There is always flexibility on how to run our classes (at MUM), and we are encouraged to add our flavour to the classes we teach. However, the syllabus is designed in Hendon, and we must run the weekly lectures as per the predetermined plan.

3. MUM is a "small" institution, as compared to the main campus in the UK. I am currently the only one who teaches mathematics and statistics, in the School of BIC. Resources are limited to employ more staff to teach these modules, as that would mean I would have fewer modules to teach.

Under these conditions, the challenge was for me to develop my interest in teaching statistics, more vigorously and productively as compared to when I was at UoG. At this stage of my career, after teaching in a HEI for nearly nineteen years, I agree with what was stated above, that is, teaching statistics can be done by a mathematician, who has experience and proper training. Very recently (since October 2017), I started teaching "Decision Making" to Level 7 students. This module is worth 15 credits and it is run only in the second semester. The components of the module are mostly statistics, with only a trivial amount of mathematics. I can honestly say that my experience in teaching statistics (to non-specialist students) since 2003 at UoG, and then at MUM since 2010, has enabled me to provide good delivery of lectures and to offer effective and meaningful assistance to my students. I was initially apprehensive about teaching the cohort, thinking that my knowledge of statistics might not be enough to take such responsibility. But I was pleasantly surprised to see that although I had to teach a lot of topics which I last came

across as a student, I thoroughly enjoyed the experience, and I felt comfortable teaching the cohort.

The motivation to do this Professional Doctorate (DProf) emanates from the fact that I, a mathematician, still feel the need to improve my teaching skills when I teach non-specialist mathematics and statistics students. Besides the above, which challenges me to use my experience when it comes to teaching statistics, there are several other reasons which provide the impetus to embark on this DProf programme.

1.3.2 My Postgraduate Certificate in Higher Education

In 2012-13, I did my Postgraduate Certificate in Higher Education (PGCertHE), with Middlesex University (MU-HEN), through distance learning mode. This gave me a unique experience as it completely changed the way I thought about teaching. It was so influential, that I started looking forward to embarking on a DProf programme as soon as I completed the PGCertHE. At the time I started the PGCertHE, I thought it would be a burden to my other responsibilities, as I thought I already knew "how to teach". So, it was with some reluctance that I started the programme.

What followed was a period of my professional life which eventually led me to believe that I could still change my style of teaching and improve the types of support I give to students. Studying through distance learning mode was a new experience. Juggling work, studies and family life was tough, but I thoroughly enjoyed it. PGCertHE helped me to view my teaching responsibilities critically, and it helped me to reflect on how I could change things, positively, in my teaching practice, and hence, in students' learning experience of mathematics and statistics. The programme was so interesting that, from the very beginning, I gave the best of myself, and this led to my final project being awarded Best Project among the cohort.

The PGCertHE provided the drive for me to start the DProf. Just after completing the PGCertHE, I found myself wanting to learn more about how to improve my teaching style. Previously, the rigidity of my teaching style, the unrealistic and specious expectations I had of my students and the anticipation that students should all enjoy mathematics and statistics, would prevent me from being an effective teacher. The following gives a brief detail on how I perceived myself, based on the points made above, before my involvement in the PGCertHE programme.

1.3.3 The Rigid Teacher

Upon careful consideration, I desired my students to emulate my passion. Initially, I aimed for them to develop an appreciation for mathematics and statistics. I was overly enthusiastic about conveying the "beauty" of these subjects, often at the expense of prioritising the specific learning outcomes of the modules I instructed. In retrospect, I

acknowledge the flaw in my approach, spending excessive time explaining concepts that may not have been essential for the students. Erroneously, I equated their depth of knowledge with the effectiveness of my teaching, a perspective that deviated from the intended focus of my role.

1.3.4 Specious Expectations

Following from above, I wanted my students to be "deep learners", when I started teaching at MUM. It made no sense to me that students would only want to pick and choose which chapters they would prepare for exams. I could not understand why students would be happy targeting and achieving 40% in their assessments. PGCertHE helped me to understand the needs and wants of those non-specialist students. The programme taught me how to respect and accept the students who would prefer the "surface learning" approach in the modules that I teach. During my PGCertHE, the constant online interaction through a Discussion Board, where we (participants) would keep challenging each other's thoughts and beliefs, was what triggered a new and flexible line of thought in me.

1.3.5 Unrealistic Anticipation

As mentioned above, as part of the LET, I am responsible for providing numeracy support to students. In the early days at MUM, I would find it intriguing that students would come to me, seeking assistance in Numeracy, and complaining about how awful, meaningless, scary, and distressing (to name just a few), mathematics and statistics were. I always assumed that these subjects were supposed to be enjoyable. Through PGCertHE, I was able to understand these students and I started finding ways to assist them in overcoming these hurdles and my doctorate is focused on finding strategies to support those students, by enhancing my teaching skills, which will influence their learning styles.

1.3.6 My Responsibilities at MUM

As stated in Section 1.2 on Page 11, this research allows me to enhance the learning experience for non-specialist students enrolled at MUM. Being the exclusive mathematician at MUM, this investigation enables me to pinpoint effective strategies for supporting students on campus. Subsequently, I intend to disseminate these findings to colleagues responsible for teaching various components of mathematics and statistics.

Furthermore, Section 1.2 highlights the substantial presence of non-specialist students at MUM. Harmonising the support provided by academics has the potential to significantly improve the overall learning experience for these students. Additionally, given that some students enter MUM with only a Pass in GCSE (mathematics) while certain programmes entail a considerable amount of mathematics and statistics content, there arises an urgent need to reassess our teaching strategies. This reassessment aims to ensure that students receive optimal instruction and assistance, considering the diverse academic backgrounds

and content requirements.

1.4 From Applied Mathematician to Researcher in Maths/Stats Education

My journey since leaving UoG (1999 - 2005) has been an eventful one, and as mentioned above, PGCertHE played a big part in it. Metamorphosing myself from being an Applied Mathematician (at UoG), who was thoroughly enjoying what he was doing, into a Researcher in the education of mathematics and statistics (at MUM), has been a long process. That experience has also triggered my interest and motivation to do this doctorate. Briefly, some of the factors contributing to this change, are:

1. Applied Mathematics is just part of what I teach now. The modules consist of discussing real-life problems, usually in the Business world, and finding solutions, by applying the mathematics and statistics taught.

2. While early in my professional career I would teach theories and theorems in mathematics, I now have to show the connection between Mathematics, Statistics, Finance and Business.

3. To do the above, I felt that my knowledge of mathematics and statistics only would not be enough. I aim to assist the students I teach, and those to whom I provide numeracy support, to understand how mathematics and statistics would help them in their professional careers.

4. My close liaison with companies like Deloitte Mauritius and KPMG Mauritius, has enabled me, after several meetings with them, to identify what these institutions need, in terms of skills, from fresh graduates.

5. Since 2017, I have been teaching on the MSc Management programme. Besides teaching the "Decision Making" module, I am also responsible for the delivery of the "Dissertation Project" module to the cohort. I am finding this combination of teaching two modules quite fascinating, as there is undeniably a strong link between them.

6. Following the previous point, and in my role as a numeracy support provider in the LET, I am assisting students in using software packages such as SPSS and NVivo. An understanding of the topics taught in mathematics and statistics is crucial in optimising the use of these resources.

To provide better support to students, whether in my classes or my LET workshops, I cannot be satisfied by just turning up and teaching. It is now vital that I bridge the gap

between theories that I am teaching, with real-life and tangible scenarios. In 2014-15, I initiated an "interview skill workshop", whereby Level 6 students from the BAAF cohort were invited to participate (as "interviewees"). I also requested colleagues (academic and non-academic) to join the panel, as "interviewers". This was a major success, as students experienced what it would be like to go for an interview. Colleagues were helpful and the whole process was done in a formal way to give the students a feel of the atmosphere they would be experiencing and facing in interviews after they would graduate from MUM.

Additionally, I have also been inviting guest speakers (usually from the corporate world) to MUM, to deliver talks on "how to run a successful business", "management", "statistics in the real world", to name just a few. With the support of Deloitte Mauritius, BAAF students were invited to participate in a one-day workshop organised by the same company, on its premises, where students experienced different aspects of what they have been studying and how those can be applied in the real world.

One of the first steps I took to assist students, when I started at MUM, was to set up a Mathematics Society (MathSoc), whose purpose was to give students a platform, from where they can voice their opinions and ideas. Mitra (2004) speaks of a few positive aspects of allowing students to voice their views. They are:

- Growing leadership skills.
- A sense of belonging.
- Building a good relationship with a caring adult.
- Improving interactions with teachers.
- Gaining respect and attachment to the school (in this case, Middlesex University, Mauritius).
- Developing new skills, such as problem-solving skills and facilitation skills.
- Critiquing the environment, which also include identifying areas that can be improved upon, in their academic institution.
- Getting along with others.
- Speaking publicly.

According to Holdsworth (2000), it is important that students have a legitimate perspective, and can have an opinion and a say, in the implementation of educational policies and practice. Cook-Sather (2006) claims that by allowing students to speak up, we (teach-

ers) are giving ourselves the chance to better understand teaching and schooling more generally.

Another vision that I had was for the society's members to assist their peers in learning mathematical software which Mathsoc members might be more familiar with. One such example is the SPSS software. Talking to my colleagues from the Department of Psychology, it was revealed that their students struggle with the quantitative side of the academic programme. Of course, the lecturers are there to assist the students, but having fellow students teaching and guiding them might be very helpful indeed. Damon (1984) fully supports this practice. He discusses three different theories and one of them is about the educational effectiveness of such a style of learning and teaching. According to him, peers approach one another as equals and work out concepts through the generation and consensual validation of intellectual strategies. They learn from one another not by copying and adopting the other's competence, but by mutually devising plans together in collaborative efforts.

With the above (implementation of Mathsoc), came a plethora of ethical issues. What was meant to be a platform where students could help each other, soon became a stage riddled with tribulations and uncontrolled, illegitimate, and unfair share of responsibilities by participants. One such example was that students seeking help and guidance, would sometimes expect all their work to be done by Mathsoc members. Furthermore, there would also be cases when Mathsoc members would be overenthusiastic in their willingness to guide their peers. It was soon clear that a proper structure was needed to improve the way mathematics and statistics support was provided to students. With that in mind, the Student Learning Assistant (SLA) scheme was introduced. This was an initiative proposed by the former Associate Director Academic, Dr Nicky Torrance, who wanted to assist both the Module Coordinators and the students. Since I was already involved in Mathsoc, I was asked to lead the scheme, assisted by another colleague, Dr. Adeelah Kodabux.

SLAs are experienced students who act as facilitators between the lecturer and the students in the class. Houssart (2012) mentions a range of activities that the SLAs can do. The SLAs' main activity is to support other students, in the development of their study and academic writing skills, through:

- Contributing to workshops, seminars or lab sessions run by the Module Coordinators. The topic covered might include writing (case studies), using statistical software (SPSS and Minitab), plus other aspects of study skills.
- Individual support is given to students in developing their study skills. This is done

under the supervision of the Module Coordinator.

- Regular meetings with the Module Coordinators to ensure that SLAs are aware of what will be discussed in the class.
- Working within policies and procedures at all times.

Hoolash and Kodabux (2014) wrote about how the SLA scheme was set up at MUM, and suggested ways to tackle issues that may arise during the pilot run. Kodabux and Hoolash (2015) discussed how to bridge the gap between SLAs involvement and lecturers' participation in the scheme. With the above in mind, it is crucial to improve the current setup at MUM, regarding the support provided to students. One of the issues mentioned by the authors is that, even though there might be many eligible candidates for the SLA role, their timetable may create some problems (SLAs normal classes clashing with their SLA responsibility). As the person responsible for providing numeracy support in the LET, I might not be able to rely completely on the SLAs to assist students. Moreover, there has been some reluctance by the SLAs to offer their help in modules with high mathematics and statistics content. Indeed, it is now important that I try to improve my teaching strategies, in the hope that they will be productive to students so that they do not need to depend too much on SLAs.

1.5 Project Summary and Introducing the Next Chapters

In conclusion, this chapter has delved into the pivotal role that MUM has to play in propelling the nation towards becoming a distinguished knowledge hub. As an international branch campus, the institution shoulders the responsibility of upholding global academic standards while simultaneously adapting to the unique needs and challenges of the Mauritian context. By strategically positioning itself in this dual capacity, Middlesex University Mauritius not only contributes to the country's intellectual capital but also fosters an environment that transcends geographical boundaries.

Moreover, the significance of this research extends beyond the institutional landscape to address a critical need in education—supporting non-specialist mathematics students in mastering the intricacies of mathematics and statistics. As we look forward, the outcomes of this study hold the potential to not only enhance the academic experience of students but also contribute to the broader goal of cultivating a skilled and adaptable workforce in Mauritius. By developing practical and effective strategies for non-specialist mathematics education, the research endeavours to bridge gaps, empower learners, and ultimately fortify the role of Middlesex University Mauritius in shaping the educational landscape

of the nation.

In essence, this chapter underscores the symbiotic relationship between Middlesex University Mauritius, the pursuit of academic excellence, and the broader socio-economic development of Mauritius. Through a focused commitment to both local and international imperatives, the institution stands as a beacon of progress and innovation, and this research serves as a testament to the dedication towards fostering a knowledge-driven society with inclusivity at its core.

1.5.1 Next Chapters

Besides the above-mentioned conclusion, this chapter (**Chapter 1: Introduction**) provides the reasons and showcases my motivation to embark on this research for my doctorate. Starting from my area of expertise (when I completed my postgraduate studies in mathematics), and my area of interest (which I discovered when I completed my PGCertHE at Middlesex University), coupled with almost 23 years of experience in teaching (specialist and non-specialist students, as well as, briefly, teaching mathematics and statistics to A-Levels students), I explained the metamorphosis in my way of thinking, and the motivation to make a change when it comes to teaching mathematics and statistics in Higher Education.

My teaching career has taken a few turns since I first started in 2000, as shown in Figure 1.3, on Page 21. My responsibilities and involvement in my job have now increased. The expectations and demands from students and management, due to the evolution in HE, coupled with my passion and interest in what I do every day at MUM, are ever-changing. I feel that by just turning up to teach in a HE setup, would not be satisfying anymore. My motivation now is to make a difference in students' lives. The challenge is to push the boundaries, and enhance my teaching strategies, to enable students to have a better learning experience at MUM.

Chapter 2: Aims, Objectives and Literature Review starts with stating the Research Questions and the Aims and Objectives of this study. A brief description of "maths anxiety" is given, linking the term with other negative emotions such as anger, sadness, disappointment, shame, frustration and boredom. Mathematics support in general is then showcased across the HE sectors. Developmental Dyscalculia is defined and the current situation with maths anxiety in primary and secondary school students is discussed before the focus is diverted towards Higher Education.

Chapter 3: Project Design and Methodology

The research philosophy, research approach and research methods are discussed in this chapter. Ethical issues as an insider-researcher are also mentioned. Data analysis (quan-

titative and qualitative) is explained.

Chapter 4: Project Activity

A reflection on the activities throughout the DProf programme is showcased here. Starting from the ethics approval to the write-up process, and the choice of participants are discussed.

Chapter 5: Project Findings

This chapter presents the findings of this research. "Value" of mathematics was tested against "Self-Confidence", "Enjoyment" and "Motivation" with the new students, and quantitative analysis (regression) was performed to see if any of the independent variables were valid in determining "Value". The main analysis of this research, though, is the Thematic Analysis of the Interviews (with staff and students). Face-to-face and focus group approaches were used.

Chapter 6: Discussion

This chapter presents a synthesised discussion that draws from the findings of this research. It will critically appraise the findings against the literature, to give insight and probe possible answers for the research questions, guiding the study.

Chapter 7: Conclusions and Recommendations Here, the researcher discusses how far he was able to achieve the purpose of the study. The chapter will also discuss the limitations encountered and suggest recommendations and directions for future works. In conclusion, the doctoral research's multifaceted impact is highlighted, and the corresponding strategies for various stakeholders are examined.

Fig. 1.3 Teaching Career Path

CHAPTER 2

AIMS, OBJECTIVES AND LITERATURE REVIEW

2.1 Introduction

Having discussed my motivation to embark on this doctoral research in the **Introduction** chapter, the Literature Review chapter endeavours to support my research by discussing the work already done, and the theories suggested by eminent researchers in the field of mathematics and statistics education. The Research Questions with their aims and objectives are introduced in subsection 2.1.1, on page 23. The literature review will have a direct impact on my teaching style, which I hope to enhance, in view to provide better "numeracy support" to (non-specialist) students at MUM. My role at the university is not only as a Senior Lecturer, teaching mathematics and statistics components, but I am also part of the LET responsible for providing numeracy support to students at any level of their studies. Since 2018, I am also the Lead at CeMaSTeL (which has replaced MathSoc).

It is worth noting that students seeking assistance from the LET are not necessarily those whom I teach. Understanding their requirements for mathematics and statistics is important, and by doing so, I expect to broaden my approach to teaching strategies. These students are usually those who want to improve their mathematics and statistics knowledge in parallel to what they are taught in class.

With the above in mind (my motivation, current position and responsibilities), the main focus of this research is to enhance my teaching strategies to provide better support to non-specialist students in mathematics and statistics. The approach to collect data will be through Focus Group interviews, an online questionnaire, and Face-to-Face Interviews of students and academic staff. This research will attempt to answer my Research Questions and to find ways to achieve my doctoral aims and objectives. Details are given below.

2.1.1 Research Questions

1. What past experiences, perceptions, and personal expectations do non-specialist students have, to help me understand their learning needs in mathematics and statistics?

2. What are the ways in which I can develop mathematics and statistics teaching across the institution, for non-specialist students?

2.1.2 Aims and Objectives

1. To investigate the perception of students in mathematics and statistics in Higher Education, in Mauritius.

2. Developing methods to assist those students to alleviate their "fear" and "anxiety" towards these subjects.

3. To lead and manage changes in connection with the teaching and learning of mathematics and statistics.

2.2 Mathematics and Statistics Learning Support in Higher Education

Lawson et al. (2020) defines mathematics support offered to students (not necessarily of mathematics) as a mechanism, which is in addition to their usual programmes of teaching through numerous avenues, such as lectures, tutorials, seminars, problems classes, and personal tutorials. The authors go on to say that the main forms of support may be in the shape of either drop-in sessions or bookable one-to-one appointments. MacGillivray (2009) goes further in her suggestions, namely:

- Sessions on specific topics.
- Support facilities in paper or electronic form.
- Designated space for support.

Lawson et al. (2020) added that whilst informal support was always given to students, it was only in the early 1990s that the development of mathematics support provision gained momentum, in what is now known as the "Mathematics Problem", which can be sum-

marised as the under-preparedness of fresh undergraduates, usually in non-mathematical disciplines for the mathematical and statistical demands of their study programmes. It is now considered normal to provide mathematics support to students in HE. Their article is a thorough investigation of how mathematics support (which from now on, will include both mathematics and statistics) has been progressing in the last 30 years. The common characteristics of participants (students) needing mathematics support are:

- Newly enrolled students in HE.
- Students who consider themselves as "weak" (at risk).

The Hodgen et al. (2014) report for The Higher Education Academy, confirms that most undergraduate programmes in British Universities (and the list includes programmes taught at MUM) do not contain only qualitative elements, but some are also quantitative in nature. The findings of this study conclude that it was consistently reported that some students suffer from anxiety and lack of confidence when studying mathematics and statistics. The authors reported that it is now a known fact that a lot of students joining HE do not possess the required skills to study mathematics and statistics. There are several reasons given by the authors, and some of them are:

1. Time elapsed since last used mathematics.
2. Failure to see the relevance of mathematics.

Interestingly, the report mentions the Business and Management programmes (the BABM, BAAF and MM programmes at MUM fall under this) as well as the Psychology programme, to be those where there are big discrepancies between students' expectations and those of the teachers. Students in these disciplines anticipate a limited amount of quantitative elements to be studied, while teachers expect students to know an intensive amount of quantitative content.

Croft et al. (2022), experts in Mathematics Education, wrote an excellent article recently. The authors revealed that there is an increasing concern across British universities, about the quantitative skills of students. They note that only around 38% of GCSE students, go on to study mathematics (including statistics) and this harms their studies when they start their higher education in universities. Going back to the definition of "mathematics support" mentioned above (Section 2.2, Page 23), the authors here focused on the key element in that definition, namely "*in addition*". They explain that support in mathematics addresses the needs that are not met by the usual standard learning and teaching elements in the curriculum.

2.2.1 Nature or Forms of Support Provided

Before we embark into the discussion on possible forms of support that have been, and can be, provided, it is important to understand the ethical considerations which come with this mechanism. Lawson et al. (2003) in a report submitted to the Advanced Higher Education, mention a few, such as:

- To provide non-judgmental support for students outside their teaching departments.
- To ease the transition of all students to HE courses with a significant numerate component.
- To provide one-to-one support for any member of the University with mathematics difficulties no matter how small.

Moreover, the authors claim that "a pleasant environment where students can work, study and support each other, may also be considered". Their study revealed that "one-to-one help" is preferred by a lot of institutions, based on research they conducted with their students. This is also supported by Cronin et al. (2016) who claim in their audit report submitted to The National Forum in Ireland, that 61% of students would prefer this method of support. Fletcher (2013) mentions that support can be provided through online meetings as well, to reach a maximum number of students and to cater for issues such as travelling back to campus, or not having the required space to accommodate a large number of students. This means is also helpful for students who study part-time and who have difficulties in attending drop-in sessions. Although evening drop-in sessions can be organised, this was not appealing to students and the support provider.

2.2.2 Some Caveats

Lawson et al. (2003) mention issues which may develop with the support system at universities. They reveal that students who struggle in only one or two topics will find this support mechanism very helpful, whereas those who need more help may expect too much from the support group. These students may find themselves overwhelmed with the amount of work they have to do. They first have their own academic content and their teacher "to deal with", and they then need to adapt to new content and approaches from a second person (who is providing additional support). This can confuse students to the extent that, instead of helping, the support mechanism creates more issues for the students.

2.2.3 Impact of Mathematics Support

Ní Fhloinn et al. (2014) did an extensive survey (1633 students in Higher Education) to investigate the impact of mathematics support on students. The results were as follows:

- 62.7% felt that the support received influenced their decision to **not** drop out of their academic course.
- The most common theme was that students appreciated the type of encouragement they received in the support group, such as "to trust that their worries were normal, and that practice would improve it".
- The mathematics support system helped students understand their discipline better.
- A major boost in students' confidence level.

Bhaird et al. (2009) analysed the effectiveness of mathematics support in two ways. They studied the feedback obtained through a survey, and they analysed the grades obtained by students who attended the support group. Their academic paper focused more on the second one and the participants were all in their first year of studies in a HEI. The group consisted of Arts students (including those who study Finance) and the findings from the study are worth debating. Out of the 201 students, 28% of the students needed mathematics support, more than once. The pass rate of those students was 89%. Out of the 72% of students who required mathematics support once or less, the passing rate was only 62%. The reason I find the results of this article intriguing is that the authors failed to investigate the following, which I feel should have been important factors to test the impact of the support mechanism:

1. The authors mention that the support sessions were in the form of drop-in sessions, but they did not mention whether the sessions consisted of one-to-one meetings or small/large groups of students.
2. Did those who attended once or less than one session, skipped the remaining sessions because they were comfortable with the topics covered in other sessions, or because they just did not want to turn up?
    - A survey should have been conducted to enquire about the reasons why those students decided not to return after attending a maximum of one session.
3. A feedback form should have been distributed to all students to evaluate the support mechanism.
4. The authors did not investigate other factors that could have influenced the higher passing rate of those who attended the sessions, more than once.

Although I believe that there might be a positive correlation between the support students receive and students' performance, this study would require a robust longitudinal research

design and would also require that students agree to reveal their marks obtained to the researchers. This argument is supported by the study done in a HEI in Essex (Van Vegge and Amory (2014)). Their research consisted of three data collection methods and analysis, namely:

- A survey to gauge students' confidence level.
- A set of focus group discussions to investigate students' motivation.
- An analysis of students' performance in modules with mathematics contents.

With a study population of $N = 101$, and a sample size $n = 45$, results demonstrated that students who required support in mathematics, were more confident after receiving assistance. On a scale of 0 - 10, they rated their confidence level as 3.5 before receiving maths support, and 7.6 after receiving support. With regard to their qualitative data analysis, 34 of the 101 students participated in the focus group sessions and thematic analysis was used to extract themes from the data. The five main findings were:

1. The support provided was excellent and students even requested for more advanced mathematics contents to be considered.
2. Materials covered in the support groups were relevant to the course taught.
3. Roughly 50% of the students agreed that the timing of the support service was good although most preferred that support should be offered in the first semester.
4. Students were happy with the support but also requested that online support be considered.
5. Most participants believed that the support system helped them achieve better grades in their assessments.

It is clear that support in mathematics and statistics is beneficial to students. Increases in confidence level and in academic performance have been linked to the running of such support mechanisms.

2.3 Attitude and Emotions Towards Learning Mathematics and Statistics

Researchers have long assumed that "self-doubt" and "lack of confidence" are sometimes the factors affecting the study of mathematics and statistics, especially when it comes to non-specialist students in Higher Education (Eisenberg (1991)). Students experience a range of emotions when they study numeracy (Gómez et al. (2020)), such as, hope, joy,

anxiety, relief, pride, gratitude, shame, anger, calm, sadness, disappointment, frustration, boredom and relaxation. The authors categorise the emotions as follows:

Table 2.1 Categorising Range of Emotions

Positive Emotions	Negative Emotions
Hope	Anxiety
Joy	Anger
Relief	Sadness
Pride	Disappointment
Gratitude	Shame
Calm	Frustration
Relaxation	Boredom

Several studies have found that emotions have an important effect on academic performance. Harley (2014) and Martínez-Sierra and García-González (2017) indicate that positive emotions tend to improve students' academic performance as well as the reverse. Interestingly, negative emotions may also have a positive impact on students' performance. Grills-Taquechel et al. (2013) reveal that "shame" can motivate students to avoid failure and "anxiety" may help students to focus more on their studies, although not much research has been done to investigate the positive impact, negative emotions may have on students' performance (Di Leo et al. (2019)).

I believe, before we embark on investigating these emotions and their links with mathematics and statistics learning, a brief section needs to be allotted to Developmental Dyscalculia, a condition which affects the learning of mathematics.

2.3.1 Developmental Dyscalculia

Dyscalculia is often referred to as the inability to count and is used to describe people who have difficulties with numbers (Cohen Kadosh and Walsh (2007)). It usually refers to as a developmental problem, and hence its terminology "Developmental Dyscalculia" (DD). Usually, DD can be explained by the inability to perform basic arithmetic calculations and evidence indicates that it is a brain-based disorder (Shalev (2004)).

In his doctoral thesis submitted at Loughborough University, Drew (2016) suggests adjustments for the teaching of students suffering from DD, such as:

1. Tailored one-to-one support.
2. Squared paper in examinations.
3. Mind maps.

4. Colour overlays.

The study, diagnosis and prognosis of DD, is outside the scope of this research as I do not possess any expertise in the field of psychology, nor in that of medicine. This requires expertise in child development, and it may need deeper investigation by neuropediatricians (Von Aster and Shalev (2007)). Nevertheless, it is crucial to recognise that there might be instances at MUM where students experience DD. As outlined by Osiagor et al. (2021), DD poses a significant challenge to students' proficiency in arithmetic. Consequently, there is a necessity to offer additional support to students grappling with the difficulties of DD, aiming to improve their academic achievements in mathematics and statistics. Notably, Rubinsten and Tannock (2010) clarify that various terms are commonly employed to describe challenges in acquiring mathematical concepts and skills. These terms encompass Maths Difficulties, Maths Disability, Mathematical Learning Disability, Mathematics Disorder, Specific Disorder of Arithmetic Skills, Maths Anxiety, and DD. The next section will introduce the term "Maths Anxiety" and delve into its impact on students across different academic levels.

2.4 Introducing the Term "Maths Anxiety"

Similar to the study of DD, it is outside the boundaries of this research to meticulously differentiate between the psychological definitions of "Anxiety", "Anger", "Sadness", "Disappointment", "Shame", "Frustration", and "Boredom", when it comes to learning mathematics and statistics. As stated above (Table 2.1, **Categorising Range of Emotions**, Page 28), they are all defined as "Negative Emotions" and hereafter, they will be referred to as the reasons for Arithmophobia, or simply, "maths phobia". Ihechukwu, Nwoke and Ugwuegbulam (2016) define maths phobia as a feeling of anxiety that hinders one from efficiently tackling mathematical problems. Actually, most academic journals associate maths phobia to "Maths Anxiety", which can be linked to the above-mentioned negative emotions, as suggested by Haase et al. (2019). According to Maloney and Beilock (2012), people with maths anxiety may even find it difficult to open a maths textbook or enter a (maths) classroom as it can trigger a negative emotional response. The same authors claim that there is a correlation between maths anxiety and performance in mathematics, simply because if one tends to stay away, or be disconnected in maths classes, then clearly this will result in obtaining less marks in exams or tests, as compared to their non-anxious counterparts.

2.4.1 Maths Anxiety at Lower Education Levels

Khasawneh et al. (2021) in their very recent publication, define maths anxiety as,

"*... a feeling of tension and apprehension that interferes with maths performance ability, the manipulation of numbers and the solving of mathematical problems in a wide variety*

of ordinary life and academic situations."

The authors also claim that maths anxiety may occur at all levels of education, that is, from primary school to university education. Although my research is mainly focused on maths anxiety at the HE level, it is important to first briefly explore the situation at lower levels. Whyte and Anthony (2012) did a literature review on maths anxiety in New Zealand on students from disadvantaged backgrounds (indigenous) coming from a diverse student population (ethnicity). The authors explain that maths anxiety affects someone in several ways, inducing the following reactions:

- Cognitive
  - blanking out and avoidance
- Affective
  - distinct of ability
  - fear of looking stupid
  - loss of self-esteem
- Physical
  - perspiring
  - boost in heart rate
  - tenseness
  - nausea

Primary and secondary school students were considered in this literature review. The authors used data collected by Lee (2009). A closer look at the latter's research, provides a good insight on the maths anxiety phenomenon. The participants were 15-year-olds from 41 countries who participated in the "Program for International Student Assessment" (PISA) 2003 project. The total number of participants was $N = 276,165$. Five maths anxiety items were used with a 4-point scale of agree-disagree responses. and they were:

1. "I get very nervous doing mathematics problems";
2. "I get very tense when I have to do mathematics homework";
3. "I often worry that it will be difficult for me in mathematics classes";

4. "I feel helpless when doing a mathematics problem," and;

5. "I worry that I will get poor grades in mathematics".

Robust quantitative analysis was performed on the collected data (first, a maths test, then participating in the survey) and the results showed that the above-average maths-performing countries tend to show low levels of anxiety. These countries include those from Western Europe, New Zealand, Hong Kong and Macau-China. Interestingly, countries such as Australia, Belgium, Canada, Czech Republic, France, Ireland, Japan and Korea, performed well on the maths test but exhibited high maths anxiety. The last part of the results is very interesting as it, again, shows that students having maths anxiety may still perform well in their assessments.

It must be noted that my study is not about measuring the level of maths anxiety of students. I shall also not be comparing the nationalities, or ethnicities of my participants as this would require studies on a much bigger scale, such as understanding and comparing their pre-university mathematics curricula. Most of the studies on primary or secondary school levels were done through meta-analyses (Cipora et al. (2022)), and this is not within the scope of my study. But is it still important to understand why young students (primary and secondary school levels) suffer from maths anxiety. Going back to Whyte and Anthony (2012) and their review of literature on the topic, they reveal that maths anxiety can have multiple origins, namely:

1. At home, where parents who themselves suffer from maths anxiety may unintentionally transfer such anxiety to their children.

2. Society, where the myth that boys are better than girls in maths, may induce or reinforce maths anxiety for some students. It is also mentioned that the concept that it is "cool" to hate mathematics, with people proudly stating that "I'm no good at maths" may be a societal trigger for maths anxiety. Actually, a study in the United States affirms the view that failure in mathematics is socially acceptable, as compared to the lack of linguistic skills (Latterell (2005)). Hence, a lack of consideration towards learning mathematics and statistics may have a negative impact in further studies where these disciplines may be required.

3. In the classroom, where students may have been taught by "maths anxious" teachers. Maths anxious teachers are those who still heavily rely on orthodox and unpractical activities, such as, drills; clash cards; assigning the same work for all students; an over-reliance on teaching to textbook; insisting on having only one correct method; concentrating on basic skills, instead of concepts; and, whole class

instructions.

Richard (2022) published an interesting article on the correlation between "fear of mathematics" and "self-esteem" in relation to their "anxiety" levels, amongst adolescents. In addition to that, he also investigated gender differences, as well as whether the educational qualification of the parent, influences the fear of mathematics. 240 adolescents, through stratified sampling, aged between 15 and 17, participated in this study in Bangalore, in the State of Karnataka, India. The ratio of male to female students was 1 : 1 (that is, 120 male and 120 female). Karl Pearson correlation was used to determine the correlation and the following hypothesis was considered:

H_0: There is no significant relationship between fear of mathematics, self-esteem, and anxiety level among the adolescent student respondents.

Data was collected through a questionnaire and the following tools of measurements were used:

- MARS - Maths Anxiety Rating Scale;
- RSES - Rosenberg Self-Esteem Scale;
- Beck's Anxiety Inventory.

Following a meeting with the Heads and teachers whereby the purpose of the study was explained, consent was obtained prior to the investigation. The identities of the participants were kept strictly confidential. Interestingly, no mention of parental permission was discussed in this study, although the research was conducted with "minors" (the age of majority, in India, is defined as the age of someone who is 18 or above (Procedure (1875))). The findings were:

- There is no significant gender difference with regards to fear of mathematics, self-esteem and anxiety among the adolescent student respondents.
- There is no significant difference in fear of mathematics, self-esteem and anxiety with regard to the occupation of the parents.
- There is no significant difference in fear of mathematics, self-esteem and anxiety level with regard to Educational Qualification of the father.
- There is no significant difference in fear of mathematics, self-esteem and anxiety level with regard to the Educational Qualification of the mother.
- There **is** a significant relationship between fear of mathematics and self-esteem

among adolescents.

- There **is** a significant relationship between anxiety and self-esteem among adolescents.
- Fear of mathematics influences negatively self-esteem.
- Fear of mathematics influences anxiety by 22%.

To conclude this section, not much literature is available on the quantitative correlation between maths anxiety at lower levels of education (in primary and secondary schools), and maths anxiety at higher levels of education (in Higher Education). This clearly needs a longitudinal quantitative intervention and may require substantial ethical considerations. My research will try to explore students' past experience (at lower levels) before they studied mathematics and statistics at MUM (at higher levels), and although the "measure" of maths anxiety at different levels will not be considered, at least, qualitatively, we may be able to have an idea about the "progress" or "development" of maths anxiety across students' academic experience.

2.5 Maths Anxiety in Higher Education

The early research done by Quilter and Harper (1988) was a motivation to embark on this research journey. Although their data collection was for both quantitative data (a survey) and qualitative data (interview, with two main open-ended questions), I believe the limitations of their study were that the two questions would only be asked if the survey identified that the participants "possessed negative attitudes" to some aspects of mathematics and that they did not feel confident about their abilities in the subject. Subsequently, four brief questions were then asked, for further investigations. The two (main) questions were:

1. Do you think this is a fair judgement in your case?
2. Why do you think you have these attitudes?

The four brief questions were:

- to specify their first encounter with real difficulty in mathematics, and to indicate their topic of preference;
- to agree or disagree with the view that they might have a poor memory and to indicate their effective memory mode;
- to indicate whether or not they experienced a "cultural" or "social" pressure to succeed (at O-level) in mathematics, to indicate how many attempts were made to

succeed at O-level mathematics and to indicate what learning strategy was used in order to achieve this;

- to indicate which of the main causal variables had been identified during the interview, the interviewee considered to be the most significant contributor to negative attitudes and perceived disability.

Indeed, this article was published more than three decades ago, and it was considered a breakthrough in the "detection" of mathophobia (the fear of doing maths). But I believe, in this day and age, the structure of these questions, and most of these questions, would now be obsolete, for the following reasons:

- "*Do you think this is a fair judgement in your case?*"
  - The answer would just be a YES or a NO. Since the survey detected that the participant is indeed "someone with negative attitudes" and if the participant replies NO, then this puts both the interviewer and the interviewee in an uncomfortable position.
- "*Why do you think you have these attitudes?*"
  - This seems to be a question which challenges the participants' knowledge of the definition of "attributes" for not liking mathematics.
- "*To specify their first encounter with real difficulty in mathematics, and to indicate their topic of preference.*"
  - This seems to be a conflicting line of investigation with the participant expected to remember their early negative memories, and then it is assumed that the participant does indeed have favourite topics.
- "*To agree or disagree with the view that they might have a poor memory and to indicate their effective memory mode.*"
  - It may now be considered ethically wrong to assume and use the term "poor memory" directly to a participant who may be vulnerable and conscious of the predicament (maths anxiety) they are in.
- "*To indicate whether they experienced a "cultural" or "social" pressure to succeed (at O-level) in mathematics, to indicate how many attempts were made to succeed at O-level mathematics and to indicate what learning strategy was used to achieve this.*"

  - As mentioned above, this may put the participant in an awkward position if the latter have failed numerous times.

Nevertheless, the findings were crucial (bearing in mind that the study was done in 1988) as they, at least, gave an indication of future research in mathematics support mechanisms and detection of issues with mathematics and statistics learning. Participants admitted that they had some kind of dyscalculic syndrome, although they refused to consider innate disability to be a contributory factor in the difficulties in learning mathematics and statistics. Instrumental Learning was another factor which enabled dissatisfaction towards the learning of mathematics. The third factor mentioned was that participants became anxious when they were introduced to formulae and symbols, notably in Algebra, although they enjoyed Geometry. Interestingly, their teachers also played a crucial role in their "dislike" of mathematics. Some of the reasons mentioned were:

- poor teaching methodologies used by teachers;
- the perceived rigidity in mathematics, as taught by the teachers;
- teachers were often seen as arrogant;
- teachers tend to "belittle" students who have learning difficulties in mathematics and statistics.

Other factors that contributed towards maths anxiety were:

- The affective domain, that is, maths anxiety arose because of the style of teaching. In simple terms, the teacher, by the use of poor teaching methods, triggered a negative emotion in the students.
- Learning styles - a big discrepancy between their preferred style of learning and the suggested methods as directed by the teachers.
- Relevance of mathematics - participants failed to see the connection between what was taught in the class, with real-word examples.
- Memory - participants found it tough to recall previously taught chapters.

In a more recent work, Foley et al. (2017) explain that many governments and private organisations have revamped Science, Technology, Engineering and Mathematics (STEM) education by promoting training to enhance maths and science skills among students. They claim that there have been numerous studies which suggest that maths anxiety should be considered when trying to increase achievement in mathematics and statistics,

and, in turn, STEM career success. Khasawneh et al. (2021), whom we already mentioned above, did a meta-analysis of several articles for their study. Their main focus was on university students and their findings were as follows:

1. A positive correlation between maths self-efficacy (due to maths anxiety) and maths performance.

2. High maths anxious students have less precise representation of numerical magnitude than low maths anxious individuals.

3. Some studies claim that gender has a role in maths anxiety, while others found that there is no significant difference between male and female students.

Non-specialist students at the university level are often expected to have mathematical knowledge and reasoning skills to deal with analytical and statistical tasks of their academic studies (Olango (2016)). The author claims that non-specialist freshmen usually struggle and face extensive difficulties in doing their respective academic studies when it comes to employing mathematical and statistical applications. His paper investigated the direct and indirect effects of maths anxiety in first-year, non-specialist undergraduate students across five academic departments of two faculties. There were 245 participants, of which, 201 were males and, 44 were females. The method used to collect data was through a descriptive survey and intense statistical analysis was used to analyse the data. His findings were as follows:

- Test- and task-related anxieties were high among both male and female students.

- course-related anxiety was moderate among male and female students.

- No significant differences in anxiety were noted between male and female students.

- Maths anxiety has a direct impact on mathematics achievement.

On a side note, a more detailed section of this chapter has been allocated to the "gender study" with regard to maths anxiety (Section 2.6, Page 43).

With regard to the STEM fields, Beilock and Maloney (2015) state that efforts in innovating the teaching of mathematics and statistics, to boost achievement in mathematics, became a bigger priority for STEM fields, following former US President, Barack Obama's campaign "Educate to Innovate". Their research was mainly focused on studying how maths anxiety impacted achievement in mathematics and statistics. The authors claim that students with maths anxiety tend to find the classroom stressful and as mentioned in Section 2.4.1, on Page 29, students are afraid to look stupid in front of their classmates.

These arguments are also supported by Marshall et al. (2017). Beilock and Maloney (2015) added that students who have a genuine fear of mathematics tend to avoid the subject, and this results in a scarcity of skilled STEM workers, which has definite negative consequences at a national level. In this day and age, as societies become more dependent on technology, it is thus important to understand the concept of maths anxiety and to find ways to mitigate this emotion (more on this, in Section 2.7, on Page 46).

In a recent article, Isabel Núñez-Peña and Bono (2021) studied 251 undergraduate Psychology students at the University of Barcelona (210 female and 41 male students), and discovered, through quantitative analysis using survey questionnaires, that students with high maths anxiety obtained lower grades in their final multiple choice examinations. These students tend to skip more questions than their peers who did not have maths anxiety. However, on a closer look, it was observed that the number of errors by the two groups (high maths anxious students and low maths anxious students), did not differ.This is an interesting finding, as it may conclude that the errors or mistakes that students do, are independent on how anxious they are (in maths) and the reason students with maths anxiety score lower grades is mainly because they tend to skip more questions, and not necessarily because they do not know mathematics (and statistics). Students high in maths anxiety might be disadvantaged to skip questions and one may suggest that by trying to answer those skipped questions, those students may score better marks. Interestingly, another argument proposed by Isabel Núñez-Peña and Bono (2021), while referring to the work of Ashcraft and Faust (1994), claim that because students are involved in many other components of their study programmes (i.e studying other modules unrelated to mathematics and statistics), their working memory may be impacted by those other subjects, and the amount of studying that they have to do, and hence this leaves them with insufficient cognitive resources to successfully carry out mathematics-related tasks. Ashcraft and Faust (1994) find that there is a negative correlation between maths anxiety and aptitude tests and general achievement tests. This further confirms that students who show maths anxiety, do not necessarily work poorly in other modules that they study. They may have a sound aptitude and usually perform well in their studies, in general.

Ashcraft and Moore (2009) study can be summarised in Figure 2.1 below. It shows that there is a slow but gradual and direct impact on STEM fields for students who are maths anxious. It has to be stated that the authors define "poor attitude in maths" as:

- Little or no engagement in the lesson.
- Little or no participation in class activities.
- Less time spent on studying.

- Late submission of homework.

In general, "avoidance" of mathematics and statistics is an overriding characteristic of maths-anxious students. The authors also mention that avoidance of mathematics and statistics was a behavioural pattern for students, in response to having teachers whose teaching styles were "cold and unsupportive". Interestingly, as per the authors' study, the impact of such teachers on students may also discourage students from taking outside help (maths support mechanism). A section of this chapter (Section 2.11, Page 59) will be dedicated to those types of teachers, more precisely on "maths anxious teachers".

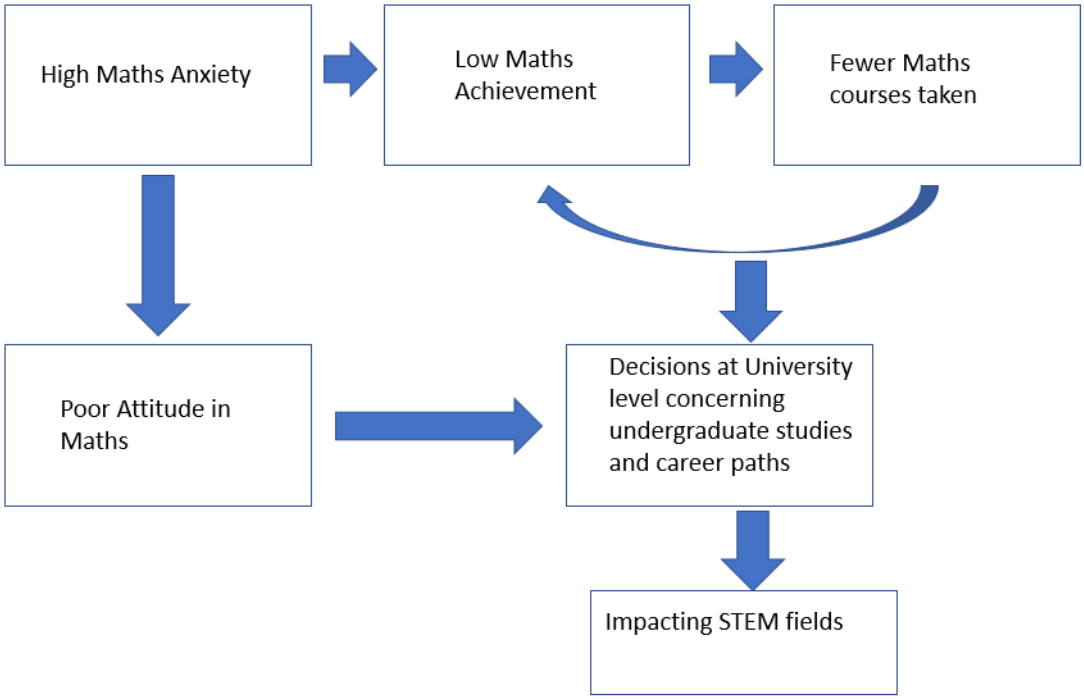

Fig. 2.1 Adapted from Ashcraft and Moore (2009) - Maths Anxiety Cycle Impacting STEM

Although "maths anxiety" has already been linked with negative emotions in mathematics and statistics (see Section 2.4 on Page 29), there are a few research studies that are only dedicated to statistics-related anxiety. This is discussed below.

2.5.1 Statistics Anxiety

Statistics anxiety is defined as "the feelings of anxiety encountered when taking a statistics course or doing statistical analyses; that is, gathering, processing, and interpreting data" (Malik (2015)). It is often said that many students find statistics to be the most difficult, challenging and least pleasant course (Berk and Nanda (1998)) in their curricula, and they complain about its mathematical nature, and the lack of appropriate skills (Johnson (1989)). Bose (2017) observes that students who have difficulties in statistics may not necessarily show the same characteristics as those who have difficulties in mathematics. It is clear from Balo_lu (2004) that before 2004, statistics anxiety was never fully investigated and the term "maths anxiety" was still being used to define anxiety for both mathematics and statistics students. This argument is supported by Primi and Chiesi (2018) in their relatively recent study, and they claim that most research studies look at maths anxiety and statistics anxiety as similar constructs, although there are indeed few researchers who view them as two different constructs. Some of these differences are:

1. Statistics involves different cognitive processes as it requires more than just the manipulation of mathematical symbols.

2. Though statistics employs mathematical concepts, it is more related to verbal reasoning than mathematical reasoning.

According to Primi and Chiesi (2018), it is important for teachers to provide adequate resources to students, to cope with both maths anxiety and statistics anxiety. The authors reveal that, even now, studies on statistics anxiety have been very sparse and this can be a good research area in the future. Having mentioned the different constructs in statistics anxiety, it is also important to understand the similarities between maths anxiety and statistics anxiety. Balo_lu (2004) states that the two similarities are:

1. The frequent appearance of statistics courses in the Mathematics Department.

2. There is indeed a statistically significant relationship between maths anxiety and statistics anxiety.

According to Zeidner (1991), the statistics anxiety levels among students from non-mathematics backgrounds may be higher than among those students from mathematics-oriented areas. This is an interesting observation, as it seems to still connect statistics anxiety with mathematics, or the amount of mathematics one would have done before

starting a course with strong statistics content. Similarly, Pan and Tang (2005) noted that students having limited prior training in statistics and mathematics-related disciplines may have a significantly higher level of statistics anxiety. The authors added that most undergraduate students in social sciences are required to take statistics courses as part of their programmes of study and it is, therefore, important to address anxiety in statistics. Onwuegbuzie (2004), in his study, stated that there are usually six components of statistics anxiety, namely:

1. Worth of statistics.
    - This refers to how students perceive the relevance of statistics.
2. Interpretation anxiety.
    - This refers to the interpretation of data, following statistical analysis. This also includes the decision-making process, based on the interpretation of statistical results, which students find challenging.
3. Test and class anxiety.
    - This refers to all types of assessments (tests, quizzes, exams) in statistics.
4. Computational self-concept.
    - This refers to the anxiety experienced by students when attempting to solve problems related to mathematics. This also includes students' perceptions of their own capabilities in solving mathematics problems.
5. Fear of asking for help.
    - This refers to the reluctance of students to seek assistance, either from their peers, or from their teachers, on statistics-related problems that they encountered in class, or elsewhere (such as in books or articles).
6. Fear of statistics teachers.
    - This refers to the students' perception of the teacher teaching statistics.

Maths anxiety and statistics anxiety have some common characteristics. In my view, all, but the second item above, also applies to maths anxiety. However, it is clear that the concept of data interpretation and decision-making ability, which are heavily connected to statistics, are crucially linked with statistics anxiety. This will have a knock-on effect on students' studies as they progress from the undergraduate level to postgraduate level.

Onwuegbuzie et al. (1997) wrote an excellent article as they claim that statistics anxiety is, at least to some degree, responsible for the procrastination of students enrolled in statistics courses. A combination of statistics anxiety and procrastination would undoubtedly lead to a low performance level in statistics, as claimed by the authors.

Zanakis and Valenzi (1997) findings of their research on statistics anxiety were related to students studying statistical courses in Business programmes. They stated that students' grades in the course were primarily influenced by initial maths anxiety and computer experience. Furthermore, they discovered that there was significant improvement at the end of the statistics course, in understanding and interpretation of statistics but students still had high test (or assessments, exams, etc.) anxiety. Unfortunately, according to the authors, not much progress was made to help students in understanding the worth and relevance of statistics in their study. The authors suggested a few steps that may be taken to mitigate the effect of statistics anxiety, namely:

- Review and modify the contents of the statistics syllabus.
- Group work is extremely promising.
- Reduce the weight of tests in determining the course grades.
- More group assignments and group discussions should be implemented.
- Increase emphasis on short, real-world data cases, with a non-technical report submission.

The research done by Malik (2015) was one which I felt connected with, as it helped me understand the concept of statistics anxiety, in a more practical way. The participants of the study were students who had enrolled in statistics modules at a university in the US. Her research study aimed to provide an understanding of undergraduate students' experiences and perceptions of statistics anxiety. She initiated her study by, first, sending out a survey to undergraduate students at the university. Following an assessment of the survey results, using a modified version of the Mathematics Attitudes Scales, participants who had high statistics anxiety were identified. In total, six undergraduates with high statistics anxiety were asked to participate in the face-to-face interviews. The questions were:

1. What are the specific situations that trigger intense feelings of statistics anxiety among undergraduates?
2. What factors do undergraduates believe contribute to their heightened levels of statistics anxiety?

3. What factors do undergraduates believe contribute to their reduced levels of statistics anxiety?

Thematic Analysis was used to analyse the data and her findings and recommendations are given below. I must add that the reason why I felt comfortable reading her article is because, her sampling method (purposive sampling), data collection (interviews) and data analysis (thematic analysis), are aligned with my research study on the perceptions that non-specialist students have in learning mathematics and statistics. Her findings and recommendations are as follows:

1. Situations That Trigger Statistics Anxiety:
    - Exams, due to time limitations.
    - Whenever there is a statistics problem to solve, as unsure if answers would be correct or not.
    - Speaking in front of teachers and classmates.
2. Factors That Heighten Statistics Anxiety:
    - Inability to understand terminologies and to decode symbols (statistical formulae, symbols and terminologies did not make sense).
    - Feeling of inadequacy (lack of confidence, frustration, negative emotions, ...).
    - Physiological symptoms (increased heart rate, shaking, urge to cry, deep breathing, ...).
    - Giving up (running away from lectures).

Her recommendations to mitigate statistics anxiety are:

1. Having a formula sheet is very helpful.
2. Assessments should be in the form of multiple-choice questions, and take-home exams.
3. Willingness of the teacher to help.

To conclude this section, I will have to reiterate that for this research, I have used "maths anxiety" for students who study both mathematics and statistics at MUM. As mentioned in my first chapter, **Introduction**, Subsection 1.3.1, Page 11, my students, and those who take mathematics / statistics classes from other teachers (at MUM), are not taught

mathematics and statistics separately. These two are combined, to make up whole modules. On a final note, the recent paper by Zhang et al. (2019), who did meta-analyses on several research articles on statistics anxiety, claims that even now (his article was published in 2019), the proper definition, interpretation and causes of statistics anxiety in numerous fields of study, are still vague. This statement supports my decision to use the term "maths anxiety" for my research study.

2.6 Gender Comparison - Maths Anxiety

From the above section, I have only mentioned the gender difference towards maths anxiety, twice. To summarise, they were:

Table 2.2 Brief Summary of the Above Section on Male/Female Difference with Maths Anxiety

Reference	**Data Analysis**	**Maths Anxiety Between Males and Females**
Khasawneh et al. (2021)	Meta-Analyses of published articles	No significant difference
Olango (2016)	Descriptive Survey, N = 245 (M = 201 , F = 44)	No significant difference

Taking into account that the gender composition of my participants is split to almost 50 : 50, (Appendix G, Participants Gender Details, on Page 210), it becomes important to further analyse the gender difference when it comes to maths anxiety.

Solomon et al. (2011) observe that while many learners may excel in mathematics and statistics, some of them consider themselves to have a fragile identity. Although we cannot stereotype girls and women as those who express this fragile identity, they do appear to show these traits, more often, or at least more readily, in their years of learning mathematics (young adolescents to students, in HE). Bartholomew (1999) found that in a top-set class, middle-class boys were considered to be the teacher's equal, and they were expected to produce correct answers quickly. They were usually labelled as "budding mathematicians", due to their confident behaviour, although this did not correlate with their actual performance. In contrast, girls were likely to be positioned or to position themselves, as having "less right" to be there. The author states that from the early days, it was " culturally acceptable" to think that boys were better at mathematics than girls. It is claimed that girls felt that they did not belong to the community of "good mathematicians". Bartholomew (1999) further states that, should a girl do well in mathematics, maintaining that position becomes challenging. Girls are expected to justify their place in top sets, both to others and to themselves, but the markers of

such a position may be elusive and shifting. Walkerdine (2012) notes how boys' "poor performance is both excused and turned into a good quality", while girls work hard and strive for what are "feminine" qualities which are both required but at the same time devalued by teachers, resulting in a generalised sense of insecurity. Interestingly, Goetz et al. (2013) whose research was to study the difference in anxiety levels between boys and girls, claim that though performance-wise there are no differences between boys and girls, the latter suffer more anxiety due to a lack of confidence.

Wai et al. (2010) state that the lack of trust "bestowed" on girls, to study mathematics, has a big impact on the choice of courses girls would choose in HE. There is usually an ongoing debate about the under-representation of women in pursuing high-level careers in STEM fields. Shapka and Keating (2003) support the above findings, as they claim that fewer girls study mathematics to an advanced level in secondary schools, and this results in a lower number of girls choosing mathematics-related courses at university. The authors suggest that all-girls schools could be considered, although this may come with its issues. According to them, there is no concrete evidence that this approach will work, but more importantly, in European countries, and mostly elsewhere in general, these types of schools would not be public run. They would be private institutions, and hence may only cater for girls who can afford to pay the fees.

Interestingly, in Mauritius, most of the public-run schools are either girls-only or boys-only, in contrast with the private-run institutions, which are mixed. This may give room for further research on this topic, in Mauritius.

With this type of "discrimination", although unintentional, towards girls' capability in doing mathematics, it is indeed important to understand the maths anxiety difference that girls show, if indeed they decide to study mathematics at any level. Mann and Walshaw (2019) recent study was based on schools in New Zealand, with year 9 students (both male and female). The data collection was both through a survey and three focus group interviews. The 16 selected participants (female) in the focus groups (ranging between 5 to 6 per focus group) were those who showed high maths anxiety, through the survey reports. The female students described their perception of mathematics as "cloudy" and "stormy". The most common themes, when describing mathematics, were "nervous", "panicky" and "unsure". The participants claim that, though mathematics was deemed to be enjoyable, they still felt that mathematics was unpredictable and changeable. The participants stated that most of the time, they had no idea what they were doing in mathematics, but if they did understand the topic, then it became enjoyable. Many of the participants mentioned their past experience of mathematics as being enjoyable, but gradually got worse due to boredom with studying mathematics. As mentioned many

times in this chapter, the tests (assessments) also played a big part towards maths anxiety with girls. The fear of failure was shown predominantly in the assessment of the focus groups.

Keshavarzi and Ahmadi (2013) research in Iran had some interesting conclusions, based on studies done on 562 school children, aged around 13, with roughly the same number of boys and girls. A quantitative method was used, as data was collected through a questionnaire. The results, for kids that young were:

1. There is no significant difference between boys and girls in respect to mathematics anxiety.

2. there is no significant difference between boys and girls concerning learning maths, although there was a significant difference in

    - evaluation of maths problems;

    - solving maths problems.

In a recent study, Jameson (2020) focused on three research questions which he wanted to investigate:

1. To what do highly mathematics-anxious female adult learners attribute their high levels of anxiety?

2. How do highly mathematics-anxious female adult learners perceive various environmental and personal factors in the development of their mathematics anxiety?

3. What do highly mathematics-anxious female adult learners believe that higher education institutions can do to assist them in mathematics?

The interesting feature of this research was that the participants were all adult female learners who self-identified themselves as "highly mathematics anxious". As my study does not entail any measurement of anxiety and depends on students self-identifying themselves as maths-anxious, Jameson's research was welcomed. The participants were all adults studying at university. The research identified the following as causes of maths anxiety with adult female learners:

1. There was a long gap in time since the participants had studied mathematics.

2. Teaching styles. The participants qualified "good teaching style" when the teacher makes mathematics fun to learn. In addition, teachers who ask female students to contribute to discussions is also considered a good approach. "Negative teaching

attributes", which does not help with maths anxiety, include teachers reading from slides and hardly having eye contact with students. The lack of examples used when teaching mathematics as students want to connect mathematics with real-life scenarios, was also mentioned.

3. Holding negative self-beliefs (lack of confidence, feeling stupid).

To conclude this section, understanding female students' perceptions and expectations in learning mathematics and statistics, is one of the main focuses of my research. One of the reasons that a focus group, in my study, consists of all female students, is to show them how important they are to my study and how their views are highly valued. The findings will be discussed in later chapters.

2.7 Mitigating Maths Anxiety

Starting with "the very specific" statistics anxiety, Pan and Tang (1997) themselves confess that their study had its limitations as only one focus group was used to collect data. Nevertheless, this early research on statistics anxiety and the proposed actions to remedy the situation, provided a platform for future researchers to conduct their studies. The authors identified most of the reasons already mentioned above, with regard to statistics anxiety (Subsection 2.5.1, Page 39), and a summary table is provided below in Table 2.3.

Table 2.3 Study on Statistics Anxiety

Pan and Tang (1997) Results from Focus Group Interview	
Theme	**Factor**
Factors contributing to statistics anxiety	Maths phobia. Lack of connection to daily life. Pace of instruction. Instructor's attitude.
Helpful instructional strategies	Practical application. Real-world examples carried through. Orientation prior to class. Multiple evaluation criteria. Flexible availability of assistance.

Most of the above "solutions" have been mentioned in previous sections of this chapter, but additionally, the authors emphasize on the revision of the examination system in place, to mitigate anxiety in students. The authors advise that the focus should be on long term learning rather than outcome evaluation. Several methods were suggested, such as:

1. Optional grading system.

2. More flexible office hours.

    - The availability of assistance is important because students will know that they can ask for help at any time. This may decrease their level of anxiety.

3. Orientation letter.

4. Note sheet.

Newstead (2002) reveals that academics (teachers and tutors) are expected to assess their students and similarly, students expect to be assessed at some point during their studies. Students eventually become more interested in the marks that they will achieve, and less interested in the subject throughout their studies. The author suggests the following improvements in the way we assess students in HE,

1. Use more MCQs. This method is reliable and cost-effective. It is considered to be the most efficient way to measure memory for facts.

2. Use a greater variety of assessments. This leads to greater reliability and probably greater validity.

3. Abandon double marking. There is little evidence that a second marking has any impact on the degree awarded, and it may lead to marks regressing towards the mean.

4. Use smaller assessments. The time saved to double mark can be used to produce more, smaller assessments. This also improves reliability and possibly validity.

5. Abandon external examiners. Though Newstead (2002) accepts that this is a radical and contentious suggestion, and politically not possible to implement, the author claims that due to time limitations, external examiners may feel more like second markers, instead of experts who validate the standard of the assessments.

Potts (2010) study on a simple alternative to grading, was initiated when she realised that she was putting more effort into grading stacks of students' work, than her students put into writing them. Claiming that many educators are hesitant to try alternatives, she recognises that disciplines such as psychology and mathematics may benefit from a change in assessment methods. She suggests that "Contract Grading" should be the way forward. Contract grading is a mechanism where students are given all indicators on how to pass a particular assessment. Usually, it starts with the lecturer setting up instructions about the minimum requirement to pass. Details about different parts of the assessments are then given to the students, which include in-depth aims and objectives of each section

of the assessment, and what students must do to achieve the minimum and maximum marks.

Noting that Potts (2010) article was published in 2010, it is fair to say that many HEIs have already initiated her suggested approach and I need to confirm that a few of the modules that I teach contain information which enables students to understand the detailed marking criteria of their assessments. Having more but shorter types of assessments, while allocating small weights to those assessments, may also help students. If they do not do well in one particular assessment, they can make up their grades from other assignments. These assignments should be designed to give students the opportunities to reinforce learning concepts. Similarly, a lot has happened since Newstead's article in 2002. With regard to MUM and MU-HEN, external examiners now have access to the university's Virtual Learning Platform throughout the year, and they may peruse the submission of assessments at any given time. Nevertheless, another point that Newstead made, may still be valid, namely on ensuring the equality of standards:

"*I certainly know that I cannot, given the time available and the small number of scripts I am able to sample*".

The use of practical real-life assignments should be prioritised (Newstead (2002)). This is known as "Authentic Learning". Lombardi and Oblinger (2007) paper discussed the importance of such an approach in the field of I.T. and some of the points mentioned there can also be adapted to mathematics, statistics and quantitative methods. The process of learning by doing is known as Authentic Learning. Educators do believe that the Authentic Approach is an effective way to learn even though it is not always easy to implement. Some experiments might be too dangerous to do, or resources might not be available to perform certain exercises as they would be too expensive. Or it might just be impossible to do some of the experiments. Still, if it is within the capacity of an educator and if students do not run the risk of getting hurt due to the dangerous nature of a particular experiment, Authentic Learning should be encouraged.

Authentic Learning focuses on real-world, complex problems and their solutions, using simulations, problem-based activities, case studies, and role-playing. Today, where we need to prepare our students to compete in the global job market, Authentic Learning is an important tool which students can use to become more comfortable with the complexities of poorly defined real-world problems. The more they are faced with these types of problems, the better prepared they will be to deal with their complexity and ambiguity. This will allow them to sharpen their analytical sense and develop their communication skills which are required of them as professionals.

Ihechukwu, Nwoke and Ugwuegbulam (2016) investigated teachers' perspective on what ought to be done, to alleviate maths anxiety among secondary school students. A sample of $n = 110$ teachers from a population of $N = 580$, were chosen through Simple Random Sampling, to participate in a survey in Imo State, Nigeria. The selected participants were further split into 70 females and 40 males. Factors triggering mathematics phobia and anxiety were first discussed, and they are aligned with what has already been mentioned in the early part of this chapter. Furthermore, their findings, based on the survey, included the following (in addition to what has been mentioned above, by other researchers):

1. Use of instructional materials in teaching mathematics.
2. Use of students' centred/innovative teaching approach.
3. Teaching mathematics in a conducive atmosphere.
4. Developing a good teacher-student relationship.
5. Motivating students to have a positive attitude toward mathematics.
6. Provision of reading materials for students.
7. Ensuring that only qualified teachers teach the subject.
8. Organising seminars and workshops to train teachers on current issues in the subject.
9. Encouraging those regarded as low achievers through attention.
10. Make the mathematics curriculum in such a way that students can cope with the content.

What we can take from the findings, is that there must be a close working relationship between students and academics, to help alleviate the issues of maths anxiety. There is a significant relationship between what teachers perceive as factors that contribute to maths anxiety, and solutions proposed; with what students expect teachers to do, to help them with mathematics and statistics.

Marshall et al. (2017) argues that the first step for addressing maths anxiety, is to raise student awareness on what maths anxiety is, and how their negative beliefs are affecting them. Setting up a "Maths Anxiety Workshop" is strongly recommended, and this can take place within the first two or three weeks at the start of the academic year. The workshop is embedded in the timetable schedule, and it is compulsory (rather than being optional and voluntary) to participate in the workshop. Interestingly, the title of the workshop does not include the word "maths" or "mathematics", as this is usually seen

as a reason why maths-anxious students would not attend such events. Activities in the workshop include:

- Increase awareness about maths anxiety;
- Dispel common myths;
- Encourage engagement between teachers and students.

As seen above, researchers have suggested lots of solutions to mitigate the maths anxiety factor. In the sections below, teachers' approach to enabling the mechanism required to assist students, will be discussed.

2.8 Positive Emotions - in Mathematics and Statistics Learning

One of the common themes in the previous section was that negative emotions can hinder students' achievements in mathematics and statistics. This section is dedicated to literature focusing on positive emotions in mathematics and statistics. Zan and Di Martino (2008) state that:

"*When it refers to an emotion, 'positive' normally means 'perceived as pleasurable'. So, anxiety when confronting a problem is seen as 'negative', while pleasure in doing mathematics is evaluated as 'positive'*".

The authors' data collection process was through an interesting procedure, namely through essay writing. They asked their students to write an autobiography about their experience in mathematics and statistics, and the focus of the research paper was to study the dichotomy between positive and negative emotions towards learning mathematics and statistics. Most of the effects of negative emotions have already been mentioned in previous sections, by other researchers, but with regard to positive emotions, one finding was quite peculiar. Many students confessed that they "accept", and "get on with" the rigidity of mathematics, only because they like the subject. Students agree that mathematics is made on rules that need to, appropriately and rigidly, be applied, but their love for the subject encourages them to learn maths without asking too many questions or challenging their way of thinking.

Villavicencio and Bernardo (2016) studied Filipino university students, and their research was focused on the effect of positive emotions of students, towards mathematics, in a Trigonometry class. A survey was conducted to collect data and the "emotions measure" was determined through the "Academic Emotions Questionnaire-Maths". Achievement of students was measured using the students' final grades (after consent was granted

by the students), in Trigonometry, and the grades were computed by combining various assessments: problem exercises, quizzes, assignments, and midterm and final exams. The highest grade possible was 100 and the lowest grade given was 65; the passing grade was 75. The researchers observed that there was a positive correlation between "achievement" and "positive emotions". The study also revealed that there was a negative correlation between "pride" and the final grades obtained by some students. This is aligned with the findings by Pekrun and Perry (2014), who state that:

"*in cases when high levels of pride become associated with basking in the glory of achievement, the student might not focus as much resources to further academic pursuit and lead to declines in performance. Thus, instead of building on and broadening the cognitive and affective resources for further achievement, it seems that the students who reported high levels of pride may have rested on their laurels, so to speak*".

Teachers must value these positive emotions when their students experience them and, whenever possible, create opportunities wherein these emotions can be experienced and sustained (Villavicencio and Bernardo (2016)). The authors went on to explain that it is important for teachers to create learning activities that are enjoyable to students to make them believe that they can engage and manage the learning tasks and also to engender more cognitive flexibility and self-regulation while doing the task. Fredrickson (2001) and Fredrickson (2003) suggest that the creation of these positive resources further enhances positive emotional experiences, and, if this is sustained, the students can achieve optimal outcomes at the end of the learning cycle.

To summarise this section, it is a usual perception that positive feelings have a positive impact on students' achievements, but we have also seen that this may not always be the case. It is thus important for researchers who want to investigate maths anxiety and positive emotions towards maths, to have a sustainable plan of action, which they wish to implement, to successfully support students in learning mathematics and statistics.

2.9 Enhancement in Teaching Strategies in Mathematics and Statistics

Quality education is the key to the success of a HEI, as "an education provider." As educators, we must be ready to implement necessary changes in our practice to keep up with the new trends. Tang and Biggs (2007) talk about the dramatic change in the nature of higher education that has occurred since 2000. They recognize the fact that the student population is now more diverse, and it has become important for us, as educators, to alter our modes of delivery. Hannan and Silver (2000) wrote about how innovation is important in "teaching and learning" in higher education. According to

them, innovation does not necessarily need to be "abrupt or radical change" (in terms of curriculum design) but improving practice may also mean "engaging critically" with it. "Effective teaching", according to Devlin and Samarawickrema (2010), is a concept that does not only limit itself to students and their learning. A teacher should now be able to motivate, influence and inspire students to learn. According to the authors, a teacher in HE should possess leadership skills that will allow them to take control of the research that should be carried out, to improve their teaching qualities. The same authors mention that the teacher now must ensure that students are provided with adequate support for their development as individuals. Acceptance of the diversity of the students and valuing that diversity will enable a teacher to improve their practice. Limoges et al. (1994) talk about the continuous transformation (since the Second World War) in HE, driven by changes in knowledge production and dissemination. They claim that continuous changes can bring the emergence of a learning society, one in which training and retraining are possible. This readiness to learn greatly increases the capacity of a labour force to respond to rapid technological change and ensures that stakeholders are capable of bringing about innovations in their work which are important in a competitive market.

In terms of mathematics and statistics teaching and learning in HE, Hodgen et al. (2014) researched the needs of students studying mathematics and statistics, in various disciplines, at the undergraduate level. They identified certain issues which I can only relate to, with the cohort of students who are studying at MUM. According to the authors, "*many students arrive at university with unrealistic expectations of the mathematical and statistical demands of their subjects*". A lot of students show a lack of confidence and anxiety about mathematics and statistics, as depicted in previous sections of this chapter. They also mentioned that many universities are currently providing support in mathematics and statistics but unfortunately, few students are making use of it. An ACME report (Advisory Committee on Mathematics Education (2011)) revealed that "there is a concern about the marginalisation of quantitative methods (mathematics and statistics) and the lack of understanding of the role of mathematically based arguments within disciplines". Findings from Onwuegbuzie and Wilson (2003) (already mentioned in above sections) in their survey, reveal that between 60 to 80 percent of students appear to fear statistics. They also identified that female students and minorities are more prone to have "statistics-anxiety". The authors encourage teachers to investigate these issues and to come up with ways to make statistics teaching more productive.

More broadly, I see myself as a practitioner-researcher. My duty towards my job and the people and organisation I work for, is to make it a better place based on self-improvement. Campbell et al. (2003) give a damning assessment of the Teacher's image, which involves

a loss of autonomy, a lack of self-determination and a culture of audit and excessive accountability. To overcome this, they encourage teachers to investigate, through research in their profession, to identify future areas of development. The authors motivate teachers to explore their professional development by highlighting certain areas, such as:

- Being critical.
- Reflect on one's work.
- Self-evaluation and review.
- Explore ideas of professional behaviour.
- Setting goals and targets.
- Consider institutional contexts.
- Consider opportunities and strengths; and weaknesses and threats.

It is clear that mathematics problem-solving skills are essential for success in maths-related careers and the authors urged teachers and researchers to investigate deeper to provide better support to female students. Hannula (2002) wrote an excellent article where he identified that girls have a more negative attitude towards mathematics. He also proposed a case study which revealed how the negative emotions of a girl changed dramatically to more positive ones (which confirms that, in the right environment and with proper support, women can do well, if not better, than their male counterparts).

As mentioned above, I will try to explore more on the background of the students who are studying mathematics and statistics at MUM. Learning mathematics (which includes statistics) up to Ordinary Levels (around age 16) is compulsory for local (Mauritian) students as they sit for the Cambridge Board of Examinations. It has to be noted that "Additional Mathematics" is also taught at secondary school, but it is an optional subject. It would be interesting to know to what level mathematics is being taught to students coming from overseas. Similarly, it is useful to investigate whether local students, who did not choose Additional Mathematics (hence would not be allowed to choose mathematics at Advanced Level – age around 18, at secondary school), find it tough to "like" mathematics and statistics at the undergraduate level.

Pinxten (1994) explains that until the mid-eighties, mathematics was assumed to be "culture-free" knowledge. He claims that it is now understood and accepted by researchers that the role of culture is an important aspect of mathematics education. Ogbu (1992) mentions that students from different cultural backgrounds may begin school with differ-

ent cultural assumptions about the world and human relationships. He also claims that some students come to school lacking certain concepts necessary to learn mathematics because their own cultures do not have or use such concepts. He states a few steps that should be taken to assist those students and one of them is "prerequisites". This means that the teacher should recognise and accept that all students are different, whether in terms of "culture", or "academic ability". The classroom consists of a group of students coming from diverse social and cultural backgrounds. Some students face problems of social adjustment, and this may result in their academic performance.

My research will also investigate how my role as a lecturer affects the level of confidence and trust that the students may or may not have in me when it comes to learning mathematics and statistics. Like most teachers, there have been numerous occasions when students would approach me and discuss their previous experience in learning the subject when being taught by somebody else. Some students have had good memories and productive time learning mathematics and statistics, while others feel scarred by their experience. This is more often due to the teachers being static in their teaching style and being reluctant to address the issues. Domino (2009) claims that teachers' behaviour in mathematics (and related subjects) has a large impact on students' attitudes towards the subjects. Since this project aims to enhance students' learning experience at MUM, I must reflect on the way I "behave" and "motivate" my students, in class.

Perception of the value of mathematics in their academic programmes and their lives has usually been a topic for debate among undergraduates (Wismath and Worrall (2015)). The authors also talk about "students' perception of their ability" and "confidence and anxiety" among students doing mathematics in Higher Education. Tapia and Marsh II (2004) questionnaire was used to measure anxiety and perception levels, and I intend to use the same questionnaire, with minor modifications relevant to the structure at MUM. Though I do not intend to "measure" levels of negative emotions, the questionnaire will mainly be for the purpose of analysing the correlation between Value of learning mathematics and statistics, against Emotions. Ashcraft and Moore (2009) outline, in their article, some of the important findings about maths anxiety. They show that maths-anxious students learn less in the mathematics classroom than non-anxious students. The author also encourages educators to investigate, understand and thereby, prevent maths anxiety at an early stage. Spangler (1992) identifies some of the (unhealthy) perceived concepts that students believe mathematics to be, namely:

- Mathematics is computation.
- Mathematics problems should be solved in less than five minutes. If not, something

is wrong with either the problem or the student.

- The goal of doing a mathematics problem is to obtain the correct answer.
- In the teaching-learning process, the student is passive and the teacher is active.

Spangler (1992) encourages educators to ask open-ended questions to students, to understand their beliefs about mathematics. Rattan et al. (2012) lay the blame on some educators and parents who told their students and children that not being good in mathematics is acceptable, at a very early age. This emanates from the parents not being comfortable with the subject (mathematics) when they were students. A lack of initiative to make the subject interesting for the students helped to alienate those students from mathematics and statistics. A lot of students were led to believe that they were not good in mathematics and statistics and were asked to accept it. One interesting study by Bourdieu, as explained in Swartz (2012), claims that students in mathematics are more likely to come from higher social-class origins. The representations of success in terms of individual talent in the subject reflect greater advantages in inherited cultural capital.

From the survey that I conducted at the beginning of the 2014/15 academic year, it was revealed that 29% of the students "did not know" they would be studying mathematics and statistics modules. The survey was part of the class I was teaching, which was on "how to design a questionnaire". This percentage has hardly changed over the years, and it usually varies between 29% and 34%. One reason could be that they never bothered reading the details of the programme they were applying for. A more plausible reason would be that they did not understand the meaning of "mathematics" and "statistics" in my survey. Martin and Gourley-Delaney (2014) support Spangler's findings (mentioned above). They claim that students tend to see mathematics as largely computational and tend to believe that maths problem should be solvable in five to ten minutes, or less. Students also have difficulties in finding applications of mathematics outside schools. One of my aims is to promote the use of mathematics and statistics in real-life situations.

2.10 Linking Teaching with Learning in Mathematics and Statistics

The book by Brooks and Springer (2022) contains a chapter on "Key aspects of teaching and learning in mathematics and statistics" (page 246), written by Joe Kyle and Peter Kahn. The authors state that in recent years, there has been more focus on learning and teaching mathematics and its application in HE. The transition from one educational stage to another can often be an uncertain process. In mathematics, there has been ongoing publicity over many years about the issues around the transition to higher education, but

the authors claim that there is still much work to be done. A few steps may help in ensuring that learning of mathematics and statistics is optimised, such as:

- use of 'pre-sessional' material before arrival;
- initial assessment (or 'diagnosis') of mathematical skills;
- ongoing attention to the design of early modules;
- strategic monitoring of early items of coursework;
- Some overarching form of academic support.

Umugiraneza et al. (2018) examined teachers' perceptions of improving the teaching and learning of mathematics and statistics, through questionnaires with open-ended and closed questions, that were administered to 75 teachers who volunteered to participate in the study. 72 of the participants suggested that the best way to improve learning of mathematics and statistics, would be by increasing the motivation and interests of learners. 62 participants agreed that teachers should improve on their explanations, and more focus should be given to preparation of the chapters they are supposed to teach. The participants (30) were also willing to take part in workshops, to enable them to stay in touch with the latest teaching methodologies, which may enable them to deliver the teaching content in a conducive manner.

With the above examples, it is clear that we need to investigate the theories that teachers may adapt, to maximise their teaching potential. In his paper, Begg (2015) encourages the adoption of the "Constructivist Theories" when it comes to teaching mathematics. Constructivist theories start from the non-positivist perspectives on knowledge and understanding, that is, they are theories about "how come we know". This is in contradiction to the traditional behaviourist approach on positivism, where one believes that there is an external world independent of the observer and that the observer is able to make sense of this world and understand it.

2.10.1 The Constructivist Approach

Glasersfeld (1991) dates the concept of constructivism to Xenophanes (6^{th} century B.C.), who argued that even if someone is successful in describing exactly how the world is, one would have no way of knowing that it was the true description. The author went to mention that the sceptics would say that whatever ideas or knowledge we must have, they would be derived from our experience, which includes sensing, acting, and thinking. In contrast, constructivists would counter-argue that if this is the case, we have no way of checking the truth of our knowledge, with the world presumed to be lying beyond our experiential interface, because to do this, we would need access to such a world that does

not involve our experiencing it.

In simple terms, constructivism sees the world, and what we can know about the world, as socially constructed. This view refers to the nature of reality and the nature of knowledge which are also called ontology and epistemology in research language. In other words, meanings are not fixed but can change over time depending on the ideas and beliefs that actors hold (Cobern (2010)).

Begg (2015) compares positivism with constructivism, with regard to the world of education, by first explaining the position, positivists would take. Positivists believe that there is an external world, which is independent of the observer and that the observer can make sense of this world and understand it. Such an accurate understanding of the world implies that a shared understanding is possible, and education should therefore be concerned with ensuring that students come to share this understanding. In contrast, constructivists also agree with the existence of an external world that is independent of the observer, but in addition, they claim that the observer is not in a position to know this world. The observer makes meaning of this world by constructing a representation that depends not only on their sensory input but also upon all their prior learning and experiences. As each person has unique experiences, each person's construct will differ. In as much as people have similar backgrounds and similar views, the possibility for a significant amount of shared construction exists.

Glasersfeld (1991) argues that there are two principles of constructivism, namely:

- Knowledge is not passively received either through the senses or by way of communication. Knowledge is actively built up by the subject.
- Cognition serves the subject's organisation of the experiential world, not the discovery of an objective reality.

Richardson (2005) elaborates on the above statements and explains that while constructivism is a theory about coming to know, there is also a need to emphasize that the construction of knowledge is assumed to occur in every learning situation and despite teachers. The author goes on to say that

"*lectures provide sensory input and if learners engage with the ideas presented and construct meaning from them, then the lecture may be an efficient way of introducing ideas and promoting the construction of knowledge. In spite of this, most constructivists would agree that the traditional transmissive models of teaching do not promote the interaction between prior and new knowledge, nor the conversations and interactions that are needed for internalization and deep understanding*".

2.10.2 Constructivism in Mathematics Education

Ampadu and Danso (2018) state that until the early 1970s, behaviourism was mainly used in the teaching of mathematics in most classrooms around the world. The principle of behaviourism, where the teacher is considered as the custodian of knowledge and expected to transmit that knowledge, has been highly criticised by several researchers after it has dominated the teaching and learning practices in many classrooms over the years. According to Abrams and Lockard (2004), "*the core of behaviourism, the reinforcement principle, does not adequately explain the complexity of thinking, memory, problem-solving, and decision-making*". As mentioned in the previous subsection, the constructivist approach is based on the idea that knowledge can never be passed from one person to another, and the only way to acquire knowledge is to create and construct them (Vintere (2018)). From the survey and interviews conducted by Ampadu and Danso (2018), with teachers, it was revealed that, interestingly, teachers understand the importance of applying constructivism when teaching mathematics, but they find it easier to adopt a behaviourism approach in their style of teaching. The authors suggest that it is very important for teachers to understand the crucial role that constructivism play in students' learning of mathematics and statistics.

The study by Vintere (2018) on the teaching of mathematics and statistics, in HE, revealed that five aspects have emerged, with regard to constructivism, namely:

1. Learning is a process which connects "what we know" and "what we still need to learn".

2. Learning is a social process; that is, the relationship between people (teachers and students) is important.

3. Learning is a situational process; that is, it involves participation in social and cultural circumstances.

4. Learning is based on students' activity and autonomy.

5. Learning is a meta-cognitive process which includes the understanding of the skills and strategies that enable successful resolutions of problems, and to use those skills and strategies to learn effectively.

In accordance with Cobb (1988), there are two major goals for mathematics:

1. Students should develop mathematical structures which are more complex, abstract, and powerful and they are increasingly able to solve a wide variety of meaningful problems.

2. Students should become autonomous and self-motivated in their mathematical activity. The students have to believe that mathematics is a way of thinking about problems.

Cobb (1988) claims that teachers should not merely convey information about mathematics to students, but instead, they should facilitate profound cognitive restructuring and conceptual reorganisations. The author states that students routinely use the instructions given by teachers and apply them in solving mathematical tasks, and this approach should be discouraged as it hinders students from understanding the concepts.

The study by Cirik et al. (2015) reveals that both, the teachers, and the students, must agree to use a constructivism approach, as some students may prefer surface learning, to deep learning. Nevertheless, constructivism should be used in classes where students find it difficult to understand the whole purpose of learning mathematics and statistics.

The recent study by Lumbantoruan and Natalia (2021) was very specific to the use of a constructivist approach to teaching statistics. Their research revealed that students performed better when teachers adopted constructivism in statistics classes, and students noticed the difference in the style of teaching when teachers adopted the approach. Topics which were initially considered vague, were now easier to understand and the purpose of those topics was clear to the students, in terms of their applicability and usefulness in real-life situations.

2.11 Teacher's Maths Anxiety

Having discussed students' maths anxiety earlier in this chapter, it is important to mention teachers' maths anxiety, as this is also a factor that was mentioned by students, as one which triggers their negative feelings towards learning mathematics and statistics. Ganley et al. (2019), in their recent article, reveal that there is little research done on this topic, as it has been tough to come up with a practical "measurement" to measure teacher's maths anxiety. The authors discuss that teachers' maths anxiety usually start when teachers with a non-mathematical degree have to teach mathematics and statistics to their students. It is more predominant in secondary schools, but it is also a common problem in HE. Interestingly, Beilock et al. (2010) reported that the maths anxiety of lower elementary female teachers predicts poorer maths performance of their female students.

Ganley et al. (2019) also suggest that teacher maths anxiety may be malleable and that maths methods courses could serve to reduce prospective teachers' maths anxiety. This is also supported by Chang (2009), who claims that, with proper guidance, a teacher can teach mathematics and can overcome the anxiety issue. Ganley et al. (2019) also suggest that teachers (with or without a mathematics / mathematical degree) who will be

teaching mathematics, should go through a "Maths Anxiety Scale for Teachers" (MAST) which measures the anxiety level, so that teachers may get help if needed. Although the measure has its limitations, it can be used as a benchmark and can be further adapted. The authors encourage researchers to come up with a better scale rating that MAST currently possesses due to the limitations, such as:

- Only a few aspects of teachers' maths anxiety can be captured with their current MAST template.
- The sample size, for data collection, should be increased, for standardisation process.
- There is no clear cut-off determined for what constitutes evidence that a person is "high" in maths anxiety. The authors used a somewhat arbitrary cut-off point.

Carrying on Ganley et al. (2019) work, the suggested MAST template was in the form of a short questionnaire which can be distributed to teachers at the beginning of the academic year when they have been allotted to teach classes with mathematics and statistics contents. The proposed template consisted of the following questions:

1. I worry about making mistakes while solving maths problems in front of my class.
2. I would be nervous teaching maths to students in a grade level any higher than I am used to teaching.
3. I would feel uncomfortable if another teacher observed me teaching a maths lesson.
4. When I am teaching, I avoid going into depth about maths concepts I don't feel comfortable with.
5. I would feel uncomfortable if a student asked me to explain why an advanced maths strategy works.
6. It makes me nervous to solve a maths problem in front of my class if I haven't already figured out the solution.
7. I worry about not being able to answer students' questions about mathematics on the spot.
8. I would be anxious if my principal (Head of Department) observed my class, particularly during maths time.

As mentioned in the first chapter (**Chapter 1: Introduction**), I am the only mathematician who teaches at MUM, and other colleagues often teach quantitative components

to their students, it is important to implement a mechanism which may help teachers (including myself) identify if they are well-prepared to teach mathematics and statistics. Not much has been published on the types of help that can be given to those teachers, (who have been identified to be maths-anxious), but Bursal and Paznokas (2006) bluntly suggest that teachers who are maths-anxious should not teach mathematics or statistics.

2.12 The Current Situation at Middlesex University Mauritius

This chapter underscores the significance of researching how teachers can adapt their methods when instructing mathematics and statistics to non-specialist students. Specific and noteworthy details about MUM, particularly within the discussed literature, include:

1. MUM anticipates a 50:50 ratio of local to international students, with a current high proportion of international students.

2. A substantial 95% of MUM students are from Africa, a notable figure for a British international branch campus.

3. MUM is comparatively small when viewed in a global context.

4. Despite being French-speaking, the majority of students, including locals, are taught in English.

5. Teachers at MUM, responsible for teaching quantitative content, may not necessarily hold a Mathematics degree.

Furthermore, the examination of existing literature has revealed certain gaps that could merit additional research (at MUM or elsewhere) within the realm of offering mathematics and statistics support to non-specialist students in higher education.

1. In the realm of mathematics education for non-specialist students, most research has been quantitative, with a limited application of thematic analysis.

2. A very limited amount of literature exists on the differentiation between mathematics anxiety and statistics anxiety. This study adopts the term “maths anxiety” for students dealing with both mathematics and statistics, suggesting a potential avenue for future research at MUM.

3. Current literature on maths support often focuses on specific student groups, such as psychology, business, or engineering students. However, this study uniquely encompasses students from various academic schools.

2.13 Endnote on Literature Review

In conclusion, the challenges surrounding the teaching of mathematics and statistics to non-specialist students within higher institutions, demand a critical examination that extends beyond surface-level observations. Although outside the scope of this research, the exploration of probable cases of developmental dyscalculia will serve as an illuminating preamble to the imperative of proactive identification and targeted interventions. The urgency lies not only in addressing the challenges faced by affected individuals but also in re-evaluating institutional structures to accommodate diverse learning needs and ensure an inclusive educational ecosystem.

Furthermore, the pervasive mathematics and statistics anxiety gripping students at different levels of study forms a disconcerting narrative, unveiling a formidable barrier to the acquisition of essential quantitative skills. This anxiety, often fuelled by societal expectations and reinforced gender biases, signifies a systemic flaw that requires a comprehensive overhaul of pedagogical approaches and cultural norms. The perpetuation of the belief that girls cannot excel in mathematics becomes a self-fulfilling prophecy, a deeply ingrained bias that undermines the potential of half the population and obstructs the pursuit of gender equality within STEM disciplines.

Exploring how emotions are involved in learning mathematics and statistics reveals an important part of the learning process. It is not just about thinking - it also affects how people feel about their own abilities and what they think about these subjects. To deal with these emotional aspects, we need to change how we teach. Teachers should create a positive and supportive atmosphere that helps students connect with mathematics and statistics in a good way. This can help get rid of the negative feelings and worries that people often associate with these subjects.

Moreover, the chapter underscores a crucial but often overlooked facet of "teachers' maths anxiety". Educators, as the architects of the learning experience, play an instrumental role in shaping students' attitudes, confidence, and resilience in the face of mathematical and statistical challenges. The prevalence of maths anxiety among teachers reflects a systemic issue that demands urgent attention. Professional development programmes and support mechanisms are imperative to equip educators with the tools necessary to navigate their own anxieties and, in turn, foster a more conducive learning environment for their students.

In essence, confronting the multifaceted challenges discussed in this chapter necessitates a critical reassessment of higher education's role in shaping the future of mathematics and statistics education for non-specialist students. The call for action is not a mere sugges-

tion but a mandate to dismantle ingrained biases, challenge traditional pedagogies, and foster an inclusive and supportive educational landscape. By addressing developmental dyscalculia, mathematics and statistics anxiety, gender biases, emotional dimensions, and teachers' anxieties head-on, institutions can pave the way for a transformative educational experience. This transformation extends beyond the realm of academia, creating a ripple effect that empowers individuals to embrace quantitative literacy with confidence, resilience, and a passion for lifelong learning.

CHAPTER 3

PROJECT DESIGN AND METHODOLOGY

3.1 Introduction

This study aims at investigating students' experiences, perceptions and personal expectations, at MUM, an overseas, British university campus, to better understand their learning needs in mathematics and statistics. As mentioned before, the research focuses on non-specialist students. In addition, ways to develop a more productive teaching strategy, to facilitate learning, will be explored. The research methodology that was chosen in this study is of important consideration for numerous reasons. As the university plans to expand in size, both in terms of number of students and the variety of programmes offered, it is noted that mathematical and statistical contents in study programmes are increasing. It is expected that the university will anticipate more academics to teach modules with a considerate amount of quantitative components. Hence, to facilitate future academics in their endeavours to help students and enhance their approach to teaching, the methodology suggested in this research is crucial. The chapter starts with a personal perspective on ontology and epistemology, following which, a discussion on the research philosophy behind this study will be showcased. A rationale for research approaches will be debated, and the research methods used will then be discussed. A comprehensive reflection on the data collection approach, data analysis processes and the validity of the study is also discussed in detail. The criteria used to select the participants, which in this case are

students and academics, and issues arising around this process are examined. Ethical issues and considerations are debated and solutions on how these were handled will be discussed.

Farrow et al. (2020), as shown in Figure 3.1, describe a clear pathway of how the Methodology chapter should be framed, and the following sections will endeavour to follow the same proposed pathway.

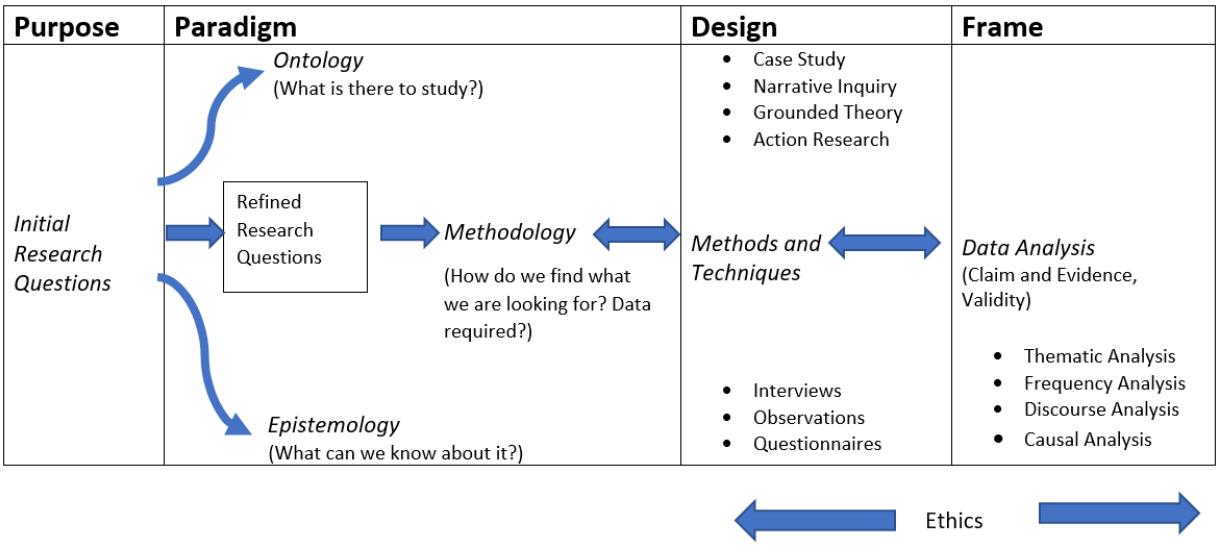

Fig. 3.1 Research Design - Adapted From: Farrow et al. (2020), Page 26.

The study was designed to investigate the following research objectives (see also Subsection 2.1.2, Page 23):

- To investigate the perception of non-specialist students in mathematics and statistics in Higher Education.
- Developing methods to assist those students to alleviate their "fear" and "anxiety" towards these subjects.
- To lead and manage changes in connection with the teaching and learning of mathematics and statistics.

To achieve the objectives, a research design was developed, after taking into consideration all the research approaches and research methods necessary for this study.

3.2 Ontology and Epistemology - A Personal Perspective

Ontology and Epistemology are two unique areas of study for branches of knowledge. According to Saunders et al. (2019), **Ontology** refers to "assumptions about the nature

of reality". In simpler terms, it means how researchers see the world, and in my case, this concerns mathematics education, and this guides me to enquire about what research I should do, in this field. My ontological belief is that education is an ever-changing field, where all stakeholders need to adapt to the dynamic system, they are working in. Moreover, working at a new HEI demands that questions to improve the current system are raised. From a personal perspective, I have observed that students are less and less keen to learn mathematics and statistics. In addition, there is that state of panic when I meet my students for the first time, as I tend to be asked about the contents of mathematics and statistics in the curriculum. Even before joining MUM, during Open Days, potential students tend to talk about their fear of mathematics and statistics, and it has been observed that they sometimes decide to avoid enrolling in a particular programme with high quantitative content, though they might have initially been keen to do so, to enrol in another programme where there is less, or even no mathematics and statistics contents. My early experience at UoG (teaching specialist students) had "groomed" me in expecting that students would enjoy modules with mathematics and statistics, but working at MUM showed me a new reality. The aim was always to support my students, and the reality slowly dawned upon me that some students were not keen on these disciplines. This experience at MUM provided all the reasons why I needed to explore the support system further, and the onus was thus on me, to understand the perceptions the students have, on learning mathematics and statistics.

The ontological questions automatically give rise to the epistemological questions. **Epistemology** examines how a researcher examines reality. As Siegel (2014) suggests, teachers may have very specific questions that they may ask themselves, to create the knowledge they want to acquire. Some of the questions are:

1. What is the best way to teach particular content?
2. How do students achieve an understanding of that content?
3. How do they best master scientific practices?

My journey since I first started teaching at the tertiary level, has been about how to give support to students studying mathematics and statistics. There have been many informal attempts to provide additional help to students, namely the creation of a Maths Society at UoG, and CeMaSTeL at MUM. The aim was to give students "a voice" so that they could talk about their feelings. The actions following these informal talks, were initiated, but the feeling that these were not enough always worried me. No formal policies or rigid support mechanisms were ever in place at the HEIs I have been working at. Students had questions and were worried, but there was no formal way to document

these, and no mechanism in place to provide efficient support to those students. The drive to understand students' feelings and perceptions, and hence, coming up with a better support mechanism, was a personal target for me. This study intends to investigate students' perceptions of mathematics and statistics and to listen to those students, as they are the main stakeholders in this academic environment. Inquiring about what bothers them, or what makes them happy when they learn mathematics and statistics, would hopefully help me answer questions of my own.

3.3 Research Philosophy

My drive to do this research is based on my philosophy to improve the teaching strategies that are currently in place at MUM, as this will have an impact on students' learning experiences. I planned to have an unbiased view of the study, and this was reinforced during the data collection process. Interestingly, when I first started my research work, my affinity, being a Mathematician, was towards using a positivist approach. I was hoping that the logic derived from literature would enable me to develop a theory. Gradually, as I became more aware of the problem and once I started organising my themes and subsequent questions towards data collection, it was evident that I needed to have an open mind to the approach that I would eventually adopt. My role was not to impose my ideas on my participants, but rather to listen carefully to what they had to say. Being judgmental was never going to work, nor was it my intention to take a specific stand on comments made by my participants, or their views on mathematics and statistics, which are my areas of expertise and also my passion.

My research comprises qualitative data collection through focus group interviews and face-to-face interviews. While trying to support the findings through thematic analysis, an online questionnaire was also disseminated to see if data collected through simple questions would validate the findings in the interviews. This will be explained at a later stage of this thesis (Section 5.2, Page 127). Due to the change in approach, albeit at completely different stages of my research work, a comparative study of the different Research Philosophies is necessary to ensure that my study fits into the correct framework. Al-Maamari (2016) wrote a very interesting article on the misconceptions of doing research. Out of the 10 misconceptions that he enumerates, the one that is mostly related to novice researchers is:

"Research is a solitary activity completed by white-coated scientists in a laboratory."

It is now a common fact that a growing number of researchers, in numerous fields (including Education), are conducting their research outside laboratories, to contribute and create new knowledge. As stated above, it is hence extremely important to understand the research philosophies.

To put this chapter in context and to further develop it, one must first understand the values and importance of doing research in education. Newby (2014) explains that Educational Researchers can be:

- Individuals (for example, teachers who seek to improve classroom performance).
- Groups of people (for example, a department trying to investigate exams results).
- Organisations (for example, schools, universities, government bodies. Some of the research will be done by individuals, and some will be undertaken by those outside the academic communities. These can be consultants recruited by the organisations to research on their behalf).

Educational Research (ER) can easily be recognised, than defined (Wellington (2015)). The author gives a sound working description of ER as *"A systematic, critical and self-critical inquiry in the field of education, which aims to contribute to the advancement of knowledge"* .

Opie (2004) explains that ER can be viewed as a process where information, in the world of education, is collected and analysed, to understand and explain it better. This study, based on the research questions and their aims and objectives, as stated in Chapter **Aims, Objectives and Literature Review**, Subsections 2.1.1 and 2.1.2, on page 23, will try to understand the feelings of students about quantitative contents in their study programmes. The ultimate aim is to have an action plan to fully support students in mathematics and statistics. The research methodology was guided by asking and answering a few questions, as suggested by Cohen et al. (2011, p. 127):

- What are the specific purpose of this research?
- What are the research questions, aims and objectives?
- what is the focus of the research to answer the research questions?
- What are the main methodologies of the research?
- Is it a mixed method research?
- How will the validity, and reliability be addressed?
- From where will data be acquired?

To answer the above questions, and to identify the research methodology, it is important to study the types of designs and do a comparative study which will then be filtered

into the ideal design for the research. Before we embark into the thought process and decision-making process, it is fair to say that the final research roadmap of my Research Design will be based on the Research Onion suggested by Saunders et al. (2019) on Page 130 of its 2019, 8^{th} edition.

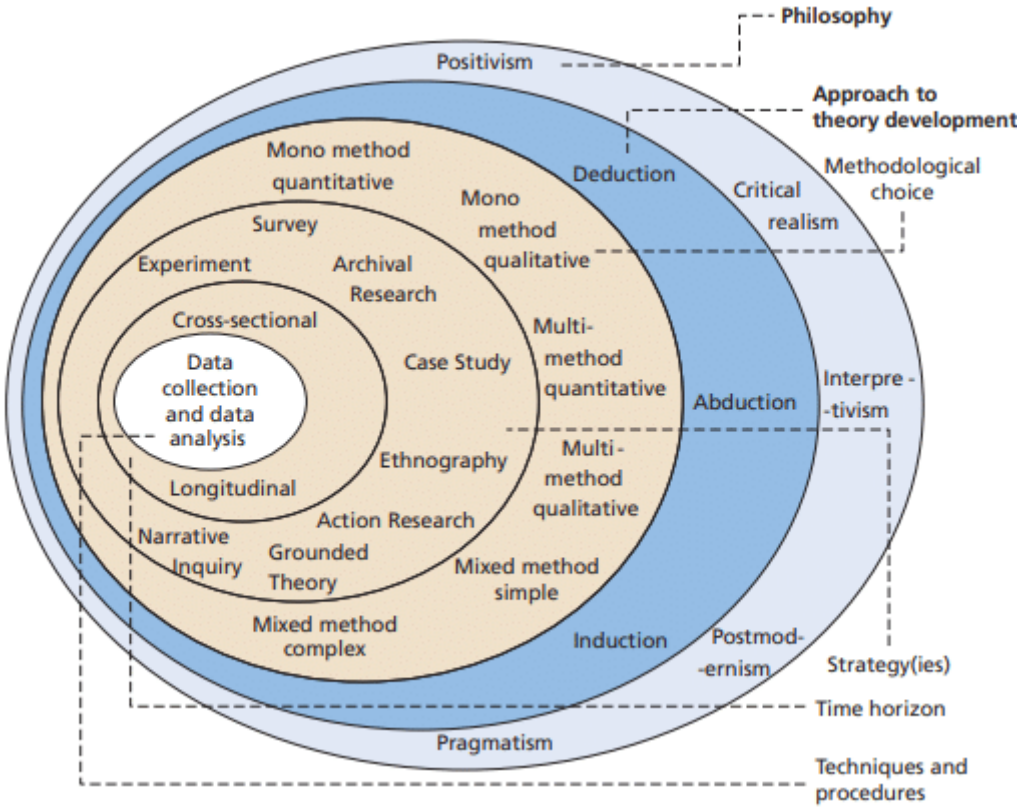

Fig. 3.2 Research Onion - Source: Saunders et al. (2019), Page 130.

The Research Onion describes the different decisions that were needed to make when developing the research design methodology in this thesis. In his article, Melnikovas (2018) indicates that the Research Onion "*is a tool which helps to organise the research and develop research design following the layers of the research onion step by step*". In simple terms, the purpose of the research onion is to provide a systematic and structured approach to research design, enabling researchers to consider and integrate different elements at each layer. The layers typically include philosophy, approach, strategy, choices, time horizon, and techniques/methods.

By using the research onion, researchers can navigate through these layers and make informed decisions at each stage of the research process. It encourages a comprehensive and thoughtful approach to designing and conducting research, taking into account the philosophical underpinnings, methodological choices, and practical considerations. Overall, the research onion serves as a guide to ensure a robust and well-considered research design.

3.3.1 Positivism

Thomas (2013) states that for positivists, knowledge about the social world can be obtained objectively, that is, what one can see and hear, can be viewed and recorded without too many issues. In simpler terms, things can be observed, measured and explained scientifically. The term was first coined by the French philosopher August Comte, who suggested that the scientific form is the most advanced form of thinking. Taylor and Medina (2011) consider Positivism as a "scientific" research paradigm whose purpose is to investigate, confirm and predict a solid, law-like pattern of behaviour. This is mostly used to test hypotheses and theories. Cresswell (2013) states that positivism mainly focuses in the objectivity of the research process, and the paradigm focuses on quantitative methodology while using experimental and control groups of participants. It is usually a longitudinal study with the scores measured prior to and after the administration of the test.

Based on my aims and objectives for this study, Positivism can be discarded as a paradigm for research. No tests were to be administered on my participants and there was not going to be any hypotheses testing.

3.3.2 Non-Positivism - Interpretivism

The interpretivists, according to Hudson and Ozanne (1988), aim to describe many perceived realities that cannot be known a priori because they are time- and context-specific. The authors state that, thus, research is an emergent process. As the perceived realities change, the research approach must adapt to the new system. In simpler terms, interpretivists believe that there are multiple "realities", and these realities may depend on other systems for meanings (Lincoln and Guba (1985)).

According to the authors, interpretivists adopt a more personal and flexible framework, as compared to positivist research, where rigid, structural frameworks are used. Black (2006) and Hudson and Ozanne (1988) add that interpretivists are more receptive to capturing meanings in human interactions and make sense of what is perceived as reality.

Interpretivism considers the differences in culture and circumstances as triggers which lead to different social realities, and applauds the insights gathered by researchers, while criticising the rigid, definite laws which are used to generalise variables and factors (Alharahsheh and Pius (2020)). An interpretivist researcher needs to understand motives, meanings, reasons and other subjective experiences which are time and context bound (Hudson and Ozanne (1988)).

As my research concerns students' perceptions and emotions, I will adopt an Interpretivism approach towards the study. The ensuing analysis of students' past experiences

will be collected through interviews, and interpretation of those experiences, as well as students' views on those, will be subjective in nature.

3.4 Rationale for Research Approaches

In this section, several research approaches, such as Action Research, Experimental Research, Case Study, Grounded Theory, Ethnography and Narrative Inquiry, will be evaluated, to put my work-based research in context.

3.4.1 Action Research

Although the origins of Action Research (AR) within the literature, are unclear (Masters (1995)), many authors, such as Holter and Schwartz-Barcott (1993) and Kemmis et al. (2014), claim that AR originated from Kurt Lewin, an American psychologist, in the mid-1940s. McNiff and Whitehead (2016) differentiate AR as a research approach where the main focus is to intentionally influence practice positively, through the implementation and evaluation of some purposeful change. It is a reflective and cyclic approach to research, which is situated in the work environment of the researcher (practitioner).

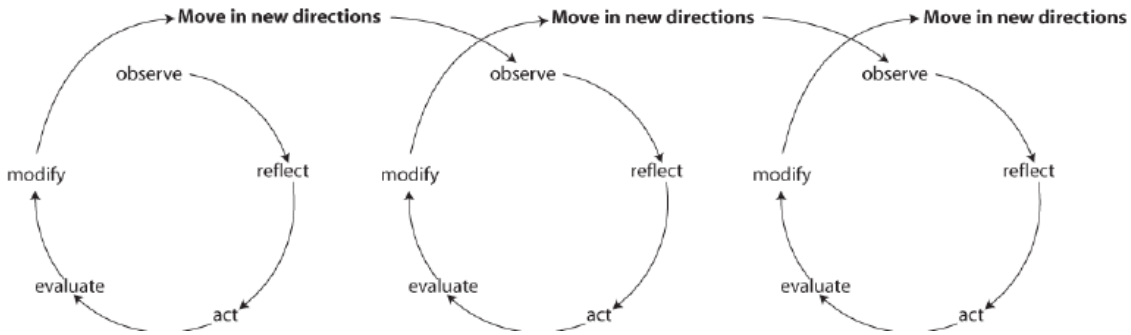

Fig. 3.3 The Action Research Cycles, based on McNiff and Whitehead (2016)

As shown in Figure 3.3, the cycle consists of continuous and repetitive steps, which the researcher undertakes in his practice. AR offers a means that can be brought to bear on the understanding of a problematic situation. The reflective cycle starts with an analysis of the problem at hand, followed by identifying a systematic intervention, that evolves and is aimed at achieving a more effective outcome (Opie (2004)). AR is therefore never solitary, as it involves individuals finding ways to improve what they are doing, in the company of others. Those individuals then claim that they have improved what they have been doing, and they test the validity of those claims against critical feedback from others. The second cycle then follows, and the same process is carried through (that is, observe, reflect, act, evaluate and modify). AR is a process where collaborative work is performed to improve practices, by improving learning about those practices, and practitioners checking with one another for feedback and validity.

In my opinion, AR is not a suitable approach for this research, as my study involves learn-

ing about students' perceptions towards mathematics and statistics. That is, my study has the purpose of exploring the unique situation and changes according to the students whom I teach every year. In contrast, AR would require the researcher to intervene in the situation, with set procedures, which was not the direction in which I wanted to take the research, as I tried to explore the events, situations and past experiences, organically.

3.4.2 Experimental Research

The premise for undertaking experiments in Educational Research is based on the suggestion that the subjects' actions can be controlled or conditioned by external events. Basically, they are the products of the environment that they find themselves in. For the case of experiments, thoughts, feelings, personality and other such subjective elements are irrelevant (Opie (2004). Experimental work follows a series of reasonably well-defined stages to set up a test, or a model, to simulate the real world (Wellington (2015)). Initially, the researcher selects the dependent and the independent variables to formulate a hypothesis and set an appropriate level to test the hypothesis. The subjects are assigned randomly to experimental or control groups of study. A particular treatment is carried out on the experimental group, and the key point is that the control group is not subjected to that treatment. The conclusion comes from looking at the differences in mean results, and uses inferential statistics to decide whether any observed differences are caused by the independent variable, or could have occurred for other reasons.

In the case of experiments, significant ethical issues arise and they are not so straightforward to implement within the constraints of an Educational Research degree. Experimental Research raises considerable moral questions, and ethical dilemmas, centred on differential treatment. For example:

- If the research involves a control group, will participants assigned to it, miss out on anything that might be beneficial? Can this be justified?
- If, before the research is finished, it becomes clear that an experiment is having either positive or negative effects, will a researcher be prepared to abandon their research plans?

In Experimental Research, it is nearly impossible to do a "true experiment", because of the kind of randomisation required. It is very difficult to conduct research in such a controlled environment that aims to keep other variables constant. Therefore, in Experimental Research, the best that can be hoped for is a "quasi-experiment", which is a compromise where the different groups involved in the experiment are deemed to be equivalent (Opie (2004)).

An experimental research design incorporates some form of change to the participants,

and tests for a causal relationship. Additionally, as explained, numerous ethical issues are raised in Experimental Research, requiring in-depth and careful consideration, due to the subjects being students (humans). My research is not aimed at exploring students' perceptions, based on testing conditions, but rather on a more subjective approach.

3.4.3 Case Study

The case study is a research approach focusing on understanding a small sample of interest, within a single setting, from one particular perspective. It aims to investigate a contemporary phenomenon within its real-life context (Yin (2018)). Crucially, case studies do not just describe a situation, but try to attribute causal relationships between the phenomenon and its context. According to Newby (2014), a case study details the analysis of an individual event or setting, chosen either because it is unusual, typical, problematic, or exemplary.

Case studies are an excellent approach to give researchers rich descriptions and details of a situation, but it has its challenges, such as:

- There may be a problem in getting at the truth. My study is not about seeking the truth, but more about interpreting students' perceptions of learning mathematics and statistics.
- Researchers can be led to the wrong conclusions because they might start on a track determined to seek or show something in particular.
- Understanding the limits of a case study. Using a case study approach requires the researcher to be completely knowledgeable about the problem at hand, but it is easy for the researcher to be side-tracked, as one thing quickly leads to another.

Cohen et al. (2011, p. 127) recognise that case studies are "a step to action", that is, they contribute to the world of action that they are part of. The insights gained may be put to use directly for staff development, institutional feedback, education policy-making, and formative evaluation. Case studies frequently follow an interpretive research tradition, rather than the quantitative approach, though this is not always the case. That is, they see the situation through the participants' views.

The case study is not a suitable approach for my research, because it mostly concentrates on a specific organisation, studying specific problems, deriving from specific situations. A case study typically investigates the practices in one particular case, with the aim to implement that elsewhere. However, my research study aims to investigate the current sentiments of students at my university, which does not fit in with the essence of a case study.

3.4.4 Grounded Theory

Grounded Theory (GT) was developed by American sociologists Barney Glaser and Anselm Strauss in 1967. Charmaz and Thornberg (2021) explain that GT is said to present qualitative research as a scientific method because it follows a set of systematic procedures for collecting and analysing data. Researchers use it after working through a manual (Strauss and Corbin (1998)) and following a series of structured workshops with a research group. Therefore, it requires systematic rigour.

A key aspect of GT is that it gives objectivity to qualitative research. Here, researchers do not have a predetermined idea on the approach of the qualitative analysis that they would use, but instead, the collected data drives the researchers into adopting a particular analysis, where theories are then developed. GT requires researchers to collect detailed and in-depth data and then generates theory inductively from the data. The theory emerges as the data collection progresses and the theory is firmly "grounded" in it.

While such an approach will work for some qualitative research studies, it is not appropriate for the purpose of my research, as my study is grounded in antecedent work. It is based on a previous sound and reliable body of knowledge, which has been used to shape the research design and data collection. Through my study, I am aiming to contribute to existing research on students' perceptions on learning mathematics and statistics.

3.4.5 Ethnography

Brewer (2000), Page 6, defines **Ethnography** as:

"The study of people in naturally occurring settings or 'fields' by methods of data collection which capture their social ***meanings*** *and ordinary activities, involving the researcher participating directly in the setting, if not also the activities, in order to collect data in a systematic manner but without meaning being imposed on them externally."*

Bell and Waters (2018) suggest that ethnographic researchers work towards understanding the dynamics of culture. Additionally, the authors emphasize that participant observation allows researchers to immerse themselves in the same experiences as the participants, enhancing their comprehension of the reasons behind their actions. To effectively study individuals or groups, the researcher must gain acceptance, often by performing the same tasks or residing in the same environment and circumstances as the participants for extended periods. This, as claimed by the authors, is often time-consuming.

Considerable deliberation went into determining whether to adopt Ethnography for this research. One drawback of Ethnography, as mentioned earlier, is its time-consuming nature, and it also presents a challenge regarding representativeness. Given that this research involves examining multiple focus groups and conducting face-to-face interviews, it was

acknowledged that participants might have had diverse experiences in studying mathematics and statistics, influenced by factors such as their teachers, families, or environment. The groups, in terms of experiences, were not uniform, emphasizing the importance of listening to individuals or groups of participants as they discussed their past experiences in learning mathematics and statistics.

3.4.6 Narrative Inquiry

The decision to reject Ethnography has been justified. Regarding Grounded Theory, Gray (2014) highlights a criticism that points out the fragmentation of data and its occasional detachment from the context of the social processes it is meant to represent. Nevertheless, using oral or life histories in research often produces qualitative data in the form of narratives and stories, leading to more holistic data sets. Using narratives is an ideal way to capture the lived experiences of participants and this approach has been widely used in areas such as traumatic events, and education.

Connelly and Clandinin (1990) assert that humans are inherently storytelling beings, navigating both individual and social realms through the lens of narrative. Therefore, the examination of narratives, as in Narrative Inquiry, is essentially an exploration of how humans engage with and interpret their experiences in the world. According to the same authors, learners, teachers and researchers are storytellers and characters in their own and other's stories. In a narrative inquiry study, the primary objective is for participants to share their life experiences by providing the researcher with detailed and immersive stories.

Narrative Inquiry data analysis is sensitive to the time sequence that the participants project into their accounts of the important events related to the research. The narrative text is viewed within the context and social situation where it is created. Some researchers accept the truth of the narrative at face value, while others see narratives as social constructions, located within power structures and other social norms (Punch (2013)).

The Narrative Inquiry approach was chosen for my research study owing to its ability to reveal unique perspectives and a deeper understanding of a situation (Cohen Kadosh and Walsh (2007)), often giving voice to marginalised populations whose perspective is not often sought. My research tries to understand students' past experiences in mathematics and statistics learning. Each participant has unique, individual experience which may differ from other participants' experiences. As mentioned in Chapter 2, **Aims, Objectives and Literature Review**, on Page 22, students who are maths-anxious, often find it tough or embarrassing to seek support. Participants from such populations are hesitant to speak up, and this research approach gives them a voice with which to share their

stories.

3.4.6.1 Contrasts between Ethnography and Narrative Inquiry

The boundaries between Ethnography and Narrative Inquiry may seem a little blurred, therefore further arguments as demonstrated in the table below (Table 3.1) helped to reject the ethnographic method as an approach in this study. The table was adapted from Creswell and Poth (2016) as a comparative foundational analysis of both Narrative Inquiry and Ethnography.

Table 3.1 Contrasting Foundational Considerations of Narrative Research and Ethnography - Adapted from Creswell and Poth (2016)

Contrasts between Narrative Research and Ethnography

Foundational Considerations	**Narrative Research**	**Ethnography**
Research focus of approach	Exploring the life of an individual	Describing and sharing a culture-sharing group
Unit of analysis	Studying one of more individuals	Studying a group that share the same culture
Type of research problem best suited for approach	Needing to tell stories of individual experiences	Describing and interpreting the shared patterns of culture of a group
Nature of disciplinary origins	Drawing from the humanities including anthropology, literature, history, psychology, and sociology	Drawing from anthropology and sociology

In my research, I aim to delineate the nuanced disparity between Narrative Inquiry and Ethnography. A pertinent illustration of this contrast can be found in the structure of the focus groups. The formation of the focus groups (students) was not based on their common feeling towards mathematics and statistics, but rather on factors such as gender, level of study program, and international diversity. Specifically, no effort was made to form focus groups with students exclusively expressing either "dislike" or "appreciation" for these subjects; instead, participants within each focus group held diverse opinions. Moreover, it was anticipated that students sharing the same nationality and cultural background would exhibit diverse opinions and feelings toward mathematics and statistics.

Upon thorough consideration of the mentioned factors, the decision was made to exclude Ethnography from this doctoral research. The identified drawbacks, especially the time-intensive nature of Ethnography and its challenge regarding representativeness, significantly influenced this decision. Given the research's nature, involving the exploration of diverse experiences within multiple focus groups and face-to-face interviews, it became apparent that Narrative Inquiry would better serve the objective of capturing the nuanced and varied perspectives of participants in their past experiences of learning mathematics and statistics.

3.5 Rationale for Research Methods

Various research methodologies were assessed, taking into account the fact that the participants included academic colleagues and students enrolled at MUM. Deliberate thought was given to the types of qualitative data required, and subsequently, a determination was reached regarding the retention or exclusion of specific research methods. A survey (in the form of an online questionnaire) was also conducted with students.

3.5.1 Observation

As people participate in social life, they are diligent observers and commentators of others' behaviour. In that respect, Observation may be seen as a daily social activity (Ciesielska et al. (2018)). Observation is also one of the most important research methods in social sciences and at the same time one of the most complex.

According to Lodico et al. (2010), conducting good observational research takes time and practice. The authors suggest that researchers who adopt this research method must be well prepared with the observation process, and have all questions and sub-questions ready, to give researchers a clear idea of what activities and behaviours they must observe. Many researchers begin with just the observation process, without collecting any information on the activities. Following this step, researchers may review their sub-questions. After the initial observation, researchers then develop a protocol and prepare recording sheets appropriate to sub-questions. The authors advise on the following steps that researchers

should undertake:

- Short observational time. The time spent observing may increase as a researcher becomes used to the process.
- Researchers need to be alert to the behaviour of their participants, and to the activities that are being undertaken. Making mental notes and writing down notes may help.
- Focusing on specifics. Having a general idea of what is happening is not advisable. Instead, researchers need to concentrate on specific behaviours.
- Remain unobstructive. Researchers need to ensure that they do not interfere with the activities that are being undertaken. This may hamper the behaviour of the participants.

This method of research has been discarded for my study, as I aimed to understand how students perceive mathematics and statistics. It would have been ethically very challenging if I, as a teacher-practitioner, were to observe my students perform, while they solve seminar questions in class or how they behaved when I teach them. As mentioned above, focusing on the behaviour of participants is important, and running a class while observing participants would not have been easy. In addition, watching students answer questions while observing how they behave would have been almost impossible as my job as a teacher needed me to interfere with their work. Even if students were correctly answering questions, my job needed me to ask further questions to trigger more critical thinking. Another challenging aspect of this method, based on my study, is the time constraint. It would have been impossible to apply the observational method in my normal class, as I am expected to teach at that time, and it would not have been easy for students to give me more time, for research purposes, outside class hours.

About academic staff who were also my participants, I initially considered conducting observations on their classes when they teach mathematics and statistics. I eventually decided against this approach, as one of the aims of my study was to learn from colleagues' experience in teaching mathematics and statistics, and not necessarily to observe their style of teaching.

3.5.2 Focus Groups

Group interviews are used when the aim is to explore the perceptions or experiences of small cohorts of people who all have a common reason for responding. Gibbs (1997) meticulously differentiates between "group interviewing" and "focus group interviewing". She describes group interviewing as a form of interviewing which involves several people

at the same time, the emphasis being on questions and responses between the researcher and participants. Focus groups, however, rely on interaction within the group based on topics that are supplied by the researcher.

According to Powell et al. (1996), focus groups employ guided, interactional discussion as a means of generating "*the rich details of complex experiences and the reasoning behind [an individual's] actions, beliefs, perceptions and attitudes*". Williams and Katz (2001) suggest that using focus groups as a research method in the field of education enhances the development, evaluation, and/or assessment, of an educational programme, tool, or curriculum. The study by Ho (2006) focuses on the challenges researchers may face when using focus groups, such as:

- It may be challenging to have the viewpoints of all participants, as some of them may feel disconnected from the topic which is being discussed.
- Findings may come from subjective opinions, particularly from the researcher who might not be neutral in reporting the data.
- The researcher is in control of the process and may be biased with the types of questions asked.
- Some researchers may confuse "group discussion" with "focus groups".

This research method was adopted for my study, and I have also used a moderator to facilitate the running of the focus groups (more information on the presence of the moderator in Chapter **Project Activity**, sub-sub-section 2, on Page 88).

3.5.3 Online Questionnaire - For Data Collection Purpose

Marshall (2005) states that the purpose of using questionnaires as a means to collect data is to yield high-quality usable data, achieve good response rates, and provide anonymity. Participants, under the cover of anonymity, feel encouraged to participate and usually give more honest answers, than for example, interviews. There are several advantages when using a questionnaire, namely:

- the target audience, even if geographically spread, can be clearly defined and identified.
- The majority of respondents know what is asked of them.
- The focus of the analysis is numerical, that is, the questionnaire yields quantitative data.

As with other data collection tools, questionnaires also have certain disadvantages. Mar-

shall (2005) mentions that participants who are not conversant in English may find it hard to understand the questions asked if the questionnaire is administered in that language. Using a translated version may help those participants, although this comes with other challenges, such as the translation must be perfect and carry the same purpose and ideas as the original version (in English). The author also mentions that visually impaired participants may find it tough to contribute much when they receive questionnaires. Other challenges that researchers may face include non-response, whereby participants refuse to participate for numerous reasons (ambiguity of the questions asked; irrelevant questions; or just not eager to participate). There are also questions about whether the chosen participants are, indeed, being the ones who filled in the questionnaires. Cresswell (2013) suggests that precautions must be taken to cater for the above disadvantages when designing a questionnaire. With proper planning, this method can yield excellent data, which can be used for analysis.

A questionnaire was used to collect data for my study. The purpose was to observe (mis)alignment with my qualitative data, collected through focus groups and face-to-face interviews.

3.5.4 Interviews

Undertaking an interview requires considerable interpersonal skills (Opie (2004)). The interviewer must be able to maintain control of the process and is also expected to probe carefully and incisively and to present a measure of authority. The researcher must give assurance to the participants that their confidentiality will be respected. The two main methods of interviewing process are: "interviews by phone", and "face-to-face interviews".

A phone interview may be quite costly but the reason it is a popular method for data collection is because the researcher can reach out to participants who are remotely located and who may not be able to physically attend the interview sessions. There may be a few disadvantages with this method, as participants may be keen for the process to be complete and may answer questions in a very "arbitrary" manner. Furthermore, due to the costly nature of this method, researchers may try to complete the process quickly and this may hinder participants from ask for clarifications on some questions.

A face-to-face interview requires the researcher and the participants to be present simultaneously, whereby the researcher asks questions and the participant(s) answer. A face-to-face interview can be done online (online interviews), where tools such as Zoom or Microsoft Teams, may be used to connect to participants. This approach has been widely used during the COVID-19 pandemic, as an alternative way to connect to participants. In the normal context of the term, a face-to-face interview usually requires the researcher and the participant(s) to be physically present for the process to take place (before "online

interview" became a useful and alternate method for data collection).

For my research, face-to-face interviews were considered in two different cases:

- With academic colleagues who teach mathematics and statistics.
- With three students who received support in quantitative contents of their curricula.

3.5.5 Document Analysis

Karppinen and Moe (2012) state that much communication policy research involves the analysis of documents. Documents include a wide variety of personal, organisational and institutional information which usually states financial, political and legal records. According to Gray (2014), there are two types of documents: running records and episodic records. Running records include organisational documents, actuarial records and political and judicial records. These records are usually found in public domains. In contrast, episodic records are private records, usually in the form of personal diaries. McIntosh et al. (1995) suggest that accessing documents (online or otherwise) must be approached with some caution, to avoid any issues of bias, which may depend on the samples used, and the purpose of the research, to acquire the secondary data.

Document analysis was an important part of this research. Policies set by the Government of Mauritius were used to position the role of HEIs in Mauritius. Other documents from the Higher Education Institution of Mauritius - a quality assurance body of the Ministry of Education, were consulted, to find up-to-date data about recruitment numbers of students in HEIs.

3.6 Sampling

When statistical information is needed about a particular group sharing some common specified characteristics, the group is called the target population which may be people, animals, plants or objects. Each member of the target population is regarded as a unit of the target population. The population is the set of all measurements or counts of some specific characteristics of the target population (Amiran (2008)).

The target population may be small, large or infinite. When each unit of the target population is surveyed, this is called a complete enumeration or census. When only part of the population is surveyed, this is called a sample survey. A sample is a proper subset of a population. For the sample survey to be valid, the sample should be free from any bias. A fair sample is representative of the population, that is, it should possess as far as possible, all the characteristics of the target population.

Most often, it is a sample survey which is carried out and not a census for the following reasons:

1. A census, particularly if the population is very large, is very expensive.
2. Carrying out a census is very time-consuming. If the required information is urgently needed, a sample is much more convenient.
3. There may be a lack of resources like expertise. When sensitive or very accurate information is needed or very precise measurements need to be made, only statisticians are qualified to do that.
4. Repeatedly collecting the same kind of information on a very large scale may result in erroneous data being collected. On a small scale, the same kind of information may be more precisely and carefully collected.
5. It is much easier to check the accuracy of data collected on a small scale than on a very large scale.
6. Not all the units of the target population are present during the time allotted to carry out the survey.
7. Not all the units of the target population are accessible.
8. Working with the target population may be a never-ending process.
9. Surveying may be destructive. That is, once a unit of the target population is surveyed to obtain the information, the unit gets destroyed.
10. Sampling may be the only option. The target population may have become extinct.

Cohen et al. (2011, p. 127) dedicate a section of their book to the types of sampling error that may creep in, when using samples (page 149 - 151). They state that if many samples are taken from the same population, it is highly unlikely that they will all have the same characteristics with each other, or with the population. Researchers are also given a word of caution when choosing samples, as they may use personal subjective choices in their selection. In simple terms, researchers may choose participants who they feel more comfortable to work with, and hence, by doing so, tend to have a biased sample. Finally, if units of the sample are not available, researchers tend to replace them by choosing random participants "just to make up the numbers". Broadly, sampling methods are classified as "Probability Sampling" and "Non-Probability Sampling", and these are briefly discussed below.

3.6.1 Probability Sampling

Acharya et al. (2013) state that probability samples are used to ensure the generalisability of the study results to the target population. In probability sampling, each individual in

the population has an equal chance of being selected for the study. Probability sampling is further classified as:

- **Simple Random Sampling**. This method of sampling is mostly used when the population is uniform. All the units of the population are equally likely to be chosen.
- **Stratified Random Sampling**. If the population is not uniform and comprises of different groups or strata, the sample is divided into different strata. From each stratum, a random sample of size proportional to that of the stratum is chosen by the Simple Random Sampling technique. This ensures that the sample includes all the different groups that make up the population (no matter how small they are), in the same proportion. Examples of strata are "gender", "age", "religion", "level of studies", "nationalities", and so on. With Stratified Random Sampling, not only do we ensure that all strata of the population are fairly represented, but analysis can be done separately on each stratum. One of the biggest disadvantages of this method is that if the strata are not clearly defined, then there may be an overlap.
- **Systematic Random Sampling**. In this method of sampling, the population is first arranged in a certain order numerically or alphabetically or in any other way that suits the researcher. The population size (N) is divided by the sample size (n), $\frac{N}{n} = k$, say. Then the first unit of the sample is chosen from the first k units on the ordered list by the Simple Random Sampling technique. Then the others are chosen after every k^{th} unit.
- **Cluster Sampling**. Often, units of the target population which have some affinity (same characteristics), tend to group themselves. These groups so formed, are called "clusters". The problem that researchers face when they adopt this type of sampling, is that the units within the same clusters may be homogeneous (they display the same behaviour and characteristics), hence rendering the sample biased.

3.6.2 Non-Probability Sampling

Etikan (2017) states that non-probability sampling is a sampling procedure that does not use the concept of probability to choose a sample or select units for the samples. In simpler terms, units of the population will not have the same chance of being selected for the research. Moreover, some units of the population may even have zero chance of being selected. Representativeness of the population is hence jeopardised (Sharma (2017)). This bias can be minimised if the researcher is an expert in data collection methods and has good knowledge of the techniques required to 'design" samples from the population (Vehovar et al. (2016)). Some of the non-probability sampling methods are:

- **Convenience Sampling**. Emerson (2021) explains that a convenience sample

occurs when participants who fit a study's criteria are enrolled in the study. The main limitation of convenience sampling is that the study results lack generalisability due to the bias of the sample. To counter this bias, the author suggests that using a larger sample through convenience sampling, rather than utilising a single-subject approach, allows for slightly greater generalisation. Nevertheless, the lack of random selection of participants means that selection bias restricts large-scale generalisation of the findings.

- **Purposive (or Judgment) Sampling**. This method is appropriate when the typicality and specific relevance of the sampling units to the study and not to their overall representativeness of the population, is important (Krishnaswami and Satyaprasad (2010)). As my research is dedicated to understanding students' perception of mathematics and statistics, I was motivated to investigate students who were struggling to cope with the aforementioned subjects. Undoubtedly, part of my research was to study students who "like mathematics/statistics" but I was inclined to focus my attention on students who needed assistance in learning mathematics and statistics, as I aimed to find ways to help them. The authors go on to enumerate several advantages and disadvantages of this method. The advantages include:
  - It is less costly and more convenient.
  - It guarantees the inclusion of relevant elements in the sample. Probability sampling (e.g. Stratified Sampling) cannot give such a guarantee.

  In contrast, the disadvantages are:
  - This does not ensure the representativeness of the sample.
  - Less efficient.
  - Requires more prior extensive information about the population.
  - This method does not satisfy the underlying assumption of randomness.

  Care must be taken when this particular method is used. It will be used only when the typicality and specific relevance of the sampling units are important to the study.

- **Quota Sampling**. In Quota sampling, the units of the population are not preselected. They are chosen by the interviewer (researcher) who already has a target number of participants. The choice of participants may depend on certain criteria, such as "age group", "gender", "religion", "level of study", and so on. The advantage of this method is that if one participant is reluctant to participate, they are

immediately replaced by the next available participant, who answers the required criteria for selection. To minimise bias, the researcher needs to find a suitable place where the interview may take place. Additionally, choosing a suitable time may help to maximise participants' involvement in the process. One of the biggest disadvantages of Quota Sampling is that participants may give arbitrary answers "just to get rid" of the interviewer.

- **Snowball Sampling**. This sampling method is effective when the researcher knows little about a group of organisations to study. The researcher first contacts only a few individuals, who will then direct the researcher to other participants who may answer the selection criteria and are willing to participate.

Before beginning the research process, the researcher needs to carefully evaluate the advantages and disadvantages of each sampling method. Using the mixed sampling method is acceptable in some cases, based on the purpose of the study. In my research study, the following approach has been used:

1. **For Staff's face-to-face Interviews**: A combination of Convenience Sampling and Purposive Sampling was used here. Although willing to help, recruiting colleagues to participate in face-to-face interviews proved to be quite challenging. I aimed to enlist those who teach components of mathematics and/or statistics in their modules or academic programmes. The choices were quite limited. As mentioned before, I am the only mathematician on campus but there are a few academics who also teach a sizeable amount of quantitative content. Some of them were quite sceptic about participating as they believed they would not be able to contribute much because they only teach basic mathematics or statistics. This gave me a platform to explain the importance of investigating the teaching and learning of mathematics and statistics at the "root level", that is, basic mathematics. While I was excited about having colleagues who teach quantitative components at a basic level, they were indecisive about their contribution towards my research. A non-mathematician, teaching mathematics or statistics, was going to be an ideal candidate for my study, as it would help me look at my analysis through a different lens. It was also crucial that I stay unbiased towards my findings and those colleagues would have been the perfect participants to help me in my endeavour. Following several meetings with them, I was able to explain the importance of having their views on how to teach quantitative components of their modules, and most academics volunteered to participate in the data collection process. I was then left to choose three participants, which I planned in my Project Proposal. These three participants fit the profiles as shown on Page 102, Table 3.8.

A relatively new lecturer (with less than a year of teaching experience, but who was completing her PGCertHE) who teaches components of mathematics and statistics in a few of her modules, volunteered to pilot the interview questions designed for the academic staff. It must be noted that she was a former student at MUM and being a relatively new member of staff, she was keen to contribute towards my research and she made herself available to participate. The choice to have her pilot the interview questions, rather than include her as a participant in the final data collection process, was based on her limited experience in teaching at MUM. Her job at MUM consisted of teaching mainly small-sized cohorts of undergraduate students, coupled with other responsibilities such as facilitating seminar and workshop sessions at MUM.

During the pilot session, it was observed that she tended to stray off-topic and discuss matters unrelated to my research. After gently reminding her several times about the purpose of my investigation, I succeeded in redirecting her focus toward my research areas, and our conversation gradually centred on providing accurate responses to my questions. I noted that her answers were quite detailed, often without specific prompts from my side, and I was intrigued by the enthusiasm with which she addressed my inquiries. This experience allowed me to identify a few minor issues with my questions, which were promptly rectified through amendments. These adjustments involved:

(a) The meaning of "non-specialist" students, was unclear.

(b) The word "cues" in question 2 on Page 216 was misinterpreted by the "pilot candidate" who thought I was asking if she would ask students if they had issues with what was being taught.

(c) She struggled to answer question 3 (Page 216). I believe this was because of her limited experience in teaching. It also warranted my choice of participants for my interviews with staff, who were experienced lecturers.

Considering the substantial workloads of my colleagues, attributable to both teaching responsibilities and research commitments, along with personal obligations, coordinating the data collection process initially posed a challenge. Fortunately, we managed to overcome this by scheduling separate interviews, allowing us to meet occasionally after working hours or during extended break times to conduct the data collection.

2. **For Focus Groups (students)**: A combination of Stratified Sampling, Quota

Sampling, Convenience Sampling and Purposive Sampling was used to select the participants. I intended to run three focus groups with six participants in each group (Quota Sampling).

- For focus group 1, (see Table 3.5 on Page 101), as there were 37 students studying BABM, with 17 male students and 20 female students, which is almost equivalent to a ratio of 1 : 1, three male students and three female students were chosen to participate in the focus group (Stratified Sampling). Students were openly invited to participate and once the quota was reached, the invitation was politely stopped and the unselected participants were requested to participate in other focus groups.

  It can be observed from Table 3.5, Page 101, that all the participants are Level 4 (Year 1) students studying the BABM programme. Data (focus group) was collected one week after the end of the academic year. The main reason why only students from the BABM programme were chosen was that they did not have any end-of-year exams, and they were free after the final week of lectures. In contrast, BAAF students were not chosen to participate in this focus group, as they were planning for their exams, and I did not want to disturb their preparation. Furthermore, BABM students in Level 5 (Year 2) and Level 6 (Year 3) were asked not to participate as they also had exams to prepare for.

  Another interesting feature of this focus group is that it consisted of only one Mauritian student, while the other five were international students. This is simply because the international students were staying across the road, in the halls of residence and it was easier for them to participate as compared to local students who had to travel to university while they were on holidays.

  Ultimately, I chose to exclusively involve Level 4 students, considering they had recently completed their first year at university. My intention was to gather their perspectives on their experience in my class, providing valuable insights that could inform any necessary improvements in my teaching style for their subsequent years at the university. Additionally, I aimed to pinpoint effective practices within my Year 1 class, to implement these for the benefit of future students joining MUM.

- For focus groups 2 and 3, Quota Sampling was used, as the number of participants was to remain at six, in each group. In focus group 2, all male students, from different levels of studies were invited to participate, while in focus group 3, all female students from different levels of studies were welcomed. The Pur-

posive Sampling method was used, as only those who mentioned that they had wanted to contribute towards the research, were eventually selected. The intention was to use Stratified Sampling in choosing the number of UG and PG students. At the time of collecting data for the focus groups, there were 55 students studying BABM and BAAF and 11 students studying MM. This included 25 male students for BABM and BAAF combined and six male students from MM. There were 30 female students from BABM and BAAF combined and five female students from MM. The ideal ratio of UG to PG should have been $5:1$, but we eventually settled for a ratio of $4:2$.

Both these focus groups were held much later in the holiday period when the undergraduate students had completed their exams. I was able to invite students coming from varied backgrounds, in terms of academic level of study and programme of study, to participate in these focus groups due to the timing of the events. The postgraduate students (Level 7) were international students, except one, and were mainly on campus as they had planned meetings with their dissertation supervisors.

Participants in my study originate from diverse cultural backgrounds. Mauritian students, being bilingual in English and French, contrast with international students who may have exclusively studied in French-medium schools before joining MUM. I frequently observe challenges among students in grasping the terminologies used in mathematics and statistics, particularly stemming from this linguistic diversity. Additionally, students with prior education in a different language often request repetitions during my teaching sessions.

To ensure that my questions were well understood in the interview process, the service of a moderator was used to facilitate communication between them and me. The moderator, Nusreen Rozah, a colleague of mine, has a degree in English and she is also Head of the Learning Enhancement Team (LET) at MUM. Her role was to simplify my questions in case participants did not understand what I meant. She had to sign a confidentiality agreement which prevented her from speaking about the participants, the contents of our discussions in the focus groups and anything related to the data collection. Her assistance was also sought before the focus group interviews, as it was important for me to go through the questions I intended to ask, with her. Being a non-mathematician, Nusreen Rozah had to be briefed about certain aspects of the mathematics/statistics teaching process. These are simple things, such as the use of Greek alphabets, symbols and nomenclatures.

When the invitation was sent to numerous students to participate in the focus groups, a few of them, eight in total, made it quite clear that they would prefer being involved in the pilot process rather than in the actual focus groups. After being asked for the reasons, they were quick to reply that they would be too shy to discuss, debate and talk in front of their peers. I decided that instead of running a proper "pilot focus group", I would instead go through every question that I intended to ask and investigate if they understood the questions.

Remarkably, once the pilot run commenced, all their initial reservations dissipated, leading to an engaging conversation revolving around the themes of my questions. Furthermore, the group actively contributed to the development of additional sub-questions, which I gladly considered for incorporation into my subsequent focus group sessions with the actual participants. The pilot group demonstrated an impressive thought process and exhibited ease in responding to the questions. Notably, nearly all of them eagerly expressed their sentiments about mathematics and statistics. The key insight gleaned from the discussion was their persistent discomfort with these subjects, and they displayed a keen interest in understanding when they would no longer be obligated to study them. An interesting observation was that they tended to skip the first question and went on to discuss, at great length, the second question. I noted this down and reminded myself that should this happen when I collect data from the focus groups, I should remind participants to spend time discussing the first question (Appendix H, Page 213). Some of them also took the opportunity to discuss their previous experiences in detail. To summarise, not a lot of issues were raised regarding the structure of the potential line of questioning that I had in mind for the focus group interviews. The only problem I foresaw was that it would take me more than one and a half hours to complete the interview process. This was confirmed when I ran the focus groups with the actual participants, about the final data collection.

Observation 1:
As noticed in the pilot run, one or two participants in the focus groups were hesitant to talk. They had to be called upon to give their opinions and to respond to the questions asked.

Observation 2:
The focus group, comprising exclusively female participants, exuded enthusiasm. There was a tendency for the discussion to veer off-topic in their responses, necessitating occasional reminders to address the specific questions

posed. Nonetheless, all participants displayed a high level of eagerness and willingness to contribute.

3. **For Students' Face-to-Face Interviews**:

The process of recruiting participants for the face-to-face interviews posed greater challenges than anticipated. While any students enrolled in programs involving quantitative components were eligible, my preference was to prioritise individuals whom I did not typically teach but had previously assisted with numeracy support in my role as the Lead for Numeracy Support at MUM. As this support group operated under the LET umbrella, I maintained regular communication with the LET team, seeking their assistance in recruiting participants fitting the specified profile.

Emails were sent to students, but I received no interest from those whom I do not personally teach. I had to resort to my backup plan, which was to recruit participants who were already my students. The Purposive Sampling method was used here, as I wanted to interview students who faced difficulties in learning mathematics and statistics. The reason I wanted to interview students whom I do not teach (but whom I have assisted in Numeracy) was to study their methods of learning. Cook-Sather (2009) wrote an excellent article on how teachers can learn from students. She suggests that to have students as active partners in dialogues and learning, teachers should listen to what students have to say. Giving a platform for students to voice their experiences helps both the teachers and the students. It enables teachers to be co-creative instead of being authoritative in classes.

Following this minor setback, I enlisted three participants from volunteers who I have been teaching already. I have to emphasize that these three students had also asked me for extra help outside their usual class hours with me. I had to be very careful during the interviews for the following reasons:

- I interviewed them as students whom I had given extra support to, and not as students whom I have been teaching.
- The participants tended to view me as their teacher, instead of as the person who assisted them outside the usual teaching hours.

As stated above, recruiting participants was challenging for this data collection process. Similar challenges were faced in recruiting participants for the face-to-face pilot interview. Only two students agreed to participate in the pilot run. Nevertheless, it was a good experience, and the feedback was that the questions were very

clear and easy to answer.

4. **For the Online Questionnaire**: No sampling was required in this data collection process. I invited new students (at MUM), to participate, as I wanted to have a fresh account of their feelings towards learning mathematics and statistics. Invitations were sent via emails, and 132 students responded positively (41 students from IFP, 80 students from UG (BABM, BAAF and BAPsy) and 11 students from MM).

   Distribution of the online questionnaire was planned for the initial week of the academic year, ensuring participants had not yet attended any mathematics/statistics classes. Participation was voluntary and one week before university started, "new students" of BAAF, BABM and MSc management were contacted by email. The PIS form was sent together with the link to the questions. Regarding Psychology and IFP students, I contacted the respective Program Coordinators, providing an explanation of my research study. They were willing to assist and agreed to distribute the questionnaire link to new students enrolled in the programs.

   A meeting was held with three final-year students who volunteered to examine my set of fixed questions for my online questionnaire. This was a smooth process and there was nothing that was removed or added to the initial set of questions.

3.7 Ethical Issues

Ethical considerations relate to all aspects of the research process, to influence and guide researchers in their research design. Cohen et al. (2011, p. 127) identify three different levels of ethical regulation in educational research: legislative, professional and personal. At the legislative level, official institutional approval was obtained to conduct the study from Middlesex University's School of Health and Education Research Ethics Committee (Appendix B, Page 193). Professional bodies have formulated codes of conduct that reflect the values, aims and vision of the professional group and provide guidelines for research activity within the specific discipline which are ethical, justifiable and sound. In this study, particular attention was given to the BERA (2018) Ethical Guidelines for Educational Research to inform codes of practice, especially since student participants are concerned, to safeguard them against any harm. The guidelines also served as reference points for any specific issues arising in the study such as the care required to access data.

In educational evaluation research such as this, the issue of researcher's "power" to guide and justify programmes and services can become controversial if not carefully conducted and managed. Hearne (2013) argues that "*ethics in research should be an integral part of the research planning and implementation process, not viewed as an afterthought*". In this study, the educator-practitioner-researcher is a member of the academic team, teaching

on several programmes at undergraduate and postgraduate levels (in simpler terms, an 'insider-researcher'). While the researcher's insight into the research topic can be highly valuable, due care is necessary when negotiating the professional boundaries of sampling, accessing data and reporting. In such circumstances, Hearne (2013) proposes that the activity needs to be distinct from professional practice It needs to be viewed as research requiring scrutiny of ethical issues and exploring appropriate strategies to deal with them.

3.7.1 Informed consent

Securing informed consent involves procedures for individuals to choose whether or not to participate in the research once they have received adequate information on the purpose and the requirements of the study. Cohen et al. (2011, p. 127) provide four elements which need to be met: competence, comprehension, full information and voluntarism; whereupon participants' rights will have been given appropriate consideration.

"Competence" implies that responsible, mature individuals will make correct decisions if they are given the relevant information, and the onus lies on the researcher to ensure they do not engage individuals who are not capable of making such decisions. In this study, all undergraduate students (Levels 4, 5 and 6) and postgraduate students (Level 7) were eighteen or above, hence they were categorised as adults. However, it is important to note that students on the IFP (Level 3) are sometimes under 18 years of age. For this study, such individuals are being considered as students with a level of maturity that is fit for university, who can make decisions in their own right; that is, they are not part of a vulnerable population in the sense of the data that the study uses. Therefore, to conduct research with any student of the university who is under 18 years of age, it was not deemed necessary to obtain permission additionally from a parent/guardian of the student.

"Comprehension" implies that participants fully understand the nature of the research project. I, the researcher, had the opportunity to speak about the research topic with students and I had the chance to explain the purpose of the research. Additional, a Participant Information Sheet (PIS) was distributed to all participants before they agreed to take part in the data collection process:

- PIS - Staff and Students Interviews: Appendix C, Page 194.
- PIS - Students Focus Groups: Appendix D, Page 199.
- PIS - Online Questionnaire for Student Participants: Appendix E, Page 204.

"Full information" implies that consent is fully informed. In practice, however, it is often impossible to inform participants of everything about the investigation and how it will

unfold. Hence, detailed information about the research was given to participants, before receiving their consent in taking part in the research. The PIS contained all the necessary information about the research that I was undertaking, and the purpose of the research was made clear to potential participants.

"Voluntarism" implies that participants choose to take part or not to take part in the research freely. All reasonable steps were taken to ensure that consent was attained from all participants without undue pressure or coercion.

3.7.2 Confidentiality

To protect the privacy of participants in this study, participants were informed of their rights to withdraw from some parts, or the full research study. The onus was on the researcher to ensure participants were aware of their rights to withdraw or to give permission to the researcher to include them in the study. The identities of the respondents always remained confidential and anonymous.

Confidentiality means that the privacy of individuals will be protected in such a way that the data participants provide to the research will be handled and reported in such a way that they cannot be associated with them. The participants' names were not used nor any other personal information, thus ensuring the confidentiality of their identities. The participants were informed that all personal data would be hidden behind pseudonyms, retrieved with their signed informed consent and stored in password-protected files on a laptop which was used only by the researcher, whose access was also password protected. Cohen et al. (2011, p. 127) argue that confidentiality cannot be guaranteed or expected in face-to-face interviews, so good practice entails that the researcher can promise to abide by the principles of confidentiality.

The proposed study is situated in the higher education institution (HEI) at which I am employed. As such, it would be classified as endogenous research or insider research, furthermore, within my teaching practice. I align with the stance of Breen (2007) to conceptualise a continuum between insider and outsider positioning as one's researcher identity changes relative to each situation.

The researcher assumes that a reader will be able to identify the programme and faculty, if they want to. Therefore, the researcher is not going to try to guarantee anonymity on these counts, but instead, Trowler (2011) advocates assuring the senior leadership team that the research will not damage the reputation of the institute; as well as assuring colleagues who participated in the interview process, that they will not be traceable in the research. Ethical and methodological issues are also raised around data collection within power disparities - those more powerful than you, those who lack power relative

to you, or also your peers. These issues concern how one writes up the research, what the circulation is, and whether people have been protected. Good practice would include offering participants to view drafts of all research outputs so that they can assess for traceability or whether their particulars are sufficiently obscured.

3.7.3 Insider-Researcher

As mentioned at the earlier part of this chapter, my study is what I would qualify as "Educational Research", as it involves doing research in the field of education. Gorman (2007) argues that an incompetent or unethical professional might cause harm to an individual because of poor practice. Carelessly planned research, without considerations for ethical implications, can damage the institution and the profession as a whole and impact the future willingness of potential participants to engage in research.

Hammack (1997) mentions that researchers (like me), will have a dual role to play: the role of The Researcher and that of The Teacher. These might be conflicting roles. I will be the teacher of all the students in my class, but as a researcher, I might be selecting only some of those students to assist me in my research. The table below (Table 3.2) lists the issues that a teacher/researcher in my position, may face, and also proposes ways to solve them (Wong (1995) and Hammack (1997)).

Table 3.2 Teacher/Researcher Ethical Considerations

Teacher / Researcher issues (Hammack (1997))	**Proposed solutions (Wong (1995))**
1) The students not taking part in the study might feel that they are not doing enough. This usually happens if the teacher is discussing the data used for the research with the class, and only those participating in the study might be taking part in the discussion.	(Wong (1995) suggests that teachers could try to use topics of their research and questions to associate with a genuine interest and valuing of students' knowledge. Furthermore, efforts need to be taken to reinforce the belief that extended discussion with a student does
2) Other students might want to get involved, but the teacher might decide to listen to only those who are assisting with the research.	not suggest that the student must be wrong or confused. In fact, exactly the opposite would be implied. Continued conversation with a particular student would indicate that his or her ideas are
3) Students not involved in the research will get easily distracted and frustrated in their inability to take part in further discussions, and for not knowing why the teacher is discouraging their involvement.	insightful and important. Finally, when the teacher does not immediately call on other students in the class who wish to participate, these occasions must be made to represent opportunities for the students to learn from their peers.

Hammack (1997) suggests that teachers should remember that the students' main priority is to acquire knowledge when they enrol at an academic institution, and not to become "subjects" of some research. Of course, we, teachers, should be encouraged to do research, but we need to make our students aware of any research that is going on. We should be able to let them decide whether they want to participate in the research or not. Stocker (2011) even suggests that some students might have feared the teacher's authority and have involuntarily consented to be participants in the study. We should obtain consent from the students before we enrol them in any of our research, as subjects. The author also talks about informed oral and written consent, but these can be elaborated upon in the future. Nolen and Putten (2007) focus on the ethical principles and practices for an action researcher in education. Table 3.3 below shows some of their recommendations to tackle the "ethical concerns":

Table 3.3 Recommendations (Nolen and Putten (2007)) and Propositions.

1) Informed consent of participants.	(a) Participants will be made aware of the nature of the study. Risks (if any) will be explained to them. (b) Participating in any survey, interviews and group discussions is not compulsory. Participants will be allowed to withdraw from participating, at any time. (c) Most, if not all, of the students are adults (over 18), so parental approval will not be needed. (d) Staff members (academic, administrative and top management) will be made aware of the implications of the research and its findings, on their respective jobs.
2) Protecting the Confidentiality of Participants.	Confidentiality may be compromised by the fact that students could be identified because they are from the classes I usually teach. This can be resolved by the fact that I will be investigating other students (whom I do not teach) as well.
3) Autonomy of Participants.	(a) Students should feel at ease with the research. (b) No undue pressure will be put on them to participate in the study.
4) Ethical Standards Related to Discipline.	(a) Show respect to the students and inform them that the findings will enable me to provide better service as a teacher of mathematics and statistics. (b) Play my "dual" role of the teacher and the researcher in such a way that the best interest of the students is consolidated.

Students' feeling towards my research was something that I considered while I progressed in my study. Some might feel belittled and embarrassed if I chose them to participate in a study which targets students in need of academic support. Students might also feel that they were wasting their time in participating in the research. It was made clear to them that it was not compulsory to take part, and if they did, they could withdraw from any surveys and interviews, at any given time. The importance of the research and its findings were explained to them, and I endeavoured to make them feel valued, as their contribution was priceless in terms of contribution to the support MUM provides to its students. I also anticipated that my role and responsibilities at MUM might change while I conduct my research. I informed my line manager about any conflict of interest that may arise in a situation like this. Written permission from senior management team at MUM, to carry out the study, was sought.

Participants were made aware of any change in my status and my research, if it affected

their confidentiality and anonymity status. They were allowed to withdraw from participating in the research if they felt that my new role might affect them in any way possible. It is worth noting that I was promoted to the post of Academic Area Head for the School of Business, Innovation and Creativity in March 2020, by which time all data had been collected.

3.7.3.1 Teacher-Researcher: A Position of "Power"

Engaging in research within my workplace, where my students serve as participants in the data collection process, can introduce potential biases. As mentioned by Cothran and Ennis (1997), a teacher's power is based upon the fact that, because of their status as expert knowledge givers, teachers hold an authoritative status. This leads to receiving automatic respects from students. In accordance with Dunbar and Taylor (1982), this authority is also derived from the power conferred by law or the quasi-legal force associated with the position or tradition.

In acknowledging the ethical complexities related to power dynamics and coercion within the context of teacher-researcher roles, Poulton (2023) highlights the likelihood of teachers encountering unforeseen and persistent ethical dilemmas well beyond the completion of the research. This challenge is exacerbated by the continuous presence of the researcher and their sustained relationship with the research site. As observed by Olitsky et al. (2005), the presence of a teacher-researcher may create a sense of obligation among students to participate in the research due to power differentials and the teacher's authority in grading. The potential coercion of students to partake in the teacher's research raises concerns about the validity of results, introducing bias. Moreover, according to the same authors, this experience may negatively impact students, causing them to feel "used" and "bullied" into participating in an experiment that they found uncomfortable. The lasting repercussions of such dynamics underscore the need for a nuanced and ethically approach in teacher-researcher endeavours.

Poulton (2023) suggests that addressing the unexpected and persistent ethical challenges inherent in teacher-research goes beyond mere adherence to externally prescribed principles or codes of conduct during the initial phases of the research. The author rejects a superficial "tick-box" approach to ethics approval and posits that teacher-researchers should embrace flexibility, continual learning, and reflective practices to navigate evolving ethical dilemmas, ensuring the maintenance of positive ethical conduct. Such an approach necessitates a profound understanding of how teacher-researchers can act with integrity, emphasizing the importance of a research ethics framework grounded in an ethic of care and virtue. The author advocates for ongoing dialogues between the teacher-researcher and student participants, with the former consistently emphasizing that non-participation will not adversely impact students' performances. Furthermore, it is stressed that students

who choose to participate will not receive preferential treatment from the teacher.

3.7.4 Ethical Considerations in Narrative Inquiry

The difficulty associated with the Narrative Inquiry approach lies in the researcher's interpretation of the stories recounted by the participants. As outlined by Smythe and Murray (2000), the primary ethical concern revolves around narrative ownership. The authors raise essential queries concerning the ownership of the narratives of research participants and the ultimate control and authority over how these narratives are presented and interpreted. Frequently, there is a risk that the researcher may not fully capture the unique and individual nature of the narratives. The authors note that participants might feel "betrayed" by the researcher's interpretation of their stories. Inevitable reactions may arise when individuals' stories are translated into examples of broader social or psychological phenomena. The narrative researcher adopts a substantially different perspective on a life story compared to that of the individual narrating it. Typically, as stated by the same authors, the goal of narrative analysis is not to elucidate what participants intended to express, but rather to interpret the implicit meanings underlying their narratives.

According to Chase (1996), narrative researchers widely concur that, due to their distinct perspective on individuals' stories, it is crucial for them to assert some ownership and control over the narratives they investigate. As stated by Bar-On (1996), after the narrative has undergone analysis, it becomes both the researcher's text and that of the participants. The interviewees may express satisfaction or dissatisfaction with how the researcher has treated their texts, yet it remains a perspective that the researcher intends to defend and elucidate.

During the data collection phase, I clarified the purpose of the process to the participants, specifically for my doctoral thesis. I obtained their consent for recording and analysing the collected data for my research. Throughout the interviews, I meticulously captured the subtleties of the conversation, placing particular emphasis on participants' emotional expressions, including laughter, hesitation, grimaces, and subtle changes in body language. This facilitated the identification of their emotions, which I interpreted and used to present the data.

3.8 Project Design

The Tables below give a detailed description of the data collection approach that was used for specific participants.

Table 3.4 indicates the breakdown of the participants who took part in the focus groups, online questionnaire and face-to-face interviews.

Table 3.5 shows the Year 1 (Level 4) students, both male and female, who participated.

Gender of those participants is highlighted.

Table 3.6 contains details of all the male participants. They are from several programmes and are studying at different levels. Both local and international students participated.

Table 3.7 shows details of all the female participants. They come from numerous programmes of study and study at different levels. Both local and international students participated.

Table 3.8 contains details of the academics who participated in the interview. Their areas of teaching and their gender were highlighted.

Table 3.9 gives details of the three student participants who took part in the interview. They were all female and two of them were undergraduates, while one student was from the MSc Management programme.

Table 3.4 Details of participants

Methods	Participants and Other Details	Number of Participants
Focus Groups	3 groups of 6 students Assisted by a moderator (Admin Staff) Where applicable, UG:PG is 4:2 Where applicable, Male:Female is 3:3 Combination of Local (Mauritian) and International students	18
Online Questionnaire	IFP Students	41
	Undergraduates (Year 1)	80
	Postgraduates	11
Interviews	Students whom I provide numeracy support to	3
	Academic colleagues:	
	Female lecturers who teach math/stats components	2
	I.T (Male) Lecturer who teaches math/stats components	1
		156

3.8.1 Participants Details - Interviews

Table 3.5 Participants in Focus Group 1 - with Pseudo Names

Pseudo Names based on ethnicity	Gender	Nationality	Study Status	Level	Programme
Malini	F	Mauritian	UG	4 (Yr 1)	BABM
Tina	F	International	UG	4 (Yr 1)	BABM
Jane	F	International	UG	4 (Yr 1)	BABM
Tom	M	International	UG	4 (Yr 1)	BABM
Rick	M	International	UG	4 (Yr 1)	BABM
James	M	International	UG	4 (Yr 1)	BABM

Table 3.6 Participants in Focus Group 2 - with Pseudo Names

Pseudo Names based on ethnicity	Gender	Nationality	Study Status	Level	Programme
Vikash	M	Mauritian	PG	7 (Masters)	MSc MGT
Vishnu	M	Mauritian	UG	4 (Yr 1)	BABM
Rajiv	M	Mauritian	UG	5 (Yr 2)	BABM
Tim	M	International	PG	7 (Masters)	MSc MGT
Gervais	M	Mauritian	UG	4 (Yr 1)	BABM
Steve	M	International	UG	6 (Yr 3)	BAAF

Table 3.7 Participants in Focus Group 3 - with Pseudo Names

Pseudo Names based on ethnicity	Gender	Nationality	Study Status	Level	Programme
Sandra	F	Mauritian	UG	6 (Yr 3)	BAAF
Salma	F	Mauritian	UG	6 (Yr 3)	BAAF
Renuka	F	Mauritian	UG	6 (Yr 3)	BAAF
Fatema	F	International	UG	6 (Yr 3)	BAAF
Nicole	F	International	PG	7 (Masters)	MSc MGT
Karen	F	International	PG	7 (Masters)	MSc MGT

Table 3.8 Staff Interviews

Staff Pseudo Names	Gender	Programmes in which mathematics / statistics contents are taught
Manju	F	International Foundation Programme
Pratibha	F	Psychology
Rahul	M	I.T

Table 3.9 Student Interviews

Students' Pseudo Names	Gender	Programmes enrolled in
Melodie	F	BAAF
Farida	F	BAAF
Benazir	F	MSc Management

3.8.2 The Online Questionnaire

The online questionnaire was disseminated to students who had just joined MUM, either in IFP, or as undergraduates (Year 1 - Level 4), or as postgraduates (Master level - Level 7). A copy of the questionnaire can be viewed in Appendix K, Page 222. The questionnaire was adapted from Tapia and Marsh II (2004). While the authors used robust statistical analysis to **measure** emotions such as the self-confidence of participants, the value of mathematics and statistics in everyday life, emotions (enjoyment, excitement and happiness), and motivation level of participants, my aim was different. The data gathered via the online questionnaire was considered crucial for analysing whether there was indeed a correlation between the "value of learning mathematics and statistics" and the other variables. Another purpose of using an online questionnaire in my research was to see if the results (with new students) were aligned with the analysis in interviews and focus groups.

The questionnaire was designed in five parts (A, B, C, D and E), with the following breakdown:

- Part A - About You:
  - Qu 1 - Participants choose the programme they are enrolled in.
  - Qu 2 - Participants' information about their year of study.
  - Qu 3 - Students' gender.

  - Qu 4 - Age range of participants.

- Part B - Self-Confidence:
  - Qu 5 - Confidence about learning mathematics and statistics.
  - Qu 6 - Feeling relaxed in a mathematics/statistics classroom.
  - Qu 7 - Ease with which participants solve mathematics and statistics problems.
- Part C - Value:
  - Qu 8 - Importance of mathematics and statistics in everyday life.
  - Qu 9 - Query about the importance of mathematics and statistics in academic studies.
  - Qu 10 - Importance of having studied mathematics and statistics before starting at MUM.
- Part D - Enjoyment:
  - Qu 11 - Emotion when learning mathematics and statistics at secondary schools.
  - Qu 12 - Excitement when studying mathematics and statistics.
  - Qu 13 - Happiness when doing mathematics and statistics, as compared to other modules.
- Part E -Motivation:
  - Qu 14 - Motivation about learning mathematics and statistics, at university.
  - Qu 15 - Feeling about studying mathematics and statistics in future years.

Question 1 was important as I had to ensure that only programmes running mathematics, statistics and quantitative-content modules were considered for this data collection process. Students in those programmes were eligible to participate in this research, whereas students in other programmes, though they might have studied mathematics and statistics before starting at MUM, were not considered.

The purpose of Question 2 was to collect data on participants' level of study at MUM. As mentioned above, the five cohorts that were targeted were new students from IFP, BAAF, BABM, BAPsy and MM. The online questionnaire was sent to them before they had any class with their respective lecturers who teach them mathematics and/or statistics.

The gender of the participants was recorded in Question 3. The purpose was to see if there was no variation in the responses based on gender.

Question 4 recorded the age group of the participants.

The independent variable used in the questionnaire was "value" and the independent variables were "self-confidence", "enjoyment" and "motivation".

The study by Hannula (2002) supports that a change in attitude can affect students' perspective of the value of mathematics and statistics in their academic and personal lives. The author claims that students will understand the value of mathematics more if they understand what they are doing in the class. Moreover, the reverse is also true. The more students understand mathematics while learning it, the more they will understand its value inside or outside the classroom.

The aim of using a online questionnaire at a very early stage of students' academic experience at MUM, was to investigate if there was indeed a correlation between the variables, as mentioned above. This will give a clear indication of what students feel and how they perceive learning mathematics and statistics.

3.8.3 The Focus Group Interview

A copy of the main questions asked in the focus group interviews is in Appendix H, Page 211. The first two questions (Qu 1 and Qu 2) were to investigate the reasons why the participants' may or may not like mathematics. They were asked to elaborate on those reasons. The aim was to see if past experiences were a trigger for them to like/dislike mathematics.

Question 3 investigated their feelings about learning mathematics and statistics at university. I tried to separate mathematics and statistics in this query as I wanted to see if the participants could differentiate the two, or if they considered both to be the same.

Question 4 queried about the views on the current quantitative contents of their syllabus. The aim was to see if any improvements could be brought to the contents that we are teaching at MU-HEN, and hence at MUM.

Question 5 investigated the preparedness of the students when they had to study modules with quantitative elements. The purpose was to see how we, at MUM, could support students better when they start studying with us. Many students begin their academic studies with a relatively basic level of mathematics and statistics, whereas other students have studied intensive mathematics and statistics. Some students have done advanced levels of mathematics but have not performed too well. This question provides a platform for academics teaching quantitative components, to better understand what the students

need and what they expect from teachers.

Question 6 investigated, from students' perspective, the ways that we, as a Higher Education Institution, can remedy the situation. We usually take it for granted that students should come prepared and should know a minimum level of mathematics and statistics when they start at university. This is not always the case. Hearing students' ideas is important to improve the support system that we have at MUM.

Question 7 asked the students to elaborate on the previous question by querying what type of support students would need in the short term and the long term.

Question 8 was asked to see if the support mechanism at MUM is indeed effective as compared to students' previous experience. At the university level, it is expected that we provide better and more efficient support to students, as compared to what they were used to receive before joining a HEI.

Question 9 enabled the researcher to learn from good practices that the students may have had, before joining MUM.

3.8.4 Face-to-Face Interview with Students

This interview consisted of two parts. Part A collected the programme of studies of the students and the year of studies. Information on Gender and Age Group was also collected. Part B consisted of eight main questions (labelled Qu 5 to Qu 12 as seen in Appendix J, Page 218).

It is important to remind the reader that these were students who have asked for additional support in mathematics and statistics.

Question 5 queried about students' past experience in learning mathematics and statistics, where participants were asked to discuss positive experiences. The aim was to see if participants connected emotions with their learning experience. This was also investigated in Question 6, where participants were asked to focus on any negative experience they may have had.

Question 7 enquired about the level of mathematics participants may have studied before joining MUM. The aim was to see if there was any connection between learning a basic amount of mathematics, with the need for additional mathematics support at university.

Question 8 queried about the reasons why participants studied mathematics to a certain level, before joining MUM. The aim was to see if their feelings and emotions had an influence on the level (and amount) of mathematics and statistics they had studied before.

Question 9 investigated whether students could have studied mathematics and statistics any further to when they stopped. The aim was to see if they purposely decided not to pursue learning of these disciplines.

Question 10 queried the general perception of learning mathematics and statistics.

Since the participants in this interview were those who asked for additional support, Question 11 investigated students' expectations of teachers teaching them modules with quantitative content.

Question 12 was asked of participants as their views on how teachers should approach teaching mathematics and statistics, were important, to reflect on the current methods of teaching at HEI.

3.8.5 Face-to-Face Interview with Staff

The first part of the interview was about details on which programmes the academics were teaching. Additionally, they were asked to select the levels they were teaching at. A copy of the interview questions can be perused in Appendix I, Page 215.

Part B had 10 questions which provided the gist of the face-to-face interview.

Question 1 queried about the modules that the academics were teaching. Further investigation about the "amount" of mathematics and statistics contents was investigated.

Question 2 queried about the cues that academics may pick up if they have students who struggle in mathematics and statistics.

Question 3 was asked to identify the cues academics pick up when students are enjoying mathematics and statistics.

Question 4 was asked to see if teachers teaching mathematics and statistics to non-specialist students, are facing difficulties in teaching the disciplines.

Question 5 queried about the teaching strategies that academics adopt when teaching non-specialist students.

In view to make the curriculum more meaningful for students, Question 6 tries to investigate the strategies that academics adopt while teaching.

Question 7 explores the ways Numeracy support should be provided at MUM.

Question 8 investigates the methods that need to be adopted when students start studying in a HEI. Students usually find it challenging to adapt to the new system and providing support to them, while they transition between secondary school studies, to higher

education, is important.

The teaching practice of academics was investigated in Question 9. From the Literature Review chapter, we found that there is a correlation between negative emotions towards learning mathematics and statistics and the importance of planning effective interaction with students.

Question 10 explored the types of workshops that we, at MUM, should introduce, to provide students with better numeracy support.

3.9 Data Analysis

SPSS was used for Descriptive Statistics and data analysis of the online questionnaire. As mentioned above, a correlation between Value of mathematics and statistics; and other dependent variables was investigated. Concerning qualitative data (focus groups and interviews), Thematic Analysis was carried out.

3.9.1 Quantitative Analysis - The Online Questionnaire

Before investigating the correlation between the variables, a Normality test must be carried out to determine the types of regression that need to be used for the analysis.

Table 3.10 Types of Regression Models Based on Normality Test

Normally Distributed Likert Scale Data (Parametric Method)	**Normally Distributed Likert Scale Data (Non-Parametric Method)**
Linear Regression	Ordinal Regression
Pearson Correlation	Spearman Rank Correlation

3.9.1.1 Transforming the Variables in SPSS

The Likert scale data is first transformed, to calculate the mean of values for the variables. The next step involves checking if the data is normally distributed (the importance of this step is mentioned above). The Kolmogorov-Smirnov Normality test was used as the number of participants exceeded 100. In the Chapter Project Findings, on Page 125, further details on the results will be showcased.

3.9.2 Qualitative Analysis - Thematic Analysis

Thematic Analysis (TA) (Braun and Clarke (2006)) was used to identify trends in those data. TA is usually used for its flexibility (within the boundary of the study area). The six phases of the analysis, as stated by the authors, are:

Table 3.11 Braun and Clarke (2006) Thematic Analysis phases

Phase		Description of the process
1	Familiarizing with the data	Transcribing data, reading and re-reading the data, noting down initial ideas.
2	Generating initial codes	Coding interesting features of the data in a systematic fashion across the entire data set, collating data relevant to each code.
3	Searching for themes	Collating codes into potential themes, gathering all data relevant to each potential themes.
4	Reviewing themes	Checking if the themes work in relation to the coded extracts (level 1) and the entire data set (level 2), generating a thematic "map" of the analysis.
5	Defining and naming themes	Ongoing analysis to refine the specifics of each theme, and the overall story the analysis tells, generating clear definitions and names for each theme.
6	Producing the report.	The final opportunity for analysis. Selection of vivid, compelling extract examples, final analysis of selected extracts, relating back of the analysis to the research questions and literature, producing a scholarly report of the analysis.

Ibrahim (2012) states that qualitative data is usually dependent on interpretation. The author goes on to state that there is often an overlap between analysis and its interpretation, for qualitative data. TA is considered the most appropriate for any study that seeks to discover using interpretation. According to Terry et al. (2017), TA is now commonly used in the field of psychology, and beyond.

Javadi and Zarea (2016) support the use of TA in Interpretative Analysis, which I have adopted in my study. Themes are extracted from the codes developed by the researcher, and the following methods can be considered to analyse the themes:

- Inductive Thematic Analysis
  - An inductive analysis means that the recognised themes are strongly made related to the data. In this approach, data is collected for a specific research purpose, but the recognised themes may have little relationship with the questions asked to the participants.
- Theoretical Thematic Analysis
  - Theoretical Thematic Analysis is done based on the theory linked to the re-

search. Thus, this approach is adopted when the researcher needs to extract themes based on the theory. One of the main disadvantages of using this approach, is that care should be taken when reading similar research, as the researcher "may try too hard" to align their study with that of published theories. On the other hand, reading theories connected to their research, may help the researchers in their preparation when they use Theoretical Thematic Analysis (DeSantis and Ugarriza (2000)).

3.9.3 Pitfalls - Thematic Analysis

Although TA is considered to be an enjoyable, flexible and relatively simple way to analyse qualitative data, Javadi and Zarea (2016) warn researchers about some issues that may arise, which may hamper a good analysis of the data. The authors advised that researchers should have an unbiased approach when conducting TA, as some researchers may try to have a positive and desirable outcome through their analysis. Just bringing out themes, is not the purpose of TA. Researchers need to process further and try to understand any underlying patterns in their data. Additionally, personal inferences and prejudgments should be avoided, and researchers need to be flexible and neutral in their assessment.

Though there are some criticisms of the TA approach (as mentioned above, under "pitfalls"), the flexibility and simplicity of TA have been a blessing for new researchers. Additionally, the results deduced from TA, are usually easy to understand, even for those who are not used to a high level of analysis and producing findings (Javadi and Zarea (2016)).

3.10 Validity

The validity of this research study was achieved in the following ways:

1. The online questionnaire is heavily based on the paper published by Tapia and Marsh II (2004). As mentioned earlier, the authors' aim was to measure emotion levels, whereas my quantitative analysis will only look at the correlation between the identified variables. The results will be tested with the qualitative data analysis, from the interviews with students and academic staff.

2. All the questions for the online questionnaire and interviews were pre-piloted and rectified accordingly, based on the feedback obtained by the pilot participants.

3. The questions for the interviews were based on articles published on mathematics and statistics education.

4. Thematic Analysis was used to analyse the qualitative data, and the findings were compared with existing literature and with the results obtained from the online

questionnaire.

5. The questions from the questionnaire were analysed using the expert software, SPSS.

6. Triangulation by quantitative data, qualitative data and theory was used.

3.11 Summary

This chapter **Project Design and Methodology** states the purpose of this research and presents methodological approaches to its design and implementation. The ontology and epistemology issues have been addressed, and ethical considerations and issues regarding my position as an insider-researcher have been highlighted. A summary of research approaches, research methods, research techniques and sampling methods and justifications have been mentioned, with regard to data collection. In this study, although both quantitative and qualitative analysis were undertaken, the study design does not adopt a mixed-method approach. The quantitative analysis was performed only for the researcher to observe if there is any alignment with the data obtained through the interviews (focus group and face-to-face).

In conclusion, this chapter gives the rationale behind choosing Narrative Inquiry over ethnography, providing a strong foundation for the methodological framework adopted in this study. The comprehensive explanation of employing an online questionnaire, focus groups, and face-to-face interviews not only underscores the methodological diversity but also ensures a exploration of the research questions. Ethical considerations have been addressed throughout the research process, demonstrating a commitment to integrity and respect for participants' rights. Moreover, the evaluation of the insider-researcher role adds depth to the reflexive stance, acknowledging and navigating the complexities inherent in this position. By seamlessly integrating these methodological choices and ethical considerations, this study not only advances the field but also contributes to the scholarly dialogue on rigorous research practices.

CHAPTER 4

PROJECT ACTIVITY

4.1 Introduction

In this chapter, I recount my DProf journey from its initiation to its conclusion. Initially, I regarded mathematics as the paramount passion in my life, culminating in the realisation of my dream to be acknowledged as an Applied Mathematician (refer to Section 1.4 on Page 15). However, the transition to a new vision and goal proved to be a challenging and unfolding process, making this journey far from effortless. As discussed in Subsection 1.3.2 on Page 13, my DProf began when I was reluctantly (at least, initially) doing my PGCertHE. That is when I decided that instead of embarking on a PhD, a DProf would be more suitable and completely aligned to what I always wanted to do. It dawned upon me that, more than being recognised as a Mathematician, I wanted to be viewed as someone who dedicated his professional life to helping students understand the concept of mathematics and the values that mathematics and statistics have in areas of studies at HE level. Irrespective of how students view these subjects, I wanted to participate in their experience of learning mathematics and statistics, hoping that this would enable me to improve my style of teaching.

4.2 Why a DProf and not a PhD?

As mentioned above, I opted to embark on a Professional Doctorate (DProf), instead of the traditional Doctor of Philosophy (PhD) pathway. Scott et al. (2004) state that the defining feature of a DProf is its focus on the development of the individual about their professional work. In my mind, I knew that I wanted to improve myself as a Teacher and

as an Educator. Interestingly, there are not a lot of published articles on the differentiation between a Teacher and an Educator, but Sackstein (2016), in her blog "Work in Progress - An Adventure in Teaching Writing" (based on her TEDx talk), tries to explain the difference between these terminologies. According to her, a Teacher **teaches**, that is, whose occupation is to instruct, whereas an Educator is skilled in teaching and would go farther than what is expected. She further explains:
"*An Educator is a teacher who makes relationships with students more important than the content, but because of those relationships, the content comes alive*".

I am deeply passionate about the field of education, considering it to be my true "calling". Teaching mathematics and statistics provides me with a platform to express myself in the classroom. I see it as my responsibility to guide students on a path of discovery, demonstrating how mathematics and statistics can significantly contribute to their future careers, irrespective of their personal preferences toward these subjects. My overarching goal is clear. I recognise that students may not always feel comfortable with the content I teach, but I am committed to showing them the "bigger picture". I aim to live the educational experience alongside my students, gaining a deeper insight into my teaching practices. Wellington and Sikes (2007) describe the Professional Doctorate pathway as one that places high value on support, friendship, and social interaction. This journey allows researchers to connect with individuals from diverse backgrounds, fostering the exchange of new and varied ideas. In my role as a teacher, educator, and researcher, I am open to learning from my students. I seek to understand their perspectives when grappling with the modules I teach and aspire to be an integral part of their educational journey.

This chapter will cover my trip in the world of research which hopefully will culminate in earning a Doctorate. I will discuss the enablers and the challenges I faced during my DProf studies. Ethical issues that arose, as well as the hurdles I faced in planning the data collection process will be presented in detail within this chapter. My write-up was also hindered by the Covid-19 pandemic and by my unpredictable health. I also had to cope with my work responsibilities which include my role as Academic Area Head for the School of Business, Innovation and Creativity (BIC) at MUM.

As a mathematician, I have been doing (and enjoying) quantitative analysis for a while, but in this research, I had to re-focus my mind and my approach, to perform qualitative analysis. The tendency to "see numbers" in everything (as my colleagues and students would say), was heavily tested and my journey in adopting qualitative analysis was quite challenging. Particular attention will be given to explaining to the reader, the following points:

- The value of the research for stakeholders and the feasibility of the study.
- The enablers.
- Challenges that arose in this research.

4.3 The Research Topic

The choice of the Research Topic was quite an obvious one. Having been at MUM since 2010 and comparing my experience at the university with that at UoG, London, UK, where I was teaching "specialist" students, it was evident that my next venture into research would be on how to share my knowledge with "non-specialist" students. As it has been documented in the **Introduction** chapter, and as mentioned above, the PGCertHE programme helped me to learn a lot about myself. Moreover, it gave me a convenient platform from which I was able to structure my DProf topic. As the only academic teaching mathematics and statistics at MUM, at the time I embarked on the doctoral journey, it was evident that my investigation would be more inclined towards the education of mathematics and statistics at the university. MUM is also part of a corporate group known as Medine Group Mauritius. One of the numerous aims of the Group is to revitalise the education sector in Mauritius, focusing more on Higher Education. At the time of writing this thesis, Medine Group Mauritius has been considering inviting other HEIs to set up their campuses in Mauritius, and we, academics, have been encouraged to do high-level research in our fields of interests and expertise, to provide the best learning experience to our students. It was quite a deliberate, easy and exciting choice for me to select the topic that I am now working on, towards my doctorate.

4.4 Value and Feasibility of the Study

It is quite clear at this stage, that this research aims to benefit a wide range of stakeholders, who are Medine Group Mauritius, Middlesex University Mauritius, Middlesex University UK, students, academic staff teaching quantitative components and, as mentioned in subsection 1.1.2 on Page 3, the Government of Mauritius who have prioritised "Education" in the last decade. Having also discussed in detail about positioning MUM in the field of education and its endeavours in Mauritius, in section 1.1, this study is expected to contribute in a productive mechanism in making the island a knowledge hub, and in helping MUM in leading the way towards a valuable contribution in mathematics and statistics education at Higher Education level.

I was fortunate enough to have the support of my line managers (the then Campus Director, Dr Karen Pettit and the then Associate Director Academic, Dr Nicky Torrance) in Mauritius, at MUM. Furthermore, communication with Hendon counterparts at MU-HEN was triggered and facilitated by them and I was quickly introduced to my Academic

Advisor, Dr Gordon Weller and my Supervisor, Dr Leena Robertson. Following a first online interview with a panel of experts from MU-HEN, I was encouraged to embark on the DProf experience, and I received advice and guidance from Dr Gordon Weller. Following the departure of Dr Pettit and Dr Terrance, the new Campus Director, Prof. Mari Jansen Van Rensburg extended her support towards my study. My research is sponsored by the university, in the form of fee-waiving research and the support I have received from all the above stakeholders has been remarkable.

4.5 The DProf Research Programme and the Research Project

In my view, the DProf Research Programme is split into four major parts, namely:

- Submission of IPL4013, IPL4040, IPl4060
- Submission of IPL4016
- Ethics Approval
- The Final Project, IPL5360

The Research Programme consists of all the above modules and depends on the Ethics approval. Since this chapter is about Project Activity, I shall focus mainly on the last two items. It is important for me to briefly highlight my experience in the first three years of my research, which consisted of working on IPL4013, IPL4040, IPL4060 and IPL4016.

To say that I enjoyed working on IPL4013, IPL4040 and IPL4060 would be an understatement. The momentum that I had carried with me since I started (and completed) my PGCertHE, 18 months before I started my doctoral journey, flowed smoothly into the activities involved in the three modules. I felt full of energy and although I had adequate experience in learning and teaching, studying online was quite exciting for me. I completed all three modules in the first year and I only had to focus on my Research Proposal (IPL4016) in my second and third years.

I believe this is when I realised the amplitude of the task I had in hand. Following the unexpected passing of my mother, my studies were affected and soon after, I was diagnosed with high blood pressure and high cholesterol. Although that was quickly taken care of, with medication that I now have to take permanently, I was then diagnosed with an acute allergic reaction which greatly hindered the smooth running of my research. I had no other choice but to take a temporary break from my studies as I had swollen hands and was on medications which affected my sleep patterns. After eight months and constant reliance on antihistamines, I was finally cured of the allergic reactions, but I was asked

to control my diet, in terms of the ingredients that were present in my food. Soon after, I returned to my research work, and I successfully cleared my viva voce for my research project (through the Programme Approval Panel).

4.6 Ethics Approval

Once the Programme Approval Panel approved my project, the first activity was to obtain ethical clearance for my research. I found this endeavour to be fully satisfying, interesting, challenging and exciting. I aimed to submit a watertight ethics package with all the necessary details. The whole process, from the first day, till I received ethics approval, took two and a half months of hard work. This includes the initial "approval with minor changes" conclusion of the package submission. I was particularly happy with one of the remarks from the Chair who stated the following in her comments (Appendix A on Page 192):

This is one of the most meticulous and well thought through ethics applications I have ever read. I fully approve it. Very well done, and good luck with your study!.

Following this positive feedback, I submitted the required amendments, within the 10-day deadline I was allotted. My amended ethics package was well received and I got the approval as shown in Appendix B, on Page 193.

4.6.1 The Watertight Ethics Package

Although a section has been dedicated in the **Project Design and Methodology** chapter, (Chapter 3, Section 3.7, Page 91) on Ethical Considerations, I must write about another aspect of my journey through the submission process of the Ethics Package. Having seen a few colleagues around me who had already worked on their ethics submissions, I noticed that some of them were frustrated with the sheer amount of time it was taking them to complete the ethics form. Furthermore, their ethics packages were getting rejected and they had to work on the amendments, which required a lot of their time and effort. They were indeed my first "informal" guides, in the sense that I was adamant that I would not go through the process, unprepared. I had no experience in seeking ethics approval and this was my first foray in evaluating my research through an ethical angle.

I started reading a lot of academic articles connected with my research, but I was also very meticulous while going through all sections of the form. My main concern was that although I was identifying the nucleus of my research, I was still unsure about how to proceed with my data collection and analysis. The choice of my participants was important, and I started working on the participants' profiles that I wanted for my study. This was a lengthy and tedious process. My participants come from a plethora of academic and social backgrounds, and I had to ensure that they were well-represented in my data collection. I was also apprehensive of having participants who would take

this data collection process lightly. In that respect, I decided to explore the possibility of using a moderator when I would eventually collect qualitative data.

In summary, the initiation of the thought process during the experience of writing and submitting the Ethics Package carried forward into my research, influencing aspects such as data collection, the selection of students for the online questionnaire, and the choice of participants for my focus groups.

4.7 Ethical Concerns

The nature of my work with students requires a high level of ethical considerations. Not much has been published on Teacher-Student Relationship (TSR) in Higher Education, as claimed by Hagenauer and Volet (2014), although there is enough research work that has been done at the school and pre-school level. The authors claim that, when describing TSR in HE, two main dimensions can be differentiated, namely:

1. The *affective dimension*, which describes the bond between the teacher and the student. This forms the basis of a happy, secure and trusting relationship between the teacher and the student.

2. The *support dimension*, which describes the support that must be provided to students, for efficient relationship and communication between the teacher and the student.

Bearing the above in mind, I had to be very careful when I approached the participants (students) and also while I was conducting my data collection. The trusting nature of students towards their teachers was something that I did not want to jeopardise, by using an inefficient approach or by asking the wrong questions. Other ethical considerations that needed to be applied or avoided, as discussed by Leentjens and Levenson (2013) were:

- The feeling that students were coerced into participating in the research.

- "The educational misconception", whereby students think that they will get something else in return (usually bonus marks, or better attention from the teacher).

- Voluntary, whereby students should not feel that they must participate to please the teacher.

Prior to the start of this project, permission was sought from the Management at MUM to conduct the data collection and the research. I had the opportunity to explain my study and it was well received by the Management Team. They provided all the necessary support, starting with the Approval Letter (Appendix F on Page 209). Permission was granted and after a few meetings with my Supervisory Team, I proceeded with completing

the online form, as discussed in Section 4.6. All students and academic staff at MUM are adults (18+) and there were no "vulnerable" groups, either in the Focus Groups or in the individual face-to-face interview sessions. The participants were restricted to only those who study some components of numeracy, hence, for obvious reasons, students registered in programmes such as "Law" and "Advertising Public Relations and Branding" were automatically excluded. I would like to further clarify that the International Foundation Programme (IFP), which is a Level 3 programme, is catered for students before their enrolment in an undergraduate study at MUM. Although they had a relatively smaller amount of mathematics and statistics content in their syllabus, the students involved in IFP warranted their participation in this study because they were fresh from secondary schools. Their opinions were extremely important for several reasons:

- I may, in the future, have to teach on the IFP programme, and hence this was an opportunity to understand their past experiences and hopes, on the quantitative contents.
- At the time data collection was being planned, the retention rate of IFP students who would stay back at MUM to pursue an undergraduate degree, was around 70%. Providing them with a better learning experience may increase this figure.
- Undoubtedly, anybody who would teach quantitative content on the IFP programme, would benefit from the findings of this study.

Sensitive issues, such as religious beliefs, sexuality of participants, grades obtained in previous mathematics or statistics exams or tests, and political affiliation were avoided in any format of the data collection process. Participants were free to participate, and it was made clear to them that they could withdraw from the data collection process at any given time, without any pressure or repercussion from the researcher or the moderator. Since the interviews took place during the holiday period, the campus was almost deserted, and it was not tough to find a conducive place to run the meeting sessions. In that respect, a room was usually booked in advance and emails were sent to participants informing them about the time and venue of each meeting. In terms of refreshments, a bottle of water was provided to each participant. Participants in both the online questionnaire and the interviews (including focus groups and face-to-face discussions) were not required to engage in any mental calculations. Every precaution was taken to ensure that they did not feel biased by the experience.

The Participant Information Sheet (PIS) was read before starting the interviews and the document was also sent by email to participants who took part in the online questionnaire. Copies of the PIS were made available well before meeting the participants for the

interview sessions. A tape recorder was used with the permission of the participants, to record the process. The purpose of the study was carefully explained to them, both on the PIS and verbally. The audio recordings were safely kept in a password-protected folder on a cloud system and no other person had access to the recordings. Pseudo names were used to conceal the identities of the participants and they were asked not to mention their friends' names during the focus group interviews.

Ultimately, a debriefing session occurred after each interview activity, and participants in the online questionnaire were likewise encouraged to reach out to me via email for a debrief. This process is essential as it aids researchers in identifying any issues that may have arisen during the data collection process. Participants who may have been affected by the types of questions asked by researchers can then voice out their concerns and this allows the researchers to either clarify any doubts that the participants may have or to refer participants to the proper department, should they need support in dealing with the experience. In my case, the debrief took just about 10 minutes, and no participants showed any signs of distress nor did they have any doubts about the interview questions. Regarding the online questionnaire, given the anonymous nature of the data collection process, participants were initially invited to contact me if they had any questions or uncertainties about the questions or the study's nature.

4.8 Equipping Myself with the Best Tools Available

As mentioned earlier, I was already very familiar with doing quantitative analysis. I soon realised that I needed to equip myself with enough knowledge to embark on analysing qualitative data. Feeling hesitant about familiarising myself with a new software during that stage of my research, I opted to stick to the traditional approach of identifying themes within the collected data (interviews). This involved utilising coloured pens and pencils to annotate and categorize notes and themes in columns within my transcribed data. For practice purposes, I decided to try this method on one of my interview transcripts and I must admit that I was overwhelmed with the sheer amount of work that was required to perform such an analysis. Due to the number of focus groups and interviews that I intended to transcribe, I realised that it would be almost impossible for me to remember all the themes that I could develop, and this was a setback for me. I had no other choice but to explore other means of analysing my qualitative data.

4.8.1 Learning Nvivo for Qualitative Analysis

Following a meeting with Dr Robertson and Dr Weller, I decided that it would be beneficial for me, in the short and long term, if I could master the Nvivo software which was available to academics and students at Middlesex University. Furthermore, I realised that this would be a unique opportunity to add more value not only to my research but also to

my students' learning experience. As Lead of the Numeracy Support group, and as one who also teaches on the MSc Management programme, I found this as a chance to run workshops for students who must write postgraduate dissertations involving analysis of qualitative data. I thus embarked on a journey of discovery, through YouTube channels and I finally discovered the best online workshop for Nvivo (Hull University free online tutorials). I must also add that, although Nvivo was extensively used for the analysis of my qualitative data, I would still, occasionally, go back to the orthodox way.

4.8.2 Using Qualtrics, an Online Platform, for the Online Questionnaire

I was also quite unfamiliar with designing online questionnaires. Up until that time, I was reliant on printing copies of questionnaires which I would then distribute to participants. I discovered that Middlesex University provided the license for Qualtrics to its academic staff and after designing a few questionnaires for my class, I was quite conversant with the use and purpose of Qualtrics. The features available were very helpful, and they included the direct and easy conversion of the collected data into an SPSS format, which I was going to use for my quantitative data.

4.8.3 Choosing LaTeX over Microsoft Word

While most dissertations or theses are written in MS Word, I chose LaTeX to write my thesis. LaTeX is a high-quality typesetting system which gives the user a large margin of flexibility in the way they write and reference their works. In simple terms, LaTeX is an open-source software which provides a smooth style of writing and delivers an excellent output. It is mainly used by scientists and mathematicians. Having used it for more than two decades, and being very comfortable with it, I decided it would be best for me to persevere with it. The only drawback with LaTeX, once compiled, is its final output, which is in read-only format (Portable Document Format (.pdf), Postscript Format (.ps) and Digital Visual Interface (.dvi)). At first, this raised a considerable concern for me, given the difficulty my supervisors might face in providing feedback on the PDF documents I planned to send. However, after conducting additional research to find a solution, I obtained Adobe Acrobat Pro from work. This software allowed me to convert my PDF documents into a readable format, specifically in MS Word.

4.8.4 Mendeley - Reference Manager

An excellent free web and desktop reference manager, Mendeley was used to store all the articles that I read. Its ability to detect the sources of those articles, and extract important information such as authors' names, journals of publication, and dates of publication, amongst other features, makes it a robust working tool which LaTeX users, as well as MS Word users, will find useful. It helps the user to organise research articles in an orderly fashion and automatically generates the bibliography in a format that is convenient to

the user (BibTeX format for LaTeX users).

4.9 Setting Up CeMaSTeL

While engaged in the data collection process, I realised that students required more than what I, in my role as the Lead for Numeracy Support, could offer. Aligning my free time with theirs proved challenging due to time constraints. In July 2018, I took the initiative to develop online content, which was subsequently uploaded to a website. This marked the establishment of the **Centre for Mathematics & Statistics - Teaching and Learning** (CeMaSTeL). For the latest updates, the current website can be accessed at https://www.cemastel.org/ while the the initial link in 2018 was https://cemastelmdx.edublogs.org/.

CeMaSTeL aims to offer online support to students struggling to schedule face-to-face academic assistance sessions, particularly in mathematics and statistics. Initially established as a basic platform using the free service provided by Edublog, it quickly gained popularity as students increasingly preferred online materials over traditional in-person meetings. Subsequently, a YouTube channel (**CeMaSTeL MDX**) was created to upload our video content. This channel was seamlessly integrated with Edublog and eventually linked to the new CeMaSTeL website.

The success of mathematics and statistics support through CeMaSTeL brought a lot of positive changes to the functioning of the support system. Some are:

1. Many academics at MUM volunteer to add their content to the YouTube channel and hence to the website.
2. Colleagues from MU-HEN contribute to tutorials and workshops.
3. A separate budget is now allocated to CeMaSTeL. This provided for:
    - The purchase of a domain name where https://www.cemastel.org/ is now hosted.
    - Hosting workshops and small conferences on campus.
4. Students' contribution towards content creation.

4.10 Area Head, Health Issues and COVID-19

Regrettably, my progress in writing my thesis was significantly impeded by my deteriorating health, compounded to some extent by the impact of COVID-19. Since January 2020, I have undergone two surgeries, necessitating extended periods of bed rest that hin-

dered my ability to concentrate on my research. Additionally, recurring allergic reactions have compelled frequent visits to clinics, leading to four hospital admissions. The cumulative effect of these health challenges has taken a toll on both my mental and physical well-being..

Thankfully, I had already collected all my data before January 2020 and this process was also unaffected by COVID-19, which hit Mauritius in March 2020, when the country went into total lockdown (until July 2020 - the first wave). On a personal front, this could not have happened at a worse time. My eldest son was due to start his studies in India at a Boarding School (Grade 7) and he was expected to leave Mauritius in June 2020. Because of the lockdown both in Mauritius and in India and because of travel restrictions, his trip was cancelled, and he had to rely on my wife and me, for his education. We focused on teaching him at home and that too, took its toll on my research work. He eventually left Mauritius two years later, in June 2022. A second COVID wave hit our island in 2021 and we again found ourselves concentrating on the kids' education, as they could not go to school for months. In between my stay in clinics and the pandemic situation, I was able to learn Nvivo and transcribe all my data connected to my study.

Incidentally, one day before the first lockdown in March 2020, I was promoted to Area Head for the School of BIC. Instead of being a moment of joy, I found myself dealing remotely with affairs regarding my School. All preparation for the new academic year (September 2020) was done remotely and this was not the best experience for a newly appointed Head of School. There was no handing over, due to the lockdown and I had to find my steps in the chaos surrounding me. My thesis write-up took a back step as I had to prioritise my health, my family committent, and my new responsibilities at work.

4.11 Write-up of the Thesis

As mentioned above, the write-up of this thesis took longer than initially anticipated, because of my poor health and other personal responsibilities. Chapter 1, **Introduction** on Page 1, was completed very early. I was comfortable with this particular part of my thesis. I had the chance to send a draft of this chapter to my Supervisory Team at the very beginning of my write-up process and feedback was duly sent to me.

Chapter 2, **Aims, Objectives and Literature Review** on Page 22, is the biggest chapter of the thesis. It took a while for me to have a definite structure of what I wanted to write but eventually, it came down to two parts:

1. Literature Review on maths anxiety.

2. Literature Review on teaching of non-specialist students, and learning.

These two main themes were then split into numerous subthemes, and it was easier for me to structure my chapter.

Chapter 3, **Project Design and Methodology** on Page 64 is the chapter where I struggled the most. Here too, it was divided into two parts, with the first part being about the research philosophy behind my study and the choice of research methods used (Narrative Inquiry for qualitative research and Thematic Analysis for qualitative data analysis (one-to-one and focus group interviews), Correlation between several variables (online questionnaire)). Although my main focus was on the narrative thematic analysis, I wanted to investigate whether a correlation existed in my quantitative data and verify if the analysis corroborated with the qualitative findings.

Chapter 4, **Project Activity** on Page 111, is an interesting chapter which gave me time to reflect on my research path. This chapter gave me the freedom to express myself and a research diary was kept since the beginning of my research journey, which eventually helped me in writing this chapter.

Chapter 5, **Project Findings** on Page 125, is the chapter where my findings from my qualitative data analysis and quantitative data analysis were showcased. The findings in this chapter helped me in discussing the results in Chapter 6, **Discussion** on Page 158. Chapter 7, **Conclusions and Recommendations** on Page 164 followed, and I would like to say that these three chapters (5, 6 and 7) were done simultaneously.

4.12 Dissemination of the Study Through Conferences

This study has given me the chance to showcase my work to my peers and experts in the field through participation in conferences. This is crucial to a researcher's work as it enables researchers to receive feedback and to evaluate their work. The list of conferences I have attended are:

1. **Research Students Summer Conference, 2015, Middlesex University, UK**, Academic support to non-specialist mathematics and statistics learners in Higher Education.

    - This was held at MU-HEN and it was a great opportunity for me to meet my Supervisory Team. The conference was organised for doctoral students, and it was a chance for me to learn about my peers' work and to receive constructive feedback on my study.

2. **National Research Week For The Higher Education Sector, 2019, Ter-**

tiary Education Commission, Mauritius, Implementing changes in Teaching and Learning, focusing on mathematics and statistics support to non-specialist students.

- The conference was held in Mauritius one year before the COVID-19 pandemic. Lecturers in the Higher Education sector, as well as doctoral students, were invited to present their work. This was indeed a unique opportunity for me, due to my role as an academic in a HEI and as a doctoral student. I was able to evaluate my practice against those of my colleagues and peers from other HEIs.

3. 21^{st} **Annual Learning And Teaching Conference, 2022, Middlesex University, UK**, An Evaluation of Academic Support Advising (ASA) in Partnership with SLA's at Middlesex University Mauritius.

    - This was my first participation in an online conference, and it took place shortly after my second surgery which slightly hindered my preparation. I was able to successfully present my paper via live streaming and the feedback received was excellent. It was organised by MU-HEN and it accommodated academic and non-academic (professional services) staff. It gave me an insight into how other colleagues, mainly from the professional services, such as the Academic Registry, Learning Enhancement Team, Counselling and Mental Health Services can work together with students and academics, to provide an excellent learning experience.

4.13 End Note

My journey through the DProf programme has been very eventful. Though I initiated the journey with enthusiasm and anticipation, it gradually transformed into a sluggish expedition, influenced by the challenges mentioned earlier. Despite this, I have relished every aspect of the journey, and various elements have contributed to this positive experience, including:

1. The DProf programme is structured very well.

    - The breakdown of the programme is in modular format, and that rendered the doctoral journey interesting. The constant communication with the excellent supervisory team helped in structuring the final project.

    - The proposal was presented to a panel of experts and academics and this activity helped in shaping the project. Constructive feedback was given by several panel members, and this is a productive process for doctoral candidates.

- Excellent resources available to doctoral researchers on Unihub. Besides the software needed to carry out good research (SPSS, Nvivo, Qualtrics), a plethora of workshops and tutorials were made available online for researchers to use and prepare at various stages of their research.

2. Complete support from the Supervisory Team

   - I cannot thank Dr Leena Robertson and Dr Gordon Weller enough for the trust they showed in me, since the day I started my research. Even during the hard times, when I was hospitalised a few times, they kept encouraging me. This research would not have been possible without their support.

   - I have learned a lot from Dr Leena Robertson and Dr Gordon Weller. Being a dissertation supervisor myself (at MSc Level), I learned about how to communicate productively and constructively with supervisees. A few simple words can do a lot to boost students' confidence. Both have been very supportive of my research, and they lent me their ears when I wanted to share my views, which sometimes contradicted theirs.

3. Support at MUM

   - It sometimes takes just a few words to raise someone's motivation. My colleagues at work knew about my study and they have constantly shown an interest in my methodologies and my findings. The three participants (academics) in my interview process were very keen to contribute towards my research and I had no problem getting the best data out of them.

   - My students (participants) have been very supportive. They understood the importance of this research and how it may develop into a mechanism which will improve mathematics and statistics learning at MUM. They were excited to participate. They played a crucial role in the smooth running of my data collection process.

CHAPTER 5

PROJECT FINDINGS

5.1 Introduction

Before we discuss the findings, it is worth reminding the reader about the participants' profiles. Table 5.1 below shows the number of participants who were involved in the data collection process; and Table 5.2 gives a breakdown of the students from each programme, as well as their gender.

Table 5.1 Online Questionnaire - Participants

Cohorts	Frequency	Percentage
International Foundation Programme	41	31.1%
BA (Hons) Accounting and Finance	18	13.6%
BA (Hons) Business Management	37	28.0%
BA (Hons) Psychology	25	18.9%
MSc Management	11	8.3%
	132	100%

Table 5.2 Programme - Gender Cross Tabulation

			Male	**Female**	**Total**
Programme	**IFP**	Count	22	19	41
		% within programme	53.7%	46.3%	100.0%
		% within gender	38.6%	25.3%	31.1%
		% of Total	16.7%	14.4%	31.1%
	BAAF	Count	8	10	18
		% within programme	44.4%	55.6%	100.0%
		% within gender	14.0%	13.3%	13.6%
		% of Total	6.1%	7.6%	13.6%
	BABM	Count	17	20	37
		% within programme	45.9%	54.1%	100.0%
		% within gender	29.8%	26.7%	28.0%
		% of Total	12.9%	15.2%	28.0%
	BAPsy	Count	4	21	25
		% within programme	16.0%	84.0%	100.0%
		% within gender	7.0%	28.0%	18.9%
		% of Total	3.0%	15.9%	18.9%
	MM	Count	6	5	11
		% within programme	54.5%	45.5%	100.0%
		% within gender	10.5%	6.7%	8.3%
		% of Total	4.5%	3.8%	8.3%
Total		Count	57	75	132
		% within programme	43.2%	56.8%	100.0%
		% within gender	100.0%	100.0%	100.0%
		% of Total	43.2%	56.8%	100.0%

5.2 Online Questionnaire - An Introduction to its Importance in this Study

The first part of this section, detailed in Subsection 5.2.1, outlines the procedures for configuring SPSS to analyse the data gathered through an online questionnaire. The subsequent part, elaborated in Subsection 5.2.6, provides insights and observations derived from the data analysis. Before delving into the questionnaire analysis and findings, it's crucial to grasp the significance of using quantitative data and analysis obtained through the questionnaire, in enhancing and complementing the results derived from qualitative analysis, which includes face-to-face interviews and focus groups.

Referring to the information provided in Section 3.3 on Page 67, the questionnaire, featuring simple inquiries aimed at newly enrolled individuals at MUM, was designed. Lawson et al. (2020) have strongly emphasized the importance of offering support in mathematics and statistics to new students in HEIs. Therefore, it was imperative to examine, using participants at MUM, the sentiments of these students regarding the mathematics and statistics aspects of their academic programmes.

Tapia and Marsh II (2004) identified four variables that researchers can use in the questionnaire, namely:

1. **Value** of learning mathematics and statistics.
2. **Enjoyment** of mathematics and statistics.
3. **Motivation** to learn mathematics and statistics.
4. **Self-Confidence** in learning mathematics and statistics.

The authors investigated the aforementioned variables **independently**, with their participant samples. They also put forth the idea that future research could delve into possible relationships among the four variables. This study has provided me with the chance to expand upon their research. Frequently, non-specialist mathematics and statistics students ponder the significance of mathematical and statistical concepts in both their academic programmes and real-world applications (Lee (2008)). Additionally, it has been noted, as cited by Bromage et al. (2022), that non-specialist mathematics and statistics students frequently lack the motivation to actively participate in the mathematical and statistical aspects of their study programmes. They often perceive themselves as lacking the necessary skills and motivation to perform well in these subjects. The authors further emphasize that academics are now placing significant emphasis on elucidating the importance of mathematics and statistics to students.

Drawing from the research conducted by the previously mentioned authors, it is evident that when extending the study initiated by Tapia and Marsh II (2004), the analysis should explore the potential correlation between the **Value** of learning mathematics and statistics (the dependent variable) and various other independent variables (in this case, **Enjoyment**, **Self-Confidence** and **Motivation**).

As a researcher, it became evident that I required new perspectives on the aforementioned variables. Therefore, the participants in this study needed to be free from any form of interaction with academics at MUM, as these interactions might have inadvertently impacted some of the variables, by:

- Engaging in discussions about the significance of learning mathematics and statistics.
- Motivating students to study mathematics and statistics.
- Boosting students' self-confidence in their mathematics and statistics learning journey.
- Creating a classroom atmosphere, while teaching mathematics and statistics, that students found enjoyable.

It was evident that gathering data from newly enrolled students through interviews or focus groups would not be practical. These students had just begun their studies at MUM, with data collection taking place during their first week, prior to any exposure to mathematical or statistical lectures. Due to the constrained time frame for sending out my Participation Information Sheet and other required documents, I opted to use a questionnaire to gather data from these new students. Additionally, the study done by Arnkoff et al. (1996) claims that Hypothesis Testing is a valid method to address specific research questions. My doctoral research includes an exploration of the prior experiences and individual expectations of non-specialist mathematics and statistics students. The questionnaire presented an ideal opportunity for me to examine the hypothesis that the perceived "Value" of learning mathematics and statistics may be influenced by factors such as "Self-Confidence", "Enjoyment", and "Motivation".

In the analysis of the data collected through the online questionnaire, the sequential steps are summarised in Table 5.1, which is presented below. This table provides a comprehensive overview of the processes undertaken to derive meaningful insights from the gathered data.

Item	Step	Action	Purpose	Conclusion
1	Choosing between Linear Regression Analysis and Ordinal Regression Analysis.	"Transforming" the variables.	To calculate a Mean value using the Likert Scale Responses.	Ordinal Regression Analysis is used, and Linear Regression Analysis is rejected.
		Test for Normality on the "Transformed" values, using Kolmogorov-Smirnov Test, as N > 100.	To test for Skewness. It is seen that the data is not Normally distributed.	
		Since Normality Test failed, Variables are "Transformed" again.	To calculate the Logarithm of the Mean values, to Base 10.	
		Test for Normality on the Log of the Mean using Kolmogorov-Smirnov Test, as N > 100.	To test for Skewness. It is seen again, that the data is not Normally distributed.	
2	Model Fitting Information investigates if the Model created by SPSS fits the data collected.	The p-value in SPSS indicates if the Model created fits the data collected.	It is expected that the Model fits the data so that further analysis can be explored.	The Model fits the data well.
3	The Goodness-of-Fit further validates if the Model provided by SPSS.	This is an additional validation process with further confirms the Model fitness. The p-value indicates the fitness of the Model.	It is expected that the conclusion here aligns with the previous step, which is the Model Fitting	Confirmation that the Model is a good fit.
4	Test of Paralell Lines. This tests investigates whether the distribution of opinion on the independent variables "Enjoyment", "Motivation" and "Self-Confidence", towards "Value of Mathematics and Statistics", is uniform.)	The p-value indicates if the distribution of opinions is consistent across the three independent variables.	To check the rate at which the responses vary for the three covariates.	The rate at which the responses vary is the same.
5	"Parameter Estimates" indicates which of the three independent variables is "more connected" to the dependent variable.	The p-value of the three independent variables will indicate how "strong" they are connected to the dependent variable.	To check the dependence of the variables.	Based on the data collected, it is confirmed that "Value" of mathematics and statistics depends only on "Motivation"

Fig. 5.1 Summary of Steps in the Analysis of the Data

5.2.1 Ordinal Regression: "Value" Against Independent Variables

The aim of the analysis was to explore potential correlations between the dependent variable, "Value", and the independent variables, namely "Self-Confidence", "Enjoyment" and "Motivation". This investigation was customised for participants at MUM. The anticipated results were expected to be robust, considering the sizeable sample size of 132 participants. Additionally, it is important to note that the participants represented a diverse range of academic programs, as outlined in Table 5.1, Page 125.

Figure 5.2 below shows sections (B), (C), (D) and (E) of the questionnaire which was administered to the participants. Part (A) primarily contains descriptive data and can be found in Appendix K on Page 222; however, it does not bear relevance to the investigation of correlations.

Likert Scale:

1 = Strongly Disagree (SD) 2 = Disagree (D) 3 = Undecided (U)
4 = Agree (A) 5 = Strongly Agree (SA)

5.2.1.1 Purpose of "Transforming" the Variables

As observed in Figure 5.2, each variable (Self-Confidence, Value, Enjoyment and Motivation) has multiple "sub-variables" ((SC1, SC2, SC3), (VAL1, VAL2, VAL3), (ENJ1, ENJ2, ENJ3), (MOT1, MOT2)). To carry out an analysis of the main variables, a mean value is calculated using the Likert scale responses for each sub-variable. The mean value of each of the four variables is now denoted as SC, VAL, ENJ and MOT, as shown in Table 5.3.

Table 5.3 Nomenclature of the Mean Transformed Variables

Mean Transformed Variables	Definitions
VAL	Mean transformation of "Value"
SC	Mean transformation of "Self-Confidence"
ENJ	Mean transformation of "Enjoyment"
MOT	Mean transformation of "Motivation"

5.2.1.2 Test of Normality on the Mean Transformed Variables

A Test of Normality is then performed on the newly transformed variables. The Test of Normality verifies if the data collected is, to some tolerance, not skewed towards certain types of responses. In simple terms, the test investigates whether or not the values available on the Likert scale were evenly used (to some extent). This test is important, as it helps guide researchers on the methods that need to be used for further analysis.

A brief description of Table 5.4 on Page 132 is given below:

Likert Scale Questionnaire							
Variables		**Items**	**Agreement Scale**				
			SD	**D**	**U**	**A**	**SA**
			1	**2**	**3**	**4**	**5**
SELF-CONFIDENCE (SC)	SC1	I feel confident studying mathematics and statistics.					
	SC2	I am relaxed in a mathematics and statistics class.					
	SC3	I am able to solve mathematics and statistics problems with ease.					
VALUE (VAL)	VAL1	Mathematics and statistics are important in everyday life.					
	VAL2	Mathematics and statistics are important subjects for people to study.					
	VAL3	High (secondary) school mathematics and statistics courses would be very helpful no matter what I decide to study.					
ENJOYMENT (ENJ)	ENJ1	I have usually enjoyed studying mathematics and statistics in secondary school.					
	ENJ2	Mathematics and statistics are exciting.					
	ENJ3	I am happier in a mathematics/statistics class than in any other class.					
MOTIVATION (MOT)	MOT1	I would like to study mathematics and statistics at university.					
	MOT2	I plan to study as much mathematics and statistics as I can during my education at university.					

Fig. 5.2 Likert Scale Questionnaire

1. **Kolmogorov-Smirnov Test of Normality**

   (a) There are two methods to test for normality in a dataset, namely the "Kolmogorov-Smirnov Test of Normality" and the "Shapiro-Wilk Test of Normality."

   (b) Kolmogorov-Smirnov Test of Normality is used if the number of participants is greater than 100 ($N > 100$).

   (c) Shapiro-Wilk Test of Normality is used if the number of participants is less than 100 ($N < 100$).

   (d) In this particular (online questionnaire) research, $N = 132$, and the Kolmogorov-Smirnov Test of Normality is therefore used.

2. **Statistic**

   - This is a number used to calculate the probability (the p-value) of the results obtained.

3. **Degree of Freedom (df)**

   - The Degree of Freedom (df) here is the number of participants who took part in the online questionnaire.

4. **Sig (the p-value)**

   - The p-value is a number which describes how likely (probability) it is that the data would have occurred.

   - It is observed that all the p-values are less than 0.05.

The Hypothesis is that the data set is normally distributed, and can be defined as:

- Null Hypothesis H_0 : The data set is normally distributed.

- Alternative Hypothesis H_1 : The data set is not normally distributed.

Since all the p-values are less than 0.05 (that is, $< 5\%$), the Null Hypothesis (H_0) is rejected. In simple words, it claims that there is less than 5% chance that the hypothesis is true. **Hence, it is concluded that the data set is not normally distributed (The Alternative Hypothesis H_1).**

Table 5.4 First Test of Normality

Test of Normality - 1			
	Kolmogorov-Smirnov		
	Statistic	df	Sig
VAL	0.178	132	< 0.001
SC	0.95	132	0.006
ENJ	0.118	132	< 0.001
MOT	0.113	132	< 0.001

Since the test of normality failed, further transformation of the data was required. For the initial transformation, the mean values were taken for each variable, whereas for the second transformation step, the logarithm (to base 10) of the first transformed values was used. The logarithmic transformation tries to reduce the skewness of the variables in the dataset.

5.2.1.3 Test of Normality on the Log of the Mean Transformed Variables

The new set of transformed data (Shown in Table 5.5 as "LogVAL", "LogSC", "LogENJ" and "LogMOT") was hence tested for normality and the results are shown below in Table 5.6. It shows that the log-transformed values are also not normally distributed (all p-values are again less than 5%).

Table 5.5 Nomenclature of the Log of the Mean Transformed Variables

Log of the Mean Transformed Variables	**Definitions**
LogVAL	$\log_{10}$ (transformation of VAL)
LogSC	$\log_{10}$ (transformation of SC)
LogENJ	$\log_{10}$ (transformation of ENJ)
LogMOT	$\log_{10}$ (transformation of MOT)

Table 5.6 Second Test of Normality

Test of Normality - 2			
	Kolmogorov-Smirnov		
	Statistic	df	Sig
logVAL	0.239	132	< 0.001
logSC	0.148	132	< 0.001
logENJ	0.120	132	< 0.001
logMOT	0.170	132	< 0.001

Based on the results obtained above (the dataset is not normally distributed), **Ordinal Regression Analysis** was therefore used to analyse the correlation between "Value" and the other three variables, namely, "Enjoyment", "Motivation" and "Self-Confidence". In contrast, if the variables were normally distributed, Linear Regression Analysis would have been used instead.

5.2.2 Model Fitting Information

The "Model Fitting Information" was retrieved from SPSS (Figure 5.3), to evaluate how well the model fits the data. The Null Hypothesis and the Alternative Hypothesis are defined as follows:

- H_0 : The model does not fit the data.
- H_1 The model fits the data.

As seen in Figure 5.3, the $p-$value (Sig.) indicated the likelihood of H_0 being true. In this case, the p-value is smaller than 0.001, which is itself less than the 5% (level of

significance). The conclusion, based on the p-value, is that the Null Hypothesis H_0 is rejected (because the likelihood of H_0 occurring is less than 5%) in favour of the Alternative Hypothesis H_1). This concludes that the model fits the data very well.

Model Fitting Information

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	534.955			
Final	502.810	32.145	3	<.001

Link function: Logit.

Fig. 5.3 Model Fitting Information

5.2.3 The Goodness-of-Fit

The Goodness-of-Fit was also tested, as an **additional** way to validate the model. The Deviance, which is a measure of error, ranges between zero (0) to infinity (∞) and is here given as 481.617 (Figure 5.4). The smaller the Deviance value (that is, the less error), the better the model fits the sample data (deviance = 0 means that the logistic regression model describes the data perfectly). Higher values of the deviance correspond to a less accurate model. The Hypothesis can be defined as:

- H_0: Deviance is not large.
- H_1: Deviance is large.

The level of significance, p-value (1.000 as shown in Figure 5.4), being greater than 0.05 indicates that H_0 is accepted, hence, an indicator that the model fits the data well.

Goodness-of-Fit

	Chi-Square	df	Sig.
Pearson	1132.198	1196	.906
Deviance	481.617	1196	1.000

Link function: Logit.

Fig. 5.4 Goodness-of-Fit

5.2.4 Test of Parallel Lines

The "Test of Parallel Lines" was then performed on the data (Figure 5.5). This tests for proportional odds assumptions. To understand this better, one may consider the null hypothesis, as defined in Figure 5.5. The (null) hypothesis states that the location parameters (slope coefficients) in the model are the same across response categories. The

location parameters here are the independent variables ("Enjoyment", "Motivation" and "Self-Confidence") and the response category is the dependent variable ("Value"). In simple words, the Test of Parallel Lines investigates whether the distribution of opinions on "Enjoyment", "Motivation" and "Self-Confidence" towards the "Value of Mathematics and Statistics", is uniform.

Test of Parallel Lines[a]

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Null Hypothesis	502.810			
General	461.625[b]	41.185[c]	30	.084

The null hypothesis states that the location parameters (slope coefficients) are the same across response categories.

Fig. 5.5 Test of Parallel Lines

H_0: The odds for each explanatory variable (the independent variables) are consistent across different thresholds of the outcome variable (the dependent variable).

This examination ensures the consistency of odds for each explanatory variable ("Enjoyment", "Motivation", and "Self-Confidence") across different thresholds of the outcome variable ("Value"). According to our model, it seems that the proportional odds assumption holds, given a significance level of 0.084 (the p-value, representing the probability that the Null Hypothesis is true, is 0.084), which exceeds 0.05. Therefore, there is sufficient evidence to accept the Null Hypothesis, indicating that opinions on "Enjoyment", "Motivation", and "Self-Confidence" regarding the "Value of Mathematics and Statistics" are uniformly distributed. In other words, the rate at which the response varies is the same for the three covariates, implying parallel regression lines for these variables.

5.2.5 Parameter Estimates

Based on the aforementioned results, specifically the absence of violations in the proportional odds assumptions, it became valuable to study the parameter estimates. This analysis aimed to provide insights into the impact of "SC" (Self-Confidence), "ENJ" (Enjoyment), and "MOT" (Motivation) on "VAL" (Value). The corresponding visual representation is illustrated in Figure 5.6 below.

The Null Hypothesis is defined as the estimates being equal to 0. That is, those estimates may not be useful. However, a closer look at the significant value for each independent variable (SC, ENJ, MOT), Table 5.7 (values obtained from Figure 5.6), indicates that two values, for Self-Confidence (p = 0.266, hence greater than 0.05) and for Enjoyment (p = 0.180, hence greater than 0.05) are not significant, and hence may not be useful

(accepting the Null Hypothesis). In simple terms, there is enough evidence (due to the high probabilities, as both are greater than the 0.05 threshold) that the Null Hypothesis is true (those estimates may not be useful). As for Motivation ($p = 0.010$, hence less than 0.05), the estimate is statistically significant. The low probability here ($0.010 < 0.05$) indicates that there is not enough evidence that the Null Hypothesis is true hence we can instead consider the Alternative Hypothesis, that is, the estimate for "Value" is not equal to 0, therefore useful.

Parameter Estimates

							95% Confidence Interval	
		Estimate	Std. Error	Wald	df	Sig.	Lower Bound	Upper Bound
Threshold	[VAL = 1.00]	-1.502	.717	4.388	1	.036	-2.907	-.097
	[VAL = 1.67]	-1.191	.656	3.303	1	.069	-2.476	.093
	[VAL = 2.00]	-.414	.555	.555	1	.456	-1.501	.674
	[VAL = 2.33]	-.277	.544	.260	1	.610	-1.343	.788
	[VAL = 2.67]	.241	.514	.221	1	.638	-.766	1.249
	[VAL = 3.00]	.819	.500	2.684	1	.101	-.161	1.799
	[VAL = 3.33]	1.456	.501	8.432	1	.004	.473	2.438
	[VAL = 3.67]	2.577	.531	23.570	1	<.001	1.536	3.617
	[VAL = 4.00]	3.734	.580	41.505	1	<.001	2.598	4.870
	[VAL = 4.33]	4.318	.607	50.524	1	<.001	3.127	5.509
	[VAL = 4.67]	4.950	.642	59.473	1	<.001	3.692	6.208
Location	SC	.252	.227	1.235	1	.266	-.193	.698
	ENJ	.291	.217	1.800	1	.180	-.134	.716
	MOT	.428	.167	6.550	1	.010	.100	.756

Link function: Logit.

Fig. 5.6 Parameter Estimates of Coefficients

Table 5.7 Summary of Parameter Estimates obtained from Figure 5.6

Independent Variables	Estimates	Sig
SC	0.252	0.266
ENJ	0.291	0.180
MOT	0.428	0.010

The importance of Motivation ("MOT") can be confirmed by further analysing Table 5.8. The Ranking column in Table 5.8 which has been summarised from Table 5.7 indicates that the highest value is assigned to the variable "MOT" (Motivation) as compared to the other two values. This confirms that "Motivation" was valued highest (as compared to "Enjoyment" being valued second and "Self-Confidence" being valued third among the three independent variables).

Table 5.8 Ranking of Estimates

Independent Variables	Estimate	Ranking	Sig
SC	0.252	Lowest	0.266
ENJ	0.291		0.180
MOT	0.428	Highest	0.010

5.2.6 Findings of Quantitative Analysis

The online questionnaire was disseminated at MUM, with **new** students as participants, in their first week at the university. Those students had never before had a mathematics or statistics class at MUM. The results indicate that those students may only need to be motivated to learn mathematics and statistics, to understand its value in real life. From Table 5.7 and Table 5.8, there was not enough evidence to confirm that the variables "Self-Confidence" and "Enjoyment" had an effect in determining how **new** students view the value of learning mathematics and statistics.

5.3 Analysis of Qualitative Data

The data was derived from interviews with academic staff and students (for face-to-face interviews) and students (for focus groups). For this research, these groups are representative of the staff/student population.

The interviews were audio recorded using a smartphone, with additional observational note-keeping to provide an added dimension to the subsequent transcript by being able to analyse the paralinguistic clues such as body language, laughter and nods of (dis) agreement. Private paper-based notes of the discussion were kept, while the moderator ensured that all questions were well understood by all participants.

The discussions flowed freely initially; however, it was observed in the focus groups that certain members were visibly participating less after some time. The participants had to be reminded of the purpose of the focus group and were prompted to participate more actively in the discussions. This provided an opportunity for more students to contribute or comment. At the end of the focus group interview sessions, after the participants had left, a debriefing session took place with the moderator.

This section details the analysis of data derived from participants as detailed in Tables 3.5, 3.6, 3.7, 3.8 and 3.9, in Chapter 3, **Project Design and Methodology**, on Page 101. The six phases of the Braun and Clarke (2006) Thematic Analysis were implemented for each of the three data collection groups. In phase 1, the data was transcribed (Appendices L, M and N on Page 226, Page 241 and Page 250, respectively, for a sample transcription

of each type of data collected - interview and focus group). After reading and re-reading the data, the initial ideas were noted down. Appendix O on Page 255 shows a visual representation of one sample (Staff 1, based on Transcription in Appendix M on Page 241), which also includes phase 2 generating the initial codes.

As soon as data collection was completed, the interviews were transcribed. The raw data from the transcriptions were then broadly coded by giving descriptive labels to discover emergent themes. An interactive process of reading, analysing, reflecting and further examining the transcripts, was then carried out. This process lasted several weeks, until conclusive findings from the data were determined (Braun and Clarke (2006)).

The research findings in the following sections are organised in relation to the broad key emergent themes.

5.3.1 Staff Interviews - Analysis

The three academics who participated in the interview process were given the pseudo-names "Manju", "Rahul" and "Pratibha". From the staff interviews, the transcripts generated five emergent themes, namely "Support Mechanisms", "Emotion", "Teacher's Awareness", "Teaching and Learning Strategies", and "Resources". These are individually analysed here.

5.3.1.1 Support Mechanisms

Through the staff interviews, two main types of support mechanisms were identified, namely:

- Those provided by academic staff.
- Those provided by students.

It was noted from Manju's interview, that students were willing and open to seek help in front of their peers.

"*...so students they're very happy to raise their hand and say that they don't understand something, they'll stop me in the middle or if it's a seminar work where they have work-sheets to do, they'll just raise their hand and say that I need to explain things to them.*"

In contrast, in Pratibha's interview, it was observed that students sought help only when they were in the safety of privacy with the lecturer.

"*...Often times, while we are running the labs and the workshops, I will sit next to them and try to get them to do the workshops and that's where they feel a little more comfortable, to tell the tutor that they are struggling.*"

Alternatively, another way that students make their requests for support in Pratibha's

classes are through the Student Voice Leader.

"*... How we overcame that, was that the student class rep, came and talked to me, about students not knowing, or feeling that they were not supported.*"

Although students are hesitant to seek support from their lecturer openly, they show more willingness to receive help from their peers.

"*...And you can already see if they are hesitant to contact their tutor, they may raise their hands and have their peers help them. So, that's how I spotted earlier on,...*".

Manju added the following statement, describing her appreciation when students collaboratively assist each other.

"*...Or, you know, they take a lot of peer support which I find very encouraging, so they might raise their hand and it might be that another student walks over and asks them what they can help with.*"

Pratibha's interview highlighted that it takes a lot of the lecturer's time to assist students properly.

"*...that was because I took out, like, two, three hours of my time every few weeks to kind of sit with her and rework the materials with her. Which as a lecturer, you can do it once or twice, but you don't have that time to be able to give to that student*".

However, Pratibha proposed an alternative support mechanism.

"*...So, it could be a setup where it's not just one lecturer doing everything, but where you are using different resources or different people, that can meet with the student, in scheduled time slots, for an hour*".

5.3.1.2 Emotions

In this subsection, we have categorised positive and negative emotions separately.

Rahul, a new lecturer in the IT discipline raises many points on the emotions of students and the cues that can be observed in the class.

He noted that when he was explaining a chapter on Conversion, there were particular cues.

"*...when we do explain about Conversion they have the facial expression like they are being confused and then we have to ask them if [they] have any issues*".

According to Pratibha, who considers statistics, the subject she teaches, to be a "dry"

subject, the researcher noted this has an impact on how the students receive this emotionally.

"*...its dry material to teach Statistics to students, so in general they do not enjoy it*".

Interestingly, Rahul observed positive body language when students got their calculations right.

"*.....Visually some of the students will say, Oh, this calculation was supposed to do like this. You have this smiling expression*".

Manju seemed more inclined to elicit positive emotions from students. She feels that she can easily be approached by students ("*I am somebody who they can approach*") and this has an impact on the way the students "behave" in her class.

"*...good body language so they start to smile, they start to fidget, to raise their hands to provide answers, they start to walk around amongst the other students who probably are not so confident and give the benefit of their advice so that they are kind of like mini coaches in the classroom and also it shows in their work because they keep asking you know how can I improve it...*".

This leads nicely to the next subsection.

5.3.1.3 Teacher's Awareness

Manju, who interestingly has an excellent academic background in mathematics and education, demonstrated awareness and understanding of the issues at hand.

"*...I think it comes from, probably from experience and my own personal journey for mathematics has also been a bit up and down through school so it comes from an understanding like an awareness, a personal awareness that students often don't enjoy mathematics*".

She also places great importance on the position of the teacher in the classroom.

"*...I really think the teacher has a very powerful position to play in whether students enjoy maths and thrive in mathematics ... and if you get it right once then I think that makes a lasting impact for the students*".

Pratibha seems to have developed an awareness of the learning issues in mathematics and statistics education because she has followed a similar learning journey in her academic studies. Having acknowledged that "*her background is also non-specialist*," she can draw on her own experience.

"*... So, I think in that sense, coming from a non-specialist background, teaching to non-specialist students, can help*".

However, she also identifies a weakness with this approach particularly when students want to go deeper into the mathematical aspects of the content.

"*... they want you to, for example derive the equation. Or, they want to know more about it. Then, that would mean, either, us doing more homework and coming back to them, or referring them to resources and materials, where they can learn more*".

The awareness that teachers have for their approaches helps them to adapt their teaching and learning strategies. This is the next theme.

5.3.1.4 Teaching and Learning Strategies

Foremost, is the type of environment created by the lecturer in the classroom. Pratibha, who we already know comes from a non-specialist background, and views statistics as a dry subject, acknowledges the effort to motivate students using appropriate teaching and learning strategies.

"*...But it takes a lot of enthusiasm and a lot of ....., kind of relating the materials to them, to make it engaging*".

In her discipline, students are already struggling just to have a surface understanding of the topic.

"*...I think we already struggled with them having a surface understanding of maths and stats (laugh)... that, it's not always easy*".

She recognises the benefits for those few students who want to take a deeper approach and always finds ways to support them.

"*...I would never discourage a student who wants to go deeper, because that means they are more excited by the material, they want to know more about the statistics or maths. I don't get many students asking me this. But one or two. And those that ask, we sometimes do it together, or they go and look through books themselves, and they learn more about it*".

Manju uses a lot of the learning theories to enhance her teaching and learning approaches.

"*...I've read a lot about the theories of teaching, the theories of learning and I try to put all of that into practice so erm, you know, the first, I think it's also about things like the tone of voice, the kind of contact that you have with your students*".

She further explained,

"*...Very early on I think we establish already that it's a classroom where students don't need to feel like they're alone, students don't need to feel afraid of anything, [urm] they have a professional respect and I think that's the type of classroom that I cultivate...*".

Rahul's overarching teaching and learning strategies are centred around the real-world application of the content. He also teaches his students how to use shortcuts in mathematics applications, offering a surface approach to learning.

"*...So putting myself in their shoes, I will do some customization in terms of, for example, real-world application and also a more, I would say more learning for a strategy to deliver the lecture as well, in terms of, for example, if we have some shortcut because in mathematics we always have some shortcuts*".

He further added,

"*...I will customise my notes in terms of doing it simple for them to understand. And then, for example, we will be having the simplest form and then the complex form. And it's for them to decide which calculation to adopt*".

The final theme discussed here is "Resources."

5.3.1.5 Resources

According to Rahul and Manju, teaching mathematics and statistics requires more hands-on approaches, which rely on hardcopy learning resources, such as handbooks and worksheets.

Manju who teaches IFP and MA Education, only prints hardcopy materials for her mathematics and statistics modules of the IFP, as she believes that this is the most suitable way to teach this module.

"*...this is one of the few modules where we have . . . I think on the IFP because of the maths and stats component it's the only module which is actually printed out . . . the whole workbook, the whole module handbook is framed like a workbook, it's about 180 pages long and it's kind of what we work through in the module*".

The workbook follows a differentiated learning strategy with certain sections for those more confident in the topics, and more explanations for those who require more support.

"*...I've presented it in the workbook in a way where there are pages which if you're very confident in mathematics you tackle that topic through those pages but if you're not so confident in mathematics then you tackle the same topic but through different pages and these are numbered.*"

Rahul emphasizes the importance of online resources as a means to support students.

"*...There are online courses where you have videos. So apart from these videos, we also have exercises. So sometimes as a challenge I would, ... apply, for example, they*

would go online and then do some further calculation."

These are particularly helpful in some cases when he could not cover the full class material.

"*...Online learning, yes, because sometimes in class you are not able to cover the whole aspect... So, I will encourage them, for example, to do online ... Because using online, for example, if we were in a traditional class, you can't go back. And then the students, while viewing some videos, they can go back and then learn at their own pace*".

Pratibha is in a unique situation since her Level 4 module is designed to be followed through online resources. The purpose of this structure is to promote independent learning. She highlights the importance of well-designed materials in this approach.

"*...I have a few minutes where I explain to them the general principles and then let them work through it because it is really well-designed and. . . So, basically they tell you step by step what they have to do and sometimes they have little video nuggets as well, and then they practise and it is assessed... The statistical portion is assessed by two tests that they have to do online*".

This approach continues in her Level 5 module, however, she points out that sometimes these students do not have enough time to finish all the activities.

"*...For PSY2005 which is the Year 2 level Stats, it's is deeper. It is further research and methods. So, for one hour lecture I go over the principles for example, what is an experiment? The design and as well as the basics of ANOVA and in the lab portion which is about one and a half hour, that's where they practise what they have learnt, and they practise in terms of exercises. Often, we find that the time is not enough, for the students to practise*".

At MUM, the LET offers additional support for students. Under the LET, CeMaSTeL is particularly focused on numeracy support. This Centre was mentioned several times in the interview

While Pratibha appreciated the initial efforts of the Centre, she was also diplomatically critical (through laughter) about the visibility of CeMaSTeL among the students.

"*...Another thing would be, trying to motivate students to kind of seek more help with the CeMaSTeL, those are other strategies though. Those are more like, how to market (laugh) CeMaSTeL. So, it could be that people from CeMaSTeL would pop in the class to say "we are there", or that during Induction, you guys have a slot. Just that LRC [Learning Resource Centre / library] has it, LET would have it during Induction. That way it's done and you don't have to take more time*".

She further suggested that CeMaSTeL could host "Statistics Clinics", with the help of student peer-assisted learning.

"*...I think we could eventually think about, like, a statistics clinic, if you want to see it that way. Where there would be a dedicated space, like a small little space, where there could be, it may not be lecturers, but it could be with the CeMaSTeL that there are students that are really good, that are there, that can help other students, with their work, one-on-one*".

Manju independently shared the views of Pratibha on both of the above points. CeMaSTeL is not reaching all students (referring specifically to IFP) and believes that it is more catered for UG and PG students. She stated that:

"*...you asked me about the kind of numeracy support and I think you know we have some very good ideas already because there's CeMaSTeL on campus which I think is a very good idea but probably it's not reaching maybe the level of Level Three, I think it's probably at undergraduate and masters level more so it might be that things could become simpler so that it engages. Remember IFP is almost like secondary school*".

Manju further suggested the possibility for CeMaSTeL to make an impact beyond the university.

"*...I have to say CeMaSTeL is I think making its presence felt on campus and that is a good thing but there's scope even to move CeMaSTeL outside of just the campus and make it something which might be used for students across different universities in Mauritius. Because i've seen MRU is a small island and the impact of particular initiatives, if it is properly designed and properly thought through, the impact can actually be quite powerful*".

Contemporary teaching approaches using technology and online resources are evident.

Overall, the staff interviews have evidenced the five themes above on teaching and learning non-specialist mathematics and statistics students. The next subsection will look at the students' perspectives.

5.3.2 Students Interviews - Analysis

There are several overlaps and differences in the emerging themes between the students' perspectives and the staff's perspectives. The following sections will detail the five themes "Gender", "Teaching & Learning Strategies", "Attitude", "Support Mechanism" and "Resources". The three participants in this interview process were all female students, with one being from a PG programme.

5.3.2.1 Gender

All three students interviewed have the perception that girls like languages, and boys are more inclined to like mathematics.

Melodie's perception is that girls have a higher pass rate in mathematics because they study harder.

"*...It's just something I mean, apart from that, I have read somewhere that usually girls are more into languages and art, more than mathematics and other subjects which require ...*".

Farida states that "Mathematics" has often been labelled as a challenge. She believes that girls avoid challenges, which is the reason she says that girls do not like mathematics. In contrast, she believes that boys like mathematics.

"*...I've noticed that girls, they don't really like maths. They like to do other things, maybe like Science. But when it comes to boys, they like challenges*".

For Benazir, she concurs with Melodie that females are better at languages. She also adds gender differentiation among the teachers of mathematics. She believes that male teachers understand abstract ideas better, and they are better at transferring abstract concepts, making them better maths teachers.

"*...According to me, maybe the male gender understands abstract concept more. That doesn't mean that the female, female teachers do not understand it, but they, they lack in the (...) in the transfer of that concept*".

Benazir further differentiated between the genders at the level of teachers at secondary school. Her perception, based on her learning experience, is that her female mathematics teacher simply opened the book and tackled the theoretical aspect whereas her male teacher displayed a better approach by being more energetic.

"*...I had a female teacher who was teaching us Mathematics. And she was doing only the theory part. The book was opened, doing like some concepts in, in, in (...) mathematics, integers for example. But you [can't] just sit and then read the book. You have to be on the board explaining the concept behind. And the, like, I would say, the logic, the explanation is very important in mathematics to be visual on the board. But then in Form 4 (Grade 10), I changed the teacher and I got the (...), he was a male teacher. And yes, I would say his approach was very different. I would also add that the female teacher was someone who has studied from Oxford University. But the delivery, the class delivery, lecture delivery, was not adequate, I would say. ".*

We can now move on to considering the teaching approaches used.

5.3.2.2 Teaching & Learning Strategies

Students discussed the teaching and learning strategies that they have observed in their mathematics teachers' approaches. from primary to secondary to tertiary level.

For Melodie, there was a lack of interaction with her teachers in secondary school, which she viewed as negative.

"*...They just came in class and did what they had to do, but there was no interaction as such. That's what made the experience negative*".

Farida's statements independently supported this view. At secondary school, the teaching was more mechanical. She added that teachers at secondary schools did not show interest in explaining the concepts.

"*...For instance, at secondary level, we are just taught mechanically, like how we should do it....I remember we were doing Permutations and Combinations, so it was not easy for me to understand because the teacher just went very ... like ... we got the answer like this. There was no explanation, so it was very difficult for me to understand this*".

Benazir's view is that a jovial teacher in her secondary school helped her to become interested in the subject. This teaching strategy of being jovial purposely lightened the mood.

"*...And then my secondary teacher was someone who, who was very jovial, I would say. And I enjoyed his classes. It was really lively.....He likes to joke. But then when (...) when he was explaining he meant business*".

Melodie perceived teaching approaches that highlight the application of mathematics, such as practical workshops, are more effective.

"*...Yes, in tertiary ... at tertiary level, it was more interesting, I think the lecturer made the class more interesting.....he went around and asked questions. He made sure that everyone was following classes, and he made sure that everyone was understanding as well. And I think that's a good thing, which happened in class*".

Farida singled out group coursework as a good learning strategy.

'*...I really, ... through coursework, I really understood the chapters that were needed to do. So for me it was ... it was very interesting. It was a new way because we didn't do that at secondary level. It was a new way to understand maths. So for me it was a very nice experience*".

Benazir is a teacher herself. This has helped her reflect on her previous teachers' ap-

proaches. She noticed how students connect with a teacher's passion for the subject to create a positive impact.

"*...And then I remember the lecturer, perhaps the first, ..., first time he came into the class, he was talking about his passion for the subject. And then he said like, he has the habit of playing with numbers. So instantly that clicked in my mind*".

In contrast, a non-specialist teacher lacks that passion.

"*...And I didn't detect any passion for the subject from this lecturer. It was a lethargic module, which I was impatient to finish*".

One unique perspective that Benazir has brought to these discussions, is regarding the language. Because some teachers are not fluent in English, this has a negative impact, right from the Primary school level, on mathematics understanding.

"*...There are many factors for that because firstly students do not understand English. They cannot read English. So, those who cannot understand do not know what operations need to be done*".

She further added that in Mauritius, students and teachers are more comfortable speaking French and this impacts the learning mathematics.

"*...You know, in primary school, we are more versed with either speaking the our, ... our mother tongue or French. There, there, there ... is reduced language, like teaching in English in the primary school. Only when we are doing English classes, we speak English. And then also we explain that in either French or mother tongue because our mother tongue is more connected to French, is more close to French, than English. So maybe we should ask educators to be a bit more conversant*".

A final point of interest which is brought up by Benazir is that teachers need to assess their students first.

"*...Maybe try to see which type of learners, the students are. Because we have different types of learners, we have visual learners, auditive, kinaesthetic and all that. It doesn't have to be the traditional way*".

It was interesting to note that the students brought up many different ideas associated with teaching and learning, not necessarily identical to the staff's perspectives.

5.3.2.3 Attitude

This theme highlights the positive and negative attitudes of students towards the subject, and it also includes their willingness to learn it. Interestingly, Melodie has a positive learn-

ing attitude towards mathematics, because she considers mathematics to be a challenge. Her perception is that mathematics is boring for other students.

"*...It's just that I love challenges, I love puzzles. So this is something that I really enjoy ..... most of students here (Mauritius) think that mathematics is boring. And I don't really understand why. I do think that it's because teachers don't make it interesting enough*".

Interestingly, Farida claimed not to recollect any positive past experience, at secondary school ("*...I can't remember (laughs)*"), yet, she cited her fascination with mathematics and statistics, as the reason for wanting to study them further. She also specified that she likes the calculation side of mathematics and not the theory.

"*...Actually Maths is the only subject that is quite different from the others because [there is] no theory, there's nothing, just calculations*".

She further elaborates that at university the reasoning behind the concepts is explained in the teaching and this is a positive motivator for her.

"*...But at university, we were taught that this is like this because of a certain reason. So it was easier to understand*".

Benazir added two new elements to this theme. One of her reasons for liking mathematics, ever since primary school, was the teachers' influence, but more interestingly, her parental influence.

"*...I would say right from the primary school, I have started liking mathematics because (. . .) because of my teacher, firstly, and then I had the support of my parents who were both in the education field. So they were like, guiding me and it was quite an enjoyable experience, right from the primary*".

The second element was about gaining a certain social status amongst her peers by choosing to do mathematics as a Main subject at the secondary school level. This was a positive motivator.

"*...Like I will (. . .) I will tell you when you are doing Mathematics, Main (. . .) as Main subject, there is some kind of status which you get in the college. Like, She is a "Maths Main student". So obviously, this triggers some interest in other classmates who are not so good in mathematics like they were not understanding how she, how she, she's able to understand those concepts*".

Some of these observations are quite contextual to the Mauritius education landscape, while others are much more universal.

5.3.2.4 Support Mechanism

Students were able to identify certain support mechanisms for their learning of mathematics and statistics.

Melodie believes that giving incentives is a good support mechanism to motivate students.

"*...I would give them chocolates. ...Incentives. That's, that's one of the things that I would do....*".

Farida identified that as a university student, engaging in research helped them to learn more.

"*...Because the lectures that we had, when we went to do research, we found out other things that were very interesting, so we added that in the coursework*".

For both Melodie and Farida, they expected that the teacher should closely monitor the class, even at the final year level.

Melodie was quoted as saying "*...Maybe correct the workshops in class because you don't really know whether the students are doing the workshops (laughs) That's the only improvement I would say*".

This view was shared separately, by Farida.

"*...I think the group coursework, the teacher should be more involved maybe. Because in the coursework, exactly, the teacher just give the coursework and there's no participation. So I think that there should be ... the teacher should get more involved. Just to have a follow-up to see where the work ... how the work is progressing*".

Benazir took the perspective from both her role as a teacher and as a student, to propose the benefit of using real-life examples in teaching, as a very effective support mechanism. Such a strategy helps a student to bring to life concepts which would be otherwise quite vague to understand.

"*...Like, Okay, we have this module, the slides are on, reading these other concepts, you have to apply it. Because like I said, many students do not even understand those concepts. So reverse it around like a more interactive, maybe a more interactive way. Like start to question the, for example on Probability. I remember my ... one of my lecturers started with the weather. If it ... if it will rain today and what is the probability that it will not rain today? These are like real examples which you can connect your reader. So more of this*".

The support mechanism proposed by the students should be considered carefully, since

they offer a unique perspective.

5.3.2.5 Resources

Learning resources from the perspective of modern-day students are discussed here.

Melodie can trace her interest in mathematics to the resources used at primary school, which made it interactive learning. She found this very appealing.

"*...I think we should have more interactive devices. For example, like when I was in primary school, we had like those huge boxes. And when we had Volumes and all those things to do, we would usually ask the students to come and put the squares ... the cubes on there. So I think that we should make it more interesting in terms of interaction*".

Farida believed that videos would be a helpful tool since they can be used by students as a means for online refresher of knowledge.

"*...I think there are little things that maybe we have forgotten, like the small things like simultaneous equations or other lectures, ... other chapters that we forgot. But maybe there should be some kind of online videos where we go to get a refresher*".

For Benazir, the online resources could take the format of revision sessions, utilising the available tools, such as Zoom. This is an effective support mechanism that also caters for better time management.

"*...But as you say time is, ... is limited for, for a quick revision. But what's the point in, ... in going further with the chapter with the module without your students understanding it. So I've, maybe I would suggest ... send a worksheet as homework and then take like, one hour on ... online or Zoom session to, ... to explain or to correct the worksheets. Not only send the model answers*".

It is interesting to see the different resources highlighted by the students, both from a traditional perspective of using boxes to learn mathematics in primary school, to the utilisation of online resources at university.

5.3.3 Focus Group Data Analysis

The various themes in the previous section were based on individual student interviews. The section we will look at now, discusses the data analysed from the focus group interviews with a diverse group of specially selected students. The Thematic Analysis here is premised on the notion of data saturation. As such, any emergent data within the existing themes, that have already been considered during the interviews with students and staff, will not be highlighted again. However, only new data or themes will be brought into the discussion.

5.3.3.1 Resources

A new idea emerged on the use of Excel and Minitab. The students found it easier to understand the concepts at the university level, because they were also taught the use of ICT tools, related to mathematics and statistics.

Jane, FG1: "*...I found it more interesting here (Middlesex). It's actually easier here. It's easier here because you focus on certain specific things. And then you get to use like Excel and all that and not necessarily just with your calculator to figure out what you are going to do, even when you don't know what you are supposed to do*".

James, FG1: "*I like use of Excel because before, coming to university I never knew, like, how to use excel, Minitab. A week before we had our test, yeah? I ran to Tom, and I was like, "Oh, please Tom, can you like help, like can you put me through excel and Minitab". He said OK. He showed me the basics. He showed me the, like, one or two steps in excel, and I found it very very interesting. So, to me, excel is like the best part*".

Interestingly, students in the focus groups discuss their views on maths and statistics anxiety, separately.

Malini, FG1: "*...I don't like mathematics, but statistics seems to be easier, due to excel*".

The use of Excel was highlighted as a very motivational part of the learning resources used at the university.

5.3.3.2 Emotions or Attitudes

A student in Focus Group 1 brought up a negative emotion that has not been discussed yet, regarding the hatred of learning mathematics. These are especially strong emotions.

Rick, FG1: "*...I don't like maths. Honestly, I really don't like it. I just like the basic, like addition, subtraction, multiplication and division. But if you take me to the complex numbers and, I don't know, for example, spheres, trigonometry, I really hate them*".

Despite having a preconceived notion that they do not like mathematics, the student does not label mathematics as a difficult subject but rather notes that it comes with practice.

Rick, FG1: "*As I said previously, I don't like maths. But one thing is that, I know maths is not hard, neither is it easy. You need to do practise to get it*".

Another very interesting idea was posited by this focus group participant who recognised and acknowledged that his confusion with numbers is the reason why he hates mathematics.

Rick, FG1: "*So personally for me, what I hate in maths, it's the number. Like those*

numbers, when I see them at least numbers in manual or something, I can understand. But when I see the numbers and the calculations and I have to do this and that, like I said it is easier to do addition, subtraction, multiplication and division. It's much easier. But when you go to complex stuff, for example, probability, charts, stuff like that, it kind of gets harder for me. For example, in statistics, I find it easier for me, to understand something like Sampling, where its more words, you see, more for understanding. But for the numbers it gets confusing for me".

Rick's views are supported by another participant in a separate focus group.

Nicole, FG3: "*...Ermmm Numbers! And it's just doesn't. Okay, there's just lots of things that don't make sense. And I'm like, wondering, why are we doing this? Why? For what? Why? Why? Why? Why? And definitely in Secondary School, there are lots of things that, you know, equations, like Quadratic Equations, all sorts of things like that. So, I was just like, why? Why do I need to know this? How is this helping me outside, when I leave those classrooms. So, there's more of. and all my life, even all my degrees and my undergrad, you know, I have done maths because I have to. Like it's part of the module. And it's always compulsory. So, I can never avoid it. I can never run away from maths. Or from numbers. (Laughters. . .). So, its just.. I just do it, I just get through, I just have to get through. But, for me, I'm more of a "words" person. I love words. With maths, really, I have struggled all my life* ".

The need to pay attention to the details in mathematics was a matter of contention for one of the focus group participants but he seemed to laugh it off yet seems to have learned from his mistakes. Other students seem to convey that they do not like being that meticulous and having to be so focused.

James, FG1: "*there are many parts when it comes to maths and statistics, where you miss a sign, you miss everything. Because the word "Regression" it's like it's going to tell you that you will "regret" at the end [laughters. . . . .]. It's true. Because once you miss a sign, probably like in the excel file, if you forget the plus sign, man. . . .It's gonna give you the wrong answer [laughters. . .]. and you are like ooh, it gives me the answer, I am right, I am right. Maybe like, after few minutes like, while solving the equations, we are like huh, I forgot to add the sign! [laughters]*".

According to one participant, they have negative emotions towards attending mathematics or statistics classes, to such an extent that they would try to evade those classes.

Fatema, FG3: *...So, every time I had maths classes, I will go to toilet*".

This was brought about because of the negative classroom management of the teacher,

where they would get angry when the student made a mistake.

Fatema, FG3: *"...For me, there was a time I hated mathematics. Because of the teacher. He never allowed us to make mistakes in High School. [laughters. . .]. If we make a mistake, for example, if he calls us on the board to do some calculations, and if we make a mistake, he gets angry and he kicks us out of the class*".

The emotions were largely negative for this group of students, which have not been discussed previously, in the individual students' interviews.

5.3.3.3 Teaching & Learning

Lecturers often assume that students have been learning mathematics and statistics right until the point they are joining university. Jane mentioned that there is a feeling lecturers start teaching on the assumption that students join university with all the necessary prerequisites to do mathematics. This is a misconception, as highlighted by Jane, as she asked for more support at an early stage when joining higher education.

Jane, FG1: "*...First of all, I don't know if the lecturers get the chance to know which people are in their class. I don't think they do. But the focus should be, you have new people, don't think everyone knows maths, or did it in A-levels. You might find that maybe only 5 out of 27 might have actually done maths. And the rest just did it at O-Levels. And they remember nothing. So if at the beginning, like, in orientation or something, they could just talk about what is to come. This is what students should expect. Like the way we get our handbooks, and we know, this is the next chapter, or in our class this is what we are going to be doing. Then also maybe during orientation, we should be able to, you know, you see statistics, this is what is required, this is what we should be doing. If you have not done maths, this is what you can do. You can come to me*".

The students themselves recognise the importance of mathematics in everyday life, and this was highlighted by one of the focus group participants.

Tim, FG2: "*...Myself, I like mathematics because I encounter mathematics every day of my life. Because most of the things that I do, are around mathematics. You understand? Like I play music, so you have to remove this one, add this one, to make a sound. You cannot just bring any key. You have to plus this key, you have to minus this key. And I am a programmer too. So I encounter mathematics every day of my life, you understand? So I like mathematics, I like statistics, very well*".

The notion of students having to arrive at a solution by themselves was highlighted by one participant. They discussed how the answers are just given to them, but they are expected to construct the answers by themselves.

Steve, FG2: "*...I find it hard. Let me explain. In class for example, if you are doing Black [Scholes] Theorem, or something, they teach you part of what to do but not everything. For example, they will show you the formula but you have to get there. They don't do it. You have to get there. For example, they might tell you to use simultaneous equations to get an answer. They do not show you how to do simultaneous equations. They state it. I know you can do it on your own but I do not know which one is correct. Because sometimes you do one type of simultaneous equation and they say no it's better if you do another one. So they do not show you step by step. They rather just show you, like maybe, they will give you the figures to use and the formula and what is in between, you have to explore. But if, for example, on the lecture notes they showed you what to do it would be simple when we go home, we can explore in the lecture notes. But if it's not in the lecture notes we have nowhere to go to*".

The teaching and learning strategies demonstrated a Constructivist approach to engaging students in their learning at university.

5.3.3.4 Support Mechanism

University programmes help students to understand the concepts of mathematics and statistics. However, one of the criticisms raised is that not enough is being done to show the students the future applications of these concepts, or where they might be used, after university.

Vikash, FG2: "*...I do not think too much emphasis has been put by the University to tell us how we should use this later. We do not know how to use it, we are just expected to use it later. But emphasis has not been put how we will use it later*".

Students have mentioned with concern the gap between studying mathematics at school and studying at university. Students expect the university to provide more support to bridge that gap.

Rajiv, FG2: "*...The first thing that we have to understand is, the gap will never ever be covered completely because lack of time. There's never enough time to do this*".

The understanding of mathematics and statistics concepts was reinforced by visual aids, for one participant. Such tools provided essential support to help their comprehension.

Nicole, FG3: "*...They tried to explain it in ways, like. . . they'd even use props. Something that I can see, to maybe visualize. That, why am I doing this? if you do this I'm going to get this. Especially with graphs, like angles, and all sorts of things. I needed to see it. Just the numbers alone were not sufficient for me. Visual aids helped me a lot, and colours. Just making it more visual*".

Nicole had some ideas for how to better support the students for numeracy skills.

Nicole, FG3: "*...I would think that, you have your lectures and you have seminars, which are smaller groups. Where I would think that, that's the time students can freely ask questions and get further assistance from the lecturer. So, its kind of an extra lesson, but, you know, yeah, it's kind of extra lesson. Because I could say, maybe on Friday afternoons, or Wednesday afternoons, when you guys don't have class or something, you guys can have workshops*".

Students have suggested a number of support mechanisms, including extra workshops, which could potentially be a consideration.

5.4 Conclusion of Project Findings

As previously mentioned (Page 127), the analysis conducted on the questionnaire serves as an extension of the research conducted by Tapia and Marsh II (2004). The outcomes of this analysis unveil the potential necessity for motivational intervention, particularly by lecturers, to enhance the academic performance of new students in the realm of non-specialist mathematics and statistics in higher education. A parallel observation is echoed by one of the participating academics, Pratibha, during the interview process. Her discernment highlights that establishing a closer connection with students and manifesting a keen interest in their academic endeavours, contributes to heightened student motivation, fostering increased engagement in class through questioning and active participation. This instructional approach finds additional affirmation in the scholarly perspectives of Eloff et al. (2021) and Devlin and Samarawickrema (2010), who assert the substantive role of university lecturers in student well-being. They emphasize the crucial nature of lecturers' attitudes towards students, underscoring their pivotal role in motivating students to feel more at ease within the higher education environment.

Academics are advised to recognise the influential role they occupy in the classroom, acknowledging the potential impact of their position on students' performance. Manju (academic participant) underscores this point, encouraging academics to draw upon their personal experiences as students, to cultivate an environment conducive to students' enjoyment of mathematics and statistics. Corroborating this, student feedback from the interview, indicates an appreciation for teachers sharing anecdotes, fostering a sense of connection. The article by Szumski and Karwowski (2019)) aligns with these findings, asserting that students perceive a positive affective climate in the classroom as enhancing the overall learning experience, promoting academic enjoyment, self-efficacy, and effort in mathematical pursuits.

Insights gleaned from student interviews reveal a disconnect with lecturers who merely

"turn up to teach", adversely affecting the learning experience and occasionally demotivating students in their engagement with mathematics and statistics. Notably deemed "dry" by Pratibha (an academic teaching statistics), these subjects are more favourably received when instructors exhibit a blend of joviality and seriousness in their teaching approach, with students expressing a preference for educators who embody both lively and focused instructional qualities.

Maintaining a positive attitude towards mathematics and statistics emerges as a significant factor in the students' enjoyment of these subjects, according to their assertions. The students conveyed that their past experiences significantly influence their approach to learning mathematics and statistics at the university level. Consequently, this research positions us to provide guidance to primary and secondary school teachers on effective strategies for teaching these subjects. The **Literature Review** chapter (Page 50), underscores this point, examining the interplay of negative and positive emotions in students' learning experiences. Citing the works of Villavicencio and Bernardo (2016), Fredrickson (2001) and Fredrickson (2003), as highlighted on Page 51, the literature advocates for educators to design engaging learning activities that foster positive emotional experiences among their students.

Participants, encompassing both academics and students, express a collective endorsement for the incorporation of supplementary support within the classroom setting, notably through the deployment of Student Learning Assistants (SLAs). The facilitative role undertaken by SLAs proves instrumental in alleviating student hesitancy in posing questions, with students often preferring to seek assistance from SLAs rather than their primary instructors. The perceived affinity between students and SLAs fosters an environment where students feel a sense of camaraderie, facilitating open discussions about academic challenges. Emphasizing the significance of furthering the learning experience, participants advocate for the implementation of additional workshops, whether conducted online or on campus. This perspective aligns with discussions in the **Literature Review** chapter (Page 26), where scholars such as Bhaird et al. (2009) posit that such supplementary support mechanisms contribute significantly to elevating students' confidence levels, ultimately resulting in improved academic performance.

The nature of resources provided to students plays a pivotal role in enhancing the learning experience of non-specialist mathematics and statistics students in higher education. According to academics involved in the interview process, utilising workbooks that incorporate lecture materials and space for students to perform mathematical calculations proves to be an effective strategy for promoting a positive learning experience. However, this approach may entail the printing of hard copies, posing a potential challenge. Over

the past five years, MUM has actively advocated for a "green environment", discouraging the printing of resources. To address this, a solution has been implemented. At the commencement of each academic year, academics receive a reminder to refrain from printing materials for students, except in exceptional cases. Interestingly, counterparts in MU-HEN often opt to print workbooks for their students. With the support of MU-HEN colleagues, academics at MUM have the option to propose the printing of specific workbooks, recognising the potential benefits this may offer to students.

A commendable initiative highlighted by interview participants is the establishment of CeMaSTeL, which has garnered praise for its excellence. CeMaSTeL serves as an alternative avenue for students to acquire knowledge and seek assistance from individuals other than their regular lecturers. Participants emphasized the need for CeMaSTeL to enhance its visibility. Notably, in recent years, CeMaSTeL has developed its own YouTube channel and website, facilitating more regular uploads of materials. The increased participation of academics (both at MUM and MU-HEN) in contributing to the contents has further enriched the resources available, offering students a diverse array of materials to select from.

Regrettably, a noteworthy observation within the research context is the persistent belief among female participants that girls are inherently incapable of excelling in mathematics and statistics. This phenomenon aligns with findings discussed in the **Literature Review** chapter (Page 43), where various scholars have similarly noted such perceptions. Notably, some participants attribute the formation of these negative perceptions to their past experiences with female teachers. In light of these findings, it is recommended to proactively address and mitigate this perception at the early stages of students' enrolment at MUM. Initiatives aimed at dispelling such misconceptions may contribute to fostering an inclusive and supportive learning environment for female students pursuing mathematics and statistics.

An insightful revelation surfaced during the data collection phase, particularly within the interviews and focus groups, indicating the occurrence of data saturation within both the students' individual interviews and the focus groups. The thematic content derived from the individual face-to-face interviews with student participants exhibited consistent recurrence in the corresponding focus groups. Remarkably, despite the diverse "profiles" of participants in each focus group (refer to Page 101, Tables 3.5, 3.6 and 3.7), there was a notable convergence in the perspectives expressed on the posed questions. Upon reflection, conducting face-to-face interviews with only two students and organizing two focus groups appears to have been adequate for the necessary data collection.

CHAPTER 6

DISCUSSION

6.1 Introduction

The project findings were presented in the previous chapter, as an analysis of the quantitative questionnaire data, and the qualitative data obtained from individual interviews with staff and students and focus groups with students. The emergent themes have already been identified and key points within these were presented.

In this chapter, using the aims and objectives of the research study as guiding foci, the findings will be synthesised and critically presented with the relevant literature, to formulate arguments in response to the research questions.

6.2 Research Question 1

RQ1: What past experiences, perceptions, and personal expectations do non-specialist students have, to help me understand their learning needs in mathematics and statistics?

Student participants felt that lecturers start teaching on the assumption that their learners join university with all the necessary prerequisites to embark on a module of mathematics or statistics. This was stated to be a misconception by the participants that has consequences for their learning at the university. This is supported by the Hodgen et al. (2014) report, where they cited "time elapse since last used mathematics", as one of the reasons why students suffer from anxiety and lack confidence when studying mathematics and statistics.

The same report also cited the failure to see the relevance of mathematics be a reason why there are big discrepancies between the students' expectations and those of the teachers. The primary qualitative data gathered in the study shows staff and students' perceptions regarding the practical application of mathematics and statistics, to be very effective. This result supports the work by Uyen et al. (2021) who claim that there is an improvement in students' results and that students' horizontal mathematics and vertical mathematisation take place in the teaching phases and achieve significant efficiency. Staff's teaching and learning strategies centred around real-world application of the content, correlate with students' views that lecturers make the class more interesting, by using real-world examples. Lombardi and Oblinger (2007) discuss Authentic Learning (AL) which is an approach that focuses on the real world, complex problems, and their solutions, using problem-based activities and case studies. The importance of such an approach in this piece of literature was highlighted in the field of I.T, whereas many points mentioned, can be adapted to mathematics, statistics and quantitative methods. In the contemporary context, where HEIs need to prepare students to compete in a global job market, AL is a powerful tool where students can become comfortable with complex real-world problems. In my research study, the lecturer participant, representing the I.T programmes, confirmed his significant use of real-world applications in his content. He also emphasized the positive impact on the student learning experience. The literature and the primary data support the argument that educators do believe that AL is an effective way to learn, even though it is not always easy to implement.

Whyte and Anthony (2012) conducted a literature review which revealed that maths anxiety can start from home, where parents who themselves suffer from maths anxiety, can potentially transfer that to their children. In the data collected, we have a case of positive parental influence, positively impacting the child's affinity to mathematics. Rather, several students have shared how teacher anxiety has had a negative effect. Latterell (2005) showed the relationship between maths anxiety in students, who have been taught by "maths anxious teachers". The author identifies such teachers as being heavily reliant on teaching by textbooks, focusing on basic skills instead of concepts, and giving instructions to the whole class, rather than being able to customise the learning. Many students in the sample of my study, shared similar experiences at their primary and secondary school levels, and they also displayed negative emotions related to mathematics and statistics learning. Interestingly, many negative emotions stated by our students were listed in the literature, associated with maths anxiety.

The difference between mathematics and statistics anxiety has been well documented in the **Literature Review** chapter, Section 2.5.1, on Page 39. Many authors, such as

Balo_lu (2004), claims that before 2004, maths anxiety encompassed both mathematics and statistics fields. Although I do have a small section written specifically on statistics anxiety, it has been challenging to demarcate them. One lecturer participant, who is a non-specialist academic, teaching non-specialist students, characterises statistics as a "dry" subject and noticed that students were reluctant to openly seek help. Onwuegbuzie (2004) confirms the fear of students to seek assistance on statistics-related problems. Interestingly, one of the strategies used by the lecturer participant, above, is to sit closely with the students, on her initiatives, which is a strategy that has been recommended by Onwuegbuzie (2004).

Richard (2022) investigated gender differences as part of his study, as did Latterell (2005). The societal myth that boys are better than girls in mathematics and statistics can reinforce maths anxiety for some students. The gender disparity emerged numerous times in my research findings. Participants mentioned that boys can tackle abstract thinking and that boys like a challenge to support the authors' claims. Interestingly, in my research study, it was usually female participants making this claim, who themselves were strong and successful in mathematics (Melodie is one example). Contrary to Latterell (2005) who claimed that some students think that it is "cool" to hate mathematics, my research study revealed one female participant who affirmed a high social status when she chose to study mathematics at a high level in secondary school. This was a positive motivator.

6.3 Research Question 2

RQ2: What are the ways in which I can develop mathematics and statistics teaching across the institution, for non-specialist students?

The study by Lawson et al. (2003) revealed that, "one-to-one" help is preferred by many HEIs, based on research authors conducted with their students.

As mentioned by Fletcher (2013), support can be provided through online meetings as well. The advantage of this is to reach a maximum number of students, to cater for any travelling issues students might have, or logistical issues to host a large number of students on campus. From the qualitative data that was collected, it was evident that students requested online support sessions, utilising platforms such as Zoom, to provide more support for their learning. Additionally, one student requested that a weekly support session is organised online, for one hour, outside their timetable activities as a support mechanism.

This undoubtedly will come with its challenges, as lecturer participants have already raised a time management issue, whereby they are not able to complete prescribed teaching materials within the allocated time. It can be assumed that if academics do indeed

agree to take one extra hour per module, they would use that to complete their teaching content, instead. Furthermore, depending on the size of the cohorts and the number of seminar groups per module taught, this could become a very burdensome situation for the academic. Students will also struggle and find themselves overwhelmed with the amount of work they have to do according to Lawson et al. (2003), because they will first have their own academic content to contend with, and then need to adapt to new content from the additional support provided. Making it a weekly support schedule may defeat the purpose, however, having a support session once a semester for three hours, in the Review Week, may alleviate these issues. The Review Week is specific in every semester, given to students to catch up on their studies, and there are no timetabled teaching activities scheduled in that week. This may suit both students and teachers.

Students singled out their aversion to numbers as a reason for disliking mathematics, even going as far as using the word "hate" in relation to mathematics. Numbers and calculations, related to addition, subtraction, multiplication and division can be handled, however, students labelled Probability, and Charts, as complex concepts. Although these participants have not been assessed for learning difficulties, literature is abundant on developmental dyscalculia. Support mechanisms, including reasonable adjustments, are required. Such an assessment has never been done in Mauritius, but it could be an area of study, for future research, although this is outside the scope of my doctoral research. Negative emotions have already been shown to be one of the reasons for Arithmophobia. Any teaching strategies developed must incorporate considerations towards these types of adjustments.

The study found that lecturers implemented effective strategies to counter mathematics and statistics anxiety among participants. Group work and fully coursework-based assessments were identified as highly successful methods in alleviating anxiety levels. According to lecturers, collaborative learning allowed students to exchange ideas and support each other, while coursework-based assessments reduced the pressure associated with exams. These findings highlight the potential of these strategies to address anxiety in mathematics and statistics education. Additionally, the module's content was delivered using customized workbooks, enabling the implementation of differentiated learning. The participants' perspectives on the potential ethical implications of differentiated learning were explored. It was found that these concerns were effectively addressed through the establishment of a classroom environment that promoted peer respect among all students. Furthermore, peer collaboration was highly valued, contributing to the mitigation of any ethical issues that could have arisen. The above discussions and findings are supported by Zanakis and Valenzi (1997) who suggested that the following steps can be taken to

mitigate the effect of statistics anxiety:

- Reviewing contents of the syllabus.
- Group work, including group assignments and group discussions to be implemented.

Based on my quantitative analysis from the questionnaire, it was noticed that new students (freshers) at MUM, may not see the relevance (value) of mathematics in their studies, and in everyday life. Interestingly, the value did not correlate with self-confidence and enjoyment. In contrast, the motivation level to study mathematics was significantly correlated with the value of learning mathematics. In my study, the focus group participants proposed significant benefits to using real-life examples in teaching mathematics, as a very effective support mechanism. Such strategies help students to bring to life concepts that would otherwise have been too vague to understand. This will also be impacted by positive motivation.

At MUM, CeMaSTeL is a support mechanism provided to all students on campus, who require numeracy support. The current mode of operation is that its service is detailed in every module and programme handbook, given to students, and it states that students may approach CeMaSTeL should they require additional numeracy support. At the time of writing this thesis, there is no plan to promote the CeMaSTeL or its services more actively to the students. Through the research study, lecturers appreciated the service, however, suggested more visibility amongst students and potentially even going beyond the institution. Bhaird et al. (2009) mention drop-in support sessions as one form of mathematics support. The authors also claim that using this type of support provided by HEIs may have a direct positive impact on students' pass rate.

Ampadu and Danso (2018) elaborated on the evolution of mathematics education. Until the early 1970s, Behaviourism was the prevailing approach to teaching mathematics in classrooms worldwide. However, contemporary teachers now recognize the significance of incorporating Constructivism when instructing mathematics and statistics. According to Constructivism, our perception of the world and our understanding of it are socially constructed. This principle directly influences teaching strategies, particularly among constructivist educators who strive to foster a collective comprehension among students. The data from the focus groups conducted at MUM underscored the frequent utilization of such teaching approaches. Small group work was employed as a learning strategy, acknowledging that each group member possesses unique experiences and individual constructs. Consequently, the potential for substantial shared construction of knowledge emerged. At MUM, participants shared how students are not simply provided with answers to mathematical problems but are expected to construct their solutions autonomously.

6.4 End Note

This chapter has taken the two research questions that guided the entire study, and detailed thematic discussions as responses. The discussions have synthesised data from the quantitative methods, the qualitative methods, and the secondary data from the literature review.

In conclusion, this chapter synthesised and critically presented the project findings (refer to Page 155) in alignment with the research study's aims and objectives. The data, encompassing both quantitative questionnaire results and qualitative insights from individual interviews and focus groups with staff and students, facilitated the identification of emergent themes. The analysis focused on addressing the research questions and synthesizing the findings with relevant literature.

In essence, this chapter consolidates the multifaceted perspectives of staff and students, shedding light on various factors influencing the learning experience in mathematics and statistics. The interconnectedness of these factors underscores the complexity of the educational landscape and calls for nuanced approaches to address the diverse challenges students encounter. The synthesis of findings with existing literature (also discussed in the conclusion of the **Project Findings** chapter, Page 155), contributes to a comprehensive understanding of the dynamics involved in shaping students' attitudes and performance in mathematics and statistics, offering valuable insights for educational practitioners, researchers, and policymakers alike.

CHAPTER 7

CONCLUSIONS AND RECOMMENDATIONS

7.1 Introduction

This concluding chapter takes a critical view of how far the research study has met the objectives that the researcher started with. It also addresses the limitations of the study while reflecting on the validity of the discussions for each research question detailed in the previous chapter. It looks forward to providing recommendations, and possible future directions for further research. In the end note, it will offer some final reflections from the researcher.

7.2 Review of Aims and Objectives

1. To investigate the perception of students in mathematics and statistics in Higher Education, in Mauritius.

    - After designing the research data collection instruments and obtaining approval from the ethics board, various data collection methods were employed. A questionnaire was given to 132 new students at MUM, while interviews were conducted with three staff members of MUM and three students who had received support in mathematics and statistics. Additionally, three focus group interviews were conducted, each comprising six students from different levels of study at MUM. These primary data collection activities provided the researcher

with the opportunity to comprehensively explore and analyse the students' perceptions of mathematics and statistics in higher education, allowing for an in-depth investigation.

- The selection of primary data collection instruments was informed by a thorough review of the existing literature. Additionally, the data analysis process was guided by the relevant literature, providing a solid theoretical foundation for the study.

2. Developing methods to assist those students to alleviate their "fear" and "anxiety" towards these subjects.

   - In 2018, the initial phase of CeMaSTeL (Mathematics and Statistics Support) was introduced to provide additional assistance to students seeking support outside of regular classroom settings. Since its inception, CeMaSTeL has experienced organic growth, and a new website was launched in November 2022 (https://www.cemastel.org). The development of CeMaSTeL has been a collaborative endeavour involving both staff from MUM and MU-HEN, as well as students at MUM. The resources developed for CeMaSTeL have been instrumental in empowering students to address their fears and anxieties related to mathematics and statistics. Interviews also revealed that staff at MUM are utilizing the services of CeMaSTeL, although there is still potential for further utilization.

3. To lead and manage changes in connection with the teaching and learning of mathematics and statistics.

   - After analysing the collected data and considering the perspectives of both staff and students regarding their learning needs in mathematics and statistics, the researcher has formulated a set of recommendations aimed at implementing improvements at MUM.

7.3 Validity of The Research Study

In Mauritius, there has been a scarcity of research focusing on mathematics and statistics education for non-specialist students, despite it being a significant challenge in higher education (HE). To address this gap, the researcher employed a representative participant group within a higher education institution (HEI) to gather data, allowing for the collection of genuine perceptions regarding past experiences and personal expectations. By including staff as participants, an independent perspective was obtained, which was crucial in establishing a comprehensive understanding of these issues within the academic

community.

While the quantitative analysis provided a valuable perspective from students who were in the process of transitioning to Higher Education (HE), it was considered a minor contribution to the overall study. This decision was based on the understanding that the characteristics of the student cohort vary annually and differ between Higher Education Institutions (HEIs). Although it was important to include this analysis, it is crucial to recognise its limitations within the scope of this study.

The final lens came from the literature review, which provided an additional perspective to the study, drawing upon contemporary research from various regions worldwide. This comprehensive review encompassed numerous topics relevant to the scope of the study, allowing the researcher to gain a deeper understanding of current debates and insights derived from a wide range of research articles and books.

7.4 Limitations

1. The research design, which involved six interviews and three focus group interviews, was excessively focused on qualitative methods. The researcher encountered data saturation, indicating that conducting just two focus groups with students and two interviews with academics would have been more beneficial.

2. 2. Furthermore, the intention was to interview only two students who fit a specific profile - individuals seeking mathematics and statistics support whom I do not personally teach. However, I encountered difficulties in recruiting participants who matched this criterion. As a result, I decided to interview three students who I did teach and who requested (additional) numeracy support.

3. The smooth data collection process was hindered by logistical challenges arising from the heavy workload of both staff and students at MUM. These challenges encompassed difficulties in finding suitable time slots for staff interviews, as well as the need to wait for students to become available, particularly during holiday periods. Moreover, there was a requirement to wait for students who did not have ongoing exams or had recently completed their assessments.

4. To enhance the robustness of the quantitative analysis, it would have been beneficial to incorporate objective measurements of emotions, such as “fear”, “joy”, “hate”, “value”, “motivation”, “self-confidence”, and other relevant factors.

5. There was a scarcity of literature regarding the distinction between mathematics anxiety and statistics anxiety. Considering that this is an emerging field, it is expected that more literature will become available in the near future, providing

valuable insights and understanding of the topic.

6. The existing literature on teachers' anxiety has a limited scope in terms of the topics it covers. It is important to note that the researcher is not suggesting a lack of literature on this subject, but rather highlighting that the current literature only discusses the support provided to teachers to a limited extent.

7. The researcher's health has been significantly compromised since early 2020, which has hindered the progress of writing this thesis. Additionally, personal and professional responsibilities have also impeded the smooth advancement of the write-up phase.

7.5 Recommendations

- Due to MUM being a small university, there is a limited number of staff available who are specialist mathematics teachers. The researcher recommends hiring part-time staff to handle modules with high mathematics and statistics components.

- It is advisable for all academic lecturers, particularly new lecturers, to enrol and complete the PGCertHE program. This will provide them with a grounding in contemporary pedagogical insights for teaching and learning in higher education.

- The assessment strategies should be revised to eliminate exams and introduce more coursework-based assessments.

- Students require training in study skills, including time management, collaborative work, and shared project management, to effectively engage with their coursework.

- This approach will assist teachers by reducing their marking time since they will have fewer individual scripts to grade as work is submitted in groups. Consequently, it will free up some time for lecturers to develop enhancement materials and online revision sessions once per semester.

- Students should be encouraged to work in pairs for labs and seminars, as the literature suggests that this can lead to "knowledge spillovers" among diverse student groups. Differentiated learning strategies can be implemented.

- Academics play a vital role in identifying cues for student learning. With the student's permission, academics are well-positioned to refer them to various support structures and mechanisms.

- It is necessary to reassess the purpose of the Review Week. Academics can utilize this period to invite students for catch-up sessions conducted either by the lecturers

themselves or by members of CeMaSTeL.

- The existing guest speaker programme can be revised, and its purpose reviewed to allow students to benefit more from insights of speakers who will focus on real-world applications.

7.6 Future Works

In the pursuit of advancing this research, there exists promising potential for collaboration with Psychology lecturers to enhance the quantitative dimensions of the study. Such collaboration may encompass the integration of critical elements such as Emotions, Attitudes, and Values, thereby enriching the research framework. Furthermore, an imperative aspect for future investigation involves conducting more profound examinations into the ethical considerations surrounding the involvement of students with heightened sensitivity in their learning needs. By introducing a more rigorous quantitative component into the research methodology, a comprehensive scope can be attained, contributing to a more holistic and insightful analysis.

As potential avenues for future research, this thesis sets the stage for an exploration into various dimensions surrounding the teaching of mathematics and statistics to non-specialist students at MUM. A prospective investigation may delve into understanding the nuanced impact of a high proportion of international students on teaching dynamics, examining how this unique demographic composition influences instructional strategies. Furthermore, an in-depth study could unravel the significance of MUM's predominantly African student population within the context of a British international branch campus, shedding light on its noteworthy aspects. Investigating the educational experience for non-specialist students, particularly in the context of MUM's comparatively small size, provides a promising area for future research to elucidate the specific influences at play. The language dynamics, where French-speaking students are instructed in English, offer another avenue for exploration, aiming to uncover the multifaceted effects on the broader learning environment at MUM. Additionally, future research could delve into the broader implications arising from the limited utilisation of thematic analysis in existing studies on mathematics education for non-specialist students. Exploring the scarcity of literature differentiating between maths anxiety and statistics anxiety, and its potential impact on teaching approaches at MUM, presents an intriguing research trajectory. The thesis also paves the way for a deeper examination into how the diverse academic backgrounds of students contribute to the distinctive nature of this study in comparison to prior research on maths support. Lastly, future research may explore potential variations in the instructional approaches of teachers without a Mathematics degree to the teaching of quantitative content at MUM.

7.7 End Note - Impact and Significance of the Research

The motivation behind this research study stems from a keen interest in investigating the pedagogical methods employed by educators teaching mathematics and statistics at MUM (a Higher Education Institution) when instructing non-specialist mathematics and statistics students. Furthermore, this research delves into the experiences and emotions of students entering an institution like MUM.

Despite my tenure as a lecturer since the year 2000, this study has equipped me with fresh perspectives on my professional role. The influence of this research has proven to be profound, particularly in my capacity as a researcher, as it has greatly enhanced my comprehension of the educational requirements of non-specialist students at MUM.

The following subsections will provide a more comprehensive overview, offering insights into both the current and prospective impacts stemming from this research.

7.7.1 Impact as a Researcher

As a researcher, embarking on this doctoral journey has provided me with invaluable insights into both my personal growth and a deeper understanding of my students. Before commencing the data collection phase, I devoted my efforts to crafting my Review of Learning (ROL), in addition to undertaking two Recognition and Accreditation of Learning (RAL) projects. Subsequently, I submitted my Project Proposal.

The above-mentioned projects gave me the opportunity for deep introspection, ultimately sparking my passion for delving into research within the realm of Mathematics and Statistics education. It played a pivotal role in shaping the objectives and goals for my doctoral thesis, instilling a profound sense of belonging to my chosen research field. It was through this experience that I wholeheartedly embraced the transition from being an Applied Mathematician to a dedicated researcher in Mathematics and Statistics education. This newfound connection to my research proved to be a vital source of motivation, fuelling my determination to persist in this doctoral journey.

Moreover, it instilled in me the self-assurance to share my research with fellow scholars. Prior to embarking on my doctoral research, I had never ventured into the realm of academic publishing. However, buoyed by the newfound motivation I gleaned from my reflection on the ROL project, I mustered the confidence to engage in research conferences in Mauritius and the UK, and successfully published two articles in well-regarded journals.

This research has allowed me to reflect on my dual roles as both an academic and a researcher, as explained in Subsection 3.7.3, Page 94. It has allowed me to gain a new

perspective on my students' viewpoints, which, in turn, has proven invaluable in reshaping my approach to ethical considerations in research. The impact has been so profound that I willingly assumed the position of Chair of the Ethics Committee for the School of BIC shortly after concluding my data collection for my doctoral research. I aspired to actively participate in all decisions related to research ethics, as this subject had become intimately aligned with my area of interest. I am happy to report that to date, I have successfully overseen about 70 Ethics application packages submitted by students and staff and two external ethics application packages submitted by external researchers.

7.7.1.1 Future Plan of the Researcher

Upon completing my doctoral research, I plan to actively publish my findings in academic journals to facilitate the dissemination of my research outcomes. Serving as the sole Mathematics lecturer at MUM, I aspire to organise workshops in collaboration with other educators teaching Mathematics and Statistics components at the university. These workshops will serve as a platform to demonstrate the innovative teaching approaches we can implement.

7.7.2 Impact at Middlesex University Mauritius (MUM)

Upon completing my term as the Academic Head of the School of BIC in early 2023, I was presented with compelling recommendations to consider the role of Head of the School of Foundation Education (FE). This school administers two distinct departments: the International Foundation Programme (IFP) and the PGCE/PGDIP/MA Education programmes. The offer came as a surprise, given that I had never personally taught any of these programmes. However, when I inquired with the Management team at MUM, they explained that my doctoral research had equipped me with a deep understanding of the needs of students, particularly those in the IFP, who required someone with insight into their academic transition from secondary school to higher education studies.

Furthermore, this research has empowered me to offer more effective assistance to my students. In 2022, under my leadership, CeMaSTeL received additional funding to enhance student support. These resources were allocated based on the positive outcomes of the measures I implemented during my doctoral research. This resulted in the expansion of academic staff within CeMaSTeL and the development of a professional and improved website designed to provide comprehensive guidance for students.

I am also now part of the following committees at MUM:

- Teaching and Learning Committee.
- Quality and Assurance Committee.
- Research and Knowledge Exchange Committee.

My doctoral research has empowered me to make meaningful contributions to the aforementioned committees. I believe I am now well-prepared to engage in discussions that can influence the future of MUM, with a primary focus on the well-being of both students and academics.

7.7.2.1 Future Plan at MUM

As the newly appointed Head of the School of FE, I am committed to working closely with students who are commencing their Higher Education endeavours (IFP students). I am confident that my research will play a pivotal role in helping them successfully adapt to the ever-evolving expectations and requirements within a higher education institution (HEI).

Furthermore, considering that the School of FE encompasses programmes such as PGCE / PGDIP and MA Education, I will have a more substantial role in overseeing and shaping the curriculum changes at MUM. This will allow for the effective dissemination of my research findings to our target audience, primarily consisting of secondary school teachers and advisors at the Ministry of Education.

7.7.3 Impact at Middlesex University (MU-HEN)

As briefly stated in **Subsection 1.1.3, Page 7**, the governance framework of MUM is defined by the policies established within MU-HEN. Furthermore, MU-HEN assumes the primary responsibility of curating all pedagogical resources, while the academic faculty at MUM is entrusted with the task of disseminating knowledge in alignment with these materials. Furthermore, within the purview of its duties, MU-HEN is charged with the comprehensive development of all components of student assessments, ensuring uniformity in assignments across all campus locations, be they essays, individual coursework, group projects, or examination papers.

Over the past three years, I have been invited to participate in meetings that revolve around discussions regarding learning objectives, assessment formats, the development of examination questions, and the structure of assessments. Throughout these engagements, my contributions were warmly received, and I had the privilege of leveraging my doctoral research findings to offer valuable insights in multiple instances. Some of the changes I proposed and which were successfully adopted include:

- In a Level 4 (Year 1) module, a 15-question paper-based quiz has been substituted with a 50-question online quiz. Additionally, the time available for students to complete the original quiz format, which was 2 hours, has now been extended to one week for the new format.
- In a Level 5 (Year 2) module, the traditional three-hour final year examination has

been substituted with a week-long individual coursework assignment.

- Within a Level 7 (Master) module, the learning materials and resources have undergone comprehensive revision, enhancing constructive alignment with the intended learning outcomes. This update aims to enhance students' comprehension of the taught concepts.

7.7.3.1 Future Plan with MU-HEN

My research has already piqued the interest of colleagues at Middlesex University (Hendon), leading to several invitations for discussions on my findings. I am dedicated to actively participating in the development of curriculum modules that involve quantitative components and promoting the adoption of some of the teaching approaches proposed in my thesis among colleagues in the UK.

This moment presents an ideal opportunity to elevate our teaching strategies, coinciding with the university's recent release of its "2031 strategy." **Transforming Learning** is a key priority in the 2023 strategy, and I believe that my research can play a crucial role in contributing to this transformation. To ensure the wide dissemination of my findings and to reach a broader audience (given that mathematics and statistics are taught in several schools in Hendon), I plan to engage in major conferences organized by MU-HEN.

I have recently received an invitation to draft a proposal outlining the teaching approach enhancements I aim to implement at MUM. If this plan gains approval, it has the potential to be elevated to the level of MU-HEN.

7.7.4 Potential Impact in Mauritius and Beyond

Throughout my doctoral research, I had the privilege of taking part in several conferences hosted in both Mauritius and the United Kingdom. Regrettably, the onset of the COVID-19 pandemic in early 2020 posed significant travel challenges, making conference attendance, both domestically and internationally, nearly impossible. Nevertheless, before the pandemic disrupted these opportunities, I successfully shared my research findings during these conferences. In Mauritius, I had the opportunity to present at two conferences and share the findings of my research. These presentations garnered favourable feedback from fellow researchers and government stakeholders. Notably, in 2019, I participated in a conference organized by the Higher Education Commission (formerly known as the Tertiary Education Commission) under the theme "Preparing for the Future" (Appendix P). My presentation at the conference was warmly received and centred on demonstrating how transformative changes in the teaching of Mathematics and Statistics in Higher Education could positively enhance students' learning experiences.

At the start of 2023, I was fortunate to engage in a distinctive dialogue with Cambridge

International regarding the current O-Levels Additional Mathematics curriculum (Appendix Q). This provided me with a remarkable platform to actively participate in the curriculum restructuring process, which will influence millions of students worldwide who participate in the Cambridge Board of Examinations.

7.7.4.1 Recommended Plan for the Government of Mauritius

The Government of Mauritius has encountered a prolonged timeline in its efforts to position Mauritius as an education hub. Despite its initial proposal in 2010, the number of academic publications on this subject has remained limited. The initial goal was to host over 20,000 international students in the country by 2020, but as of 2021, the actual figure stands at 6,909 (HEC (2022)).

Significant efforts are required in this regard. The Ministry of Education should consider increasing funding for research in private HEIs (such as MUM), a step that is currently lacking. It is essential to foster stronger collaboration between public and private HEIs to facilitate the exchange of ideas. Establishing a committee is advisable to ensure the careful consideration and implementation of recommendations, particularly those originating from higher education institutions, including private ones.

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Appendices

APPENDIX A

ETHICS COMMITTEE LETTER WITH MINOR CHANGES

data collection session, number of sessions
and location of data collection with
rationale and information on how
participants will be supported.

This is one of the most meticulous and well thought through
ethics applications I have ever read. I fully approve it.
Very well done, and good luck with your study!

You will need to make these changes and resubmit your application before you receive your approval letter.

You must not start your research until you have received an Approval letter.

Yours sincerely

Dr Mona Sakr

Education REC

Fig. A.1 Ethics Committee - Comments by Chair

APPENDIX B

ETHICS APPROVAL LETTER

Education REC

The Burroughs
Hendon
London NW4 4BT

Main Switchboard: 0208 411 5000

20/02/2018

APPLICATION NUMBER: 2571

Dear Bheshaj Kumar Ashley Hoolash

Re your application title: Mathematics and Statistics support to non-specialist students in HEI, Mauritius

Supervisor: Gordon Leena Robertson Weller

Thank you for submitting your application. I can confirm that your application has been given approval from the date of this letter by the Education REC.

Although your application has been approved, the reviewers of your application may have made some useful comments on your application. Please look at your online application again to check whether the reviewers have added any comments for you to look at.

Also, please note the following:

1. Please ensure that you contact your supervisor/research ethics committee (REC) if any changes are made to the research project which could affect your ethics approval. There is an Amendment sub-form on MORE that can be completed and submitted to your REC for further review.

2. You must notify your supervisor/REC if there is a breach in data protection management or any issues that arise that may lead to a health and safety concern or conflict of interests.

3. If you require more time to complete your research, i.e., beyond the date specified in your application, please complete the Extension sub-form on MORE and submit it your REC for review.

4. Please quote the application number in any correspondence.

5. It is important that you retain this document as evidence of research ethics approval, as it may be required for submission to external bodies (e.g., NHS, grant awarding bodies) or as part of your research report, dissemination (e.g., journal articles) and data management plan.

6. Also, please forward any other information that would be helpful in enhancing our application form and procedures - please contact MOREsupport@mdx.ac.uk to provide feedback.

Good luck with your research.

Yours sincerely

Chair Dr Mona Sakr

Education REC

Fig. B.1 Ethics Approval Letter

APPENDIX C

PARTICIPANT INFORMATION SHEET - STAFF AND STUDENTS INTERVIEW

PARTICIPANT INFORMATION SHEET

Interviews

Version Number: 01

Date: 29 / 11 / 2017

1. Study Title

An exploration of strategies to support non-specialist mathematics and statistics learners in higher education in Mauritius.

2. Invitation paragraph

You are being invited to take part in a research study. Before you decide, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. Ask the researcher if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part. This is a doctoral research project being conducted by B.K. Ashley Hoolash, Doctoral Candidate at Middlesex University. It should take less than 1.0 hours to participate in this interview. Interviews will take

place in meeting rooms, in Archway building, Middlesex University, Mauritius. Thank you for reading this.

3. What is the purpose of this study?

This research focuses on enhancing students experience in learning Mathematics and Statistics, and will also enable the researcher to identify areas of improvement in his teaching style.

4. Why have I been chosen?

Students:

You have been invited to take part in this research because you are currently enrolled in a programme which has mathematics and statistics components. Similarly, students from other programmes, studying mathematics and statistics modules, will also participate in this research.

Staff:

You have been chosen as you teach mathematics and statistics components in your modules.

Students who have sought support in Mathematics and Statistics are invited to participate in the face-to-face interview.

Three female lecturers will be chosen, as currently we do not have any other male (besides myself) lecturer who teaches mathematics or statistics components. We currently have 1 I.T male lecturer who teaches some components of mathematics and statistics.

5. Do I have to take part?

It is up to you to decide whether or not to take part. If you do decide to take part, you will be given this information sheet to keep and be asked to sign a consent form. You are still free to withdraw and without giving a reason, although the time limit to do so, is 2 weeks after the focus group discussion takes place. After that point, data collected would be analysed. Decision to take part, or not, and withdrawal within the deadline of 2 weeks for focus group discussions, will not affect your course or assessment in any way.

Should you decide not to take part, this does not impact upon a student's studies, relationship with the lecturer or access to the LET.

6. What will happen to me if I take part?

At most twice during the span of this study, you will be called upon to participate in an interview process. You will be asked to answer the questions honestly and to the best of your knowledge.

Interview:

The interviews with students (those, whom the researcher provides numeracy support to) will enable the researcher to identify the requirements of students, when they start their studies at Middlesex University, Mauritius. As for staff colleagues, the researcher wishes to learn about good practise and also wants to learn about the issues colleagues might have when taking a class with mathematics and statistics components.

Please note that in order to ensure quality assurance and equity this project may be selected for audit by a designated member of the committee. This means that the designated member can request to see signed consent forms. However, if this is the case your signed consent form will only be accessed by the designated auditor or member of the audit team.

7. What do I have to do?

If you decide to take part, the researcher would request you to participate in a fair and honest way. As mentioned in details, above, the process will consist of being interviewed by the researcher. There is no specific preparation required prior to taking part in the focus group discussion.

8. What are the possible disadvantages and risk of taking part?

Whilst you may be asked to answer questions about yourself (age, gender, nationality, etc.) and on your perception of mathematics and statistics, all information provided by you will be kept confidential at all times. All data collected will be kept only by the researcher in a One Drive account (set up by academic supervisors, and given access by them), on his personal laptop, and will be password-protected. These data will be destroyed 3 years after the researcher completes his doctoral thesis. The researcher also endeavours to avoid setting up these focus groups when you have coursework submission deadlines and exams. In general, there are no known risks in taking part, however, contribution of your time may be seen as a disadvantage.

9. What are the possible benefits of taking part?

The information you provide will enable the researcher to identify factors affecting students' learning of mathematics and statistics. This will have an impact in the way the researcher run the lectures, lab sessions and workshops, in those subjects. Whilst you

may not reap the benefits straight away, the researcher will implement changes to other module delivery system. We hope that participating in the study will help you. However, this cannot be guaranteed. The information collected from this study may help the researcher to enhance students' learning experience in mathematics and statistics, in the future.

10. Will my taking part in this study be kept confidential?

All information that is collected about you during the course of the research will be kept strictly confidential. Any information about you which is used will have your name and address removed so that you cannot be recognised from it. The data will be stored only on the researcher's laptop and documents will be password protected. All data will be stored, analysed and reported in compliance with the Data Protection Act 2004, Mauritius (http://dataprotection.govmu.org/).

The University has a Safeguarding policy and the research team members are guided by professional codes of conduct which requires us to report any information to the appropriate authority, when a person may be at risk of serious harm. We will endeavour to discuss this with you first.

11. What will happen to the results of the research study?

This research is part of a doctoral programme currently being undertaken. Results will be published in academic journals, whilst participants' identities will not be revealed in the process. The aim is to publish at least one paper per year, in the next 2 years. Results can be perused after contacting the researcher, and links to any published articles will be made available to the participants, upon request.

12. Who has reviewed the study?

Middlesex University, Hendon, UK has reviewed the study. This includes submission and approval of ethics form and risk assessment forms. The committee is the Middlesex University, Education Ethics Sub-committee.

13. Contact for further information

Researcher: Bheshaj Kumar Ashley Hoolash
Email: BH305@live.mdx.ac.uk
Supervisor: Dr Leena Robertson
Email: L.Robertson@mdx.ac.uk
Office Phone: (+44) 0208 411 4768
Address: Middlesex University,

Hendon Campus,
The Burroughs,
London NW4 4BT,
UK

The researcher would like to thank you for taking part in this study. A copy of the information sheet and the signed consent form will be given to you to keep.

APPENDIX D

PARTICIPANT INFORMATION SHEET - STUDENTS FOCUS GROUPS

PARTICIPANT INFORMATION SHEET

FOCUS GROUPS

Version Number: 01

Date: 29 / 11 / 2017

1. Study Title

An exploration of strategies to support non-specialist mathematics and statistics learners in higher education in Mauritius.

2. Invitation paragraph

You are being invited to take part in a research study. Before you decide, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. Ask the researcher if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part. This is a doctoral research project being conducted by B.K. Ashley Hoolash, Doctoral Candidate at Middlesex University. It should take less than 1.5 hours to participate in the focus group discussion. Focus Group

discussions will take place in meeting rooms, in Archway building, Middlesex University, Mauritius.

Thank you for reading this.

3. What is the purpose of this study?

This research focuses on enhancing students experience in learning Mathematics and Statistics, and will also enable the researcher to identify areas of improvement in his teaching style.

4. Why have I been chosen?

You have been invited to take part in this research because you are currently enrolled in a programme which has mathematics and statistics components. Similarly, students from other programmes, studying mathematics and statistics modules, will also participate in this research. Focus groups will consist of 6 participants and they will be as follows:

3 focus groups with 6 participants each. Assisted by a moderator (Admin Staff)

5. Do I have to take part?

It is up to you to decide whether or not to take part. If you do decide to take part, you will be given this information sheet to keep and be asked to sign a consent form. You are still free to withdraw and without giving a reason, although the time limit to do so, is 2 weeks after the focus group discussion takes place. After that point, data collected would be analysed. Decision to take part, or not, and withdrawal within the deadline of 2 weeks for focus group discussions, will not affect your course or assessment in any way. Should you decide not to take part, this does not impact upon a student's studies, relationship with the lecturer or access to the LET.

6. What will happen to me if I take part?

You will be asked to answer the questions honestly and to the best of your knowledge.

Focus group discussions: These will be focused on questions about what the researcher should do to improve on his services in delivering mathematics and statistics modules, so as to enhance your learning experience in these aforementioned subjects. To do that, the researcher would ask questions which will help him understand your past experience in mathematics and statistics. The researcher also wants to know how your feel about the mathematics and statistics contents in your curriculum. Please note that in order to ensure quality assurance and equity this project may be selected for audit by a designated

member of the committee. This means that the designated member can request to see signed consent forms. However, if this is the case your signed consent form will only be accessed by the designated auditor or member of the audit team.

7. What do I have to do?

If you decide to take part, the researcher would request you to participate in a fair and honest way. As mentioned in details, above, the process will consist of participating in discussions with other students under the supervision of the researcher. There is no specific preparation required prior to taking part in the focus group discussion.

8. What are the possible disadvantages and risk of taking part?

Whilst you may be asked to answer questions about yourself (age, gender, nationality, etc.) and on your perception of mathematics and statistics, all information provided by you will be kept confidential at all times. All data collected will be kept only by the researcher in a One Drive account (set up by academic supervisors, and given access by them), on his personal laptop, and will be password-protected. These data will be destroyed 3 years after the researcher completes his doctoral thesis. The researcher also endeavours to avoid setting up these focus groups when you have coursework submission deadlines and exams.

In general, there are no known risks in taking part, however, contribution of your time may be seen as a disadvantage.

9. What are the possible benefits of taking part?

The information you provide will enable the researcher to identify factors affecting students' learning of mathematics and statistics. This will have an impact in the way the researcher run the lectures, lab sessions and workshops, in those subjects. Whilst you may not reap the benefits straight away, the researcher will implement changes to other module delivery system. We hope that participating in the study will help you. However, this cannot be guaranteed. The information collected from this study may help the researcher to enhance students' learning experience in mathematics and statistics, in the future.

10. Will my taking part in this study be kept confidential?

All information that is collected about you during the course of the research will be kept strictly confidential. Any information about you which is used will have your name and address removed so that you cannot be recognised from it. The data will be stored only on the researcher's laptop and documents will be password protected. All data

will be stored, analysed and reported in compliance with the Data Protection Act 2004, Mauritius (http://dataprotection.govmu.org/). The University has a Safeguarding policy and the research team members are guided by professional codes of conduct which requires us to report any information to the appropriate authority, when a person may be at risk of serious harm. We will endeavour to discuss this with you first. A moderator (Administrative staff at Middlesex University, Mauritius) will be present during the focus group interview sessions. The role of the moderator is to oversee the smooth running of the interview process. The moderator will also be responsible for taking notes whenever necessary and for handling the audio recorder. The moderator will not liaise with you after the interview session, to discuss anything about what has been said during the interview. Your identities will be kept confidential, and nothing that you say during the interview will be discussed by the moderator, after you leave the session.

11. What will happen to the results of the research study?

This research is part of a doctoral programme currently being undertaken. Results will be published in academic journals, whilst participants' identities will not be revealed in the process. The aim is to publish at least one paper per year, in the next 2 years. Results can be perused after contacting the researcher, and links to any published articles will be made available to the participants, upon request.

12. Who has reviewed the study?

Middlesex University, Hendon, UK has reviewed the study. This includes submission and approval of ethics form and risk assessment forms. The committee is the Middlesex University, Education Ethics Sub-committee.

13. Contact for further information

Researcher: Bheshaj Kumar Ashley Hoolash
Email: BH305@live.mdx.ac.uk
Supervisor: Dr Leena Robertson
Email: L.Robertson@mdx.ac.uk
Office Phone: (+44) 0208 411 4768
Address: Middlesex University,
Hendon Campus,
The Burroughs,
London NW4 4BT,
UK

The researcher would like to thank you for taking part in this study. A copy of the

information sheet and the signed consent form will be given to you to keep.

APPENDIX E

PARTICIPANT INFORMATION SHEET - ONLINE QUESTIONNAIRE

PARTICIPANT INFORMATION SHEET

Questionnaire

Version Number: 01

Date: 29/ 11 / 2017

1. Study Title

An exploration of strategies to support non-specialist mathematics and statistics learners in higher education in Mauritius.

2. Invitation paragraph

You are being invited to take part in a research study. Before you decide, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. Ask the researcher if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part. This is a doctoral research project being conducted by B.K. Ashley Hoolash, Doctoral Candidate at Middlesex University. It should take less than 10 minutes to complete the questionnaire. The labs in Bound

Green building will be used, so that you (participants) can use the computers, to access the online questionnaire. Thank you for reading this.

3. What is the purpose of this study?

This research focuses on enhancing students experience in learning Mathematics and Statistics, and will also enable the researcher to identify areas of improvement in his teaching style.

4. Why have I been chosen?

You have been invited to take part in this research because you are currently enrolled in a programme which has mathematics and statistics components. Similarly, students from other programmes, studying mathematics and statistics modules, will also participate in this research. Year 1 students will be chosen to participate in this questionnaire (around 40). Due to the small cohort of students studying mathematics and statistics modules at postgraduate level, only a minimum of 5 students from the postgraduate cohort will be required to complete the questionnaire:

Questionnaire
Undergraduates (Year 1) = minimum 40 participants
Postgraduates = minimum 5 participants

5. Do I have to take part?

It is up to you to decide whether or not to take part. If you do decide to take part, you will be given this information sheet to keep and be asked to sign a consent form. You are still free to withdraw and without giving a reason, although the time limit to do so, is 2 weeks after the focus group discussion takes place. After that point, data collected would be analysed. Decision to take part, or not, and withdrawal within the deadline of 2 weeks for focus group discussions, will not affect your course or assessment in any way. Should you decide not to take part, this does not impact upon a student's studies, relationship with the lecturer or access to the LET.

6. What will happen to me if I take part?

At most twice during the span of this study, you will be called upon to participate in the questionnaire. This will not take more than 10 minutes to complete. You will be asked to answer the questions honestly and to the best of your knowledge.

Surveys:
In a survey, we aim to collect information on your gender, age, nationality, your level of

"liking" of mathematics and statistics, your expectation regarding these modules when you initially applied at the university. The main five criteria (with regards to mathematics/statistics teaching and learning) that will be investigated are:

- About the students.
- Self-confidence.
- Value
- Enjoyment
- Motivation

7. What do I have to do?

If you decide to take part, we would request you to participate in a fair and honest way. As mentioned in details, above, the process will consist of answering some questions usually a tick-box survey, under the supervision of the researcher. There is no specific preparation required prior to taking part in the surveys.

8. What are the possible disadvantages and risk of taking part?

Whilst you may be asked to answer questions about yourself (age, gender, nationality, etc.) and on your perception of mathematics and statistics, all information provided by you will be kept confidential at all times. All data collected will be kept only by the researcher in a One Drive account (set up by academic supervisors, and given access by them), on his personal laptop, and will be password-protected. These data will be destroyed 3 years after the researcher completes his doctoral thesis. The researcher also endeavours to avoid setting up these focus groups when you have coursework submission deadlines and exams.

In general, there are no known risks in taking part, however, contribution of your time may be seen as a disadvantage.

9. What are the possible benefits of taking part?

The information you provide will enable the researcher to identify factors affecting students' learning of mathematics and statistics. This will have an impact in the way the researcher run the lectures, lab sessions and workshops, in those subjects. Whilst you may not reap the benefits straight away, the researcher will implement changes to other module delivery system. We hope that participating in the study will help you. However, this cannot be guaranteed. The information collected from this study may help the

researcher to enhance students' learning experience in mathematics and statistics, in the future.

10. Will my taking part in this study be kept confidential?

All information that is collected about you during the course of the research will be kept strictly confidential. Since this questionnaire is anonymised, no names will not be collected. IP addresses will be switched off, and will not be recorded on Qualtrics. The data will be stored only on the researcher's laptop and documents will be password protected. All data will be stored, analysed and reported in compliance with the Data Protection Act 2004, Mauritius (http://dataprotection.govmu.org/). The University has a Safeguarding policy and the research team members are guided by professional codes of conduct which requires us to report any information to the appropriate authority, when a person may be at risk of serious harm. We will endeavour to discuss this with you first.

11. What will happen to the results of the research study?

This research is part of a doctoral programme currently being undertaken. Results will be published in academic journals, whilst participants' identities will not be revealed in the process. The aim is to publish at least one paper per year, in the next 2 years. Results can be perused after contacting the researcher, and links to any published articles will be made available to the participants, upon request.

12. Who has reviewed the study?

Middlesex University, Hendon, UK has reviewed the study. This includes submission and approval of ethics form and risk assessment forms. The committee is the Middlesex University, Education Ethics Sub-committee.

13. Contact for further information

Researcher: Bheshaj Kumar Ashley Hoolash
Email: BH305@live.mdx.ac.uk
Supervisor: Dr Leena Robertson
Email: L.Robertson@mdx.ac.uk
Office Phone: (+44) 0208 411 4768
Address: Middlesex University,
Hendon Campus,
The Burroughs,
London NW4 4BT,
UK

The researcher would like to thank you for taking part in this study. A copy of the information sheet and the signed consent form will be given to you to keep.

APPENDIX F

APPROVAL LETTER BY MUM

Middlesex University Mauritius

Coastal Road
Uniciti, Flic en Flac
MAURITIUS

Friday, 24 November 2017

Dr Leena Robertson
Dr Gordon Weller

Re: Bheshaj Kumar Ashley HOOLASH (M00389229) – DProf Candidate
Title of DProf Project:

AN EXPLORATION OF STRATEGIES TO SUPPORT NON-SPECIALIST MATHEMATICS AND STATISTICS LEARNERS IN HIGHER EDUCATION IN MAURITIUS

This is to confirm that B.K Ashley Hoolash (M00389229) has been given permission to conduct Focus Group Interviews, Interviews and Questionnaire Surveys with students at Middlesex University, Mauritius.

This is in regards with the research work he has to do for his Doctorate in Professional Studies (DProf).

If you have any queries, please contact me for further information.

Regards,

Dr Nicky Torrance

Associate Director Academic

Middlesex International (Mauritius) Ltd

Fig. F.1 Letter of Approval

Tel: +230 403 6400 Fax: +230 425 5330 Email: info@mdx.ac.mu www.middlesex.mu
Middlesex University Mauritius Branch Campus registered with TEC as Middlesex International (Mauritius) Ltd

APPENDIX G

PARTICIPANTS GENDER DETAILS

Focus Group 1, Group 2 and Group 3:
Number of participants = 6 × 3 = 18
Number of male students = 9
Number of female students = 9

Face-to-face Interviews:
Number of participants = 3
Number of male students = 0
Number of female students = 1

Online Questionnaire:
Number of participants = 132
Number of male students = 57 (43.2%)
Number of female students = 75 (56.8%)

APPENDIX H

FOCUS GROUP INTERVIEW QUESTIONNAIRE

CONSENT

Please select your choice below. You may receive a copy of this consent form (upon request) for your records. Ticking on the "AGREE" button indicates that:

- You have read the Participation Information Sheet.
- You understand that the data collected from the questionnaire is only for research purpose.
- You voluntarily agree to participate.
- You are 18 years of age or older.

☐ AGREE
☐ DO NOT AGREE

Thank you for participating in this focus group session.

B.K. Ashley Hoolash
Doctoral Candidate at Middlesex University
BH305@live.mdx.ac.uk

Questions on next page

Current Academic Year (E.g. 2010/11) : .....

Today's Date (DD / MM / YYYY):.....

Pseudo-Name of the group: .....

Pseudo-Name of participants:

1. ..... 2. .....

3. ..... 4. .....

5. ..... 6. .....

Size of the group, S1:.....

Gender Split:

..... Boys.

..... Girls.

Number of Local and International students:

..... Local.

..... International.

1. What made you like (a) mathematics (b)statistics?:

2. What made you dislike (a) mathematics (b)statistics?:

3. What do you feel about your university's (a) mathematics (b) statistics modules?:

4. Is the content appropriate?:

5. What should we have done to prepare you better for these modules?:

6. How can we make amends NOW?:

7. To provide better support to the students, what type of support do you think, we should provide, in the short term, and in the long term? ["Support" would mean "numeracy support". Some of the chapters might need prerequisite knowledge of other chapters. How can we assist you in better preparing yourself to study the mathematics and statistics contents in your modules?]

8. Is there anything we are doing better in (a) mathematics (b) statistics teaching, as compared to your experience before joining Middlesex University?:

9. Is there anything your former (a) mathematics (b) statistics teacher was doing better, as compared to your experience at Middlesex University?:

You have reached the end of the interview. Thank you for participating.

APPENDIX I

STAFF INTERVIEW QUESTIONNAIRE

CONSENT

Please select your choice below. You may receive a copy of this consent form (upon request) for your records. Ticking on the "AGREE" button indicates that:

- You have read the Participation Information Sheet.
- You understand that the data collected from the questionnaire is only for research purpose.
- You voluntarily agree to participate.

☐ AGREE
☐ DO NOT AGREE

Thank you for participating in this focus group session.

B.K. Ashley Hoolash
Doctoral Candidate at Middlesex University
BH305@live.mdx.ac.uk

Questions on next page

Current Academic Year (E.g. 2010/11) : .....

Today's Date (DD / MM / YYYY):.....

(A) ABOUT YOU

1. Which Department are you associated with, at Middlesex University, Mauritius?

☐ International Foundation Programme
☐ Psychology
☐ Business School
☐ I.T
☐ Other Programme (please specify): .....

2. Students you teach mathematics or statistics components to (choose as many as you want):

☐ Level 3 (IFP students only)
☐ Level 4 (Year 1 undergraduates)
☐ Level 5 (Year 2 undergraduates)
☐ Level 6 (Year 3 undergraduates)
☐ Level 7 (Masters - Postgraduate students only)

(B) THE INTERVIEW

1. Tell me about the modules, with mathematics and/or statistics components that you teach

2. What are the cues you pick up, to realise that students are struggling?

3. What are the cues you pick up, to realise that students are enjoying the mathematics and statistics contents of your modules?

4. What are your strengths and weaknesses as a teacher teaching mathematics and/or statistics to non-specialist students?

5. What kinds of strategies do you use to challenge students to have an in-depth understanding of mathematics and/or statistics?

6. What strategies do you use to make curriculum meaningful and relevant to students?

7. What type of numeracy support do you think we should provide, to enhance the teaching and learning of mathematics and statistics (with regards to non-specialist students)?

8. How do you think we can facilitate the transition, in terms of teaching mathematics and statistics, between secondary school and higher education?

9. Mathematics and statistics can be challenging subjects for some learners. How do you make your lessons engaging and fun for students and also relevant to their studies/careers/lives?

10. Are there any specific workshops that you would like us, mathematics and statistics lecturers, to provide which will help non-specialist mathematics and statistics students?

You have reached the end of the interview. Thank you for participating.

APPENDIX J

STUDENTS INTERVIEW QUESTIONNAIRE

CONSENT

Please select your choice below. You may receive a copy of this consent form (upon request) for your records. Ticking on the "AGREE" button indicates that:

- You have read the Participation Information Sheet.
- You understand that the data collected from the questionnaire is only for research purpose.
- You voluntarily agree to participate.
- You are 18 years of age or older.

☐ AGREE
☐ DO NOT AGREE

Thank you for participating in this focus group session.

B.K. Ashley Hoolash
Doctoral Candidate at Middlesex University
BH305@live.mdx.ac.uk

Questions on next page

Current Academic Year (E.g. 2010/11) : .....

Today's Date (DD / MM / YYYY):.....

(A) ABOUT YOU

1. Which Programme are you studying at Middlesex University, Mauritius?

☐ International Foundation Programme

☐ BA (Hons) Accounting and Finance

☐ BA (Hons) International Business

☐ BA (Hons) Psychology with Counselling

☐ MSc Management

☐ Other Programme (please specify): .....

2. Level of current study:

☐ Level 3 (IFP students only)

☐ Level 4 (Year 1 undergraduates)

☐ Level 5 (Year 2 undergraduates)

☐ Level 6 (Year 3 undergraduates)

☐ Level 7 (Masters - Postgraduate students only)

3. Gender: ☐ Male ☐ Female

4. Your Age:

☐ Age < 20

☐ $20 \leq$ Age ≤ 25

☐ Age > 25

(B) THE INTERVIEW

5. Can you identify any experience in previous classes which made (a) mathematics (b)statistics positive for you?:

6. Can you identify any incident in previous classes which made (a) mathematics (b) statistics negative for you?:

7. To what level did you study (a) mathematics (b) statistics before joining Middlesex University?:

8. Why did you choose (a) mathematics (b) statistics up to that level?:

9. Could you have studied further?

10. What is students' perception on studying mathematics and statistics in your country?:

11. What do you think a mathematics and statistics teacher should do, to encourage learning?:

12. How do you think teachers should approach teaching of (a) mathematics (b) statistics in your group (undergraduate Year 1 level)?:

You have reached the end of the interview. Thank you for participating.

APPENDIX K

ONLINE QUESTIONNAIRE

Dear students, Thank you for participating in this survey. A Participant Information Sheet (PIS) has already been sent to you so please make sure you read it carefully before you proceed with this survey. A copy of the PIS form can be downloaded below , should you wish to read it again.
[Link to download PIS form].
CONSENT: Please select your choice below. You may receive a copy of this consent form (upon request) for your records. Ticking on the "I AGREE with the above" button, at the bottom of this page, indicates that:

- You have read the Participation Information Sheet.
- You understand that the data collected from the questionnaire is only for research purpose.
- Completion of this questionnaire is deemed to be your consent to take part in this research.
- Completion of this questionnaire is deemed to be your consent to take part in this research.
- You are 18 years of age or older.

This questionnaire, as mentioned in the PIS form, should not take more than 10 minutes

to complete. Should you need to contact me with regards to the results of this survey, you can e-mail me on BH305@live.mdx.ac.uk, B.K. Ashley Hoolash, Doctoral Candidate at Middlesex University. Please click below, before you proceed.

☐ I AGREE with the above

(A) ABOUT YOU

1. Which Programme are you studying at Middlesex University, Mauritius?

☐ International Foundation Programme

☐ BA (Hons) Accounting and Finance

☐ BA (Hons) International Business

☐ BA (Hons) Psychology with Counselling

☐ MSc Management

☐ Other Programme (please specify): .....

2. Level of current study:

☐ Level 3 (IFP students only)

☐ Level 4 (Year 1 undergraduates)

☐ Level 5 (Year 2 undergraduates)

☐ Level 6 (Year 3 undergraduates)

☐ Level 7 (Masters - Postgraduate students only)

3. Gender: ☐ Male ☐ Female

4. Your Age:

☐ Age < 20

☐ $20 \leq$ Age ≤ 25

☐ Age > 25

(B) SELF-CONFIDENCE

5. I feel confident studying mathematics and statistics.

(Strongly Disagree) 1☐ 2☐ 3☐ 4☐ 5☐ (Strongly Agree)

6. I am relaxed in a mathematics and statistics class.

(Strongly Disagree) 1☐ 2☐ 3☐ 4☐ 5☐ (Strongly Agree)

7. I am able to solve mathematics and statistics problems with ease.

(Strongly Disagree) 1☐ 2☐ 3☐ 4☐ 5☐ (Strongly Agree)

(C) VALUE

8.Mathematics and statistics are important in everyday life.

(Strongly Disagree) 1☐ 2☐ 3☐ 4☐ 5☐ (Strongly Agree)

9.Mathematics and statistics are important subjects for people to study.

(Strongly Disagree) 1☐ 2☐ 3☐ 4☐ 5☐ (Strongly Agree)

10. High (secondary) school mathematics and statistics courses would be very helpful no matter what I decide to study.

(Strongly Disagree) 1☐ 2☐ 3☐ 4☐ 5☐ (Strongly Agree)

(D) ENJOYMENT

11. I have usually enjoyed studying mathematics and statistics in secondary school.

(Strongly Disagree) 1☐ 2☐ 3☐ 4☐ 5☐ (Strongly Agree)

12. Mathematics and statistics are exciting.

(Strongly Disagree) 1☐ 2☐ 3☐ 4☐ 5☐ (Strongly Agree)

13. I am happier in a mathematics/statistics class than in any other class.

(Strongly Disagree) 1☐ 2☐ 3☐ 4☐ 5☐ (Strongly Agree)

(E) MOTIVATION

14. I would like to study mathematics and statistics at university.

(Strongly Disagree) 1☐ 2☐ 3☐ 4☐ 5☐ (Strongly Agree)

15. I plan to study as much mathematics and statistics as I can during my education at university.

(Strongly Disagree) 1☐ 2☐ 3☐ 4☐ 5☐ (Strongly Agree)

You have reached the end of the interview. Thank you for participating.

APPENDIX L

SAMPLE TRANSCRIPTION - FOCUS GROUP 1

Focus Group 1 Pseudo Names: Malini, Tina, Jane, Tom, Rick, James Interviewer: ASHLEY

ASHLEY: Qu 1: What do you like about mathematics and statistics?
Jane: From here? From the university?
Ashley: Up to you, even before.
Jane: No, before I did not take mathematics at A Levels. But I took it at O Levels. And I found it more interesting here (Middlesex). It's actually easier here. It's easier here because you focus on certain specific things. And then you get to use like Excel and all that and not necessarily just with your calculator to figure out what you are going to do, even when you don't know what you are supposed to do.
Ashley: You think Excel, which you did not use in mathematics before, helped you to see the bigger picture?
Jane: A great deal! For me, personally. It helped me a great deal.
Ashley: OK!
Jane: Yeah!

Ashley: But how? How?
Jane: Before, I did math in my O levels because it was compulsory. At A Levels, I didn't do it. So, here again at university, I just jumped back into it. It's not my focus but it is part of my module that I am doing. So I would have found so much difficulty, but I did not. Let's say if I am calculating something and I don't know what exactly to do, all I am going to do is like ... tap on a button or something, see a formula and go straight ahead and do it. To me that's easy. But if you just have your calculator and a paper in front of you, what are you going to do? If you don't know the formula?
Rick: I don't like maths. Honestly, I really don't like it. I just like the basic, like addition, subtraction, multiplication and division. But if you take me to the complex numbers and, I don't know, for example, spheres, trigonometry, I really hate them.
Ashley: Sorry to interrupt you. It will come later, what you don't like. But here, I wanted to know what you like. What made you like mathematics and statistics. I am pretty sure even though you dislike it, there might be some ..... little bit somewhere, what made you like it better here, compared to before, or is it completely ... nil
Rick: The way I see it, I am kind of compelled to take it and use it. I feel like I don't have a choice. But honestly, I am not a fan of mathematics. I don't like it. That's it.
James: I like use of Excel because before, coming to university I never knew, like, how to use excel, Minitab. A week before we had our test, yeah? I ran to Tom, and I was like, "Oh, please Tom, can you like help, like can you put me through excel and Minitab". He said OK. He showed me the basics. He showed me the, like, one or two steps in excel, and I found it very very interesting. So, to me, excel is like the best part.
Ashley: But then, my query is, you went to Tom. Why did you not go to your lecturer? (laughters....)
James: Well, to me, I don't like running to my lecturers. I like running to my friends.
Ashley: OK (laughters). No, perfect. But, is there any problem to contact the lecturer?
James: No, no, no.
Ashley: Did the lecturer refuse or ...?
James: I like it when I run to my friends and tell them "see, see see, I don't really understand these parts, put me through". And if does not help, that's when I run to the lecturer.
Ashley: Do you know what is "peer assistance"?
James (and others): Yeah, yeah
Ashley: How do you think your lecturer can implement this? So instead of encouraging student to come and run to the lecturer if they don't know something, and what I can hear from you now is, some students might prefer getting the help from their friends, what would you suggest? What can we do?
James: But to me, it's more like, like my own personal preference.

Ashley: No but, if it's you, it could be other students as well, and they are not telling me. I don't know. Maybe it's something we want to do.
James: Let's say, ok, we should have like, I know it's not gonna be very, very easy, but I feel we should have like, one on one chat with our lecturers. Because so many people do not like being found in crowd. They like it when they go one on one with the lecturer.
Ashley: So, you are saying that we do it last and then make sure we have a one on one, that might help students more.
James: Yeah, yeah.
Ashley: Can I ask you another question? Why did you wait one week before the test to go to your friend?
James: No, not like I waited a week before going to my friend. I was practising, yeah, on my own. And I found it like, ok, there is this friend like, living very, very close to me, then it's best that I just run to him. So, I don't get to like, have a resit, and all. Because to me, it's best to expose yourself that, ok, this part of my body is paining me than keeping it to yourself (laughters....). Yeah! Because to me, prevention is better than cure.
Ashley: Anybody else?
Malini: I do not like it (mathematics).
Ashley: Neither mathematics, nor statistics? Or maybe you like mathematics but you don't like statistics?
Malini: I don't like mathematics, but statistics seems to be easier, due to excel.
Ashley: ok, it seems to me that having a software in our syllabus, kind of help to see the bigger picture?
Jane: It is actually... That's right. Software makes life easier. I don't know if it's just for me, or for most of students. If you can figure out things in a few days' time, even the assignment, when you are doing the assignment, I highly doubt that I'll go through one, like, one entire assignment, even if there are just three questions when I don't have that software.
Ashley: So then, how do you feel now that, you have a new test, the second test, being quite based on excel and Minitab. Did that help? I know you can't compare it with previous years, but how do you feel having one test multiple choice and two tests based on labs and excel and Minitab?
Jane: Like, there has to be a balance. For me that's what I think. But before anything else, if you had asked me, if I would attempt to do any statistics or maths, I would say No.
Ashley: "Before", you mean, before coming to university?
Jane: Before. Yes. After this, I am more willing.
Rick: Yes, to add on that, previously I said I don't like maths. It's true, I don't like. Just to top up what Jane previously said, that I find it the software and the excel kind

of helps to go through the questions. I find it that excel is helpful in dealing with maths problems. So, I find it kind of helping. But it's not that I like it, but it's helping to go through it. But if I take the question of completing the exams and the test, I find it's better if they could just put those questions and reduce the lab work.

Tina: First of all, I didn't know there was going to be statistics and maths in this module, otherwise I would not have chosen this module but anyway, I did not have a choice. When it comes to the stats, basically I am understanding it, because of the quality of teaching. When it comes to maths, I don't have a basic in maths so I am struggling a bit like with the formulae, the equation and how to do the calculations. Coming to the excel part, I have a knowledge of excel but with the lab work, this has helped me to better understand excel and to do like, more calculations, in shorter time which I was doing on calculators. Instead of doing them manually on calculators, I can just go on excel and now I just type the formula and get the answers instead of having to type something ten times, fifteen times, which excel automatically does. So basically for me, excel has helped, but also the quality of teaching for statistics, the quality of teaching is very simple and clear. This part is ok for me, but when it comes to the calculations, this is the problem.

Jane: Maybe to go back to what he said (...pointing to James) about having "peer-centred help", if there is a way groups can be formed from the beginning. It does not have to be compulsory. It could be people that you want in your group or that the tutor has chosen, it would be more helpful because I also learnt Minitab and excel from someone else. I had learnt it in class but to put it in practice, I had to go and sit with someone. And then we do it together. Like, this is what you are supposed to do. The thing is, once you have the concept, no not the concept, once you know the formula, there is no chance you are going to forget it. Like, you'll always remember it, no matter what. If you have your peers tell you: this is what you can do! It's actually easier because you can find the lecturer super busy. If they are not busy, then we are busy. So we so you can just move on to the next person, before you go to the lecturer. At the beginning of the module, maybe we can have groups.

Ashley: Ok! That's a good idea. Tina, I have one question to ask you, but I think Tom has been waiting for a while to speak.

Tom: So basically I do not come from a mathematics background but I personally fell in love with maths from a young age, I think since my Year ten. I don't know what is the equivalent with you guys. I fell in love with maths. I like doing Algebra, I like doing Probability although it is not easy. Probability is not easy. In A Levels there are harder things like Logarithm and all that, but moving forward, step forwarding to university, I feel like it was more easier, it is more easier than my A Levels, because I think the lecturer, he(..), the materials first of all, are on the screen. He goes step by step rather than back in my High School, which I had actually read ahead and study a lot. In university,

there is all that you need. There is module handbook, lab notes, seminar questions. The lecturer always comes back to that. In High School I never had that, you know, kind of, materials offered to me. So basically I would say that maths and statistics, I like it personally. I like it. I would not say much to say an improvement is needed, because I enjoy my position in maths right now. I love solving questions and that's all I can say.

Ashley: Can we confirm, Year ten is what? When you were fifteen, sixteen? That's O Levels?

Tom: Yes

Ashley: I am very interested in knowing Tina's views. She said something quite important to our research. She did not know that there would be mathematics or statistics. What does that mean?

Tina: Hmmmm, basically when I applied for the programme, I thought it was just gonna be like a little bit of Marketing, a little bit of everything, but not mathematics. Because for me, like, I am not a maths person, and also I have not done maths. Like, the last time I did maths was in O Levels and then there has been, like, a little gap in my life where I have been working, but I have not like... I do not have a basic in maths to say. So basically, for me it has been like, a break, and then coming back to university, for me faced with maths, so .....

Ashley: So when you applied, you did not check the handbook, the modules that you were gonna study?

Tina: I checked, but the MSO does not say in details, what the MSO programme is all about.

Ashley: Oh! .... This is one big part of our research. Should we, in our module name, change the name? It is excellent you mentioned it.

Tina: Maybe like, just say, just a proposal, "Basics in Mathematics", or something. Just to .....

Jane: Not to scare them. But to just let them know.

Ashley: We'll move to the next question. Please remember we are talking about both mathematics and statistics. So, by all means, if you want to be specific about maths or statistics, please do let me know. Because our module was a mixture of both. Mostly statistics. Like 80% statistics and 20% mathematics. Please if you want to be specific, fine.

ASHLEY: Qu 2: What do you dislike about mathematics and statistics?

Tina: So basically, for me was that, I really hate is the Estimation, Regression. I think this forms part of the maths part. But when it comes to the statistics, such as Sampling, Box-and-Whisker, for me, I do not have any struggles with that one. But when it comes to the calculations, formulae, for me it's a nightmare.

Ashley: How can we improve it? How can we make it easier as it will be in the syllabus

anyway?

Tina: OK. Basically, like, for people in their first year, they should consider putting things from basic. Like the basic formulae they need to know. Because for me, like I said, I don't have much of a background when it comes to math. So, there are certain formulae, like sigma, which I am sure I must have heard of it when I was still at secondary school, but I have not heard about it for a long time. So for me now when I see the symbol, I am like "what is this?". So maybe they should put it in simpler way so that whoever who comes, even if the person has no background in maths, automatically will know: This is this. Instead of them trying to figure out on their own. There are certain things also when it comes to maths, I don't know, maybe because, like I said, if I don't have the basic, I don't understand the concept behind it. There are certain types when you need to add and you need to multiply. Maybe in that particular module (NB: Maybe the student meant "chapter"?), they should insert something, so that people know that in that particular situation, you need to apply this rule of addition and this rule of multiplication.

Ashley: Anybody else?

Jane: I think they should come up with a more ..... I don't know, a more ..... Let's say I missed one class, which I have, but I'm definitely not going to understand the next class. It's not like any other subject when you just come and then carry on. No! you have to understand the previous chapter, before moving on to the next one. But how are we going to ensure that this happens, if someone misses the class?

Ashley: So can we come up with a solution?

Jane: The solution actually would be that, how about these exercises that are in the book...

Ashley: The seminar?

Jane: The lecturer would come and go through. But what of the students? Are they actually doing these questions? Or are the just doing it throughout, with him? What if they do not come to the class? So, not to impose, and like someone tells you "let me see your work", ""let me do this". But it would be actually nice, maybe weekly test, or weekly essay, something where you like to be responsible to do that work and make sure someone checks up on you.

Ashley: Anything else?

Rick: As I said previously, I don't like maths. But one thing is that, I know maths is not hard, neither is it easy. You need to do practise to get it. So personally for me, what I hate in maths, it's the number. Like those numbers, when I see them at least numbers in manual or something, I can understand. But when I see the numbers and the calculations and I have to do this and that, like I said it is easier to do addition, subtraction, multiplication and division. It's much easier. But when you go to complex stuff, for example,

probability, charts, stuff like that, it kind of gets harder for me. For example, in statistics, I find it easier for me, to understand something like Sampling, where its more words, you see, more for understanding. But for the numbers it gets confusing for me.

Tina: just to add on something. I don't know maybe if I don't understand the concept. But whenever I look at the stats and I look at the maths, for me, I find it's like there is a big range between maths and stats. Basically you get topics like Samples, which for me I find it very easy and then there is a big gap and then you get topics like Regression, which is like... you don't see the connection between these two. It's just like between one and then ten. So, you get what I mean?

Jane: Also, maybe another solution could be, these handouts, the handbooks that we get, if maybe on the first page, put like the formulae and certain things, that don't change. Because, from primary to now, meaning are the same. Some things that are just the same. Some symbols never change. The equal sign will always be like that. We used to have those little calculations on the mathematical set. You open your set and you are like.. there it goes and I'm never forgetting this. So what if we had in our handbooks, on the first page. Every time it keeps coming back, so that we don't forget.

Ashley: Anything else you would like to add?

James: The truth is, there are many parts when it comes to maths and statistics, where you miss a sign, you miss everything. Because the word "Regression" it's like it's going to tell you that you will "regret" at the end [laughters.....]. It's true. Because once you miss a sign, probably like in the excel file, if you forget the plus sign, man....It's gonna give you the wrong answer (laughters....). and you are like "ooh, it gives me the answer, I am right, I am right". Maybe like, after few minutes like, while solving the equations, we are like "huh, I forgot to add the sign!" (laughters.....).

Jane: There is no marks for methods. You know like, in high school, the answers, we break that in parts.

Ashley: so, you are just saying that we need to keep that focus, and be meticulous, and that's something that you don't really like?

James: Yeah, yeah.

Ashley: How can we improve on that?

James: Up until now, I am still struggling.

Ashley: don't you think more practice would probably decrease the chance of making mistakes like this? I am just thinking.

Tina: Maybe like, I think the seminar solutions are not enough. Like, they should give more examples. Like, our second topic, you are given like, one particular example, but you are not given multiple examples for you to check whether you have really master the concept. Me thinking that, you have mastered the concept but later on when you are faced with another question, which you are supposed to be something else but you don't

know you still be doing something like you think is right, but when it is the wrong formula for you to use.

Malini: For me, I don't like statistics, in the term that we need to write the findings in terms of sentences, and it should be in mathematical form, so...

Ashley: So, the interpretation, you mean?

Malini: Yeah

Ashley: That's quite an important part of statistics because it needs to be in a certain way that the layman, the people who do not know mathematics and statistics can read, and have a conclusion. They have a statement. So, how can we change it? Is there a way we can improve on it? Or should we focus more on how to write those conclusions, you think? Back in the class?

Malini: Yeah.

ASHLEY: Qu 3: What do you feel about the university's mathematics and statistics module that you are doing? is it something that is connected to your program? Do you think it's gonna help you in the program? How do you feel about it?

Jane: Maths and statistics? How it's helping? Yeah, it's helpful...

Malini: Because we will use it later in life. We have only compulsory modules which will use later on. It's not like secondary school, where we have chapters which you won't use. You won't find any connection.

Jane: Even after university, you are up there doing your business, or whatever.

Ashley: So, you think it's quite structured and tailored?

Tina: I think the statistics module we are doing right now, is very important because, in most of the modules we are doing, there is no other one where we are doing labs which we are practising excel and learn how to do excel. And excel is a programme that later on, wherever you go in life you will come across it. And if you don't have the basics of excel, how, if you are a manager, are you going to work, and you have people like junior staff who are under you who knows excel, and you don't know. So I think it's fair that the lab work for the maths is incorporated into that module, but make it a bit more user-friendly.

Jane: I have used excel before, but not everything...

Ashley: What do you think about Minitab?

Tina: It's not very popular. I think there should be something to make it much more popular because I only heard about Minitab when I came to university. I never heard about Minitab before. So I don't know if it's the same for everybody. [In Unison: It's the same.....]

Jane: I never heard about it. I didn't know what it was.

Ashley: You never heard about it, because you did not do statistics, you did mathematics before. In mathematics, you have little bit of statistics, up to A-Levels. Minitab

is just a statistical software. Its exclusively for statistics. I am pretty sure you have an idea, now, about What it can do. It will help you in the future. What you have done in Minitab is just about 2% of what it can eventually do. You might also, never have to use Minitab again. Now, excel is good enough. But we thought we would show you a new software which does exclusively statistical stuff.

Rick: I think, for the module for statistics, I think it's better if they focus most on interpretation, just like my friend previously said. Because for me I felt like if knowing a lot of data doesn't help if I can't interpret it. Especially for me, I am doing Business. I felt it's better to put my effort in interpreting rather than the numbers. The numbers, I am kind of doing it, but I find I should focus mostly on interpretation, because I am doing [Business Management].

Ashley: No, but the thing is, we need the numbers to interpret, right? Don't you think?

Rick: Yeah, but I felt like, it should be easier for me to understand, based on the numbers.

Ashley: Ok, anything else? Should we move to the next question?

ASHLEY: Qu 4: Is the content of your module appropriate?

Tom: I think it is appropriate, I would say so. It covers a wide range of topics. You don't have to necessary focus on one topic if you open up a business. It focuses on many topics. So, you can apply your knowledge from, suppose, some basic knowledge into opening a company. So, suppose, I want to start a business, I know I'll have to be selling my goods, I know I have to calculate how much profit I'll make. I'll have to calculate how many goods are left in the store. I have to make a decision of bringing again more goods to sell. So I will basically need statistics to know whether I am a making a growth or making a loss. Now, I can use this with other modules, like suppose, Marketing or HRM (Human Resource Management), to make up a business decision on what is needed to build my company to greater success, greater heights. But basically I will need maths, I will need statistics, to know how my business is running.

Ashley: Ok, if I have to summarise, you feel that the content of the syllabus is good enough?

[All]: Yeah

Ashley: But is there anything that you feel we could have done, in terms of contents of your syllabus?

[All]: No

ASHLEY: Qu 5: This question is about you telling me now, what should we have done to prepare you better for these modules?

Ashley: I've already heard a lot of suggestions, such as peer assistance. Is there anything we could do? We talked about peer assistance, we talked about one-to-one. Is there anything else?

Tina: Maybe. They should consider to add in the module book, at the end of each chapter, like, do a summary of what each topic is all about. Because at the moment there is no summary. It's just like scattered all over the place.
Ashley: Is it a summary that the teacher should do, or the students should write themselves?
Tina: oh, it's a summary which forms part of the module book. Whoever does the module book, should include this part on the sum.
Ashley: what if we (lecturers) do one and then students do one. So lecturers do a summary on what's been covered, as bullet points, and students have one page where they can write their ideas.
Participants: Yeah, that would help us.
Ashley: Qu 6: You are completing your academic year. Almost completed it. You have only one or two sessions left. What do you think I can change now? What I mean here is, "Now" does not mean today. It means now till the next start of the academic year. Short term.
Ashley: If I can recap. "peer assistance" can be done. Is there anything else I can do straight away? **Jane**: I am not sure about this, but there could be someone out there would still not know what Minitab is. Or how it works, or whatever.
Tina: Maybe you should considerer separating the stats. The first term you do the stats only and the second term you do the maths part. Because, I think doing everything together, it's like a medley.
Ashley: The problem is that they syllabus is not 50-50 maths and stats. It's like 80-20 for stats and maths. That's the first reason. Second reason, it's all connected. So, it will happen that if I do mathematics completely and then do stats, then the problem will be, students will forget how to connect these statistics with that mathematics.
Tina: But I find it easier for me to do all the statistics together, then the mathematics all together. Instead of putting one here, and one there. It's too much to process at one time. For my understanding, I will find it far easier.
Jane: They can't do that; they can't separate it. But I think they should just keep in mind that there will be people who would not have the basic.
Ashley: Qu 7: To provide better support to the students, what type of support do you think, we should provide, in the short term, and in the long term? ["Support" would mean "numeracy support". Some of the chapters might need prerequisite knowledge of other chapters. How can we assist you in better preparing yourself to study the mathematics and statistics contents in your modules?]
Ashley: For example, some of the chapters need prerequisite. i.e. it would help if you knew something before you start the module. Knowledge of other chapters would be

helpful to do the chapters you do in year 1. You know the chapters which could have helped you in year 1. Obviously I did not do them in the class, because I thought you would have already covered them. So, is there something I could do to bridge the gap between you're A Levels and university?

Jane: First of all, I don't know if the lecturers get the chance to know which people are in their class. I don't think they do. But the focus should be, you have new people, don't think everyone knows maths, or did it in A-levels. You might find that maybe only 5 out of 27 might have actually done maths. And the rest just did it at O-Levels. And they remember nothing. So if at the beginning, like, in orientation or something, they could just talk about what is to come. This is what students should expect. Like the way we get our handbooks, and we know, this is the next chapter, or in our class this is what we are going to be doing. Then also maybe during orientation, we should be able to, you know, you see statistics, this is what is required, this is what we should be doing. If you have not done maths, this is what you can do. You can come to me.

Tom: I know some universities, before you get to the universities, they ask you, like my brother when he was going to the UK, he was asked to do a maths test. This was just a test to see the progress, how well you are with the maths, so that when you enter the university, the lecturer knows where to provide the help. This might be a good option.

Ashley: See, the purpose might be different. The purpose might be to see, by giving a set of questions, which can trigger some thoughts. In the sense that it will help the students in the next one year.

Tina: I think maybe for the first year, they should do a refresher course like, for just one month. Once you start university, especially for the maths module, like for the first month, just go back to your basics. So that in the second month you already have a feeling of what to expect. You don't have to go back, like, when did I do this? Finding your old maths book, for you to be able to answer some questions. At least you have the refresher course which will be able to help you along the way.

Jane: I think the purpose of IFP [International Foundation Program – Level 3] is for that. It's just that they don't focus on one thing. If we are business students, they are not going to focus only on maths and statistics or Integrated . . . , there they call it "Integrated something based learning". You get to see the excel. But just hardly, not in depth.

Rick: Yes, another way to look at it, I think maybe it's best if you can know the education system the person came from. Because some of the education systems are familiar. Like the topics which are included in the course are the same, like someone coming from KCC, Cambridge, IB. Some of the students who have done these courses. And then sort the students, in terms of, where they came from. So if some students have done certain topics in a course, say KCC and other, say IB, have not done them, so we know how to

help those who have not done these topics.

Ashley: The problem with this is, if I have a lot of students coming from several countries. It would need time to implement that. Don't you think it's better then, that I, because I know what the syllabus is, I design a booklet which contains easy thing, such as the meaning of gradient, y=a+bx, and stuff like that, that I give to students, during the Induction week, and they practise in their time, don't you think...

Tina: Yeah, it will be very beneficial.

Jane: Like in the first page of the handout, because we always get that book. And have it on the first two pages and we always read it. And if we have to cram it, we will cram it.

Ashley: Ok.

Ashley: Qu 8: Is there anything we are doing better in (a) mathematics (b) statistics teaching, as compared to your experience before joining Middlesex University?

(laughter)

Jane: So much better, at least from where I come from. At least this is student-centred learning environment. Where you get to ask, and you get to share. Back there we don't have student share. We just take it in, the way it is. That's why I said, some of these things, we might have seen, but we don't know exactly... I can know a formula, but I don't even know how it comes into existence. I just know how to cram it. This is how it's supposed to be. So if you ask me, do you know why it's supposed to be like that, I don't know why. I just learned that way. So I think the best part is that, I now have learned that maths and statistics are not actually hard if you understand the concept. The issue is, if you understand, if someone can make you understand, which the lecturer has actually done, he's made me understand these things. If I don't understand then I just go back to my module book, because it's right there, word by word.

James: Off late, coming from stats and mathematics, I really like the module. I know my answer might not really be relevant, but to me the best part, my lecturer, right here, is the fact that he doesn't shake students. When they get to ask questions. Because so many teachers, feel one should know everything. What they are teaching you, you should know everything. Because, life is practice makes perfection. When you practise. That's why most of the time, I prefer running to my fellow students, when I have difficulties. Because I feel that probably when I run to others lecturers they probably be like "are you this dumb? Why don't you know this? Were you sleeping in class?"

Ashley: So have you experienced anything like this before? **James**: Well my past experience yeah. Even right here, at Middlesex, yeah.

Ashley: Not the mathematics lecturer, is it?

James: No, no, no, no. That's why I'm saying when it comes to the stats lecturer, to

me, he's like the best. I won't lie to that. He's the best to me.

Tina: I think the good thing that Middlesex has done when it comes to the mathematics and statistics module is the introduction of the stats module. Basically we had to learn the stats from the very beginning but in a very comprehensible way that most of us would have understood the stats part. I don't think anybody in class would say they have not understood the stats part. I think most of us, we have our difficulties when it comes to the mathematics part. But when it comes to the stats, I think, the way it's been designed, the booklet and also the quality of teaching, it is fine. It is of standard form.

Ashley: Qu 9: Is there anything your former (a) mathematics (b) statistics teacher was doing better, as compared to your experience at Middlesex University?

Jane: Practice, practice, practice, practice. Ok yes, the lecturers here are so liberal. . . . . .

Ashley: Ok, no, we are talking about mathematics. . .

Jane: I am saying, here they are so liberal. But if they could hold you accountable for doing your work. It should be a nice thing. Like, because you are practising, but how is the person going to know that you are practising? Because they are basically they are just going to come and stand there, and say "did you do this segment? Can we do this"? But the people back home, they had to see. . . ..they have to see the work. They are not giving you the answer before.

Ashley: So do you think I should do this as well?

Jane: At some point. At some point. There has to be something. At the end of the topic, or at the end of the class session. There has to be something that lets you know that people are doing this work, or actually understanding. Because you have those days where you say "has anyone understood?". There is silence. "Who has not understood?". Then there is silence. So the only assurance you have, is from the Test. That when you have "Oh, they've got this. They've all passed".

Ashley: Tina?

Tina: I have a suggestion, but I don't know if it's feasible or not. It's almost one year, we are going to complete the stats module. But I feel like, in the second year, they should have incorporated, even though I don't like the subject, I'm starting to like it a little bit. They should have a module where we do specialisation in stats. It's just like, for me, it's not enough. I feel like we should be having something more, for the second year, especially with regards to the maths and stats. Or maybe do a specialisation in stats or maths. I don't know, but something along this line.

Jane: You say that we won't be seeing you again, does that mean. . . . Do we have any other statistics and maths? Or is it just it, we are done. Because it's like starting something, you ignite our fire and then "Bye, I won't see you".

Tina: Yeah, this is what I am saying.

Jane: There should be a little more, maybe in our last year.
Ashley: I was talking to two students earlier, and a third one who is in year two right now, in your programme, she came and showed me her work. She asked me to help her. What she showed me was a module that is being taught in year 2 and all it contained was Normal Distribution and Statistics. You won't have a module like you had in year one, proper maths and stats. But next year (Year two) will be the time, when you will connect Marketing with Stats. Business with Stats. So, whatever you learned in year one, will probably be applied in year two. But I will not be the one teaching you that.
Rick: As weird as it may seem, i feel like if there could be more exams, or tests, the marks could be split. Putting all the things at once, sometimes I like it but personally I find it hard. All the time, when I am not having a test, honestly, I don't go through my books. Because I don't like it. If they could try to split the tests that we have, it would help to keep people on their feet to remember how to study to get through the tests. Because sometimes tests motivate.
Ashley: You see everything is approved by Quality Assurance. What if we make it compulsory for you to submit your seminar questions and answers every three weeks? It connects to what Jane said as well. She said the lecturer usually does not know whether the student has done the seminar, or hasn't done, or has understood, or did not understand. One suggestion could be that we make it compulsory through some structure, where every student must show that they have done the work or have tried to do the work. And remember the seminar question is always around what you gonna get for the mock and eventually for the test. Changing the structure (for assessments) is not that easy, it comes every five years, and to be honest with you, your programme changed last year, so it's not gonna change for the next five years. That's quality assurance approved. In UK. And if they approved that three tests are enough, it means, they know.
Rick: Maybe, if the marks are going to be linked to the work, probably it could help.
Ashley: So, one suggestion then could be, submission of seminar would carry five points, and the test would carry ten points. Is that what you are saying? So, as long as the seminar work, that you are submitting, has some sense in terms of weightage, it's good?
Tina: I think they can change this. When it comes to the last test, they should take into account the other modules that we have. They should not be putting three tests in one week. In week twenty-four, we have three tests and it's not three easy topics. They should be a better planning and do not be putting everything together.
Ashley: [Wrapping up, and thanking all participants]

End of Focus Group 1 Transcription

APPENDIX M

SAMPLE TRANSCRIPTION - STAFF INTERVIEW 1

Staff Pseudo Name: **Manju**

(A) ABOUT YOU

1. Which Department are you associated with, at Middlesex University, Mauritius?

☐ International Foundation Programme

☐ Psychology

☐ Business School

☐ I.T

☑ Other Programme (please specify): **Postgraduate Masters** ...

2. Students you teach mathematics or statistics components to (choose as many as you want):

☑ Level 3 (IFP students only)

☐ Level 4 (Year 1 undergraduates)

☐ Level 5 (Year 2 undergraduates)

☐ Level 6 (Year 3 undergraduates)

☑ Level 7 (Masters - Postgraduate students only)

(B) THE INTERVIEW

1. Tell me about the modules, with mathematics and/or statistics components that you teach:

Answer: Yes, so on the IFP my module is titled Developing Independent Learning IFP0400 and it's actually, it's about one component, one part of it, the first part is about transitioning a student to HE and making them aware of what independent learning is and how to become an independent learner. But about 75% of the module is about numeracy skills that they need, so we do mathematics, we do statistics, they do a project where they actually collect primary research and do statistical analysis on it and at the other end of the spectrum I also teach post graduate masters students on the MA Education (Leadership and Management) and I'm in charge of the dissertation module so I supervise particularly those who are going for more quantitative approaches in their dissertations, so we do a lot of statistical analysis. But nobody is really a specialist, I would say, in maths.

Ashley: ok so I have a few questions on this but I don't know if I can ask them now or we can wait for later, maybe we can wait for later.

2. What are the cues you pick up, to realise that students are struggling?:

Answer: Let's talk about the IFP. At that level it's very erm clear when they start to struggle because the IFP is you know it's a very kind of coursework based programme so there's a lot of seminar work where they are doing maths problems in class, so you can easily start to see that they don't really know what to do or they don't um really engage with the material and they start to look for help. So, what I'm quite fortunate with is that the students pick up on the idea that I am somebody who they can approach, so they do try to ask for help, or they do try to ask for where they can go for support. And on the MA education as well we have people who go for quantitative type of dissertation, not necessarily having a very strong background in mathematics but probably taking the opportunity to learn and pick up the skills.

Question: You said for the IFP students you are somebody they can approach, what does that mean?

Answer: So, the kind of classroom environment that I create is where we are quite open about . . . , we're transparent about our progress, we are constantly talking to each other about how we're developing, the students can tell me about their development because that's pretty much the philosophy of the IFP. So, we . . . in keeping with those kind of, the philosophy of the programme, we have a very intimate environment, so students they're very happy to raise their hand and say that they don't understand something, they'll stop me in the middle or if it's a seminar work where they have worksheets to do, they'll just raise their hand and say that I need to explain things to them. Or, you know, they take a lot of peer support which I find very encouraging, so they might raise their

hand and it might be that another student walks over and asks them what they can help with.

Question: So, how do you create that type of environment? So basically, they are new to university, sometimes shy, sometimes not knowing what to do. If you were to advise another of your colleague teaching mathematics to create something like this, where students feel comfortable, what would you do, what would you advise your colleague?

Answer: Urrm, I mean I'm you know, my field is education, so I've read a lot about the theories of teaching, the theories of learning and I try to put all of that into practice so erm, you know, the first, I think it's also about things like the tone of voice, the kind of contact that you have with your students. Very early on I think we establish already that it's a classroom where students don't need to feel like they're alone, students don't need to feel afraid of anything, urm they have a professional respect and I think that's the type of classroom that I cultivate, but what I also really enjoy seeing is peer support and that is another thing that I try to embed in the IFP. So we do a lot of thinking in pairs, we do a lot of trying to group up people, so on the maths for example, in the workbooks, so this is one of the few modules where we have ... I think on the IFP because of the maths and stats component it's the only module which is actually printed out ... the whole workbook, the whole module handbook is framed like a workbook, it's about 180 pages long and it's kind of what we work through in the module and there are for example one of the strategies I used is when we start to introduce things like say we're doing currency conversions or we're doing fractions or ratios ... in that topic I've done , I've presented it in the workbook in a way where there are pages which if you're very confident in mathematics you tackle that topic through those pages but if you're not so confident in mathematics then you tackle the same topic but through different pages and these are numbered so I can ask them to kind of raise their hand and talk about how confident do you feel? So if they feel that they are very confident they can just go through the more challenging type of questions on that topic and then when they are paired up with somebody who doesn't feel so confident in mathematics then, you know, there's a lot of knowledge spill-over so they can try to bring out the, you know, the confidence in somebody who might not be so confident. And in this way, you know we get a lot of positive feedback from the group in that they've actually started to enjoy the mathematical components which they probably didn't used to like much in school.

3. What are the cues you pick up, to realise that students are enjoying the mathematics and statistics contents of your modules?:

Answer: So, again I think there's you know, like, for example, good body language so they start to smile, they start to fidget to raise their hands to provide answers, they start to walk around amongst the other students who probably are not so confident and give the benefit of their advice so that they are kind of like mini coaches in the classroom and also

it shows in their work because they keep asking you know how can I improve it, what can I do in my coursework to show that its more than what needs to be done? So, they might start to use different tools like use excel to start to draw graphs and embed those in the reports, they might start to use different software to create different types of charts and start to embed those and then even the discussions that they provide around those charts starts to become more critical. So I think it's the engagement that you start to realise that these are students who are really engaging in these parts and the assessments and trying to be more creative in the way that they present the mathematics and statistics content as well.

4. What are your strengths and weaknesses as a teacher teaching mathematics and/or statistics to non-specialist students?:

Answer: Urm, I think it comes from, probably from experience and my own personal journey for mathematics has also been a bit up and down through school so it comes from an understanding like an awareness, a personal awareness that students often don't enjoy mathematics and I do make , I always think that there's a crucial link between the environment that they've been grown up with at school, how has mathematics been nurtured, how has the interest of problem solving been nurtured because I'm somebody as well who if you ask any of my school friends they'll be absolutely shocked that I'm someone who ended up doing mathematics because it wasn't something that came easily or it wasn't something ... and then I found you know the prefect teacher so I really think the teacher has a very powerful position to play in whether students enjoy maths and thrive in mathematics. And it's something which if you get it right once I think it stays with you for, for the longest time so it's something which I think is done ... too... probably too poorly and if you get it right once then I think that makes a lasting impact for the students.

And for, oh yeah, for the weaknesses also I think you know sometimes you know the students just don't engage, they just don't want anything to do with mathematics so I'm not really out there to transform everybody, but I think people who do want to engage with mathematics I think there are strategies which we successfully use in our classrooms to make them enjoy it and engage with it. Errrm, ya.

5. What kinds of strategies do you use to challenge students to have an in-depth understanding of mathematics and/or statistics?:

Answer: Errr, so yeah, I mean at the IFP level and even at the masters level I don't think they're really looking for an in-depth understanding, but I think you know we don't want to keep the understanding at a surface level so i'm trying to look for ways that they students engage in deep learning in maths on the IFP and students engage in deep learning in statistics on the MA Education. So, the kind of strategies to use so for example like I said for the IFP we have different workbooks, I mean we have different pages of the

workbook dedicated to those who like to be challenged more and more, and then we have you know pages of the workbook which are for students who just want to have a kind of surface approach to it. The assessment also is a crucial aspect I think to challenge students because in the assessments they have to engage quite deeply especially for the final kind of culminative piece of work on the module, erm, it is something where they do have to, it actually it lasts three whole weeks, so for three whole weeks we're not doing much teaching we're just supporting them in their project and it's something where they have to design a questionnaire, they have to collect data and they have to statistically analyse the data and understand it to present findings and recommendations so this really by the time they emerge from doing this piece of assessment and it's a group assessment so there is a lot of peer support going on so I think when they emerge from that they really have positive comments about the depth of understanding that they've gauged in statistical analysis, in designing questionnaires, designing surveys erm understanding data (coughs) and similarly I think it's quite, at a different level, but similar kind of strategies at the masters level as well where the students have to engage in statistical analysis to quite a deep understanding level.

Question: You've mentioned deep and surface learning here, do you think the question I said in-depth understanding. I mean, I wouldn't connect in-depth understanding necessarily with deep learning. It could be surface learning but in-depth understanding of whatever the chapter is. For example if students are using SPSS and I see a lot of my students doing SPSS and doing surface learning but because the coursework is based on errr a lot of analysis they would do in-depth, they would try to understand, a lot of the use of SPSS but they don't necessarily need to understand the chapter. That's just a comment I mean I don't think we need to elaborate, it's not really something connected to the research, but my idea is I don't think in-depth necessarily needs to be connected to deep, you want to add anything?

Answer: I think I would probably, erm, I don't really agree. Because I think if you start to have an in-depth understanding that's when you can start to provide like the real critical arguments. Because unless you're having that deep learning experience, you're not engaging with the criticality of the topic. So, I don't know if I agree with you on your comments.

Ashley: Ok there are other things I would like to elaborate then but I don't think its connected to this. maybe after the set of questions we can discuss. But one thing that I want to , would have liked to discuss is then listening to you would mean that you would want all your students to do deep learning, you see, so what i've discovered is things like why should I force my students to do deep learning and they can surface learning because at the end of the day if they are more comfortable doing surface learning that's up to them. And i've seen surface learners who are quite good in maybe the difference is i'm

connecting use of software and use of applying the theory which I see in my class while you are probably thinking f just the theory I don't know. But anyway, this is, this we can discuss later.

6. What strategies do you use to make curriculum meaningful and relevant to students?:

Answer: So for curriculum you know I we have the approach of constructive alignment so what we try to do is to understand right from the microscopic level of each session to broader levels of each module to even broader levels of the programme and then even more broadly if you link programme and graduate attributes as part of the curriculum, so what we try to do is always try to do constructive alignment, so what I'm always very mindful of is are the activities, are the learning activities, are the assessment activities, the formative feedback, the kind of student engagement, are they all linked to the kind of objectives that I want to achieve for the students. So, you know it's about building everything and really rigorously designing the learning, so that it is actually meaningful and relevant to the students.

7. What type of numeracy support do you think we should provide, to enhance the teaching and learning of mathematics and statistics (with regards to non-specialist students)?:

Answer: I think there's, that's a really interesting question because there I think you know nowadays there's so many different ways to do this. I think traditional approaches might still be relevant for some students, but we have to also remember that you know that the kind of things for example like I learned at school and the kind of approaches my teachers used was very different to how students learn these days.

Question: What are traditional approaches?

Answer: Well, I mean i'm thinking about things like say if I think back to school, things like I don't know maths clubs or maths erm kind of like problem solving clubs or you know these kind of societies where you just get together like these we were termed geeks because you know we were just doing maths and more maths, but I think now maths is probably embedded in so many more things with technology, with you know apps and these kind of things, so ok – for example you asked me about the kind of numeracy support and I think you know we have some very good ideas already because there's CEMASTEL on campus which I think is a very good idea but probably it's not reaching maybe the level of level three, I think it's probably at undergraduate and masters level more so it might be that things could become simpler so that it engages remember IFP is almost like secondary school. If you're thinking about secondary school, the end of secondary school students because many IFP students are those who have only done 12 years at school, they haven't done the 13 years and that's why they can't come in to a MDX degree yet. So they have one year to catch up, they're doing the IFP, so there are things

that I guess can be organised in terms of maybe workshops or maybe things that just to make the mathematics part more fun because I do see that, I see that in my classes, that they really enjoy, some of them really enjoy it. And the... what I also see a lot of is peer support so I think why not you know open that up to a wider range of students so let different programmes interact. Different programmes have students helping each other out erm and but I think I have to say CEMASTEL is I think making its presence felt on campus and that is a good thing but there's scope even to move CEMASTEL outside of just the campus and make it something which might be used for students across different universities in Mauritius. Because i've seen MRU is a small island and the impact of particular initiatives, if it is properly designed and properly thought through, the impact can actually be quite powerful. Erm , so , errr, I think that might be it.

8. How do you think we can facilitate the transition, in terms of teaching mathematics and statistics, between secondary school and higher education?:
Question: do we consider IFP as higher education or part of higher education?
Answer: Yes.
Question: If you've answered this you can repeat and just to make things clear, how would you facilitate the transition?
Answer: Erm, so at the moment we don't, I mean we focus on the maths we do focus on mathematical topics on the IFP, we focus on it. You might say it's like Advanced maths at Advanced A-levels but I think we can do more because I think it can be something which links more to what is done in the degree programmes offered maybe at MDX or maybe just focusing on those that are offered at MUM because I think the you know the nature of maths changes once you get into mathematics in HE. But again, I think what your research is really interesting to address is this idea of teaching maths and stats to non-specialist students because I think – I don't know the statistics I mean the data – but i'm sure the actual maths and stats taught to non-specialists is probably much bigger than the proportion of students who actually just study mathematics as a subject. So I think this research is particularly pertinent and I think that what that transition needs to be ... so for them to understand that maths is actually different at school level and maths is very different at HE level and maths is something which is part of you know your whole life and it's something that you will always have to understand and to read. So just even everyday mathematics how can and that might go back to the previous question to supporting students in just tackling maths in everyday kind of ways. So, the kind of things that they see and they hear when they watching the TV or when they're reading advertisements or reading the newspaper. I think maths and stats is everywhere and if they can just realise that and get over the fear of it we're already a massive step in the right direction.

9. Mathematics and statistics can be challenging subjects for some learners.

How do you make your lessons engaging and fun for students and also relevant to their studies/careers/lives?:

Answer: Yeah, that's also I think a really interesting question because that touched on the relevance of it, and the relevancy is I think a very crucial aspect of it for all learners as long as you make it relevant to their learning and that's again where that constructive alignment kind of design process comes in. if you can make them see the relevance of it then you're going to have the students engaging with it, they're going it fun and they're going to find it something that they now only need to do but something that they will actually enjoy doing at the end of it. Erm ok.

10. Are there any specific workshops that you would like us, mathematics and statistics lecturers, to provide which will help non-specialist mathematics and statistics students?:

Answer: Yeah, I think that you know through the interview I think we've probably identified something because I think organising something where the students can see the relevance of maths in an everyday life or something that they're going to encounter anyway you know, they're going to encounter it. For example, I have students on the IFP who ask me ok, err, ask me **Staff1** which programme can I study at MDX which has absolutely no mathematics. And you know the only one or two that we have are LAW and APRM so they kind of choose that by default which is such a shame because you know after they leave they are going to encounter mathematics, its not that they have to do something but they are going to see statistics they're going to see budget reports they're going to see financial you know like they're going to have to think through these things. I think it's just that fear that they need to get over and one way might actually be that we set something up where they start to see that its part of everything and every erm something that they're going to encounter everyday anyway and once they realise that actually all of the is mathematics erm that might be something interesting.

Question: That was very nice Dr and yeah that's it. I do have a couple of things to discuss with you after the interview because they are not really connected with the research but thank you Dr for your time. Anything else you want to talk about, or anything you want to ask?

Answer: No I think this erm I'm very interested to see the results of your thesis and the study because like I said I think you know this the fact that you're dealing with,... you're focusing on non-specialist students is going to have a massive impact I think your research is going to have a massive impact and I wish you all the best and I'm very interested to see the outcome.

You have reached the end of the interview. Thank you for participating.

APPENDIX N

SAMPLE TRANSCRIPTION - STUDENT INTERVIEW 1

Student Pseudo Name: **Melodie**

(A) ABOUT YOU

1. Which Programme are you studying at Middlesex University, Mauritius?

☐ International Foundation Programme

☑ BA (Hons) Accounting and Finance

☐ BA (Hons) International Business

☐ BA (Hons) Psychology with Counselling

☐ MSc Management

☐ Other Programme (please specify): .....

2. Level of current study:

☐ Level 3 (IFP students only)

☐ Level 4 (Year 1 undergraduates)

☐ Level 5 (Year 2 undergraduates)

☑ Level 6 (Year 3 undergraduates)

☐ Level 7 (Masters - Postgraduate students only)

3. Gender:

☐ Male

☑ Female

4. Your Age range:

☐ Age < 20

☑ $20 \leq$ Age ≤ 25

☐ Age > 25

(B) THE INTERVIEW

1. Can you identify any experience in previous classes which made (a) mathematics (b)statistics positive for you?:

[**Melodie**]: Well, the practical side of the classes, when we had workshops sessions. And I think that's it. I mean, I'm a student who likes maths anyway. So I don't think that having a bad class would affect the fact that I do not enjoy the subject.

[**Ashley**]: What do mean "practical side"? What's the "non-practical" side, then?

[**Melodie**]: The non-practical side would be the theory. And practical side would be where we go in class and then we have like ... questions to answer in class, maybe sometimes in groups. That's it.

2. Can you identify any experience in previous classes which made (a) mathematics (b)statistics negative for you?:

[**Melodie**]: When the lecturer, ... when the teacher especially wasn't as interested in teaching the students...

[**Ashley**]: which level are we talking about?

[**Melodie**]: Secondary school. They just came in class and did what they had to do, but there was no interaction as such. That's what made the experience negative.

[**Ashley**]: When you say they weren't interested in teaching. So what were they doing then?

[**Melodie**]: They were just here ... teaching the basics, not answering to questions, ermmm, going through the syllabus, but not beyond the syllabus.

[**Ashley**]: Okay. Do you think they had time to go beyond the syllabus in secondary school?

[**Melodie**]: At my school, definitely because we always had about one month of revision, and so just at my school we did have enough time.

3. To what level did you study (a) mathematics (b) statistics before joining Middlesex University?:

[**Melodie**]: Maths since primary school ...

[**Ashley**]: Up to ... up to the latest level..

[**Melodie**]: Up to HSC (A-levels).

[**Ashley**]: Okay. All right. So that's an easy question. So till HSC. **4. Why did you**

choose (a) mathematics (b) statistics up to that level?:
Why did you decide to do Maths up to A-Levels?
[**Melodie**]: Because I was good at it. And I felt like it was something that I had to do given my choice of subject. I chose Accounting and Economics, and I had done Add-Maths as well. So I thought that doing mathematics would help me with my other subjects.
[**Ashley**]: Did someone tell you that it will help you or did you figure out yourself that doing Maths is something that will come handy?
[**Melodie**]: I had been told that it would be helpful, but I also chose it because I enjoy it as well.
[**Ashley**]: Who told you? Career guidance? Teachers? Friends? teachers? who?
[**Melodie**]: Teachers and some friends.
[**Ashley**]: Have you ever been to Career guidance and inquired about this?
[**Melodie**]: Not really.
5. Could you have studied further?:
[**Ashley**]: Well I know you are studying Maths/Stats. So we can change this question. What I meant here is if you have the chance to be masters degree, would you study the master's degree because of the maths component, would you be happy to continue with the maths? Or are you tired of the Maths?
[**Melodie**]: I would continue.
[**Ashley**]: Okay. Why? Not why but why so much interest?
[**Melodie**]: It's just that I love challenges, I love puzzles. So this is something that I really enjoy.
6. What is students' perception on studying mathematics and statistics in your country?:
[**Melodie**]: Well, most of students here (Mauritius) think that mathematics is boring. And I don't really understand why. I do think that it's because teachers don't make it interesting enough. I have been lucky to encounter teachers and people who have done mathematics. So maybe I'm biassed on my opinion of maths. But most of the time when I ask people if they like mathematics, it would be a NO. And I also teach mathematics like I do volunteering and I teach mathematics from Form 1 (Grade 7) to A-levels. And they tell me that they don't really like mathematics. They do my work, they follow the classes, but they don't do anything extra. [**Ashley**]: If I were to ask you more details about male and female. Boys and girls, compare their perception is anything you want to say?
[**Melodie**]: Usually, boys like mathematics more than girls from my experience. Maybe because girls, they don't really like challenges sometimes.
[**Ashley**]: You, you like.
[**Melodie**]: I am a different kind of person (laughs).

[**Ashley**]: Okay, so you're telling me that girls ... that boys would prefer maths more than girls?
[**Melodie**]: Yes, most of the times.
[**Ashley**]: And the reason is that the girls don't like challenges. Is there any other reason you think ... again, it's your perception, yeah. So I just want to hear from you.
[**Melodie**]: It's just something I mean, apart from that, I have read somewhere that usually girls are more into languages and art, more than mathematics and other subjects which require ...
[**Ashley**]: But do you that the passing rate in Mauritius for A-Levels, is higher for girls?
[**Melodie**]: That's because girls are more studious (laughs).
[**Ashley**]: So here we have a very interesting feature where girls did not like mathematics from what you said. But still they are doing better than boys. How interesting is that? That's something I want to investigate as well deeper ... my own investigation.
7. What do you think a mathematics and statistics teacher should do, to encourage learning?:
[**Ashley**]: And you said you teach a little bit as a volunteer.
[**Melodie**]: I would give them chocolates.
[**Ashley**]: So you are talking about incentives?
[**Melodie**]: Incentives. That's, that's one of the things that I would do.
[**Ashley**]: But I think it's a short-term one. What I are trying to ask you is a little bit more deep.
[**Melodie**]: I think we should have more interactive devices. For example, like when I was in primary school, we had like those huge boxes. And when we had Volumes and all those things to do, we would usually ask the students to come and put the squares ... the cubes on there. So I think that we should make it more interesting in terms of interaction.
[**Ashley**]: So what happened then in secondary school? Primary school was like that, so clearly you are saying that secondary school, they don't have enough of this interactiveness?
[**Melodie**]: Yes, when you join secondary school, most of the time it's only academic, especially in Maths. You just go there and you follow the classes, you have the homework. And you don't really have that interactive aspect of the class.
[**Ashley**]: Okay, What about Higher Education then? Tertiary?
[**Melodie**]: Tertiary is just independent learning most of the time ...
[**Ashley**]: No, no, I am talking about interactiveness.
[**Melodie**]: I think it was this same, yeah, it was the same.
[**Ashley**]: So there was lack of interactivity?
[**Melodie**]: A lack of interactivity, maybe ... in mathematics not really.

[**Ashley**]: No, let's focus on maths and stats. Just go back and think of your Year 1, Year 2, Year 3 Maths and Stats. Do you think it was boring as a secondary ... just like secondary school or more interesting? That's what I want to know.
[**Melodie**]: Yes, In tertiary ... at tertiary level, it was more interesting, I think the lecturer made the class more interesting.
[**Ashley**]: How?
[**Melodie**]: Well he went around, ... he went around and asked questions. He made sure that everyone was following classes, and he made sure that everyone was understanding as well. And I think that's a good thing, which happened in class.
8. How do you think teachers should approach teaching of (a) mathematics (b) statistics in your group (Undergraduate level)?:
[**Melodie**]: Maybe correct the workshops in class because you don't really know whether the students are doing the workshops (laughs) That's the only improvement I would say.
[**Ashley**]: Okay, don't you think that as an adult, Year 3 students should be doing the workshops anyway.
[**Melodie**]: Yes they should, but it's just to encourage them to do that.

Ashley wraps up the interview.

[**Ashley**]: Okay. All right. Well, thank you very much. That was a very productive for me. I got to learn a lot. And thank you for coming and taking part in this process. I forgot to tell you the only point, that if we have the chance to publish the data collected and analysis, your name will be kept confidential and as much as possible and there's no way anything can be traced back to you if that's a worry. Thank you very much.
You have reached the end of the interview. Thank you for participating.

APPENDIX O

SAMPLE VISUAL CODING - STAFF MANJU

skills that they need, so we do mathematics, we do statistics, they do a project where they actually collect primary research and do statistical analysis on it and at the other end of the spectrum I also teach post graduate masters students on the MA Education (Leadership and Management) and I'm in charge of the dissertation module so I supervise particularly those who are going for more quantitative approaches in their dissertations, so we do a lot of statistical analysis. But nobody is really a specialist, I would say, in maths.

Ashley: ok so I have a few questions on this but I don't know if I can ask them now or we can wait for later, maybe we can wait for later.

2. What are the cues you pick up, to realise that students are struggling?:

Answer: Let's talk about the IFP. At that level it's very erm clear when they start to struggle because the IFP is you know it's a very kind of coursework based programme so there's a lot of seminar work where they are doing maths problems in class, so you can easily start to see that they don't really know what to do or they don't um really engage with the material and they start to look for help. So, what I'm quite fortunate with is that the students pick up on the idea that I am somebody who they can approach, so they do try to ask for help, or they do try to ask for where they can go for support. And on the MA education as well we have people who go for quantitative type of dissertation, not necessarily having a very strong background in mathematics but probably taking the opportunity to learn and pick up the skills.

Question: You said for the IFP students you are somebody they can approach, what does that mean?

Answer: So, the kind of classroom environment that I create is where we are quite open about . . . , we're transparent about our progress, we are constantly talking to each other about how we're developing, the students can tell me about their development because that's pretty much the philosophy of the IFP. So, we . . . in keeping with those kind of, the philosophy of the programme, we have a very intimate environment, so students they're very happy to raise their hand and say that they don't understand something, they'll stop me in the middle or if it's a seminar work where they have worksheets to do, they'll just raise their hand and say that I need to explain things to them. Or, you know, they take a lot of peer support which I find very encouraging, so they might raise their

Bheshaj Kumar Ashley Hoolash
Cues for struggle
Reply

Bheshaj Kumar Ashley Hoolash
struggle
Reply

Bheshaj Kumar Ashley Hoolash
Struggle, seeking help
Reply

Bheshaj Kumar Ashley Hoolash
Teacher approachability
Reply

Bheshaj Kumar Ashley Hoolash
Willing to seek support
Reply

Fig. O.1 Sample Visual Coding - Staff Manju

APPENDIX P

2019 TEC CONFERENCE

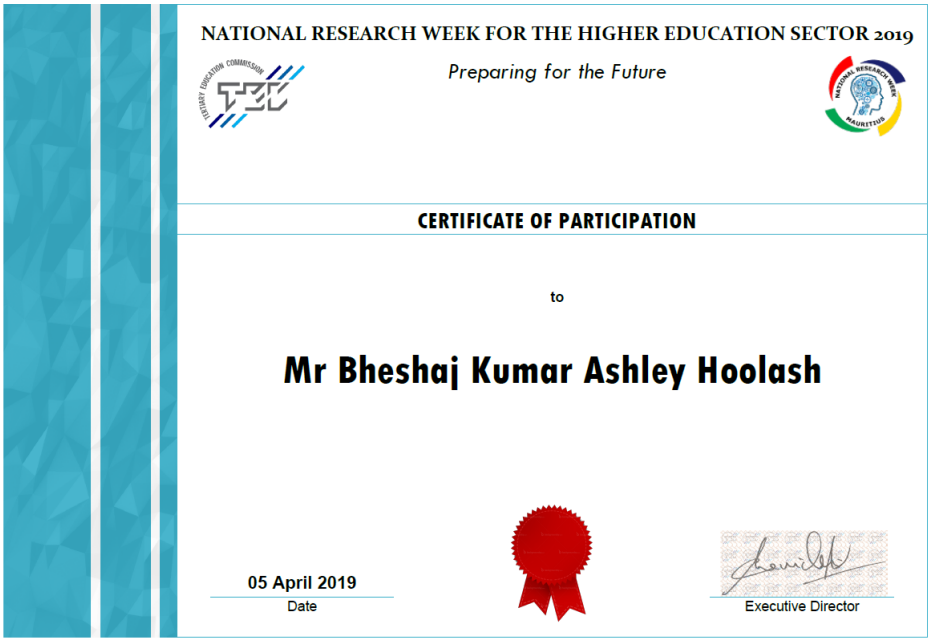
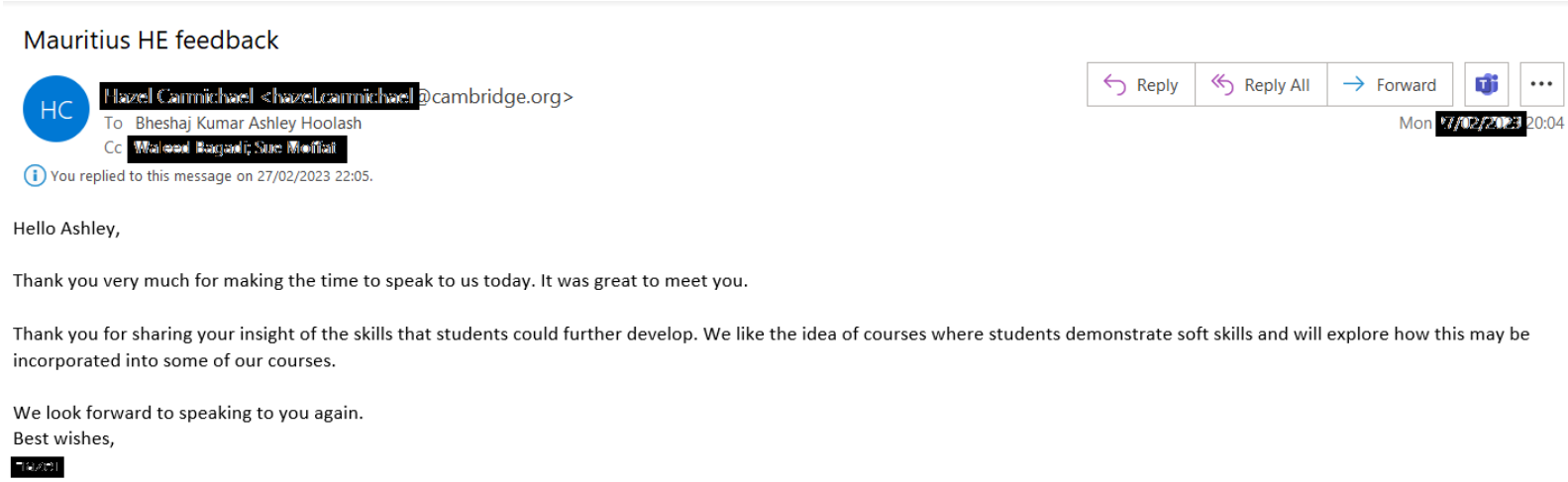


Fig. P.1 2019 TEC Conference - Preparing for the Future

APPENDIX Q

CAMBRIDGE INTERNATIONAL



Mauritius HE feedback

HC [redacted]@cambridge.org>
To Bheshaj Kumar Ashley Hoolash
Cc [redacted]

Reply | Reply All | Forward

Mon [redacted] 20:04

You replied to this message on 27/02/2023 22:05.

Hello Ashley,

Thank you very much for making the time to speak to us today. It was great to meet you.

Thank you for sharing your insight of the skills that students could further develop. We like the idea of courses where students demonstrate soft skills and will explore how this may be incorporated into some of our courses.

We look forward to speaking to you again.
Best wishes,
[redacted]

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Fig. Q.1 Meeting with Cambridge International