“Please don’t forget me!” An Exploration of Mathematical Preparedness in the context of Ireland’s Curricular Middle Child, Transition Year.



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Declaration

I declare that this thesis has not been submitted as an exercise for a degree at this or any other university and it is entirely my own work.

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Derek David Maher

Summary

This research study explores the concept of mathematical preparedness. Although this term is frequently included in literature and governmental publications on mathematics education, there is an absence of a firm definition and description of mathematical preparedness. This is despite the literature identifying a growing decline in the basic mathematical skills and abilities of students starting undergraduate mathematics-related courses.

The research methodology comprises three stages, including a mixed methods approach to data collection. Stage one comprises a Delphi Study technique, where the Panel of Participants co-create a definition for mathematical preparedness with the researcher, leading to the production of a student questionnaire on mathematical preparedness. Stage two captures the view of students, using this definition as a lens, regarding their experience in Transition Year Mathematics. Finally, stage three captures the teacher's perceptions of the key issues that should be considered when mathematically preparing students during Transition Year.

The results from this research study provide interesting insights into what it means to be mathematically prepared, resulting in a model that represents Mathematical Preparedness as Four Quadrants. This visual representation of Mathematical Preparedness contains a series of four interconnected quadrants: Academic, Social, Emotional, and Skills-Based. Each quadrant is composed of elements needed to support a student's preparedness with mathematics. Finally, this study offers recommendations for consideration by the Department of Education and the National Council for Curriculum and Assessment in Ireland.

Related Presentations & Publications

Paper Publications:

- Maher, D., & Bray, A. (2024). Transition Year Mathematics – The Forgotten Middle Child? Understanding mathematical preparedness in Transition Year using a Delphi Study methodology. *Ireland's education yearbook 2023* (pp. 221-225). Dublin, Ireland: Education Matters. (ISBN: 978-0-9956987-7-2).

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List of Acronyms

BPI – Bonus Points Initiative

CER – Chief Examiner's Report

CPD – Continuous Professional Development

CSO – Central Statistics Office

DEIS – Delivering Equality of Opportunities in Schools

DES – Department of Education and Skills

DSPOP – Delphi Study Panel of Participants

ERC – Educational Research Centre

EU – European Union

IB – International Baccalaureate

ICQCA – Inductive Conventional Qualitative Content Analysis

IMTA – Irish Mathematics Teachers' Association

ITE – Initial Teacher Educator

JC – Junior Cycle

JCHL – Junior Cycle Higher Level

JCSP – Junior Certificate School Programme

KFS – Key Finding from Students

KFT – Key Finding from Teachers

KRNW – Knowledge Resource Nomination Worksheet

LC – Leaving Certificate

LCA – Leaving Certificate Applied

LCHL – Leaving Certificate Higher Level

LCM – Leaving Certificate Mathematics

LCOL – Leaving Certificate Ordinary Level

MPQ – Mathematical Preparedness Quadrant

MWB – Mathematical Wellbeing

MYP – Middle Years Programme

NCCA – National Council for Curriculum and Assessment

OECD – Organisation for Economic Cooperation and Development

P21 – Partnership for 21st Century Learning

PDST – Professional Development Services for Teachers

PIL – Participation Information Leaflet

PISA – Programme for International Student Assessment

PME – Psychology of Mathematics Education

QCA – Qualitative Content Analysis

SEL – Social and Emotional Learning

SPSS – Statistical Package for the Social Sciences

STEM – Science, Technology, Engineering and Mathematics

TIMSS – Third International Mathematics and Science Study

TY – Transition Year

TYM – Transition Year Mathematics

TYP – Transition Year Programme

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Dedicated to:

Tommy Maher (1931 – 2014)

One of my earliest friends, and mentors. Sleep tight.

Nicole Byrne (2002 – 2024)

We all share the grief of losing a fantastic student and an excellent mathematics and biology teacher who was taken far too soon.

Your memory, your kindness, and your legacy will never end.

Chapter One: Introduction

"By failing to prepare, you are preparing to fail" – Benjamin Franklin.

1.1 Introduction to the Research Study and Chapter

This research is concerned with exploring the concept of preparedness in mathematics. This term appears in numerous areas of mathematics education (International Baccalaureate Organization, 2021; National Council for Curriculum and Assessment, 2005; Ranguelov et al., 2015), yet a universally accepted definition does not exist. Worryingly, the international comparative testing programme PISA (Programme for International Student Assessment) specifically assesses students based on this ill-defined term. The PISA 2022 Mathematics Framework measures, "how effectively countries are preparing students to use mathematics in every aspect of their personal, civic and professional lives, as part of their constructive, engaged, and reflective 21st century citizenship" (Organisation for Economic Co-operation Development, 2023, p. 43). Considering the critical emphasis that countries place on the PISA results and the impact that these results have on mathematics education policies internationally, an exploration of this term of mathematical preparedness is required. Furthermore, while the academic elements of mathematics education are essential for 21st century citizens, other elements are also required. The 21st Century Skills Framework highlights the need for students to have an academic education intertwined with learning and innovative skills; information, media and technology skills; and life and career skills (Partnership for 21st Century Skills, 2009).

Ireland's unique Transition Year (TY) programme is examined as a platform for exploring mathematical preparedness. This programme, free from the pressures of curricula and formal examinations, provides both teachers and students with the time and autonomy to explore what it means to be mathematically prepared. Richard (Dick) Burke, former Minister for Education in Ireland from 1973-1976, is the father of TY. Burke's visionary

ability saw the birth of this distinctive year, a year for students to evolve in personal development and to "discover the kind of person he is, the kind of society he will be living in and, in due course, contributing to, its shortcomings and its good points" (Jeffers, 2019, p. 36). The methodologies for this research are mixed methods, including a modified Delphi Study (Oxley et al., 2024) and a case study (Yin, 2009). The Delphi Study technique, selected as it allows for structured group communication and discussion, sees eleven experts from different parts of the education sector work together to co-create a definition for mathematics preparedness (Green, 2014; Okoli & Pawlowski, 2004). This definition takes the form of a quadrant, encapsulating four areas of mathematical preparedness: academic, social, emotional and skills-based.

As this is a Professional Doctorate Degree, this chapter begins by establishing the researcher's positionality, situating this research within the researcher's professional practice. This introductory chapter starts by presenting an overview of the purpose of mathematics education before moving on to "The Mathematics Problem", which refers to the growing international concern of mathematical under-preparedness (Carr et al., 2015; Hourigan & O'Donoghue, 2006). Then, this chapter offers the rationale for this research study by posing three research questions and provides an introduction to the research methodology. Finally, this chapter represents the significance of the research, not only in the Irish context but also on an international level, along with the research contributions and a brief overview of each subsequent chapter in this research study.

1.2 The Researcher

The "Who Am I?" question, posed in the present tense, never elicits a simple answer. It is only answerable with reference to the past, present, and future. The present is a product of my past and a vector for my future. Therefore, my response to "Who Am I?" is one who has a deep thirst for knowledge and an appreciation for education. At the heart of it all, I

am an educator, an early career researcher, a family member, a friend and a human being. However, I am also a protector of mathematics standards, a donator of pens, and a hater of wasted talent.

My journey over the past eleven years, working as a Mathematics, Biology, and Development Education teacher, along with my pastoral care roles as a class tutor, a Behaviour Management Coordinator, and a Year Head, have transformed and evolved my craft. Each role encouraged me to work independently and cooperatively with other educators. Over the last decade and a half, I have participated in numerous opportunities, taken different paths, and continued to engage in study. I am a firm believer in the ethos and practice of lifelong learning. During the period of study for this degree, we explored the "turning points" in our learning journey. To visualise my path, I used a cubic function. Figure 1.1 below depicts some turning points that shaped my professional identity. The high and low moments over my career are critical in enabling learning, reflection and growth.

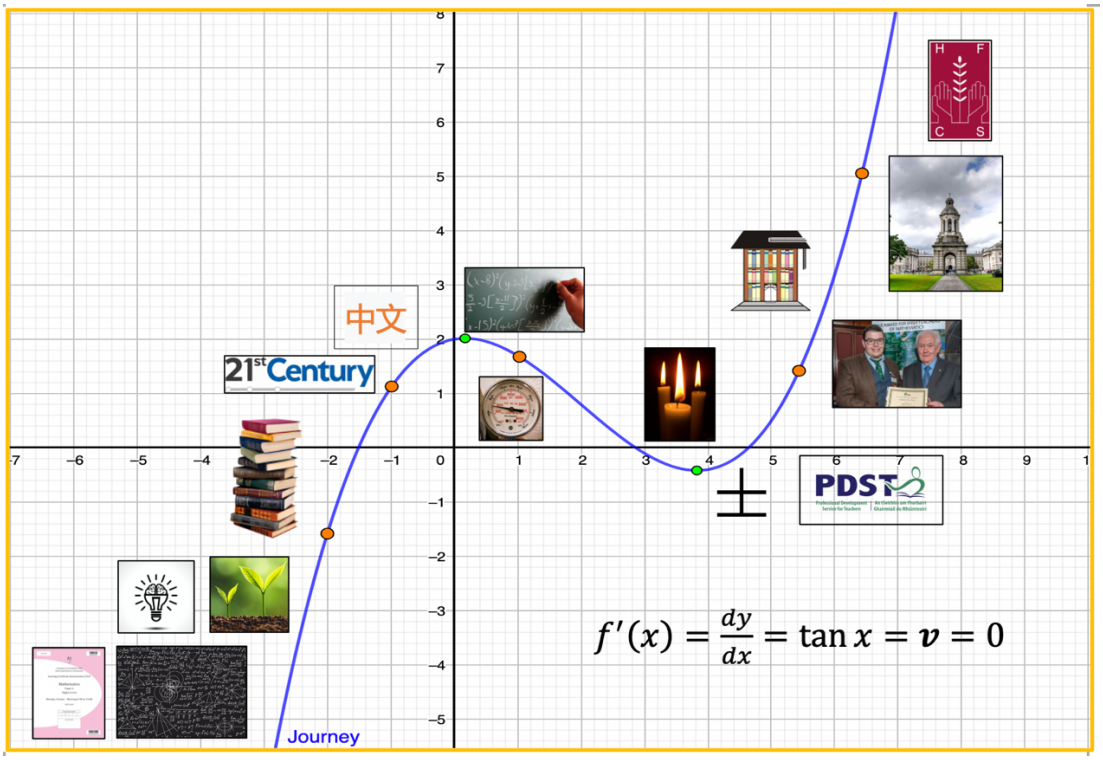


Figure 1.1: My Professional Turning Points.

The highs, such as securing my first teaching position, completing further studies, receiving awards, and career promotions, significantly shaped who I am. Organically, this journey contained many negative parts too. The growing pressures of teaching, the untimely deaths of students, and a global pandemic are some of the woes associated with teaching. Experiencing lows reinforces the importance of being prepared. Teachers needs to prepare for more than the academic demands. Additionally, I gained valuable experience as a part-time Learning Associate, working with the Professional Development Services for Teachers (PDST) on the Mathematics Development Team. This experience reinforced my perception that teaching remains dominated by preparing students, usually by rote and procedural methods, for the Leaving Certificate Mathematics (LCM) examination.

Since 2020, I am a Deputy Principal, a fortunate position which allows me to spearhead teaching and learning. I also continue to teach mathematics. I am a school leader, researcher, and practitioner all in one. These multiple roles highlight the privileged role that a teacher has in preparing students for life and for learning. I hope this study will reflect this sentiment.

During my time as a full-time teacher, my classroom contained many mathematics posters, exemplars of student work, and decorations. However, one poster took pride of place. It stated, "Fail to Prepare, Prepare to Fail". Little did I know that this poster, adapted from Benjamin Franklin's quote, would be the starting point of a doctoral thesis.

1.3 Rationale for the Study

1.3.1 The Purpose of Mathematics Education

The purpose of mathematics education depends on the lens through which you view it through. Ernest (1991, p. 125) reminds us to "not ask 'what are the aims of mathematics education?' without also asking 'whose aims?' (which social groups?)". These aims depend

on the underlying intentions and the institutions that will be affected by them. Ernest's work describes five interest groups in mathematics. These groups are based on the role of mathematics in society or institutionalised socio-political institutions influence. The five groups are industrial trainers, technological pragmatists, old humanists, progressive educators, and public educators. Each group holds a slightly different version of the purpose of mathematics education. Although there are several purposes, this research study works within the context of a "reform" agenda. However, while the researcher is not necessarily blindly agreeing with this economic imperative-driven conceptualisation of mathematics education, the researcher is acknowledging that it is the current context for the research study.

Two of the leading forces in mathematics education, governments and academic institutions, hold different interpretations of the purpose of mathematics education. Golding (2018) separates these two main perspectives into a global focus for economic progression, and mathematical fluency, reasoning and problem-solving for the functioning in the 21st century. Interestingly, the 21st century features in both perspectives, irrespective of viewpoint. The European Union Eurydice Report in 2022 claims that "in our fast-changing and technology-driven societies, education in mathematics is crucial for ensuring that children and young people have the necessary skills, knowledge and mindset to be responsible and active citizens" (European et al., 2022, p. 11). While each European country retains the freedom to build its curriculum for mathematics, international comparative tests are becoming a predominant feature in curriculum development. Golding (2018) describes the situation as "the leaders of many Western nations anxious to see improved results in international performance indicators such as the Programme for International Student Assessment (PISA) or Trends in International Mathematics and Science Study (TIMSS)" (p.460). This focus on international comparative scoring enables

governments to evaluate their education system and empowers them to compete in the "knowledge economy" to assess the "economic wellbeing of their citizens" (Baird et al., 2011, p. 1).

The economy depends on proficient mathematical graduates as a catalyst for advancement. Hourigan and O'Donoghue (2007) claim that graduates of numerate disciplines, such as mathematics and other STEM subjects, are a significant factor in a country's economic success and competitiveness. Research warns that poor mathematical performance leads to a lack of ability to function in the 21st century workforce, specifically in problem-solving and analytical skills (Morran, 2008). Of course, universities depend on second-level schools to nurture and produce well-versed students in mathematics and other numerate disciplines.

1.3.2 The "Mathematics Problem"

The "Mathematics Problem" refers to the perceived general decline in undergraduate mathematical ability, with Hourigan and O'Donoghue (2007) warning that the "Mathematics Problem" is of grave concern internationally, not only for the education sector but for governments alike. Reports now suggest that students are entering university mathematics-intensive courses with fewer basic mathematical skills needed to be successful in the course (Edwards & Edwards, 2003; Hodds, 2023; Hyland & O'Shea, 2021). This problem was identified in the mid-1990s, and despite ongoing reform, there are few signs of improvement. Described as a phenomenon, Hourigan and O'Donoghue (2007) highlight the impact this decline has on individual students, the economy and workforce, and the standards of academic institutions. Furthermore, the authors stress that a lack of mathematical proficiency significantly impedes graduates of STEM-related disciplines from fulfilling aspects of their employment, including innovative and critical thinking, which students require in joining the 21st century workforce. The "Mathematics

Problem" is a massive ongoing concern internationally and has been reported as a concern in Ireland, the United Kingdom, the United States of America, New Zealand, Portugal and Australia (Carr et al., 2015; Hourigan & O'Donoghue, 2007; Morran, 2008; Morrow et al., 2021; Thomson, 2016). More recent research by Treacy et al. (2016) highlights a continuous decline in performance of basic mathematics skills among those beginning undergraduate studies at one Irish University. Similarly, research by Fitzmaurice et al. (2021), based on a longitudinal analysis spanning 17 years (1997-2013), revealed that the "Mathematics Problem" phenomenon is now impacting pre-service mathematics teachers in Ireland. This research indicates that pre-service mathematics teachers are beginning their studies with declining arithmetic, algebra, geometry and calculus abilities. Alarmingly, the years from 2007 to 2013 report a more rapid decline than the previous years.

The United Kingdom reports similar issues with mathematics education. Its National Audit Office (2007) explicitly refers to mathematical ability contributing to lower retention and progression rates of university students in STEM-related subjects. The National Audit Office (2007) claims that STEM students are less likely to progress to their second year of study in comparison to other students in other disciplines. The NAO claims that one potential reason for this may be a lack of preparedness in key skills (knowledge and skills gaps) before starting their respective courses. Similarly, the United Kingdom's Advisory Committee on Mathematics Education (2011) reports that "many tutors of Higher Education courses that have significant mathematics content are concerned about the mathematical preparation of their students" from secondary education (p.15). These preparation issues include a lack of technical fluency, difficulties computing algebraic calculations, a decline in the ability to solve multi-step problems, and complications in understanding the essential place of precision and proof within mathematics (London Mathematics Society, 1995).

1.3.2.1 The Mathematics Problem: More than just Academics

As described above, the "Mathematics Problem" refers exclusively to academic content. The London Mathematics Society (1995) published a report in which all their proposed solutions for tackling this problem refer to issues with academic content rather than other factors. The Society cites numerous time-consuming activities (investigations, problem-solving and data surveys) as one of the root causes of mathematical under-preparedness. Instead, it suggests that post-primary teachers should focus on the core mathematics techniques in favour of "poorly focused" activities (London Mathematics Society, 1995, p. 11). However, this paper fails to examine any other non-academic factors which may impact preparedness in mathematics education.

Hong Kong and Estonia are two examples of countries which score highly in PISA testing, yet they include other skills and values besides academic elements in their mathematics education guidelines. Hong Kong's Curriculum and Assessment Guide for Teachers focuses on a parallel system where generic skills and values support the academic content of mathematics. Nine skills are embedded in mathematics teaching and learning in Hong Kong, including collaboration, communication, creativity, critical thinking, information technology, numeracy, problem-solving, self-management, and study skills. These skills support the positive values and attitudes of interest, keenness, sensitivity, confidence, open-mindedness, persistence, and appreciation (Curriculum Development Council and The Hong Kong Examinations and Assessment Authority, 2017).

Estonia, another high-achieving country in international comparison tests, emphasises that the study of mathematics should develop not only mathematics competencies but also culture and values, social and citizenship, self-management, learning to learn, communication, technological and entrepreneurial competencies. The Estonian curriculum recognises that mathematics education "prepares students for understanding and describing

logical, quantitative and spatial relations" (Ministry of Education and Research, 2014, p. 2). Interestingly, unlike the views of the London Mathematics Society, this curriculum places value on cooperative activities in the mathematics classroom, stating that "preparation for cooperation and tolerance towards other people's actions and opinions are developed throughout cooperative activities (research, group work and projects)" (Ministry of Education and Research, 2014, p. 5).

1.3.2.2 Mathematical Preparedness in Ireland: A Timeline

Since the 1980s, Ireland's third-level institutions have reported dissatisfaction with the mathematical ability of entrants (Cleary, 2007; Hourigan & O'Donoghue, 2007; O'Shea & Breen, 2021). However, O'Murchu and O'Sullivan (1982), and Hourigan and O'Donoghue (2006), argue that under-achievement within the Irish context defies all logic. This dissatisfaction stems from the interconnected relationship between many first-year STEM-related university courses and the LCM curriculum. They describe first-year university courses in mathematics-related subjects as an extension of the compulsory Leaving Certificate curriculum. Hourigan and O'Donoghue (2006) highlight the uniqueness of the "Mathematics Problem" in Ireland, considering the extensive duration of Irish students' engagement with formal mathematics education. Students study mathematics for at least five years at post-primary level and eight years at primary level, yet Irish students are still reportedly under-prepared for mathematics on entry to third level. This uniqueness arises from the fact that mathematics is a compulsory subject for all students throughout secondary education (compulsory for Junior Cycle and while not officially compulsory for Leaving Certificate, mathematics is deemed a core subject by all post-primary schools), and this is unlike several other international education systems. Both Gill et al. (2010) and Hourigan and O'Donoghue (2006) support the claim that mathematical under-preparedness

at third level is directly attributed to ineffective second-level mathematics education in Ireland.

The following chronological list provides a summary of the relevant literature that identifies some of the deficiencies leading to under-preparedness in second-level mathematics in Ireland:

- The National Council for Curriculum and Assessment (NCCA) suggests that mathematics teaching in Ireland centres on procedural matters and is highly didactic (National Council for Curriculum and Assessment, 2005).
- Gaps in mathematics knowledge in the second-level school curriculum, including trigonometry, complex numbers and differential calculus (Gill & O'Donoghue, 2008).
- Liston and O'Donoghue (2010) stress that "attitudes, beliefs, mathematical self-concept, conceptions of mathematics and approaches to learning" all need attention in the context of mathematics education in Ireland (p.65). These authors express the importance of students enjoying their mathematics learning and that value and confidence are essential factors for inclusion in mathematics classrooms in Ireland.
- Close et al. (2011) highlight that Ireland's second-level classrooms focus on algorithmic procedures and that students need more teaching on conceptual understanding.
- Faulkner et al. (2014) emphasise that students need more practice with algebraic manipulation and simplification, and that they lack the ability to reason mathematically and to deal with unfamiliar mathematical formats.
- This difficulty is mirrored in research by Prendergast and Treacy (2017), who emphasise the need for a uniform approach to teaching transformational algebraic skills. However, these researchers warn that the challenge lies in ensuring that all

teachers are entirely knowledgeable and self-confident about classroom implementation strategies.

- O'Sullivan et al. (2023) note deficiencies in mathematics textbooks in Ireland. These shortcomings include a prominence on procedural skills rather than the application of mathematics in real-life contexts, a need to promote questions that support mathematical thinking, and an absence of focus on the interconnectedness of mathematics.

Comparable to other international curricula, mathematics education in Ireland now focuses on more than academic content. Teachers are responsible for the inclusion of the following, in conjunction with academic components:

- Key Curricular Skills at both Junior Cycle and Leaving Certificate (National Council for Curriculum and Assessment, 2009).
- Wellbeing at Junior Cycle level (National Council for Curriculum and Assessment, 2017).

1.4 Research Questions and Methodological Approach

Faulkner et al. (2014) claim that many educationalists believe that the "Mathematics Problem" is best tackled at its roots (i.e., in secondary schools). However, for teachers to tackle this problem, they must understand the root causes. Most studies focus on drawing attention to mathematical under-preparedness rather than addressing what it means to be mathematically prepared in the first instance. Instead of simply highlighting a problem within mathematics education, this professional doctorate research aims to explore ways of addressing the mathematical preparedness issue. However, there is a need to understand this phenomenon first. As this is a cross-sectoral issue, the research methodology for this study captures the viewpoints of many experts familiar with both the second-level and third-level education sectors in Ireland.

To develop this understanding of mathematical preparedness while grappling with the pressure of state examinations is a challenge. However, Ireland can offer a unique opportunity to explore what it means to be mathematically prepared. Ireland's upper-secondary education consists of an optional middle year for students, known as Transition Year, which offers an environment in which to develop an understanding of mathematical preparedness without the challenges and pressures of the curriculum. Questions arise as to whether TY is being utilised as a means of preparing students for the demands of Leaving Certificate Mathematics. The TYP provides a unique, non-prescribed opportunity for teachers to delve deeper into the meaning of mathematical preparedness.

Murphy (2012) suggests that researchers apply caution when examining the "Mathematics Problem". Her research notes that while there are similarities across different countries, "local conditions, practices and needs contribute to different manifestations of the problem in different countries" (as cited in (Gill et al., 2010, p. 324)). As a result, her research advocates that researchers examine the "Mathematics Problem" within their unique context. As the problem will not be exactly replicated in other educational systems, and even if it is, the approaches to tackling the problem are not directly transferrable from one county to the next. Consequently, this research examines what it means to be mathematically prepared in the sense of the broader curriculum. However, when addressing this issue from Ireland's point of view, this research examines the impact that TY can play on mathematical preparedness.

As the name suggests, TY is a transitional pathway for students between Junior Cycle (lower-secondary) and Leaving Certificate (upper-secondary). This programme bridges content, knowledge, and skills from one second-level programme to the next. Ironically, the "Mathematics Problem" is based on the same premise, as it reports difficulties in the academic transition from secondary to third level education. These transitional issues, at

the epicentre of the Transition Year Mathematics (TYM) programme, are relatable to those found in the "Mathematics Problem".

As the aim of this research is to define what it means to be mathematically prepared, there are three components to this Mixed Methods Research study. Component one draws on the expertise of a Delphi Study panel, comprising of $n = 11$ experts to co-create a definition for mathematical preparedness (Dalkey & Helmer, 1963; Oxley et al., 2024). This co-created definition of mathematical preparedness formulates an agreed and validated student questionnaire. This stage addresses research question one: **What does it mean to be mathematically prepared, in the context of Transition Year Mathematics?**

Component two utilises the student questionnaire to gain insight into the perceptions of students in TY, 5th year and 6th year in three schools who have completed/are completing Transition Year Mathematics. This component gives an insight into mathematical preparedness and the role that TY can play in mathematical preparedness from the student's perspective. This component addresses research question two: **How do students' experiences of Transition Year, from three sample schools, reflect this definition of mathematical preparedness?**

Component three comprises an exploratory case study methodology and semi-structured teacher interviews. The researcher captures the opinions and insights of teachers on how TY is best used, and how it can improve mathematical preparedness. This component addresses research question three: **What key issues must be considered to mathematically prepare students during Transition Year?**

1.5 Mathematical Preparedness

Despite the numerous references to mathematics under-preparedness, as mentioned in section 1.3.2.2, existing literature fails to establish what it means to be mathematically prepared. The National Council for Curriculum and Assessment (NCCA) (2005)

emphasised that the educational practice of memorising facts and routine procedural performance prevalent in Ireland at the time was not effectively preparing students. The NCCA called for a shift from the academic focus to a multi-faceted approach that incorporates the social and psychological development of the whole student. This approach emerged as best practice guidelines from the PISA 2003 testing, which stated that: "students who believe in their own abilities and efficacy, and who are not anxious about mathematics, are particularly likely to do well in the subject" (National Council for Curriculum and Assessment, 2005).

Liston and O'Donoghue (2010) also support the move to encompass social and psychological development in mathematics education, emphasising that attitudes, beliefs and self-concept are crucial in developing a student's mathematical preparation. Although their research acknowledges underlying differences between second level and third-level mathematics education, they identify several crucial, non-academic factors at second level that led to under-preparedness. They claim that students must have an interest in the mathematics they are learning, warning that when students are uninterested, this promotes underachievement in second-level mathematics learning.

An underlying presumption is that teachers know the critical mechanisms required to prepare students mathematically. However, this is different from the researcher's experience in professional practice. Teachers of mathematics in Ireland fixate on the LCM examinations. This results in teachers preparing students for examination purposes rather than preparing students in the broader sense. This is also evident from the annual "post-mortem" of the state examination papers by the Irish Mathematics Teachers' Association (IMTA), where mathematics teachers meet and discuss the format and complexity of the state examination papers. These meetings are normally better attended than the regular IMTA meetings and are described as "devoted to 'what will get marks' rather than 'what

may improve students' learning" or "what might be good mathematics education" (National Council for Curriculum and Assessment, 2005, p. 17). The focus on getting the marks rather than on the understanding of mathematics is worrying. Media outlets also highlight the panic around LCM, illustrating the emphasis on preparing students for the terminal examinations. Summer 2023 saw published articles such as "Students complain to Minister about the 'cruel' Leaving Cert maths paper" (Foxe, 2023); "Leaving Cert students put off higher-level maths by workload" (Casey, 2023) and "Westmeath school principal tells exam board chiefs 'shame on you' over Leaving Cert maths paper that left pupils 'crying'" (Donnelly, 2023).

1.6 Research Contributions

Parts of this research study have been presented at six conferences. These include conferences at a national level (Educational Studies Association of Ireland) and at an international level (Association of Teacher Education in Europe, and European Society for Research in Mathematics Education). Additionally, the researcher has participated in three poster competitions (both nationally and internationally), and one national discussion panel. Aspects of this research study are published in two papers, namely Ireland's Education Yearbook 2023, and the Proceedings of the Thirteenth Congress of the European Society for Research in Mathematics Education.

1.7 Structure of the Research Study

This research study consists of six further chapters. Chapter Two comprises a review of the literature in three parts. It captures the literature on the development of the proposed Mathematics Preparedness Quadrant, provides an overview of the recent reforms in mathematics education in Ireland, and reviews the literature relating to TY. Chapter Three introduces the MMR, including methods, and ethical considerations. Chapter Four

describes the Delphi Study technique, and the validation of the data collection tools for this study. This chapter establishes the three phases of the Delphi Study. Chapter Five presents the analysis and findings of the research study. The findings are structured on the four quadrants based on the data collected from qualitative and quantitative sources. Chapter Six, the discussion chapter, addresses the research questions, outlining what it means to be mathematically prepared, and the role TY can play in mathematical preparedness. Finally, Chapter Seven concludes and summarises the research study.

Chapter Two: Literature Review

2.1 Introduction to Chapter

This chapter provides a review of the literature in relation to preparedness in mathematics. While the primary focus will be on the Irish context, this chapter will also review international literature and reports. This literature review will be in several parts:

- Section 2.2 will provide an overview of the events leading to the significant overhaul of second-level mathematics education in Ireland.
- Section 2.3 will review the literature on TY and how this unique programme can play a crucial role in mathematically preparing students.
- Section 2.4 will review the literature on Mathematical Preparedness from the empirical and theoretical perspectives.
- Section 2.5 will review the literature on Mathematical Preparedness from the curriculum and policy perspective, leading to the development of the proposed Mathematics Preparedness Quadrant, which will form the basis for the Delphi Study.

2.2 Mathematics Education in Ireland

This part of the literature review will focus on the events leading up to and including the reforms in post-primary mathematics education. Ireland has an important relationship with international testing and strives to improve its mathematics ranking to attract international business to its shores. Liz Kirwan, an Irish researcher, claims that "mathematics, in particular, is mobilised in the rhetoric as the engine of innovation, the means to developing problem solving skills and independent thinking, is the key to the success of knowledge economics" (Kirwan, 2017, p. 317).

Language is important in learning. Teachers are tasked with differentiating between aims, goals, targets, objectives, and the intentions of the curriculum. Ernest (1991) advises that

each of these different terms refers to the intentional activity of education. Furthermore, these intentions represent some individuals or groups, which have different underpinning ideologies and interests. Morris (1981) advised that "every subgroup in society has a responsibility to participate in the identification of goals…[including] the teachers, the parents, the students, mathematicians, the employers, the employee organisations, educators and the political authorities" (p.169). Ernest (1989) refined these subgroups suggesting that mathematics education is distinguishable by having three interested parties: educators, mathematicians, and the representatives of industry and society. Each party provides a unique perspective on the aims of mathematics education. Based on the work of Williams (1961) and further adapted by Ernest (1991), a set of five social interest groups based on various ideologies are identified in mathematics education. Table 2.1 outlines each of these five groups, their ideology and a brief description:

Table 2.1: Overview of the Five Social Interest Groups with Mathematics Education.

Group	Ideology	Description
The Industrial Trainers	Utilitarian	Vocational focus on education
The Old Humanists	Liberal	Maintenance of Standards
The Public Educators	Democracy/ Social Equity	Equal right to be educated
Progressive Educators	Individualist	Developing the individual's innate abilities
Technological Pragmatists	Modern Policy	Developing skills, knowledge and qualities efficacious for employment

Ireland's focus has shifted over the last number of decades, moving from the Industrial Trainer group towards the Technological Pragmatists group, with traits of the Public and Progressive Educators groups also included. This shift is largely due to Ireland's urge to transition into a knowledge economy. Hence, the need for Ireland to be seen as a successful

competitor in international comparison testing in mathematics education. This need is also responsible for the numerous curricular reforms to post-primary mathematics.

This section will review the impact of international comparative tests and the NCCA's Review of Mathematics Education report, which led to the reformed Project Maths[1] curricula. This new curriculum was Ireland's response to preparing students to meet the demands of 21st century mathematics education. However, it was not devoid of critics.

2.2.1 PISA 2003

Since 2000, PISA testing has played an important role in Ireland's development of educational policies in evaluating students' science, mathematics and reading abilities over a three-year basis. Ireland's Department of Education also uses these results to monitor literacy and numeracy (Educational Research Centre, 2023). The PISA 2003 cycle saw 3,880 students, from 145 post-primary schools, participating in this round. However, it delivered disappointing news to Ireland regarding the mathematics standards of its 15-year-old students. Ireland's overall mean mathematics score (502.8) was not significantly different from the OECD country average. It was lower than students in other European countries, including Finland (544.3), Belgium (529.3), Switzerland (526.6) and the Czech Republic (516.5) (Shiel et al., 2006). The reasons for this poor performance included the misalignment of the Junior Certificate curriculum with the PISA content and processes and the didactic, drill and practice culture of teaching mathematics in Ireland (Shiel et al., 2006). Furthermore, Lyons et al. (2003) claimed that this didactic, drill and practice culture fails to allow students to explore concepts, engage in relational thinking, or use mathematics in applied problem contexts.

[1] Project Maths was the name given to the approach to phase in the new mathematics syllabi in Ireland. The curriculum was still mathematics in terms of what the pupils were learning, and what teachers were teaching.

2.2.2 NCCA Review of Mathematics Education 2005

The Review of Mathematics in Post-Primary Education Report initiated the overhaul of mathematics education in Ireland. Although the report's title suggests that it reviewed all aspects of post-primary mathematics in Ireland, sadly, it failed to include a review of the TYP despite there being 25,000 students enrolled in the programme during the review period. This review accentuated the need for over-arching changes to the curriculum, to teaching and learning styles, and to assessment practices of mathematics education. This comprehensive review consists of four studies which influenced the rejuvenation of the post-primary mathematics curriculum in Ireland. A review of each of these studies is presented in sections 2.2.2.1 to 2.2.2.4.

2.2.2.1 Gender and Ability

The Examining Gender: Gender and Achievement in Junior and Leaving Certificate Examinations 2000/2001 by Elwood and Carlisle (2003) report, funded by the Department of Education and requested by the NCCA, investigated the influence of gender on success in state examinations. The authors questioned the approaches of mathematics teachers, suggesting "it may well be that teachers are making decisions around what to concentrate on in preparation for these examinations, and that boys and girls might well be exposed to different areas of mathematics given their teachers' interpretation of the examination papers and their perceptions of boys' and girls' abilities at Leaving Certificate" (Elwood & Carlisle, 2003, p. 79). This statement suggests that teachers may choose to prepare male and female students differently depending on gender and ability.

This study suggests that teachers may exploit the predictability of the Junior Certificate and Leaving Certificate examination papers, while preparing their students for state examinations. Finally, this study examined a deficiency in preparing students for more than predictable state examinations. Elwood and Carlisle (2003) provide a stark warning that

there is a disconnect between the aims and objectives of the mathematics curriculum and the state examinations exam questions. This research suggests that the examination papers focus on discrete mathematics skills without testing for applications or any combinations of mathematics skills. This is contrary to the Leaving Certificate curriculum, which states that mathematics education "would help to provide students with mathematical knowledge, skills and understanding needed for life and work by: promoting their confidence and competence in using the mathematical knowledge and skills required for everyday life, work and leisure*"* (Elwood & Carlisle, 2003, p. 70).

2.2.2.2 International trends on learning, teaching, and assessment

Conway and Sloane (2006) referenced emerging data from the Third International Mathematics and Science Study (TIMSS) and the OECD's PISA study, citing concerns about the extent of connection between school mathematics standards and real-world contexts. Their report entitled International Trends in Post-Primary Maths Education: Perspectives on Learning Teaching and Assessment, suggested that the mathematics curriculum did not adequately allow teachers to prepare students for real-life mathematics. However, instead, the curriculum focused on students completing procedural mathematics problems for examination purposes. This study challenges a nation's understanding of mathematics education, questioning if policymakers want teachers to prepare students for basic numeracy, real-life mathematics, or for economic development.

Conway & Sloane (2006) affirmed that Ireland should not alter its mathematics education solely for international comparative tests but for economic, educational, and social improvement. Similarly, they warned that curriculum reforms should not mirror a PISA-like approach but should be done to create and nurture a mathematical competence and literate society to embrace the 21st century. This report indicated that Ireland's current mathematics curriculum and examination structure were not preparing students with the

necessary skills and experiences for the knowledge economy. However, this report acknowledged the ambitious planning provisions of the NCCA to reform Senior Cycle education in Ireland, including the TYP. These plans proposed reforms to school culture and student teaching and learning experiences, by engaging with all the stakeholders. Conway and Sloane (2006) warned that defining a vision for mathematics education is needed before proposing any reforms to mathematics education. Unfortunately, this report alludes that Ireland's vision for post-primary mathematics is inadequate. This muddled governmental vision transfers to schools, and programmes such as TY, resulting in teachers trying their best to prepare students for the perceived end goal of post-primary education, the Leaving Certificate examination.

2.2.2.3 Classroom instruction of mathematics

The Inside Classrooms – The Teaching and Learning of Mathematics in Social Context by Lyons, Lynch, Close, Sheerin & Boland (2003) revealed that mathematical instruction in Ireland comprised of two main strategies: teacher demonstration of a mathematical procedure and the rote practising of this named procedure by students. Lyons et al. (2003) described this "traditional" classroom as a "combination of the lecture, drill and practice format, where the teacher lectured to the class as a whole and asked questions, and the students watched, listened, took notes or copied examples into their exercise book" (p.113). This worrying practice recognised the shortcomings in preparing and equipping students with the appropriate skills required in the 21st century.

Furthermore, this study reported that while teachers have some autonomy in the classroom, multiple external pressures exist, including school management, parents, timetabling and examination benchmarking. These demanding components influence how teachers prepare their students, and this may be the rationale for the high incidence of the lecture, drill and practice format in mathematics classrooms in Ireland. Teacher agency is an integral role of

a teacher's professional identity. However, external factors push an agenda on teachers, resulting in teachers opting for the lecture, drill and practice methodology rather than exploring topics in more detail.

2.2.2.4 Attainment

Smyth et al. (2002) expressed concerns about the attainment of students studying higher level mathematics in their report, Who Chooses Science? Subject Take-up in Second-Level Schools. This report revealed that over fifty per cent of all those taking higher level mathematics at Junior Certificate switched to ordinary level mathematics at Leaving Certificate level. It also identified concerns about the impact of the organisation and structure of the Junior Certificate Mathematics classes, suggesting that there is a direct correlation between class formation and higher-level LCM uptake. This study alluded to the uncertainty around current practices in class formation, warning that students in bottom or middle streamed classes are less likely to progress to higher level mathematics at Leaving Certificate level than their peers in top streamed classes or those in mixed-ability classes (Smyth & Hannan, 2002).

2.2.3 PISA 2006 & 2009

PISA 2006 saw similar results to PISA 2003. The 2006 round comprised of 165 random secondary schools in Ireland, with approximately 35 students from each school participating. Ireland's mean score (501.5) did not differ significantly from the OECD mean average but was lower than their 2003 mean score of 502.8. PISA 2006 results revealed that Ireland's mean score was significantly lower than fifteen other countries, including the Netherlands (530.7), Switzerland (529.7), Estonia (514.6) and Denmark (513.0). Interestingly, PISA 2006 results showed that students in TY scored higher than their 15-year-old peers in the Junior Certificate or Leaving Certificate programmes. TY students achieved a mean score of 530.1 compared to a mean score of 488.7 for Junior

Certificate, 522.6 for Leaving Certificate Established, and 496.9 for Leaving Certificate Vocational Programme (Eivers et al., 2008a, p. 28).

Unlike the 2003 and 2006 rounds, PISA 2009 sparked grave concerns regarding Ireland's mathematical performance of 15-year-olds. Ireland obtained a mean score of 487.1, significantly below the OECD average of 495.7, resulting in Ireland being ranked 26th out of the 34 OECD countries and 32nd out of the participating 65 countries (Perkins et al., 2010). Furthermore, PISA 2009 revealed that Ireland had significantly fewer students at the higher proficiency end of mathematics. PISA deemed 6.7% of Ireland's students as high achieving, compared to 21.6% of the students in Finland. The results from PISA 2009 highlighted that Ireland's mathematics performance was declining. When comparing results from PISA 2003 with those from PISA 2009, Ireland's mean mathematics score dropped by 16 points, with a 14-point decline noted between PISA 2006 and PISA 2009 alone. Ireland's ranking slipped from 20th to 26th among countries participating in PISA 2006 and PISA 2009.

2.2.4 Project Maths

The NCCA addressed the concerns raised in the Review of Mathematics Education Report and Ireland's declining PISA results, by launching Project Maths in 2008. Project Maths was the name assigned to the roll-out of the updated mathematics curriculum in Ireland. It was implemented on a phased basis in 24 selected post-primary schools before eventually being rolled out nationally in September 2010 (Close et al., 2011). The full implementation of this reformed mathematics curriculum in all schools, and to both Junior Certificate and Leaving Certificate, occurred in June 2015. This new approach to mathematics education brought in changes to assessment practices, reduced exam predictability, and focused on problem-solving. Supported by a nationwide development team, of 56 appointed facilitators, this team engaged 5,900 mathematics teachers in professional development

over four years (Cosgrove et al., 2012). This team further supported teachers by producing numerous supports, including teaching and learning plans, digital ICT files, posters, and other materials, to help embed this new approach to teaching and learning. This investment in mathematics education came with a hefty price tag. Initially, the Department of Education invested three million euro in 2009, followed by five million in 2010 and a sum of seven million for each year in 2011, 2012 and 2013 (Department of Education and Skills, 2010). This large-scale investment makes Project Maths one of the most expensive curricular reforms in the history of the State. Highlighting Ireland's commitment to mathematics education, the NCCA described Project Maths as "significant both because of the immense practical, cultural and symbolic legacy that it attempts to address, as well as the weight that is attached to what it aspires to achieve" (National Council for Curriculum and Assessment, 2012, p. 5).

2.2.4.1 Intentions of Project Maths

Project Maths aimed to prepare students for the 21st century. This new curriculum focused on the five main mathematics objectives of procedural fluency, strategic competence, productive disposition, conceptual understanding and adaptive reasoning. These reforms strived to boost the learning experience for students by emphasising mathematical concepts, focusing on the contexts and applications of mathematics, problem-solving, and relating mathematics to everyday life (Close et al., 2011). These intentions are akin to the suggestions from PISA, including a more interactive approach to teaching and learning, increased mathematical literacy and classroom discussion, and the need for students to solve various real-world problems (Shiel et al., 2007). These intentions would take time to be embedded and developed across Ireland. However, it was apparent that the Irish government was determined to invest in a mathematics programme that prepared students for the 21st century.

2.2.4.2 Criticism of Project Maths

The NCCA acknowledged that criticisms were likely and expected, stating that mathematics education has always been highly challenged and contested in the national education system (National Council for Curriculum and Assessment, 2012). Following on from the work of Ernest (1991), like the purpose and aims of mathematics education, these criticisms also encompass different perspectives on preparedness stemming from curricular reforms. Unsurprisingly, and as outlined in section 1.3, the university sector published two major criticisms towards Project Maths and its role in adequately mathematically preparing students for mathematics related courses at third level.

Kirkland (2012) claimed that the NCCA failed to include the experts' voices in the mathematics education reforms, suggesting that the NCCA's decisions lacked objective evaluation. Kirkland argued that with the removal of the "bread and butter" of the mathematics curriculum (elements such as calculus (integral and differential), and linear algebra (vectors and matrices)), the State is failing to prepare students for the demands of further education in mathematically related courses (Kirkland, 2012, p. 4). Kirkland disputed this shift from practising mathematics to problem-solving and feared that students would not have fluency in the basic facts of mathematics in favour of learning problem-solving.

A committee from The School of Mathematical Sciences at University College Cork also expressed numerous concerns about Project Maths. At the heart of these concerns was the issue of mathematical under-preparedness and the "extent with which they (students) will be prepared for the depth and breadth that is currently demanded upon commencing their third level mathematical studies" (Grannell et al., 2011, p. 3). These academics cautioned against lowering mathematics standards when engaging in curriculum reform, stressing that Ireland should avoid this move to protect mathematics standards. The perceived single-

mindedness of reforming the mathematics curriculum based on PISA also raised apprehensions. As PISA mainly consists of mathematical literacy and arithmetic, the committee was concerned that policymakers failed to consider Ireland's results in the Trends in International Mathematics and Science Study (TIMMS). TIMSS focuses on the same age range of students, but with a greater emphasis on algebra and geometry (Grannell et al., 2011). The committee identified several significant challenges to curriculum reform including teacher training, up-skilling, and the preparation of teaching materials.

2.2.4.3 Leaving Certificate Higher Level Bonus Points Initiative (BPI)

Since 2012, LCHL Mathematics is assigned special status, known as the Bonus Points Initiative (BPI). This process sees students who obtain a "pass" grade at higher level ($\geq 40\%$) awarded an additional 25 "bonus" points, making 125 the maximum points achievable in mathematics. This bonus scheme is unlike all other curricular subjects which have a maximum of 100 points. These additional points will increase the likelihood of these students securing a place on a third level course of their choice.

This initiative is responsible for almost doubling the number of students studying LCHL Mathematics, increasing from 15.8% to 31.5% over a seven-year period. However, O'Meara et al. (2020) stress that the increase in students studying higher level mathematics does not necessarily correlate to an increase in mathematics ability. In fact, these researchers state that only 18.9% of teachers surveyed believed that the BPI has improved students' mathematical ability overall. This is despite an increase in students studying mathematics at higher level. Interestingly, 91.4% of teachers surveyed asserted that the only reason for the increased number of students studying LCM was the BPI. However, teachers reported that the "BPI resulted in people not suited to higher level mathematics persevering with it, to the detriment of some" (O'Meara et al., 2020, p. 1430). Furthermore,

having a cohort of students with reduced mathematical ability, can result in the lowering of mathematical standards.

2.2.4.4 Mathematical Proficiency

The Project Maths curriculum, at both Junior Cycle and Leaving Certificate, describes students achieving standards in conceptual understanding, procedural fluency, productive disposition, adaptive reasoning, and strategic competence, as mathematical proficiency. However, these aims are not unique to the Irish context but were published in an earlier American report entitled Adding it Up: Helping Children Learn Mathematics by the Mathematics Learning Study Committee at the National Research Council in Washington DC (Kilpatrick et al., 2001). Figure 2.1 illustrates the five interwoven aims and a brief overview.

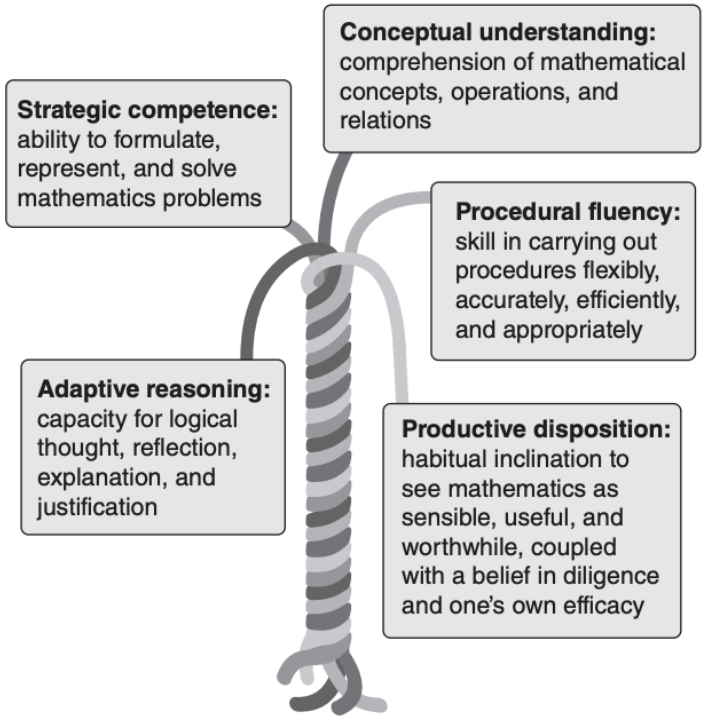


Figure 2.1: Extract of Mathematical Proficiency taken from Kilpatrick, Swafford, & Findell (2001).

These authors recognised that no single term could fully capture the expertise, competence, and knowledge of mathematics education. However, they acknowledge that "researchers

have rarely explored what it might mean to prepare for teaching in ways that would elaborate content goals and simultaneously equip the teacher with good maps of the paths they might take to reach desired destinations*"* (Kilpatrick et al., 2001, p. 337). This approach, to mathematics teaching, focuses on the academic aspects of preparedness, with four of the five components referring directly to academic learning (strategic competence, conceptual understanding, procedural fluency, and adaptive reasoning). The final interwoven component, productive disposition, refers to the attitudes, positive behaviours and skills required to support learning.

2.2.5 Junior Cycle Mathematics

Shortly after the release of the new Junior Certificate Project Mathematics Curriculum (examined from 2016), the NCCA and the Department of Education started reforming the entire Junior Certificate programme. The Framework for Junior Cycle, published in 2015, strives for a flexible programme for student learning, a balance between knowledge and skills, a dual approach to assessment and greater professional collaboration between teachers. These reforms included a focus on eight key skills and twenty-four statements of learning for students to achieve over the three years of the programme (National Council for Curriculum and Assessment, 2015). The framework claims that "these competencies and skills are critical to the preparation of young people for learning and living" (National Council for Curriculum and Assessment, 2015, p. 7).

2018 marked the introduction of a new title, Junior Cycle, replacing the Junior Certificate Programme. This reformed programme consists of a terminal examination, two Classroom-Based Assessments (CBAs), and an Assessment Task (AT). This new assessment model in Junior Cycle mathematics moves away from the traditional practice, where student assessment was based on two terminal examination papers at the end of third year. This new assessment model changes teachers' approach to preparation, as teachers must now

prepare students for the CBAs and the AT. These changes also shorten the time to deliver the curriculum content, as both CBAs require three-week periods to complete. However, the framework refers to how students should prepare for these CBAs, a feature that was absent from previous reforms. Table 2.2 below presents an extract from The Guidelines for the Classroom-Based Assessments. These guidelines explicitly include a section on student preparation, a contemporary move by the NCCA on developing student preparedness. In this context, student preparation refers to the problem-solving cycle for CBA1 and the statistical enquiry cycle for CBA2 (National Council for Curriculum and Assessment, 2020, p. 10).

Table 2.2: Classroom-Based Assessments: Mathematics.

Classroom-Based Assessments	Format	Student preparation
Mathematical investigation	A report may be presented in a wide range of formats	A student will, over a three-week period, follow the Problem-solving cycle to investigate a mathematical problem. **Problem-solving cycle:** define a problem; decompose it into manageable parts and/or simplify it using appropriate assumptions; translate the problem to mathematics if necessary; engage with the problem and solve it if possible; interpret any findings in the context of the original problem.
Statistical Investigation	A report may be presented in a wide range of formats	A student will, over a three-week period follow the Statistical enquiry cycle. **Statistical enquiry cycle:** formulate a question; plan and collect unbiased, representative data; organise and manage the data; explore and analyse the data using appropriate displays and numerical summaries and answer the original question giving reasons based on the analysis section.

However, while the curriculum makers have provided some guidelines in relation to student preparation, they lack clarity, details and are not student-friendly. It is likely that students

will not be fluent in the problem-solving cycle, resulting in this student preparation table being inapplicable. Furthermore, while the guidelines state that the reports can be presented in a wide range of formats, they fail to address the skills required by students to present their investigations or how these should be developed. There is an underlying assumption that students already have the skills and confidence to make such presentations. This guidance also offers details of teacher preparation. However, this guidance focuses on administrative tasks rather than educational practices.

2.3 Transition Year: A Unique Programme

An acclaimed Irish Educationalist, Professor John Coolahan, stated that "the Republic of Ireland, though a small island state of about three and a half million people, has a developed and intricate education system" (Coolahan, 1981, p. 141). This intricate education system includes a unique "gap year" in the middle of its second-level education system, known as Transition Year (TY). It is a unique course of study in Ireland, and currently, there are no such equivalent programmes in our European neighbourhood or international counterparts. This second part of the literature review focuses on TY, exploring what TY contains, the concept of domestication and the mission of this unique year.

2.3.1 What is Transition Year?

Wanting students to pause in the middle of the academic storm that is post-primary education in Ireland, and for, "an emancipation of the teaching profession, to educate as distinct from grind", saw the introduction of Richard Burke's TYP (Jeffers, 2019, p. 37). Seen as an innovative year for students to develop and mature, away from the pressure of high-stake state examinations, TY commenced in 1973. Burke's vision for this unique programme was simple, an optional and additional year of school for students to "stand and stare". To pause for a year full of discovery – personally, academically, and socially.

TY is interpreted differently in every schools. Thus, making it almost impossible to provide a single universal definition. This programme confers on teachers' full autonomy in curriculum design, assessment, and pedagogical approaches. Such agency in these areas offers a rich opportunity for students and teachers, not evident in other countries or programmes, to be innovative. The Professional Development Services for Teachers (PDST), since 1st September 2023 referred to as Oide, and other Department of Education agencies support teachers in creating engaging and exciting opportunities for students in TY. However, schools must still provide tuition in the core subjects of Irish, English and Mathematics as part of their domesticated TYP. The content of these core subjects is decided upon locally, by the school and the community, rather than on a national scale, resulting in a tailor-made programme for each school.

Smyth et al. (2004) contextualised Burke's rationale for the TYP, claiming that society viewed Senior Cycle education as overly academic, a view which emerged from the curriculum reforms during the 1970s. This academic focus led to growing complexity in all curricular subjects as students progressed throughout their educational journey. Today, nearly 50 years later, the issue remains the same. As students advance throughout the newly reformed Junior Cycle to the Leaving Certificate, an ever-increasing gap exists. Junior Cycle students would benefit from "a bridge" to prepare them before starting into the high-stake Leaving Certificate course. Minister for Education Richard Burke (1973-1976) recognised this and put trust in teachers, who are best placed, to identify the needs of their students, to develop and implement a home-grown programme that supports and best prepares students for Leaving Certificate. However, the Department of Education warns that this home-grown programme should not be used as an additional year to the two-year Leaving Certificate programme (Moran et al., 2013).

2.3.2 Transition Year: Domestication

Jeffers (2008) defines *domestication* as "each school putting its own distinctive local shape on the TY programme (TYP), of power devolving from the DES to the local school" (p.264). Ultimately, there are both advantages and disadvantages to schools having local autonomy. Schools can accommodate their specific circumstances, ethos and traditions while playing to the strengths of teaching teams and catering to the needs of their students. However, on the other hand, domestication can also be viewed less favourably. Jeffers (2008) cautions that "the very flexibility of TY, that facilitates imagination, and innovation can also be invoked by schools to justify a narrow selectivity that ignores key features of the TY programme" (p.248). This rich variation from one school to the next makes generalising and evaluating TY difficult. This diversity may be one of the reasons for the lack of research into this programme compared to the Junior Cycle and Leaving Certificate. Despite the vastness of TY, Smyth et al. (2004) noted several critical features common to most programmes. These include whole school input, community involvement, teacher coordination, innovation, and different teaching and assessment methods.

2.3.3 Transition Year Mathematics

TY domestication results in students experiencing different levels of mathematical preparation before LCM. This difference in preparation is one of the downfalls of such a unique programme. While some students receive an advantage, others are disadvantaged regarding the standardised LCM course. TYM teachers can feel compelled to revisit Junior Cycle mathematics or give students a head start in preparing for the demands of LCM. This position results in debates on whether TYM should be used to prepare students by reinforcing and recovering complex topics from the Junior Cycle or whether it should be used as an additional year to gain an advantage on the LCM material. Alternatively, TYM can be an opportunity to explore diverse areas of mathematics that may not be touched

upon in the mainstream curriculum, with a focus on problem-solving and project work. Some schools reported teaching elements of Applied Mathematics, engaging in the mathematics of computer science and developing logic by teaching students chess. However, the Department of Education failed to define the parameters of domestication, resulting in confusion for teachers. Furthermore, the recent significant mathematics reforms in Ireland, the growing impact of globalisation, and the comparative culture in education are all compounding factors, making it difficult for teachers to define TYM and its parameters. Amidst these factors, teachers want to ensure students get the best opportunity for success at LCM.

A study by Smyth et al. (2002) on mathematical attainment failed to fully explore the potential impact that TY could have on mathematics attainment. This report contained only one reference to TY noting that TY students are somewhat more likely Maths (21% compared to 16% of non-participants) to study mathematics at Leaving Certificate Higher Level (Smyth & Hannan, 2002). This data, albeit from different groups, suggests that TY can prepare students for the demands of the Leaving Certificate programme, in comparison to those students who moved directly from Junior Certificate to Leaving Certificate.

2.3.3.1 PISA and Transition Year Mathematics 2003 – 2009

TY 15-year-old students topped the PISA Irish scores between 2003-2009, in comparison to 15-year-old students in the 2nd and 3rd year of Junior Certificate, and those 15-year-old students in 5th year of Leaving Certificate (see Table 2.3 below). PISA 2003 revealed positive news for TY, with students achieving a mean score of 542.9, significantly higher than the 5th year student cohort, whose mean score was 515.5 (Shiel et al., 2007). These results suggest that TY may provide "an opportunity to engage students at all levels of ability in solving the types of real-world mathematics problems found in PISA" (Shiel et

al., 2007, p. 48). This report emphasises the potential impact that TY can have on a student's development in mathematics.

Table 2.3: Comparison of PISA 2003-2009 and % of TY students.

Mean Score	2nd Year	3rd Year	TY	5th Year	Overall
PISA 2003	406.8	492.3	**542.9**	515.5	502.8
Cohort	2.8%	60.9%	16.7%	19.6%	100%
PISA 2006	414.9	492.3	**530.1**	511.5	501.5
Cohort	2.7%	58.6%	21.2%	17.5%	100%
PISA 2009	384.8	480.1	**509.5**	496.1	487.1
Cohort	2.4%	59.1%	24.0%	14.4%	99.9%

Although PISA 2006 focused on science, TY students (mean score of 530.1) yet again scored higher than 15-year-old students in both the Junior Certificate (mean score of 453.6) and the Leaving Certificate (mean score of 511.5). However, overall, PISA 2006 saw the TY mean score decrease by 12.8 points, from 542.9 to 530.1 (Eivers et al., 2008b). The pattern continued in PISA 2009, which saw a further decline in the TY mean mathematics score.

Ireland's mean mathematics score notably declined between PISA 2003 and PISA 2009, dropping from 502.8 to 487.1. However, during this period the number of 15-year-old TY students increased. Table 2.3 shows that as the mean mathematics score decreased by 33.4 points, the number of TY students participating increased from 16.7% to 24.0%. As there

is no set curriculum for TY, it is difficult to establish if there is a direct relationship between TY and the PISA assessment scores. However, Ireland's Educational Research Centre (ERC) suggests that this variance may be because of the mismatch between students' mathematical experiences in TY and the requirements for the PISA test (Perkins et al., 2010). This concern was also echoed by Shiel et al. (2010), who suggest that this variance may be due to the lack of structure in the TY programme. This is unlike the students in 3rd year and 5th year, who receive a more systematic approach to instruction. This worrying decline may be because of the domestication of each school's TYM programme. Hence, raising questions about the purpose of TYM and whether it is improving students' mathematics.

2.3.4 Transition Year: Research and Development

TY has flourished over the last five decades and is now established in nearly every post-primary school in Ireland, starting with only three schools in 1974 (Clerkin, 2012).

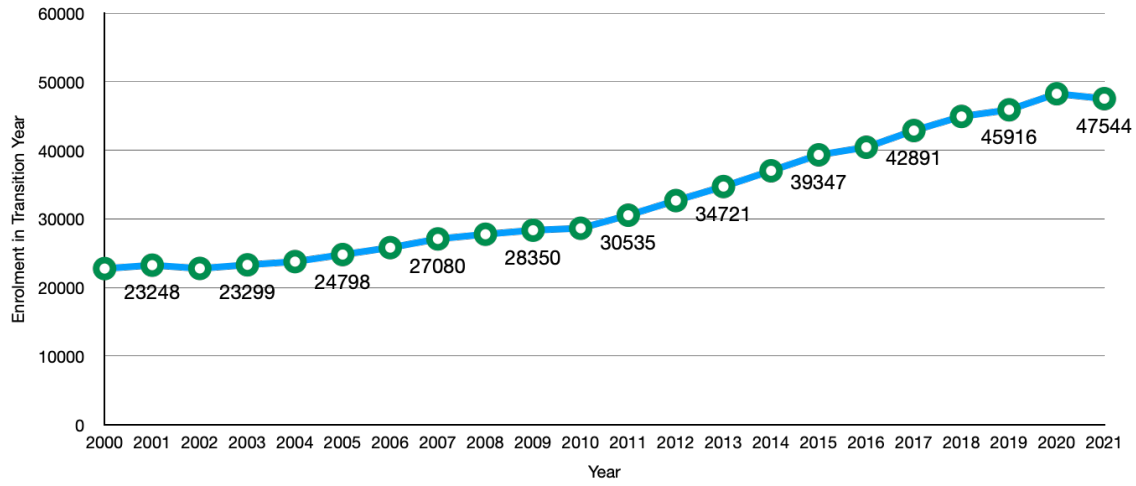


Figure 2.2: Enrolment in Transition Year from 2000 to 2021.

From 2000 to 2021, enrolment in TY increased from 22,754 to 47,544 students (an increase of 208.95%) (see Figure 2.2) (Department of Education, 2022b). The highest enrolment was recorded in 2020, with 48,264 students enrolled in the TYP. Despite the rise in popularity of TY, little research has been carried out to evaluate the programme. This lack

of evaluation is unsatisfactory, considering that since 2016, over 40,000 students have been participating annually in the TYPs.

An analysis of the published Chief Examiner Reports (CER) from the Department of Education Inspectorate revealed that TY is not a dominant feature in any of the four published reports on the Department of Education's website. In 2001-2004, the Central Statistics Office (CSO) reported 93,089 students participating in the TYP, but the CER's report failed to mention TY (Department of Education and Science, 2005). Similarly, the 2010-2012 report recorded no mention of TY despite 91,843 students enrolled in the programme (Department of Education and Skills, 2013). During the period 2013-2016, 151,139 students were enrolled in TYPs, with no reference to TY included in the CER (Department of Education and Skills, 2018).

The most recently published CER (2022) refers to 182,201 students experiencing TY and includes 22 mentions of this programme, referring to TY as "one of the major innovations in Irish education" (Inspectorate of the Department of Education, 2022, p. 134). Although the CER refers to TY, as one of the significant innovations in the Irish education system, the programme is not discussed in any comprehensive manner by the Chief Inspector in his report. This absence is notable as the report highlights the popularity of TY, claiming that more than seven in every ten students are opting to participate in this unique year (Inspectorate of the Department of Education, 2022, p. 134).

It is not solely the Chief Examiner Reports that failed to fully evaluate or review TY, the NCCA reported in 2002 that "at this point in time the Transition Year is under-evaluated and under-researched" (National Council for Curriculum and Assessment, 2002, p. 23). This lack of evaluation may be due to the domestication of the TYP. The NCCA commented on TY's perceived success, stating, "where specific school programmes are

successful…there is little evidence as to why or how such success is achieved" (2002, p. 18).

2.3.5 Transition Year: Identity

The first programme evaluation occurred four years after the introduction of TY. Egan and O'Reilly (1979) noted mixed feelings about Ireland's latest innovation, highlighting a lack of understanding and purpose, yet reporting great flexibility and opportunity in the TY programme. Based on student and teacher insights from the 19 schools hosting TY at the time, Egan and O'Reilly (1979) described TY as a programme for students to develop a better understanding of themselves and the world around them.

The Department of Education cautions mathematics teachers to ensure that students are not academically penalised when they re-join fifth year, yet they must ensure that students are not exposed to a three year Leaving Certificate programme (Egan & O' Reilly, 1979). This lack of clear definition makes it difficult for teachers to construct a programme for TY. The Department of Education suggested that they "maintain the skills without re-enacting the more traditional roles of teacher and student" while admitting that this is "easier said than done" (Egan & O' Reilly, 1979, p. 51)

Their analysis revealed that many teachers and students believed that the inclusion of the linear subjects was not in tune with the "exploratory, reflective spirit of TY", with many teachers rarely saying this "in so many words for fear of giving ammunition to critics of the project" (Egan & O' Reilly, 1979, p. 53). This fear is likely due to the Department of Education's Inspectorate's oversight of the programme. This review conveyed further vexations in the shifting from the traditional education norms to those of the more fluid TYP, with Egan and O'Reilly (1979) reporting that "linear subjects were deemed an irritation in many schools and received the minimum possible emphasis…they were generally seen to be of little importance compared with the other subjects" (as cited in

Jeffers, 2019, p.38). This lack of emphasis on the linear subjects during TY resulted in a contentious issue among teachers, who morally struggled to send students to Leaving Certificate after being "impaired – if they have really devoted the previous year to the broader type of education" (p.56).

The Egan and O'Reilly (1979) review formulated a list of common objectives apparent in the TY programmes in schools, including improved student and teacher relationships, social skills, and education for practical living. Students and teachers supported the concept that TY provided a positive difference in the teacher-student relationship, with students reporting that "caricature-images of individual students and teachers faded quickly away in the intimacy of the Transition class" (p.57). While TY at this time may have lacked identity and a strict continuum of mathematics education, it did provide an opportunity for social and personal development, with many teachers reporting that TY "had given many of their students a very valuable preparation, not merely in terms of additional skills but also in terms of general orientation" (p.57).

2.3.6 Transition Year: Mission Statement

In 1993, the Department of Education published the Transition Year Guidelines for schools, which gave teachers much-needed clarity on this programme. These guidelines contain the mission of TY, which is: "to promote the personal, social, educational and vocational development of pupils and to prepare them for their role as autonomous, participative, and responsible members of society" (Department of Education and Skills, 1994, p. 3).

These guidelines warn that the curriculum content is a matter for selection and adaptation by the individual school rather than the state (Department of Education and Skills, 1994). However, these guidelines still failed to fully address the previous concerns of teachers and students, containing only 278 words of guidance on TYM (see Figure 2.3). These guidelines refer to the fact that mathematics teachers should compose a balanced

programme for students, which develops confidence and provides students with an awareness of their potential (Department of Education and Skills, 1994).

Mathematics

The approach taken to Mathematics in the Transition Year is as important as the content itself. It should seek to stimulate the interest and enthusiasm of the pupils in identifying problems through practical activities and investigating appropriate ways of solving them. In this way, study can be brought into the realm of everyday life so that the process appears more pupil-directed than teacher-directed.

The aim is to guide the pupil towards increased confidence and attainment of a more balanced view of her/his own potential for the subject. Suggested areas and approaches for attention include:

· Activities which relate the application of mathematical skills to real-life situations involving money, weights, measures, etc. such as telephone and electricity bills, income tax, PRSI, practical examples of weighing and measuring, conversion between Imperial and metric (S1) units.
· Applying geographical methods to the solution of practical problems including use of computer software such as DRAW programmes, spreadsheet and associated statistical graphs (pie charts, bar charts, etc.).
· Activities involving the extensive and skilful use of calculators should assume a high priority.
· Problem-solving using interpretation, approximation, model making, etc.
· Activities involving the construction of questions can help pupils to gain a better understanding of approaches to answering and finding solutions.

A lack of understanding of geometrical Theorems is often noted as a weakness in the Leaving Certificate. An interesting approach to the learning of geometry is through investigation of Theorems which can be made into a more pleasant experience by anecdotal history of Greek geometers. "Investigations", as included in the Alternative Mathematics syllabus for Leaving Certificate, provides an interesting aspect of the essential skill of problem-solving which would be very pupil-friendly.

Figure 2.3: 1993/1994 TY Guidelines for Mathematics.

However, no clarity is provided for mathematics teachers on reaching this position. These guidelines maintained that TY should better equip students for the Leaving Certificate programme than those students who do partake in the TYP (Department of Education and Skills, 1994). However, the Department of Education and Science failed to define what it means to be "better equipped" for Leaving Certificate. The guidelines acknowledge that teachers should not only view the academic elements of TY as necessary but also focus on students' personal and social development.

2.3.7 Transition Year: Student Perspective

The Irish Second-Level Students' Union (ISSU) provided insight into the TYP in 2014, capturing the voices of 1,323 students and 57 Transition Year Coordinators (ISSU, 2014). Students reflected positively on their TY experience, with over 80% reportedly enjoying their TY experience. Students also stated that TY developed their social and communication skills, resulting in increased confidence and motivation. The report claims that these skills are not nurtured in Leaving Certificate due to the concentration on state examinations (ISSU, 2014).

The ISSU affirmed the importance of developing relationships during TY, specifically the teacher-student relationship: "you get to talk to teachers as if they are 'normal people'…it's kind of a break for teachers as well as they are not as stressed out" (ISSU, 2014, p. 15). TY provides a most relaxed environment for teachers and students, away from the pressure of formal examinations. In particular, one student claimed the positive impact that TY had on students progressing into Leaving Certificate: "my maths teacher knows the majority of the Transition Year people… so she talks more to them and focuses the class around them. She got to know them personally in Transition Year" (ISSU, 2014, p. 16). This ability to develop relationships during TY may give teachers more time in Leaving Certificate to focus on the academic aspects, as the rapport with students is already established.

However, TY students warn that they maintain a focus on the academic content for fear of developing laziness towards their studies. Students suggested that an academic transition piece be included in the latter phases of the year, where the final term of TY should focus on learning strategies for Leaving Certificate" (ISSU, 2014). However, in contrast, students thought that core subjects, such as mathematics, were taken too seriously during this programme.

2.3.8 Transition Year: Class Formation

TYM is open to scrutiny and evaluation from the Department of Education's Inspectorate, with the Inspectorate frequently commenting on the class formation (streaming, banding, and mixed-ability) of TY mathematics classes during their inspections. Smyth (2018, p. 8) clearly defines the three class formations of streaming, banding, and mixed-ability, defining streaming as placing students of similar assessed ability into classes, ranked from "higher" to "lower". Whereas banding is described as a somewhat looser form of streaming, where pupils are divided into broad ability bands (for example, two higher and two lower classes), but classes within these bands are mixed ability. Lastly, mixed-ability is described as students being placed in base classes based on random (e.g. alphabetical) allocation or, more rarely, to achieve an intentional mix across classes.

The Inspectorate stated that "streaming of mathematics classes in all years, other than first year, should be reconsidered and the possibility of teaching mathematics in mixed-ability classes within levels in all years should be pursued. Priority should be given to addressing this issue in Transition Year" (Department of Education and Skills, 2014). The use of "streaming" can be defined as "using performance on a test (or another metric) to allocate students to different classes on the basis of (assessed) ability" (Smyth & McCoy, 2011, p. 9). This practice, which has become increasingly less common in schools across Ireland since the 1980s, is suggested to have harmful impacts on achievement levels. A study conducted by Smyth (1999) concluded that Junior Certificate students, placed in lower stream classes, significantly underperformed their peers in other classes. Furthermore, this study highlighted that there was also no grade advantage for students in higher streamed classes (Smyth, 1999). Hence, it may be claimed that moving from streaming to mixed-ability groupings would more likely raise students' academic achievement in Ireland (National Council for Curriculum and Assessment, 2006).

2.3.9 The Inspectorate and Transition Year Mathematics

The Department of Education's Inspectorate is responsible for reviewing and evaluating mathematics programmes in schools. As TY is a domesticated programme, with outdated guidelines, inspection reports can offer advice to teachers on their planning and pedagogical choices for TY. However, Table 2.4, which presents the last ten years of TY Programme Evaluations, fails to provide rich feedback and information for teachers. Instead, these reports are vague and at times contradictory. While TY is the best time to offer subject specific feedback to schools, it seems that the Inspectorate is saying two main things: don't teach the LCM curriculum, and make sure that classes are formed as mixed ability.

Table 2.4: Overview of TY Programme Evaluation Inspections (Mathematics).

Date	School	Inspectorate Comment
May 2023	Coachford College, Cork	• Maths must be mixed ability. • Maths must be different from 5th and 6th year.
January 2020	Mount Sackville, Dublin	• Excellent examples of written formative feedback.
June 2018	Athboy Community School	• Recruitment of Mathematics Teacher issues.
October 2017	Cólaiste An Chraoibhin, Cork	• Mathematics students were set well scaffolded group tasks relating to probability. However, to effect greater engagement by students, further attention should have been given to group selection and the expectation of feedback from all groups.
September 2017	Scoil na Tríonóide, Limerick	• Mathematics students were focused on topics that developed from Junior Cycle and bridged to their learning in Leaving Certificate.
June 2017	St. Mary's College, Sligo	• Students are arranged in two mixed-ability groups for most areas of study and are co-timetabled with Leaving Certificate year one students for mathematics.

January 2017	Royal School, Cavan	• Over emphasis on LC material taught during TY. • Need to spend time developing a TY vision statement, this will allow structure to teach the necessary skills in TY.
April 2016	Cólaiste Cholmcille, Co. Galway	• Recommend organising students in mixed-ability groups for all subjects, including mathematics.
March 2016	Manor House School, Raheny, Co. Dublin	• TY Maths programme should be developed to ensure that students are developing Project Maths skills through study of non-curriculum material.
January 2016	Ardscoil Rís, Griffith Avenue, Dublin 9	• Need to prioritise other essential skills in TYM including problem-solving, investigation and discovery.
May 2015	Ramsgrange Community School, Co. Wexford	• Participation in MATHletes strongly supported numeracy in TY. • Good cross-curricular links are noted in many mathematics lessons, and inquiry-based learning is noted as a key feature. Students worked in small groups, working on open-ended numerous tasks.
March 2015	St. Joseph's Secondary, Rush, Co. Dublin	• The TYM Plan is over focused on Leaving Certificate materials. • Co-curricular outreach programme with the local primary school on tutoring primary pupils in mathematics.
November 2014	Cnoc Mhuire Secondary School, Co. Longford	• Chess and other board games that form part of the TY programme are in keeping with the spirit of TY. • TYM plan needs to be reformed to develop essential critical thinking and problem-solving skills, while also moving away from the Leaving Certificate Curriculum.
November 2014	Douglas Community School, Cork	• Examples of very good practice noted included mathematics students moving from formulae to problem-solving using practical application in one lesson.

October 2013	Presentation College, Tuam, Co. Galway	• Students are arranged in mixed-ability settings in all subjects, apart from Mathematics. This setting should be kept under constant review.
December 2013	St. Peter's College, Dunboyne, Co. Meath	• Formal examinations are held in Mathematics during TY.

2.3.10 Transition Year: Generally Untapped Resource

A 2013 report entitled Mathematics in Transition Year: Insights of Teachers from PISA 2012 acknowledged that TY is an important mechanism to improve students' mathematics education. This report called for an update of TY regarding its aims, structure and content to meet the demands of Project Maths. Moran et al. (2013) stressed the need for more Continuous Professional Development (CPD) opportunities for mathematics teachers, reporting that the vast majority of CPD undertaken was part of the formal CPD from the introduction of Project Maths (21 hours on average over the last three years). Furthermore, this report acknowledged the untapped potential of Transition Year mathematics. Their recommendation called for TY to be used as an "opportunity to consolidate the mathematical knowledge and skills learned during the Junior Cycle, and to develop these in a manner that would act as a useful bridge to the new Leaving Certificate course. The NCCA should identify ways in which schools and teachers can align mathematics activities in TY more closely with the aims of Project Maths" (p.47).

2.4 Mathematical Preparedness: An Empirical and Theoretical Basis

The current literature on mathematical preparedness specifically focuses on the academic components of mathematics learning, with little acknowledgement of the role that the non-academic factors play in mathematically preparing students. From an international

perspective, the literature on mathematical preparedness stems from several countries across the globe:

- United States (Bernstein et al., 2014; Guidry, 2020; Maciejewski et al., 2021),
- Canada (Henning, 2007),
- United Kingdom (Darlington & Bowyer, 2017; Golding, 2021; Hodds, 2023),
- Australia (Fox, 2019; Robinson et al., 2019)
- Ireland (Duggan et al., 2018; Hyland & O'Shea, 2021; Lane & Walshe, 2019).

However, all the above-named studies centre on mathematical preparedness as a mechanism for entry to tertiary education, their uses in diagnostic testing, or to describe the ill-preparedness of students in mathematics and mathematical related courses. The above literature fails to explicitly provide a definition for mathematical preparedness. In addition, this literature neglects to identify the role of other non-academic factors in preparing students. This section will examine the empirical and theoretical basis for the inclusion of the non-academic factors in the conceptualisation of mathematical preparedness. This section will focus on the role that mathematical attitudes and values play in preparing students, along with the importance of their mathematical wellbeing, self-efficacy and self-confidence. Lastly, the literature on the importance of motivation and key skills in mathematically preparing young people will be highlighted.

2.4.1 Mathematical Attitudes and Values

Kiwanuka et al. (2020) claim that students with a positive attitude towards mathematics tend to enjoy, understand, and have confidence in the subject. Having a positive attitude towards mathematics is thought to encourage students to prioritise this subject, which may result in higher levels of mathematical achievement (Dowker et al., 2019). However, this is not always the case. An OECD report in 2003 revealed that in countries with high mathematical achievement, such as Finland and Japan, many students still showed negative

mathematics attitudes despite obtaining high test scores (Organisation for Economic Co-operation Development, 2003). This report highlights that although students may score highly on mathematical tests, it does not imply that they have positive attitudes towards mathematics. However, the literature acknowledges that attitudes can play a vital role in the teaching and learning of mathematics. Smetackova (2015) and Passolunghi et al. (2016) stress that poor mathematical attitudes may exist due to students' prior experience with mathematics. Hence, teachers and their selection of methodologies, play an important role in supporting students' development of positive attitudes, and maintaining continued interests towards mathematics.

Zan and Di Martino (2007) offer a comprehensive tripartite model for mathematical attitude, based on the works of Hart (1989) and McLeod (1992). Their definition features three main components: emotional response, beliefs, and behaviours. This model regards not only the feelings associated with the object but also the knowledge, ideas and beliefs about the object, as well as the behavioural intentions towards the object (Wen & Dube, 2022). Each component differs from the next: affects are the product of emotional stimuli, cognitions are products of previous exposure, and behavioural intentions are products of past reinforcement. Hence, a combination of all three components (affective, cognitive, and behavioural) may positively impact the learning outcomes for students.

2.4.2 Mathematical Wellbeing

Following on from the importance of attitudes and values in mathematics learning and preparedness, this section considers the critical role of mathematical wellbeing when preparing students. Su (2020) highlights the importance of mathematics in the developing lives of students, describing mathematics as a 'gate-keeper' subject of the modern-day school curriculum. This description stems from the powerful opportunities that students

may gain from engaging with and studying mathematics, such as enhanced employment opportunities, and informed choices about health and their environment (Plunk et al., 2014). Clarkson et al. (2010) and Part (2011) offer a framework/definition for Mathematical Wellbeing (MWB), which incorporates three domains: cognitive, affective and emotional. The cognitive domain refers to the knowledge and skills required for studying mathematics, the affective domain encompasses the values of mathematics education, and the emotional refers to the feelings, responses, and reactions towards mathematics education (Hill & Seah, 2023). As a collective, the authors posit that mathematical wellbeing can be defined as "the fulfilment of one's core values, within the learning process, accompanied by positive feelings (e.g. enjoyment) and functioning (e.g. engagement, accomplishment) in mathematics" (Hill & Seah, 2023, p. 385). Additionally, it is argued that students with development in all three domains (cognitive, affective and emotional) hold high levels of mathematical wellbeing.

2.4.3 Mathematical Self-Efficacy

Self-efficacy refers to the personal judgement of one's capabilities to adopt, organise and execute certain behaviours and actions to attain and accomplish certain objectives and outcomes (Bandura, 1986; Paraskeva et al., 2008). It indicates the choices that students will make, the time they will give to a task, and their level of perseverance. Although self-efficacy seems to be akin to attitudes, Liu and Koirala (2009) specify a critical difference between them, claiming that self-efficacy refers to a student's self-confidence about their ability to complete a task, whereas attitudes refer to a student's feelings about the task, including whether or not they believe the task is important, enjoyable, or challenging. Furthermore, Liu and Koirala (2009) warn that although a student may believe that mathematics is a vital tool in their daily life, and they may enjoy solving mathematics problems, they may not believe that they can solve a mathematics problem. Hence, it may

be the case that a student with a positive attitude towards mathematics may have a low self-efficacy. Similarly, if a student has a strong belief to the importance of mathematics, this may positively influence their persistence, leading the development of a higher level of self-efficacy towards the subject.

Warwick (2008) informs us that an individual's judgement of their mathematical self-efficacy is based on four factors:

- Performance Evidence: where successful attainment in mathematical assessments strengthens self-efficacy, and repeated failure weakens self-efficacy.
- Vicarious Experience: comparing oneself with other classmates. The judgement, if favourable, can strengthen self-efficacy. Alternatively, feelings of inadequacy in comparison to classmates can undermine a student's self-efficacy beliefs.
- Verbal Persuasion: refers to the passing of comments by others, in particular teachers, parents, and classmates, regarding the completion of mathematical tasks. Positive comments enhance a student's self-efficacy, whereas negative comments diminish self-efficacy.
- Physiological and Affective States: refer to the feelings that students experience when tasked with a mathematical problem. These feelings may be positive (happy, confident, etc) or negative (anxiety, worry, tension, etc). An increase of the positive states raises self-efficacy, whereas an increase in the negative states has a countereffect.

Pajares (2003) suggests that teachers should pay as much focus to the development of students' perception of competence as they do to the development of actual competence, stating that "there are situations in which inaccurate self-beliefs, rather than a weak knowledge base or inadequate skills, are responsible for students short-changing themselves academically" (p.153). In strengthening self-efficacy beliefs, Linnenbrink and

Pintrich (2003) recommend that teachers provide students with specific feedback on the work assigned, along with praise for the students, without providing excess undeserved praise

2.4.4 Mathematical Self-Confidence

Self-confidence is one of the most important psychological structures and is well-researched in terms of students' mathematical achievement (Hosein & Harle, 2018). In the literature, the term self-confidence is sometimes seen as interchangeable with the term self-efficacy. However, Ciftci and Yıldız (2019) highlight that while self-efficacy refers to be a specific belief about a particular situation, self-confidence is a general personality trait. Self-confidence refers to a student's confidence in their ability with respect to their mathematics learning, and it is deemed as an important determinant of an individual's feelings, thoughts, behaviours, and motivation for a task.

2.4.5 Mathematical Motivation & Self-Determination Theory

Research has shown that many students tend to view mathematics as a complex, abstract subject that has little relevance to their everyday lives (Bray & Tangney, 2017). In addition, mathematics has traditionally been taught as a performance subject, where the most motivated students are led by academic grades (Boaler, 2020). However, Boaler (2020, p. 5) also acknowledges that "when students develop interest in the ideas they are learning, they increase their motivation and their achievement". Therefore, according to Samuelsson (2023), teachers have an important role to play in supporting students "to develop intrinsic and extrinsic motivation as regards mathematics" (p.181). Research by Wang et al. (2017) reiterates the essential functional role that teachers and the classroom environment can have on a student's psychological development, and engagement with mathematics learning.

Self-Determination Theory (SDT) offers a practical framework for educational professionals to understand the factors that support or undermine intrinsic and extrinsic

motivation in the educational setting (Ryan & Deci, 2020). This theory, based on human motivation, emotions, and development, has a valuable role to play in education and it may help teachers to support students in improving their relationship with mathematics. SDT comprises of both internal (intrinsic) and external (extrinsic) factors, and the interrelationship between both attributions. While extrinsic motivation tends to refer to the factors of rewards, punishments and compliance. Intrinsic motivation refers to the personal importance, fun, curiosity and inherent satisfaction of learning (Ryan & Deci, 2020; Ünlü, 2023).

Although, there is an acknowledgment of the role that extrinsic motivation plays in the classroom, SDT emphasises the use of intrinsic motivation in the learning environment. Teachers can positively impact students' intrinsic motivation by acknowledging achievements, providing a reasonable level of challenge, facilitating classroom discussions, supporting and encouraging group work and collaboration in the classroom, and empowering students with choice in classroom decisions (Samuelsson, 2023). Similarly, teachers can improve intrinsic motivation by utilising real-life themes to contextualise mathematics, and through the selection of activities where students can make choices, contribute ideas and methods, and by working at a reasonable level (Moreno & Rutledge, 2019).

Given that a focus on the development of students' intrinsic motivation appears to support them to achieve higher grades and at higher levels than purely relying on extrinsic motivation such as exam performance (Lemos & Veríssimo, 2014; Pulfrey et al., 2011), it stands to reason that in mathematically preparing students, teachers may reconsider the impact of their teaching approaches.

2.4.6 Key Skills for Mathematical Learning

The expansion of globalisation and the evolution of the digital world have caused a shift in educational focus in recent decades. Schools now need to ensure that their students are prepared with the necessary skills to embody, create, improve, and apply knowledge (Smit, 2016). Students need to be fluent in the skills of working together, solving problems, working with Information Technology, and being creative as they prepare to join the labour market. Rotherham and Willingham (2010) remind us that these skills are not new, but it is the critical importance of these qualities in the modern workforce, which led to their definition as "21st century", key, or transversal skills. This skill set requires familiarity with four major aspects: life and career skills, learning and innovation skills, information, media and technology skills, and core subjects and 21st century themes (Partnership for 21st Century Skills, 2009). However, learning and innovation skills are deemed to be the skills that really prepare students for life in the 21st century. These aspects centres on the 4C's of Critical Thinking and Problem-Solving, Creativity and Innovation, Communication, and Collaboration. In order for students to experience, engage and execute these skills, schools and teachers must provide safe learning environments (Smit, 2016).

Critical Thinking and Problem-Solving are traditionally linked to the learning of mathematics, with problem-solving being one of the major aspects of mathematics education. Problem-solving requires students to apply and incorporate many mathematical concepts, as well as applying decision-making skills to solve mathematical problems. Tambychik and Meerah (2010) warn that a lack of mathematical skills causes difficulties for students as they attempt to problem solve. These researchers stress the importance of five types of mathematics skills:

- Number Fact Skills: Proficiency of basic numerical operations.
- Arithmetic Skills: Accuracy in computational procedures.

- Information Skills: Expertise to connect and transfer problems into mathematics.
- Language Skills: Proficiency of terms and relevance.
- Visual Spatial Skills: Ability to visualise concepts, shapes, and space.

Tambychik and Meerah (2010) warn that many students face difficulties with problem-solving due to a deficiency in the above five types of mathematical skills.

Creative skills do not simply relate to good ideas but refer to having the skills to make the ideas come alive (Mazeh, 2020). Creativity encompasses the skills of imagination, self-motivation, resiliency, cooperation with others, and taking responsibility for tasks. These skills may assist students to offer alternative and more efficient solutions to problems. Similarly, Communication plays a vital role in the mathematical preparation of students for the demands of the 21st century. Ojose (2011) stresses the importance of mathematical literacy as a core requirement for the workforce, stating that a mathematical literate person can estimate, interpret data, solve routine problems, reason in multiple forms (numerical/graphical), and communicate in the language of numbers. Lastly, students require the skill of collaboration with Dede (2010, p. 2) stating that "collaboration is worthy of inclusion as a 21st century skill because the importance of cooperative interpersonal capabilities is higher, and the skills involved are more sophisticated than in the prior era".

2.4.7 Mathematical Resilience

Resilience refers to the fact that students must develop the ability to respond to and adapt to challenging mathematical situations. Johnston-Wilder and Lee (2010, p. 38) define mathematical resilience "as a learner's stance towards mathematics that enables pupils to continue learning despite finding setbacks and challenges in their mathematical learning journey". In developing resilience, students must make and examine their mistakes. The National Council for Teachers of Mathematics claims there is a tremendous pedagogical richness in exploring mistakes in the classroom, and that this exploration aids teachers in

deepening their knowledge of the subject (James et al., 2018). This exploration of errors also encourages teachers to demonstrate alternative problem-solving methods and techniques. Hutauruk and Priatna (2017) advised that difficulties in learning and mastering mathematics are expected, as mathematics requires students to think logically, systemically and reflectively.

The introduction of the Bonus Point Initiative in Ireland (section 2.2.4.3) furthered the need for students to develop the academic skills of resilience. O'Meara et al. (2020) highlighted that the introduction of the BPI incentive has driven students who find mathematics difficult to study the subject at higher level to obtain the bonus points. This results in a storm of struggling students who require a great deal of resilience to meet the demands of the LC mathematics course.

2.5 Mathematical Preparedness: Curriculum and Policy

Section 2.4 presents the literature on Mathematical Preparedness from an empirical and theoretical and perspective. This section will now examine the connection of the theoretical and empirical research on mathematical preparedness with the curriculum and policy aspects. An initial exploration of the concept of mathematical preparedness has led to the identification of the four key areas outlined below:

1. The "Mathematics Problem" discussed in Chapter 1 placed adequate knowledge of academic content at the centre of the issue of mathematical preparedness.
2. The curriculum reform agenda highlights various skills (Chapter 2), that are equally important in mathematically preparing our students. The European Union identified that students must be competent in various key curricular skills to successfully participate as active citizens in the 21st century knowledge economy. Skills such as creativity, critical thinking, managing information and working with others are crucial for the modern workforce (European Union, 2006).

3. The modern world also places numerous pressures and demands on students. Teachers play a crucial role in ensuring students develop an awareness and practice of social skills such as wellbeing, resilience and building positive relationships (National Council for Curriculum and Assessment, 2017).
4. The introduction of the Bonus Points Initiative (BPI) in Ireland, as discussed in Prendergast et al. (2020), compounded the underlying issues of mathematical anxiety, frustration and insecurity (Gil et al., 2006; O'Meara et al., 2020). Teachers must ensure to prepare for and manage these emotional factors in the mathematics classroom.

As outlined above, mathematics teachers are now challenged with more than teaching the curriculum content to prepare students. In fact, the areas mentioned above illustrate the different parts to mathematical preparedness in the 21st century. To frame the literature review that follows, these four areas have been conceptualised as a quadrant (see Figure 2.4).

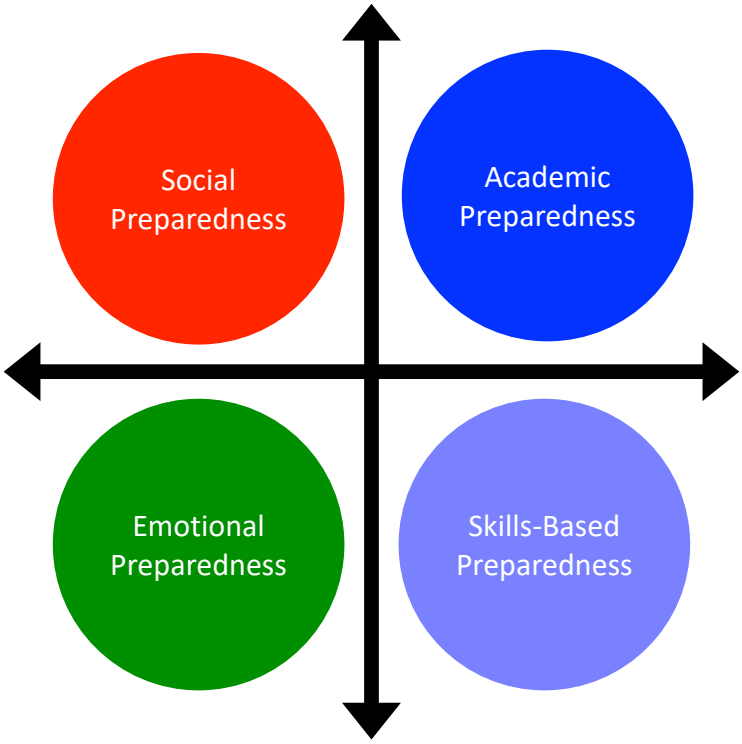


Figure 2.4: Overview of the proposed Mathematical Preparedness Quadrant.

Given the nature and scope of the TYP as a year that is free, from a prescribed curriculum, state examinations and associated time pressures, it was decided that this would be the most appropriate context in which to explore the broad concept of mathematical preparedness. As teachers can find it challenging to prepare students for the different demands of the modern world, teachers experienced a similar situation following the introduction of TY. Egan and O' Reilly (1979) believed that the confusion about the identity of TY stemmed from its description. The "transition" is viewed from two perspectives. One is the transition from school to the workforce, and the second is the transition from Junior Cycle to Senior Cycle. This dual function of TY resulted in teachers attempting to prepare students for two different worlds. The mixture of vocational and social skills and the continuum of academic education led to a muddled identity for TY (Jeffers, 2019). In comparison, teachers are now faced with a similar issue. However, this time, it is not "transition" but "preparedness". This part of the literature review will be used to inform the development of the Mathematical Preparedness Quadrant, a tool to assist teachers in the conceptualisation of mathematical preparedness, which will be presented to the Delphi Study Panel of Participants for discussion.

2.5.1 Academic Preparedness

To address the concept of Academic Preparedness, this section will focus on the curriculum documentation. From an Irish perspective, this section will review the Junior Cycle Mathematics Specification (Department of Education and Skills, 2017) and the Leaving Certificate curriculum (Department of Education and Skills, 2015) documents, TY is without a formal curriculum. Additionally, to ensure a global dimension, the International Baccalaureate (IB) Middle Years Programme (MYP) Subject Brief for Mathematics (International Baccalaureate Organization, 2021) will also be reviewed.

2.5.1.1 The Junior Cycle Mathematics Specification

The Junior Cycle (lower-secondary) mathematics specification details, preparing students for employment and lifelong learning through study in the four content strands of Number, Geometry & Trigonometry, Algebra & Functions, and Statistics and Probability. The overall objective is to "provide relevant and challenging opportunities for all students to become mathematically proficient so that they can cope with the mathematical challenges of daily life and enable them to continue their study of mathematics in Senior Cycle and beyond" (Department of Education and Skills, 2017, p. 5).

This specification lists mathematical understanding, fluency, reasoning, computational thinking, and problem-solving as key capabilities that students will need to succeed in mathematics. However, the specification offers limited guidance and support for teachers in achieving these proficiencies (Department of Education and Skills, 2017). Problem-solving should prepare students with practical techniques which they can utilise to help manage unfamiliar mathematics problems. The problem-solving cycle suggests that students learn how to mathematise a situation, decompose a problem, interpret solutions, and evaluate the reasonableness of a solution. However, teachers need instruction and support in teaching students problem-solving skills. Advice on the best approaches, methods and best practice guidance would greatly assist teachers in their planning. Unlike previous curriculum documents, the reformed Junior Cycle Mathematics Specification promotes a unifying approach to teaching mathematics. Teachers are instructed to develop strong links between the various mathematics concepts in JC, referred to as the "unifying strand". This strand permeates the specification to advance a student's "ability to think logically, strategically, critically, and creatively" (Department of Education and Skills, 2017, p. 9). The specification suggests that in preparing students mathematically, teachers should ensure to develop the unifying strands throughout their teaching and learning

practices. This approach ensures that students view mathematics as a series of interconnected topics rather than viewing topics in isolation.

2.5.1.2 The Leaving Certificate Mathematics Curriculum

The Leaving Certificate Mathematics curriculum, similar to the Junior Cycle Specification, contains five strands: Statistics and Probability, Geometry and Trigonometry, Number, Algebra, and Functions. The LCM is designed as a 180-hour course of study. The curriculum authors stress that each strand should not be thought about in isolation, and that they are all interconnected. Each strand lists numerous different learning outcomes that students must achieve and be able to demonstrate in their state examinations. However, some of these learning outcomes are vague and lack defined limits. For example, learning outcome 2.2 for coordinate geometry states that: "students working at higher level should be able to "solve problems involving a line and a circle". Broad learning outcomes, such as this, are open-ended and challenging for teachers to understand and achieve within the confines of the Leaving Certificate course. Similarly, learning outcome 2.3 for trigonometry states that students working at higher level should be able to "use trigonometry to solve problems in 3D" (Department of Education and Skills, 2015, p. 25). This learning outcome is another example of a far-reaching and ambiguous intention, making it difficult for teachers to interpret and challenging for students to achieve.

2.5.1.3 International Baccalaureate (IB) Middle Years Programme (MYP)

In contrast to the Irish curricula documents, the International Baccalaureate (IB) Middle Year Programme (MYP) provides mathematics teachers with a mathematics guide and a subject brief to support lesson planning. The IB curriculum aims to prepare students for future opportunities, stating it "prepares students for further academic (inter)disciplinary study and for life in an increasingly interconnected world" (International Baccalaureate Organization, 2014, p. 12). The comprehensive supporting documents suggest approaches

to teaching and learning, support discovery through inquiry, and provide examples for teachers on curricular planning (International Baccalaureate Organization, 2014).

Identical to the Junior Cycle Mathematics Specification, the IB MYP houses the same four branches of Number, Algebra, Geometry and Trigonometry, and Statistics and Probability. In addition, the IB MYP contains an additional branch of Calculus. This international curriculum centres on ten main mathematical aims to academically prepare, encourage and enable students to succeed, as listed in Figure 2.5.

- enjoy mathematics, develop curiosity and begin to appreciate its elegance and power
- develop an understanding of the principles and nature of mathematics
- communicate clearly and confidently in a variety of contexts
- develop logical, critical and creative thinking
- develop confidence, perseverance and independence in mathematical thinking and problem-solving
- develop powers of generalization and abstraction
- apply and transfer skills to a wide range of real-life situations, other areas of knowledge and future developments
- appreciate how developments in technology and mathematics have influenced each other; the moral, social and ethical implications arising from the work of mathematicians and the applications of mathematics; the international dimension in mathematics; and the contribution of mathematics to other areas of knowledge
- develop the knowledge, skills and attitudes necessary to pursue further studies in mathematics
- develop the ability to reflect critically upon their own work and the work of others.

Figure 2.5: Extract from the International Baccalaureate Middle Years Programme Subject Brief for Mathematics (International Baccalaureate Organization, 2021).

The IB curriculum demonstrates a student-centred approach to the teaching and learning of mathematics, placing enjoyment at the heart of this programme. This programme emphasises that students should appreciate the elegance and power of mathematics. Only then are the more sophisticated aims presented, tasking students with developing logic, mathematical thinking, generalization, and abstraction. Interestingly, the IB curriculum uses enjoyment and elegance as the hooks to prepare students academically.

The IB MYP mathematics programme consists of five components: Number and Algebra, Functions, Geometry and Trigonometry, Statistics and Probability, and Calculus. In

addition, this curriculum specifically includes an investigational, problem-solving and modelling skills component that spans a recommended 30 teaching hours. It is interesting to note that Functions and Calculus are two separate components, and that Calculus is a stand-alone component. The issues outlined in section 1.3.2.2 specifically highlight the under-preparedness in Irish students' knowledge of calculus, yet this area features predominantly in the International Baccalaureate Mathematics Curriculum.

2.5.2 Social Preparedness

The concept of mathematical preparedness should however address more than Academic Preparedness. It encompasses a range of non-academic factors. Mahoney et al. (2018) claim that "if schools aim to prepare young people for life, in today's complex and diverse world, then they must provide instruction in more than just academic content and skills" (p.1). This section focuses on developing an understanding of what might constitute a student's Social and Emotional Learning (SEL) skills within the context of mathematics education. Internationally, the inclusion of SEL skills in schools is increasing and connects to higher levels of student achievement (Elias, 2009; Kress et al., 2004). While several definitions of Social and Emotional Learning exist in the literature, the following definition has been adopted for inclusion in this section. SEL are "the processes through which children and adults acquire and effectively apply the knowledge, attitudes, and skills necessary to manage their emotions, set and achieve positive goals, feel and show empathy for others, establish and maintain positive relationships, and make responsible decisions" (Weissberg & Cascarino, 2013, p. 9). This version of SEL contains five competencies: self-awareness, self-management, social awareness, relationship skills, and responsible decision-making (Weissberg et al., 2015). These skills are prerequisites for numerous teaching and learning strategies, including presenting Classroom Based Assessment (CBAs) (National Council for Curriculum and Assessment, 2020), actively participating in group work activities, or

managing the workload of studying mathematics. The inclusion of Social Preparedness is not separate from academic teaching but rather intertwined with preparing students. TYM teachers can select suitable instruction models that support Social Preparedness. Jones et al. (2009) suggest that small changes to the mathematics teacher's existing lesson planning framework can be vital in including SEL in the mathematics classroom.

To further explore the concept of Social Preparedness, the following subsections will review Singapore's Mathematics Curriculum Framework and Ireland's Wellbeing guidelines.

2.5.2.1 Singapore: Mathematics Curriculum Framework

According to Leinwand and Ginsburg (2007), Singapore has one of the world's best examples of mathematics education. The educational goal there is to "strengthen the interest and capabilities of our students to prepare them for an increasingly complex and uncertain world…we want our students to be curious, and to think creatively and critically in solving problems" (Ministry of Education Singapore, 2023, p. 40). Problem-solving is a predominant feature of Singapore's Mathematics Curriculum Framework, and this may be the key to their success in preparing students for international comparative tests. Figure 2.6 below illustrates this framework with problem-solving at the centre surrounded by five interrelated components: attitudes, metacognition, processes, concepts, and skills.

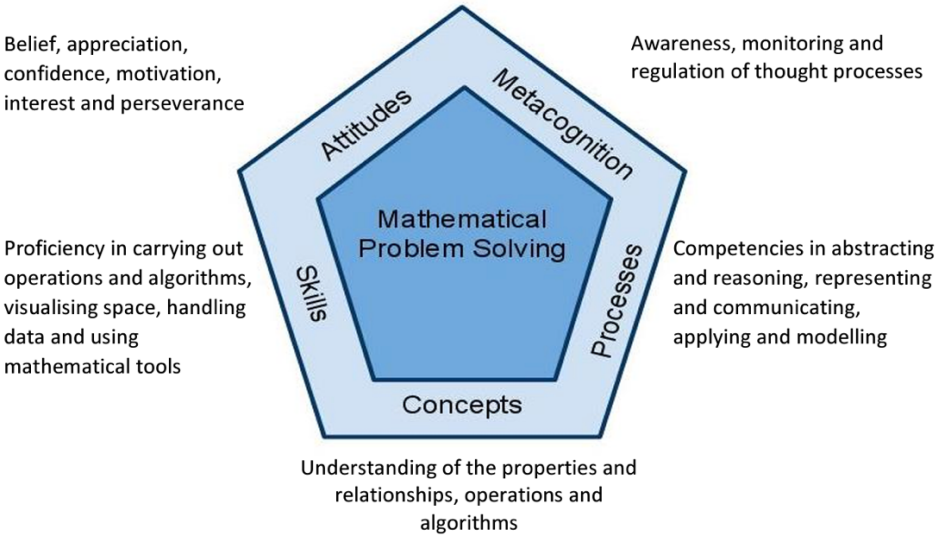


Figure 2.6: Singapore's Mathematics Curriculum Framework (Ministry of Education Singapore, 2023).

When exploring the concept of Social Preparedness, it is helpful to consider the framework's learning experience elements (attitudes and metacognition). Singapore's Ministry of Education emphasises the need to prepare students with a positive attitude towards mathematics learning. A positive attitude is required to solve problems, build self-confidence, develop perseverance and self-awareness. Singaporean teachers play a pivotal role in fostering a classroom culture that builds on and encourages positive attitudes towards mathematics learning. This framework views metacognition as critical to the learning experience. Teachers must empower students to control their thinking processes when challenged with complex problems. Teachers are supported through continuous professional development to build metacognition practices within their classrooms. Tay et al. (2020) suggest that "helping students to become aware of themselves as learners and to take control of their learning process through concepts linked to metacognition are possible ways of preparing learning at school and beyond and for the future" (p.3). Since 2020, metacognition has been one of three critical curriculum areas in Singapore, highlighting its importance in preparing students (Ministry of Education Singapore, 2023).

2.5.2.2 Ireland: Wellbeing Guidelines

Since 2021, Ireland has placed a high priority on the wellbeing of students within post-primary education. The Junior Cycle Wellbeing Guidelines contain four main aspects that support Social Preparedness. Figure 2.7 illustrates these aspects of culture, curriculum, relationships, and policy and planning. The longitudinal Growing Up in Ireland Study and the OECD's PISA 2015 results on students' wellbeing resulted in the development of these guidelines. These guidelines encompass Bronfenbrenner's Ecological Model of Human Development, which claims a strong link between wellbeing and academic outcomes (National Council for Curriculum and Assessment, 2017). Although these guidelines are not specific to mathematics, teachers are encouraged to embed these areas within their practice to support student wellbeing.

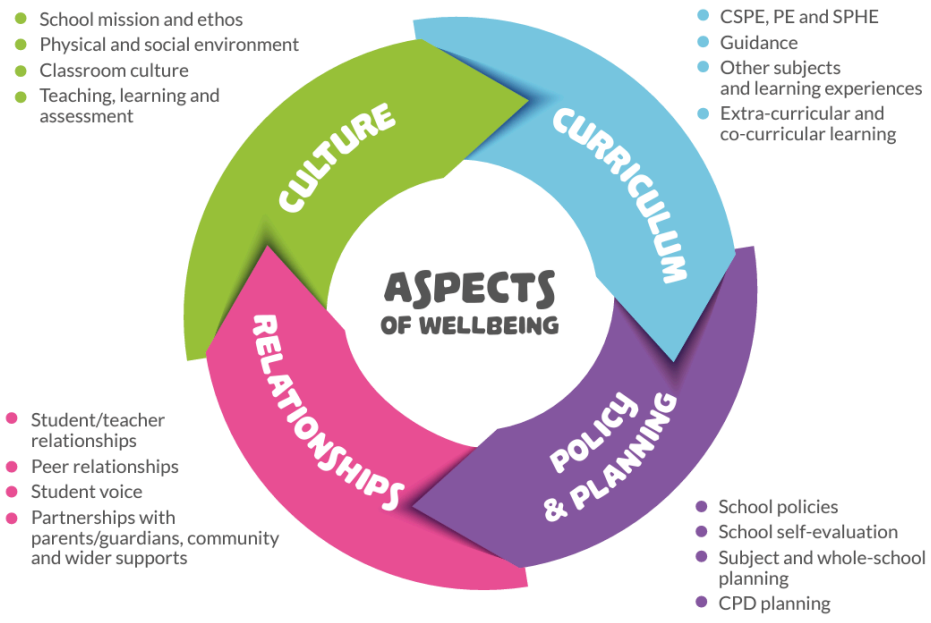


Figure 2.7: The Four Aspects of Wellbeing for Junior Cycle (National Council for Curriculum and Assessment, 2017).

2.5.3 Emotional Preparedness

This third quadrant comprises close links with quadrant two on Social Preparedness. While the previous quadrant focused on the social component of Social and Emotional Learning

(SEL), this quadrant will concentrate on the emotional component of SEL (Kress et al., 2004). What it means to be affectively prepared for mathematics, is a challenging concept to define. Gil et al. (2006) acknowledged that students frequently perceived mathematics as complex, impractical, and uninteresting. These perceptions can lead to failure and students feeling frustrated, discouraged, and anxious about mathematics learning. These researchers highlighted the importance of understanding the influence of affective and emotional factors on mathematics learning. Stating that affective and emotional factors can explain "the anxiety pupils feel when faced with a problem to solve, their sensations of unease, of frustration, of insecurity, the low level of self-esteem that they experience" (Gil et al., 2006, p. 17).

McLeod (1992) names the categories of beliefs, attitudes, and emotions to describe the wide range of affective responses in mathematics, noting that beliefs and attitudes tend to be stable, while emotions can change rapidly. Table 2.5 summarises the affective domain in mathematics education by McLeod (1992), providing examples of each category. Each category contains different contributory factors. A student's belief about themself affects confidence, metacognition, self-regulation, and self-awareness. These sub-factors play an essential role in developing a student's mathematical preparedness. Research into mathematical anxiety by Caviola et al. (2017) concluded that pressures in mathematics learning affect a student's strategic ability to complete tasks.

Table 2.5: The Affective Domain in Mathematics Education.

Category	Examples
Beliefs	○ **About mathematics:** Mathematics is based on rules. ○ **About self:** I am able to solve problems. ○ **About mathematics teaching:** Teaching is telling. ○ **About the social context:** Learning is competitive.
Attitudes	○ Dislike of geometric proof. ○ Enjoyment of problem solving. ○ Preference for discovery learning.

Emotions	○ Joy (or frustration) in solving non-routine problems. ○ Aesthetic responses to mathematics.

The research noted that worry, concern, and distracting thoughts impair students' working memory. The concept of Emotional Preparedness can also be viewed as encompassing factors such as mathematical self-determination (Makmoer et al., 2018), self-efficacy (Zakariya, 2022), the impact of parental influences (Miller et al., 2005) and student voice (Lundy, 2007).

2.5.4 Skills-Based Preparedness

Skills-Based Preparedness focuses on the skills students require for 21st century life and work. The necessity of such skills is evident in the European Union Key Competencies for Lifelong Learning, the Partnership for 21st Century Skills, and Ireland's Key Curricular Skills for both Junior Cycle and Senior Cycle (including TY). This section will expand on each of these areas.

2.5.4.1 European Union: Key Competencies

The European Union lists mathematics as one of the eight key competencies for lifelong learning. The mathematical competency states that EU citizens should have the skills to reason mathematically, understand mathematical proof, and communicate in mathematical language (European Commission, 2019). The EU promotes the belief that students should be able to develop and apply mathematical thinking, solve problems in the everyday context and have a sound mastery of numeracy. Furthermore, the EU includes another competency on personal, social, and learning to learn. This competency requires teachers to ensure students are well-versed in reflection, time management, managing information, and constructively working with others, while acknowledging that students need the skills to deal with complex situations; make decisions; organise and persevere with learning. The

EU comments that students also need cultural awareness and resilience skills to prepare for adulthood.

2.5.4.2 Partnership for 21st Century Skills

Similar to the European approach, the Partnership for 21st Century Skills (P21), established in 2006, advocates internationally for connecting core academic knowledge with critical thinking and social skills to empower students to live and work in the 21st century (Alismail & McGuire, 2015). This organisation promotes the merging of the traditional "3Rs" of education (reading, writing and arithmetic) with the "4C's" of Critical Thinking, Communication, Collaboration and Creativity, integrated with Life and Career Skills, Information, Media and Technology Skills (Alismail & McGuire, 2015).

2.5.4.3 Ireland: Key Curricular Skills

On a national level, the publication of Ireland's equivalent to the EU and P21 framework occurred in 2009. Entitled Senior Cycle Key Skills Framework, the National Council for Curriculum and Assessment (NCCA) identified five key curricular skills: communication, being personally effective, working with others, critical and creative thinking, and information processing (Figure 2.8). Ireland's identification of these key skills was as a result of the shifting global 21st century teaching and learning trends. The NCCA stresses that students need "the ability to think critically and creatively, innovate and adapt to change, to work independently and in a team, and to be a reflective learner are prerequisites for life and for the workplace in the 21st century" (National Council for Curriculum and Assessment, 2009, p. 2). However, the NCCA warns that these key skills must not appear in isolation but rather that teachers should embed these skills into all areas of the curriculum.



Figure 2.8: Ireland's Key Curricular Skills Framework, taken from (National Council for Curriculum and Assessment, 2009).

Mathematics naturally lends itself to the development of the skills of information processing and critical thinking. However, teachers must incorporate the remaining skills into their teaching and learning methodologies.

2.6 Conclusion

Over the last two decades, the lingering "Mathematics Problem" and the urge for success in international comparative assessments, altered Ireland's mathematics education agenda. Teachers experienced multiple changes to their practices, including updated content, transformed teaching and learning practices, and new assessment strategies. Despite the multiple reforms to Junior Cycle and Leaving Certificate mathematics, TY, which can be deemed Ireland's curricular middle child, was forgotten.

The concept of preparedness was referred to throughout these reforms, yet government policies, curriculum documents and research studies still need to define preparedness. What does it mean to mathematically prepare students? The literature suggests that students need more than a knowledge of the mathematics content to be prepared for the 21st century. The modern world wants creative and critical minds with the ability to problem-solve and communicate mathematically. These skills should be developed in conjunction with the

curriculum rather than in isolation. Hence, this strengthens the approach of the Mathematics Preparedness Quadrant, which not only supports the student's academic development but also develops other curricular requirements. Further development of each quadrant comes from consultation with the literature presented in this chapter.

The Mathematical Preparedness Quadrants offer a solution to this question as they comprise of Academic, Social, Emotional and Skills-Based Preparedness. The quadrant aims to demystify mathematical preparedness and offer teachers a practical tool for curriculum planning.

Chapter Three: Methodology

3.1 Introduction to Methodology Chapter

The Economic and Social Research Institute (ESRI) in Ireland describes the purpose of educational research as addressing "policy issues critical to achieving greater equality of educational outcomes and improving the experience of students, teachers, principals and other stakeholders across education. The student voice is placed at the centre of the research, providing important insights into student experiences across the school system" (Economic and Social Research Institute, 2023, p. 1). This research study aspires to follow this same spirit, seeking to positively impact the teaching and learning of mathematics by defining mathematical preparedness. The definition will be co-created by a panel of experts in mathematics education, considered by students, and further examined by practising mathematics teachers.

This methodology chapter starts by outlining the researcher's objective for this study. Next, this chapter follows the research plan process outlined by Crotty (1998), including the research philosophy, theoretical framework, research methodologies and methods. This chapter presents a Mixed Methods Research (MMR) study with three components. Component one outlines the Delphi Study technique, component two tests the Delphi Study's co-created definition of mathematical preparedness through a student questionnaire, and component three captures the critical issues in mathematically preparing students from the teachers' perspectives. Finally, this chapter includes details relating to the piloting of the research methods, ethical considerations and research limitations.

3.1.1 Researcher Objectives

I consistently improve and develop my craft. However, I continuously question and battle with what I should prepare my students for, and how best to do this. Should I be preparing students to develop a love of mathematics learning, or to reduce the fear of numbers, or to

achieve an adequate amount of entry points for third level. For me, there is never only one area of preparedness; there is always more. I believe that my educational background impacts how I prepare my students. As previously mentioned in the introduction chapter, a particular A4 poster has remained on the whiteboard of my classroom throughout my many years of teaching numerous groups of students, "Fail to Prepare, Prepare to Fail". Initially placed on the whiteboard to encourage students to work hard with mathematics, this quote made me question what it means to be mathematically prepared.

The objective of this research is three-fold:

- Firstly, as a teacher, I wish to understand what it means to mathematically prepare students. This understanding will assist mathematics teachers to direct their classes in a specific manner to assist student learning. However, I understand that there are different perspectives on mathematics education, along with different opinions of preparedness. Hence, I plan to encompass numerous perspectives in co-creating an understanding of mathematical preparedness.
- Secondly, I want to explore how well this definition of mathematical preparedness is being achieved in TY, from the student perspective. This unique middle year in Ireland's post primary system is a pivotal point for students as they progress from Junior Cycle to Leaving Certificate. Furthermore, TY provides a perfect opportunity to expose students to multiple facets of preparedness, as it is less constrained by examinations, thus making it an ideal testing ground for this research study.
- Thirdly, I wish to explore the key issues, from the teacher's perspective, that must be considered in mathematically preparing students during TY. These key issues include addressing potential barriers and developing best practice guidelines for teachers.

Based on this research objective, this study has three research questions. These are:

1. What does it mean to be mathematically prepared, in the context of Transition Year Mathematics?
2. How do students' experiences of Transition Year, from three sample schools, reflect this definition of mathematical preparedness?
3. What key issues must be considered to mathematically prepare students during Transition Year?

I will not tackle the enigma of mathematical preparedness in isolation but will extend the remit to teachers, students, school inspectors, curriculum experts, university mathematics educators, and mathematics education national association members. In doing so, I aim to capture the different insights of multiple stakeholders in tackling the research questions. This collective approach to the research methodology is vital to the researcher, primarily as this research is situated in a professional context and examines an educational problem. Mills (2019) describes educational research as the formal and methodical application of the scientific method to understand problems in education. However, Mills (2009) warns that while this sounds like an easy task, it is always complicated to interpret, clarify, predict and manage situations with humans, as they are complex organisms. This complexity of educational research in TY is compounded due to the domesticated nature of the programme, which leads to significant variation in procedure, process, focus and intended outcome. Hence, I must be careful when selecting a suitable approach to the research. This study is part of a professional degree, and it is paramount to the researcher that practical solutions to the phenomenon emerge from this study and benefit the teaching and learning of mathematics.

3.1.2 Road Map of Research Questions and Methodology

This section outlines the methodologies and research methods utilised in answering the three research questions. There are three components to this MMR methodology:

1. Component one centres on the methodology of a Delphi Study, leading to the development of a co-created student questionnaire on mathematical preparedness. This component addresses research question one: **What does it mean to be mathematically prepared, in the context of Transition Year Mathematics?**
2. Component two sees this developed questionnaire administered to students who have completed/are completing Transition Year Mathematics to gather their experiences of mathematical preparedness. This component addresses research question two: **How do students' experiences of Transition Year, from three sample schools, reflect this definition of mathematical preparedness?**
3. Component three consists of semi-structured teacher interviews aimed at developing an understanding of the critical issues in mathematically preparing students. This component addresses research question three: **What key issues must be considered to mathematically prepare students during Transition Year?**

Table 3.1 below provides a "snapshot" of this methodology chapter outlining the three components of the MMR study. Each component includes the chosen research methodology, method, and design approaches and consists of an overview of the methodology component of this research study.

Table 3.1: Systematic Roadmap of the Methodology Components.

	Mixed Methods Research Study		
	Component One	**Component Two**	**Component Three**
Research Methodology	**Delphi Study**		**Case Study**
Research Question	**One**	**Two**	**Three**
Research Method	**Delphi Study Technique**	**Student Questionnaire**	**Semi-Structured Interviews**
Research Voice	**Experts**	**Students**	**Teachers**
Research Data	**Qualitative**	**Quantitative**	**Qualitative**
Research Design	**Delphi Study Technique**	**Descriptive**	**Exploratory Case Study**
Research Population	**Panel of Participants**	**Students**	**Teachers**
Sample Size	$n = 11$	$n = 248$	$n = 13$
Sampling	**Purposive**	**Voluntary/Purposive**	**Purposive**
Data Analysis	**Controlled Feedback**	**Statistical Analysis**	**Conventional Content Analysis**
Ethical Approval	**Sought from Panel**	**Sought from Parents & Students**	**Sought from Teachers**
Research Approach	**Inductive**	**Deductive**	**Inductive**
Research Medium	**Zoom & Qualtrics**	**Microsoft Forms**	**Microsoft Teams / Face to Face**

3.2 Research Plan

Creswell (2009) recommends that the researcher utilises a research plan in the organisation of the study, defining the research plan as the "procedures that span the decisions from broad assumptions to detailed methods of data collection and analysis" (p. 22). Several

researchers offer visual representations of research plans. Examples of those considered include the "Research Onion" by Saunders et al. (2019), the "Building Blocks" by Grix (2002) and the "Methodological Layer Cake", based on the work of Crotty (1998). Although all three research plans are similar in approach, the researcher decided to use an adaptation of the Crotty approach (1998), known as the "Methodological Layer Cake", as described by Loxley (2020). Loxley's (2020) approach contains four essential components: epistemology, theoretical framework, research methodology and research methods. Figure 3.1 illustrates Loxley's four components in Lego, drawn by the researcher as part of the Doctorate in Education coursework. Figure 3.1 also contains the additional research paradigm component of ontology, next to epistemology, an adaptation that stems from Mack (2010), who states that "ontological assumptions and epistemological assumptions tend to overlap – as Crotty said "to talk of the construction of the meaning is to talk of the construction of meaningful reality" (p.6).

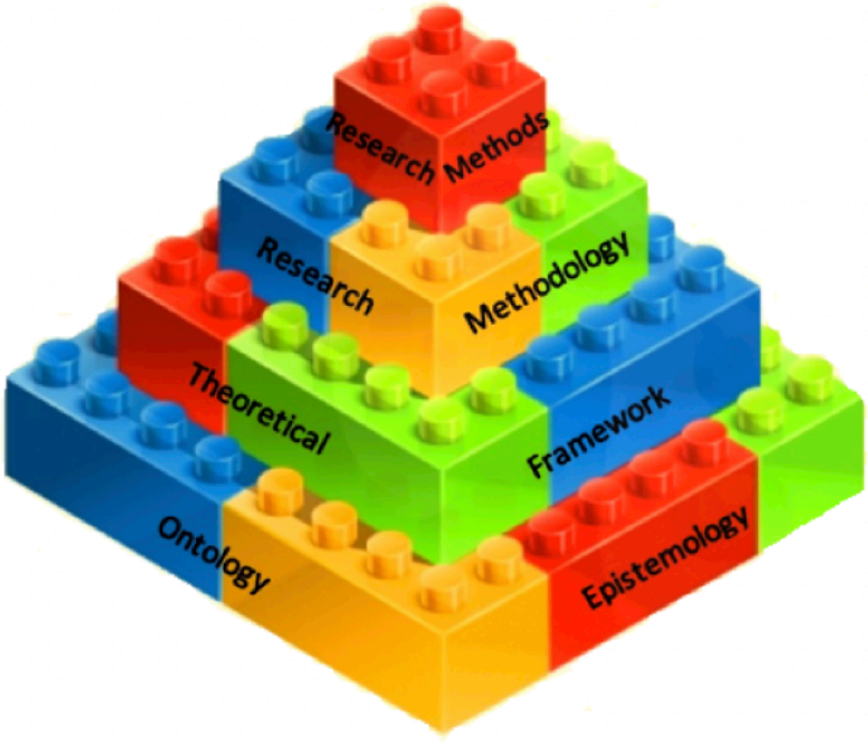


Figure 3.1: The researcher's visual of the research components described by Loxley (2020).

3.2.1 Loxley's (2020) Methodological Layer Cake

This section is subdivided into four main areas, as established by Crotty's (1998) four components of research: philosophies, theoretical framework, methodologies and methods.

3.2.1.1 Layer One: Research Paradigms, Worldviews and Philosophy

Creswell (2009) uses the term "philosophical worldview", with its meaning provided by Guba (1990, p. 17) as a "basic set of beliefs that guide action". However, other researchers utilised different terms with similar meanings. Lincoln et al. (2011) use the term research paradigms, and Crotty (1998) selected the term research philosophy, making specific reference to ontology and epistemology. Despite the differences in syntax, the essence of these different terms refers to the beliefs that guide an individual researcher to action. In this research study, the researcher will continue to follow Crotty's (1998) structure and utilise the ontology and epistemology terms of research philosophy.

Mack (2010, pp. 6-9) informs that several different ontological and epistemology viewpoints exist, including:

- Positivism – to prove or disprove a hypothesis, emphasising the scientific method, statistical analysis and generalisable findings. Positivism is based on the belief that reality can be observed.
- Interpretivism – can be described as "anti-positivism". It emphasises the ability of the individual to construct meaning. Research can never be objectively observed from the outside, but rather it must be observed from the inside through the direct experience of the people.
- Critical Theory – aims not to understand or give an account of behaviours in societies but to change these behaviours.

Teddlie and Tashakkori (2011) propose a fourth philosophical approach that merges elements from Positivism, Interpretivism and Critical Theory:

- Pragmatism – a practical approach to research that sheds light on the participants' behaviour, the beliefs that support these behaviours, and the consequences that follow (Kivunja & Kuyini, 2017).

Crotty (1998) defines ontology as "the study of being – it is concerned with 'what is'" (p.10). This ontological view is at the heart of research question one, which examines the "what is" of mathematical preparedness. Packer and Hwang (2014) discuss learning mathematics as an ontological change, suggesting that if mathematics education is viewed as a sociocultural activity, it involves some socialisation element during teaching and learning. This element of socialisation in mathematics education aligns with the work of Ernest (1991), who claims that the rationales, aims, and goals for mathematics teaching and learning do not exist in isolation, but rather that they belong to people, both individuals and social groups. However, this belonging can be viewed differently depending on the stakeholders' lenses.

Epistemology, conversely, can be described as "a way of understanding and explaining how we know what we know" (Crotty, 1998, p. 3). Dawkins (2020) captures the dilemma mathematics teachers face in preparing students, describing it as a modern-day crossroads that education institutions must navigate, while "helping students become educated citizens with 'critical thinking skills'" on one side and on the other "training students in the bodies of knowledge celebrated by the particular disciplines that comprise the academy" (p.1177). As this research aimed to address preparedness in mathematics education and hoped to provide practical guidance to teachers to assist in mathematically preparing students, the research study followed a pragmatic approach. Based on the works of Kivunja and Kuyini (2017), pragmatism forms a suitable match for the philosophical underpinnings of this study. The following reasons outline the suitability and rationale for the selection of this approach:

- Pragmatism offers a relational epistemology (acknowledges knowing as a process of developing insights). This epistemological standpoint supports the role of the professional teacher conducting research in a Professional Doctorate Degree.
- Pragmatism is a non-singular reality ontology (that there is no single reality, but individuals have their own interpretation of reality). Additionally, this ontological focus supports the work of Ernest (1991), as highlighted in section 2.2 of the literature review, on the importance of different ideologies in the development of the purpose of mathematics education.
- Pragmatism supports a value-laden axiology (research that benefits people), which aligns with the researcher's quest to advance knowledge that benefits teachers and students in mathematics education.
- Lastly, this pragmatic approach aligns with the TYP aims, which are to "promote the personal, vocational, social and educational developments of students and prepare them for their role as autonomous, participative and responsible members of society" (Department of Education and Skills, 1994, p. 3).

3.2.1.2 Layer Two: Theoretical Framework

Eisenhart (1991) defines the theoretical framework as a blueprint, which is "a structure that guides research by relying on a formal theory (or theories) constructed by using an established, coherent explanation of certain phenomena and relationships" (p.205). In addressing the research questions, while also considering the impact that TY has on students, three theories were considered: Constructivism (Cobb, 1994; Mugambi, 2018), Transformative Learning Theory (Mezirow, 2018), and Social Constructivism (Bächtold, 2013; Powell & Kalina, 2009).

A 30-year review of constructivism by the International Group for the Psychology of Mathematics Education (PME) summarised that constructivism in mathematics education contains three roots:

- Problem-solving (Polya & Conway, 1957).
- Misconceptions, critical barriers, and epistemological obstacles (Brousseau & Warfield, 2020).
- Theories of cognitive development (Piaget, 2013).

Although each of these three roots plays an essential role in mathematics education, in this context, none of them directly link to mathematical preparedness. Hence, constructivism alone will not be an appropriate theory for this research.

Transformative Learning Theory was considered due to the transformative or transitional impact that TY can have on a student's learning. This theory is the process of effecting change in a frame of reference, with a frame of reference being classified as "the structures of assumptions through which we understand our experiences, they selectively shape and delimit expectations, perceptions, cognition and feelings" (Mezirow, 2018, p. 92). A frame of reference can include cognitive and emotional components, and consists of two dimensions: habits of mind and a point of view. Mezirow (2018) describes "habits of mind" as a broad and abstract habitual way of feeling, acting and reasoning. Perpetual ways of thinking promoted during TYM may greatly assist students in developing positive feelings and attitudes towards learning mathematics. However, from the outset, this theory is focused explicitly towards adult learning and not that of second level students, with Mezirow (1997) stating that transformative learning is very different from the version of education associated with children. As this research focused on mathematics preparedness at second-level education, Transformative Learning Theory was unsuitable as a theoretical framework for this study.

Ernest (2010, p. 304) proposes Social Constructivism as a theory of learning mathematics, he argues that this term acknowledges that "both social processes and individual sense-making have central and essential parts to play in the learning of mathematics". Furthermore, Ernest (1991, p. 72) describes two critical features of the Social Constructivist theory in mathematics:

1. "There is the active construction of knowledge, typically concepts and hypotheses, on the basis of experiences and previous knowledge. These provide a basis for understanding and serve the purpose of guiding future actions".
2. "There is the essential role played by experience and interaction with the physical and social worlds, in both the physical action and speech modes".

The theory of Social Constructivism was selected as this study's theoretical framework for several reasons:

- The recognition that knowledge is constructed from experiences and previous knowledge sits well with TYM and the ideology that it acts as a bridge between Junior Cycle and Leaving Certificate.
- The purpose of the Delphi Study Panel of Participants was to co-develop an understanding of mathematical preparedness and to guide and improve future mathematics teaching.
- This theory emphasises the importance of the physical and social worlds in learning. It highlighted the importance of the social world, which aligned with the literature on Social and Skills-Based Preparedness.
- The physical aspect of this theory also aligns with the classroom dynamics, educational relationships and culture, which supported the literature on Emotional Preparedness.

3.2.1.3 Layer Three: Research Methodology

The research methodology enables the reader to understand the research process. In selecting a suitable research methodology in the research design process, the researcher addressed numerous planning questions. Cohen et al. (2017) stress that the researcher must address the following questions during the selection of a research methodology:

- How many methodologies are necessary?
- Are several methodologies compatible with each other?
- Will a single focus/research question require more than one methodology?

In addressing these questions, Cohen et al. (2017) suggest that a suitable methodology or methodologies emerge. The researcher considered these questions before choosing an appropriate methodology. Cognisant that this is a Professional Doctorate Degree, the methodology needed to capture the voice of both students and teachers while being situated in the classroom setting. The researcher was mindful of the aftermath of the global pandemic and did not wish to over-burden students or teachers as they re-adjusted to school life. As the researcher commenced his studies in 2019, the methodological planning for this study changed numerous times throughout the global pandemic. However, the safety of the students and participants was paramount to the researcher in selecting a suitable methodology.

As outlined in section 3.1.1 (research objectives), the researcher wanted to ensure that this study contributed, in a practical way, to the teaching of mathematics by co-creating a definition for mathematical preparedness. Furthermore, the researcher aimed to develop an understanding of students' experiences of mathematical preparedness in TYM and the key issues teachers face when mathematically preparing their students at this level. Hence, the researcher required a methodology that would include various professional opinions and perspectives on mathematical preparedness, while also including the student voice.

Numerous research methodologies emerged from the methodology requirements: Design-Based Research, Action Research, Phenomenology Research, Case Study and the Delphi Study Technique. In order to justify an appropriate research methodology, the researcher constructed a research objective comparative methodology table (see Table 3.2 below):

Table 3.2: Comparative Methodology Table.

	Design-Based Research	**Action Research**	**Phenomenology Research**	**Case Study**	**Delphi Study**
Develops an understanding of the phenomenon	✓	✓	✓	✓	✓
Captures the opinion of a wide range of stakeholders	✓	✓	×	✓	✓
Student-friendly methodology	×	✓	×	✓	✓
Captures the views of Teachers	✓	✓	✓	✓	✓
Manageable Timeframe	×	×	×	✓	✓
Pragmatic Approach	✓	✓	×	✓	✓
Develops an understanding of mathematical preparedness within TY	×	✓	×	✓	✓
Online Methodology	×	✓	✓	✓	✓

Table 3.2 shows that two research methodologies, Case Study and Delphi Study, aligned with the research objective. Each of the above research methodologies are expanded on below and a further rationale for not selecting Design-Based Research, Action Research or Phenomenology Research is provided.

It is important to note that throughout the study, the researcher remained cautious of the possibility of further governmental lock-downs, school closures, and other emergency

pandemic health measures. Hence, an openness to moving the research online at short notice was essential due to the timing of the data collection. The researcher had to ensure that the selected methodologies were flexible and adaptable. This rationale was also in keeping with the research philosophy of pragmatism, with Kaushik and Walsh (2019) stating that researchers should select and optimise the methodological approach that best suits their research problem.

Design-Based Research

Design-Based Research can be defined as "a systematic but flexible methodology aimed to improve educational practices through iterative analysis, design, development, and implementation, based on collaboration among researchers and practitioners in real-world settings, and leading to contextually-sensitive design principles and theories" (Hannafin & Wang, 2005, p. 6). This research methodology involved addressing complex problems in authentic contexts, collaborating with practitioners, and utilising reflective inquiry to test and refine innovative learning environments (Herrington et al., 2007). While Design-Based Research has traits similar to other research methodologies, it comprises five defining characteristics: pragmatic, grounded, interactive, iterative and flexible, contextual, and integrative. While this research methodology aligns well with the research objective of capturing the voices of multiple stakeholders and aims to improve educational practices, the core element of iterative analysis and design did not align with the time requirement of this study. Each iterative round may take months to host, and due to the one year cycle of the Transition Year Programme (TYP), this methodology was not practical.

Action Research

Efron and Ravid (2013) describe Action Research as situational and practical in the researcher's context. Furthermore, they define Action Research as being systematic and constructivist. While these elements aligned with the researcher's objective, like Design-

Based Research, Action Research is cyclical. The research objective did not align with repeated cycles to address a problem with mathematical preparedness in TY, but instead, it aimed to develop a mutual understanding of mathematical preparedness. Further to this, Ferrance (2000) specified what Action Research is not, stating that "it is not problem-solving in the sense of trying to find out what is wrong" nor is it "about learning why we do certain things" (p.3). Also, as action research emerges over time, it did not match the requirements of the research objective. Therefore, as the first question for this study aimed to understand mathematical preparedness, this methodology was unsuitable.

Phenomenology Research

Eddles-Hirsch (2015) states that "phenomenologists are interested in the analytical and descriptive experience of phenomena by individuals in their everyday world" (p.251). Hence, this method centres on the phenomena that have impacted an individual person, and not a collective. Although this research study aimed to gather the opinions and perspectives of numerous individuals (teachers, students, curriculum experts, Initial Teacher Educators (ITE), and lecturers), it was not focused on the individual experience of mathematical preparedness but on the collective. Hence, phenomenology research was not suitable for this research study.

Delphi Study

Green (2014) defines a Delphi Study as "a communication structure aimed at producing a detailed critical examination and discussion…useful in educational settings in forming guidelines, standards, and in predicting trends" (p.2). Young and Jamieson (2001) outline the main criteria needed when deciding if a Delphi Study is a suitable methodology

a) The research question does not lend itself to precise analytical techniques but benefits from subjective collective judgements.

b) Individuals are needed to examine a complex problem, and they represent diverse backgrounds in expertise and/or in experience.
c) The heterogeneity of the participants must be preserved to ensure the validity of the results.

The research rationale for this study met all three elements of this criteria. Furthermore, as the Delphi Study structures group communication and leads to a consensus, it aligned with the research objective. In particular, this research methodology included the voices and perspectives of numerous stakeholders, which matched the research objective of a collective co-created definition of mathematical preparedness. Hence, a Delphi Study was the primary methodology for the first phase of the study. This methodology was used to address research question one: What does it mean to be mathematically prepared, in the context of Transition Year Mathematics?

Case Study

Creswell (2009, p. 30) defines a case study as "a qualitative design in which the research explores in depth a program, event, activity, process or one or more individuals. The case(s) are bound by time and activity, and researchers collect detailed information using a variety of data collection procedures over a sustained period". As research questions two and three referred to a specific programme (Transition Year), a research methodology that examines a specific case is the most suitable. While the Delphi Study technique is appropriate for the development of a theoretical and conceptual understanding of mathematical preparedness, the research objectives for this study also required an in-depth exploration of the status quo from the perspectives of students and teachers. This need arose from the research objectives. Hence, the researcher decided to include a second methodology, a case study. Here, the case referred to TYM, while the units of analysis referred to interviews. This second

methodology, of a case study, combined with the primary methodology of a Delphi Study, was used to best address the research questions.

Although the case study definition refers to collecting data from various sources, this section utilised only one method. However, this phase of the methodology, combined with the literature and phase one of the methodology, resulted in the triangulation of the data sources. Furthermore, pragmatism supports the pluralism of methods (Kaushik & Walsh, 2019).

3.2.1.4 Layer Four: Research Methods

Loxley's (2020) final layer focuses on research methods. Cohen et al. (2017) define research methods as "the range of approaches used in educational research to gather data which are to be used as a basis for inference and interpretation, for explanation and prediction" (p.47). Furthermore, Creswell (2009) suggests that in selecting the research method, the researcher provides a rationale for their choice. He suggests that if the problem calls for the "identification of factors, the utility of an innovation or the understanding of the best predictors of outcomes", then a quantitative approach is best. Alternatively, if "a concept or phenomenon needs to be understood because little research has been done on it, then it merits a qualitative approach" (p. 35). However, as the research questions for this study aimed to explore the concept of mathematics preparedness, a relatively understudied phenomenon with limited international literature, and the role that TY can play in mathematically preparing students, a combination of both qualitative and quantitative methodologies was needed.

This research is comprised of a mixed methods approach. Bryman (2006), in Kaushik and Walsh (2019), acknowledge the use of mixed methods in pragmatic research, stating that "the dominance given to the research question in pragmatism means that research brings

together quantitative and qualitative research is feasible, desirable, and also required to address certain research question or combinations of research questions*"* (p. 255).

3.3 Mixed Methods Research: The Three Components

As a result of the global pandemic, the researcher had to be pragmatic with the data collection methods. The researcher was aware that the data collection methods may need to be moved online with short notice due to public health advice. Furthermore, the researcher was aware that some of the participants may be apprehensive about large gatherings of people due to viral transmission. Hence, an online mixed method research approach was best suited to this study.

Component one (Delphi Study) comprised of both qualitative and quantitative approaches, while component two (student questionnaire) was quantitative, and component three (teacher interviews) was qualitative. It was pragmatic to capture the perspectives of many students' opinions of their experience of TY through a quantitative student questionnaire. However, the researcher was conscious that a more detailed investigation of teachers' experiences of mathematical preparedness was needed. Hence, the decision to host qualitative teacher semi-structured interviews. Ponce and Pagán Maldonado (2015) claim that a mixed method research approach, which includes qualitative and quantitative data collection, combines the best possible approach to the research problem as a dual method allows for a precise and deeper understanding of the research problem. The choice of mixed methods enabled the researcher to best address the research questions. The qualitative approach captured the essence of mathematical preparedness, whereas the quantitative approach highlighted students' experiences of the Delphi Study's co-created definition of this phenomenon.

This section elaborates on each of the three components of the Mixed Method Research study.

3.3.1 Component One: Delphi Study Methodology

Mathematics teachers must ensure that they adequately prepare students for the changing dynamics of the classroom and society. Teachers may view this as predominantly preparing students for mathematics in the classroom, specifically for the Leaving Certificate examinations. Others might view it as mathematically preparing students for the 21st century beyond the four walls of a mathematics classroom. In each case, the question of what it means to mathematically prepare students arises. Of course, different stakeholders offer differing perspectives on this concept. A Delphi study methodology was used to address research question one: What does it mean to be mathematically prepared, in the context of Transition Year Mathematics? This aspect of the research brings together the various stakeholders' voices to develop a co-constructed understanding of what it means to be mathematically prepared.

3.3.1.1 Rationale for Delphi Study

Dalkey and Helmer (1963), developers of the Delphi Study, stated that the main aim of this technique is to reach a reliable consensus opinion from a group of experts. Since its origins, others have offered subsequent definitions and variations to the evolution of this technique. McGaw et al. (1976) provide the following meaning: "The Delphi Technique is a method of eliciting opinions or judgements which provide respondents with an opportunity to revise earlier views when presented with additional information" (p.59). Alternatively, Green (2014) describes the Delphi Study technique as "a communication structure aimed at producing a detailed critical examination and discussion" (p.1). Lastly, Linstone and Turnoff (1976), as cited in Okoli and Pawlowski (2004, p.16), provide the following comprehensive definition:

> *"Delphi may be characterized as a method for structuring a group communication process so that the process is effective in allowing a*

group of individuals, as a whole, to deal with a complex problem. To accomplish this 'structured communication', there is provided: some feedback of individual contributions of information and knowledge; some assessment of the group judgement or view; some opportunity for individuals to revise views; and some degree of anonymity for the individual responses".

This final definition provided the rationale for selecting the Delphi Study technique as the research methodology. This research study examined the complex problem of including mathematical preparedness in TYM. The intricacy lies in the fact that TYM can be interpreted differently in every school in Ireland due to its domestication. The brilliance of TYM is that the autonomy of creating and teaching the programme lies with each individual school and with the teachers teaching the course. Annually, TYM sees new students, innovative topics, and different teachers. While each of these factors breathes new life into the programme, it makes it challenging to interpret mathematical preparedness due to the constant state of flux. Hence, the selection of a Delphi Study methodology for this study included the opinions of many individuals to find a consensus on what it means to be mathematically prepared. Several adaptations of the original Delphi Study technique evolved as described by Dalkey and Helmer (1963), and similarly, this study presented modifications to the original structure. Modifications were necessary due to the uniqueness of the TYP and to ensure a richer conversation about mathematical preparedness occurred. A study by Okoli and Pawlowski (2004) compared a traditional survey with the Delphi Method using a range of evaluation criteria, including procedure, representativeness, sample size, individual and group responses, and richness of data. They claim that the procedure of design is similar for both methods. However, fundamental differences occurred in the sample's representativeness, the response style, and the richness of the data.

Unlike surveys, the Delphi Study method usually contains complex questions likely to possess a high degree of uncertainty and speculation, which the general population may need to be versed in to answer sufficiently. Furthermore, the Delphi Method is a group consensus rather than individual representation. Okoli and Pawlowski (2004) claim that studies have repeatedly shown that individual responses are inferior to those of a group decision process in cases of addressing complex questions requiring expert judgement.

3.3.1.2 Expert Group – Panel of Participants

The localisation of the TYM programme and its insular nature inferred a vital need to gather the diverse viewpoints of various stakeholders. The Delphi Study captured a heterogeneous group of experts to synthesise their perspectives into a concise overview of what it means to be mathematically prepared. Although Nworie (2011) stated that each panel member should be an expert in the field, the definition of what it means to be an expert can vary between studies. Grisham (2009) provides one such definition for an expert as someone with over 20 years working in the area. While mathematical preparedness will have a global reach, the parameters of this research study focused exclusively on the Irish context. Hence, there is a requirement to limit the scope and definition of the expert panel. Although focusing on people with experience and knowledge of TYM may seem limited, a Delphi Study is independent of statistical sampling for representative purposes (Okoli & Pawlowski, 2004). Instead, the definition of an expert in this study was open to those who understand and have experience working within mathematics education and TYM. Furthermore, all the panel members met the four requirements of an "expert" outlined in Skulmoski et al. (2007): knowledge and experience with the topic, capacity and willingness to participate, sufficient time to dedicate to the study, and effective communication skills.

3.3.1.3 Knowledge Resource Nomination Worksheet

Following on from the definition of an expert, in the context of the research study, Okoli and Pawlowski (2004) recommend constructing a Knowledge Resource Nomination Worksheet (KRNW) to select experts. Figure 3.2 contains an adapted version of the KRNW, with a description of each of the criteria:



Figure 3.2: Overview of the Knowledge Resource Nomination Worksheet (KRNW) as Okoli and Pawlowski (2004) described.

Step One: Preparing the KRNW

The selected expert panel were derived from multiple disciplines, including teachers of mathematics (including trainee, practising and experienced teachers), curriculum and policymakers, school inspectors and guidance counsellors (with backgrounds in mathematics).

Step Two: Populating the KRNW

Pseudonyms, letters of the Greek alphabet, were applied to protect the identity of the Panel of Participants at this stage of the KRNW. Table 3.3 provides an overview of the experts, their discipline and their organisation.

Step Three: Nominate Additional Experts

The nomination of two additional experts occurred at this stage. Their names arose from conversations with other experts about the panel's composition.

Table 3.3: Overview of Step Two and Step Three of the KRNW.

α	β	γ	δ	ε	ζ
Teacher	Teacher	Curriculum / Policy	Guidance Counsellor	Maths Ed Lecturer	Maths Ed Lecturer
Public School	Fee-Charging School	National Body	Public School	University	University
η	θ	ι	κ	λ	μ
Curriculum / Policy	Maths Ed Lecturer	Maths Ed Lecturer	Teacher	Curriculum / Policy	Past Pupil
Public School	University	University	Public School	National Body	Student
ν	ξ	o	π	ρ	σ
Past Pupil	Teacher	Guidance Counsellor	Inspector	Teacher	Maths Ed Lecturer
Student	Public School	Public School	Government	Public School	University
τ	φ				
Past Pupil	Inspector				
Student	Government				

While many experts agreed that the panel contained all the relevant stakeholders, some questioned the rationale for excluding current TY students from the KRNW. The decision for their exclusion was two-fold. Firstly, due to the timing of the Delphi Study, TYM students were only in the first term of their TYM programme and may have yet to engage with the whole TYM experience. Secondly, TYM students did not meet the above-established requirements of an expert for this Delphi Study. In place of this exclusion, three past pupils (Expert μ, Expert ν and Expert τ) who completed TY within the last five years and who are studying a mathematics-based programme at university were considered eligible to be experts.

The second additional nominated expert emerged from discussions with Expert ε and Expert ρ. Both experts stressed the importance of including teachers from a broad range of school types in Ireland to ensure an inclusive overview of mathematical preparedness across Ireland. These school types include Community and Comprehensive, Educate Together, Education and Training Boards, Voluntary Secondary, and Fee-Charging (Private) Schools. Initially, the researcher identified four experts from these sectors. However, there was a need to recruit an expert from the Educate Together school sector to represent the views of this sector. Hence, the addition of Expert α to the KRNW. With the additions to the KRNW, 20 experts progressed to the next step of the process. A Delphi Study can have between 7 – 30 experts. However, 5 – 10 experts are considered adequate (Skulmoski et al., 2007). Hence, with the expected non-participation of some of the experts, the Delphi Study still had enough members to meet the recommended quota for a rich discussion.

Step Four: Rank Experts

This step of the process is illustrated in Figure 3.3 below, which highlights the six different expert categories.

Step Five: Invite Experts

Step five saw the issuing of invitations to all the identified experts. Invitations were emailed to all between November 14th – 30th, 2021 (see Appendix A). Initially, $n = 14$ experts agreed to participate. Unfortunately, experts $\beta, \zeta, \theta, \mu, \xi$ and σ could not participate in this Delphi Study for multiple reasons, including schedule clashes, lack of awareness of the research area, and failure to respond to the invitation. The researcher conversed with some experts to address questions about the process and to clarify their role in the Delphi Study. As a result of these conversations, some participants were wary of the term "expert". While several participants considered themselves highly knowledgeable in the field of mathematics education in Ireland, they were reluctant to deem themselves experts.

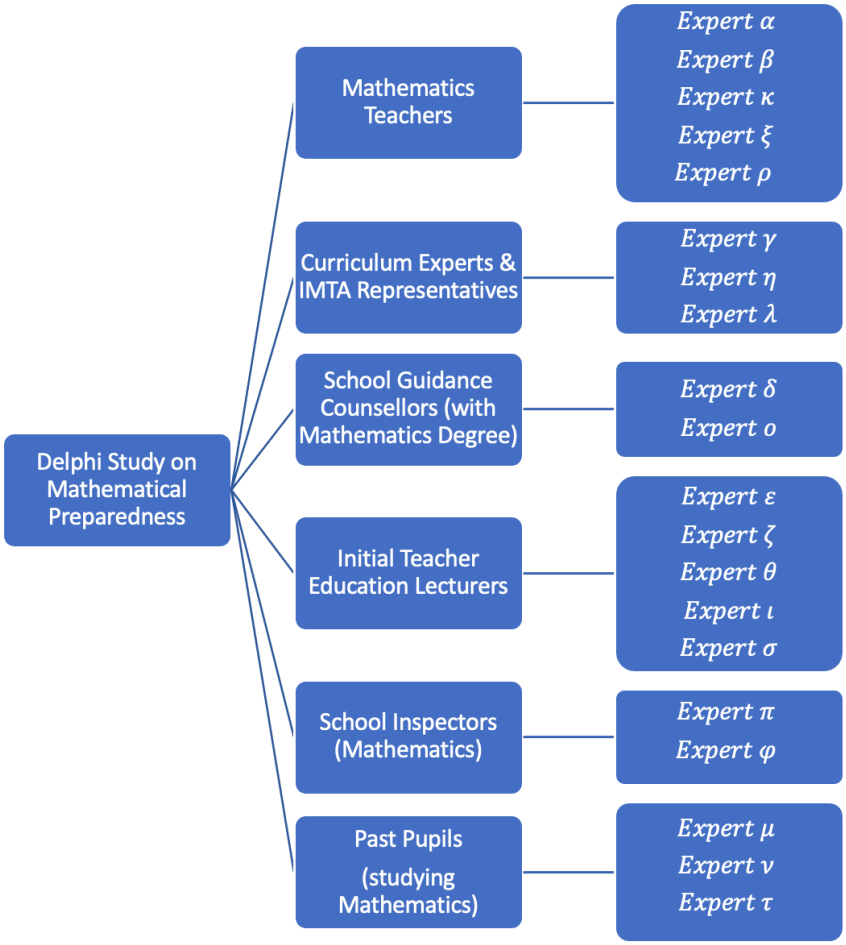


Figure 3.3: Overview of Step Four of the KRNW.

The literature has debated the appropriateness of using the term "expert" in a Delphi Study, arguing that its use should not be ascribed directly by the person. However, the descriptor of "expert" should be reserved for attributing by others, concluding that the term "expert" may not be necessary or significant in the Delphi Study (Nasa et al., 2021; O'Brien, 1978). Similarly, Dalkey (1969), one of the founders of the Delphi Study, provided his insights into the terminology, stating that a Delphi Study is a "rapid and relatively efficient way to 'cream the tops of the heads' of a group of knowledgeable people" (p.16). Irrespective of the terminology, what was important was the perceived contribution and the richness that an individual could offer to the study rather than the label. Nonetheless, from that moment forward, the researcher used the term "Participant" or "Panel of Participants" for those partaking in the Delphi Study rather than "expert".

3.3.1.4 Finalised Delphi Study Panel of Participants

Each of these participants and their discipline is listed below in Figure 3.4. Participants were divided into two groups for the initial discussion; group one was coloured orange, while group two was coloured green. Unfortunately, on the day of the Delphi Study discussion, three participants (γ, ν and φ) were unavailable, making it impossible to achieve an equilibrium of disciplines within both groups. However, several participants acted in a dual capacity throughout the Delphi Study. For example, both Curriculum Experts and IMTA Representatives (Participants η and λ) are also experienced mathematics teachers at post-primary level. Similarly, Participant π is also an experienced teacher of mathematics. Several participants are also parents and may have brought this perspective to the Delphi Study Panel of Participants.

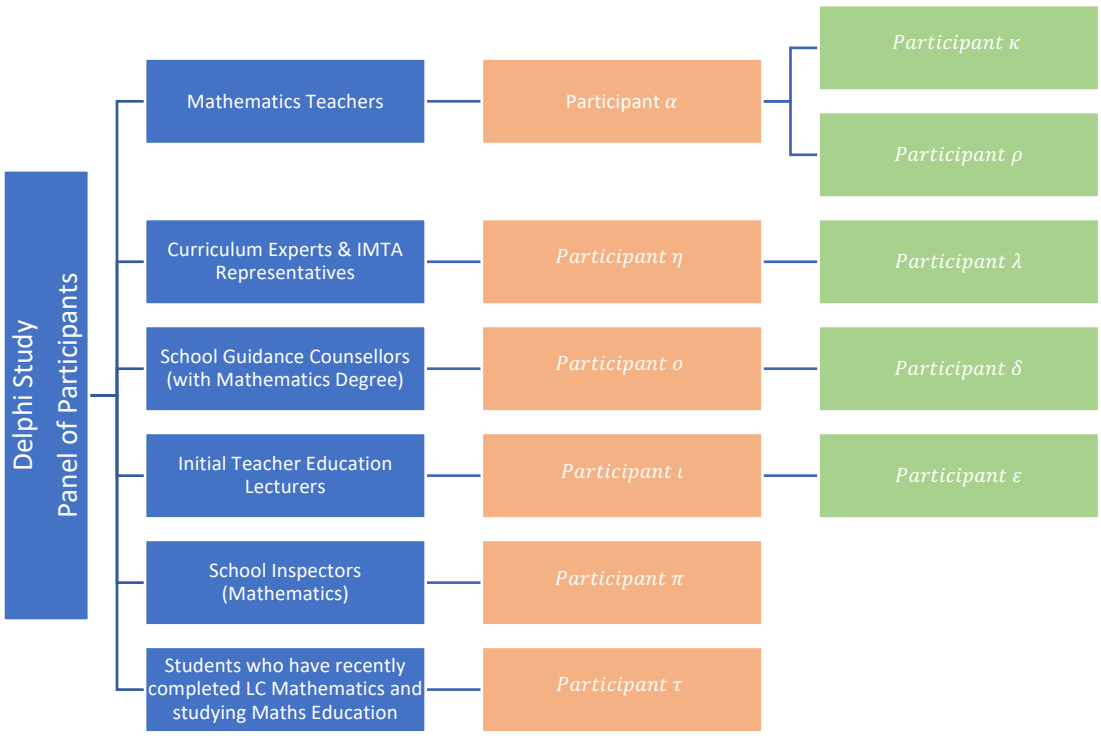


Figure 3.4: Overview of Step Five of the KRNW and the final two groups of the Delphi Study Panel of Participants.

3.3.1.5 Modified Normative Delphi Study and Adaptations

As previously mentioned, there was a minor modification to the Delphi Study, due to the complexity of the research questions. The modification of a Delphi Study is neither uncommon nor unusual, with McGaw et al. (1976) remarking that there have been numerous addendums to the Delphi Study technique since its first introduction. These researchers also comment on the benefits of selecting a Normative Delphi Study rather than an Exploratory Delphi Study, stating that a Normative Delphi Study is designed to "facilitate goal formulation, to establish the shape of the future that is desired, not to predict the shape of the future that will be" (p.61). Martino (1999), as cited in Novakowski and Wellar (2008), defined a Normative Delphi Study as "explorations of what should be, given current knowledge, and obtaining consensus about a preferred future state or process is typically the primary research objective" (p. 1486). As this research study aimed to develop a workable definition of mathematical preparedness to assist teachers, produced from current knowledge and agreed on by a panel of knowledgeable participants, it followed the normative style.

There were two central adaptations to this Normative Delphi Study. Firstly, several studies highlight anonymity as a critical feature of a Delphi Study (Diamond et al., 2014; Parrish & Sadera, 2020; Rose et al., 2019). This Delphi Study could not provide anonymity to participants, as the first phase, the discussion phase, was hosted online via Zoom. Instead, this phase relied on professional confidentiality among participants.

Secondly, as the first phase of this Delphi Study took place online, it was necessary to form two groups of participants rather than one, as illustrated in Figure 3.4 above. Each group reverted to the larger group with feedback at the end of their discussions. The remaining elements of the Delphi Study followed the classic approach as outlined by Okoli and Pawlowski (2004), Dalkey and Helmer (1963) and van Zolingen and Klaassen (2003).

3.3.1.6 Introduction to the Delphi Study Phases

This modified Delphi Study comprised three phases: discussion, controlled feedback, and consensus. Figure 3.5 below provides the schematic overview of these three phases of the Delphi Study for the Panel of Participants.

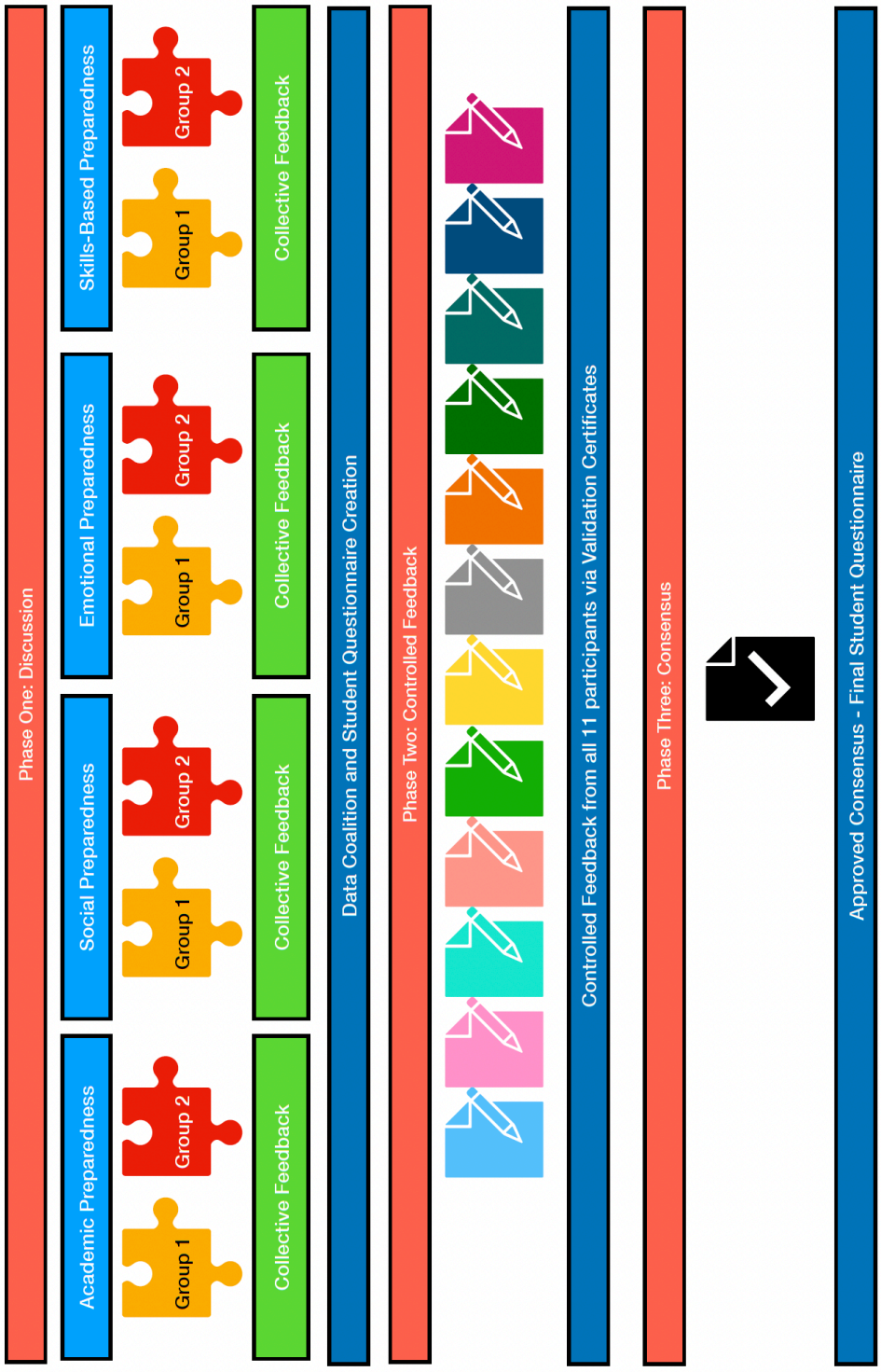


Figure 3.5: Schematic Overview of the three phases of the Delphi Study.

Delphi Study Phase One: Discussion

The discussion was held online via Zoom on December 2nd, 2021. The Panel of Participants received brief introductions to the other panellists, followed by an introduction to the Delphi Study process and a reminder about professional confidentiality. Phase one comprised of four rounds based on the identified areas of mathematics preparedness — each round contains an introduction to the area of preparedness as outlined in the literature review (section 2.5). The preparedness quadrant stemmed from an initial conceptualisation and operationalisation of the literature on mathematics education. The purpose of the Delphi Study Panel of Participants was to further develop the quadrant based on their diverse knowledge and expertise of mathematics education. Both subgroups had a 15-minute discussion on each of the four areas of the quadrant, before a nominated participant gave feedback on the discussion. This process was repeated for the remaining three areas of preparedness. In constructing the first draft of the student questionnaire, the suggested feedback, comments and remarks were considered by the researcher.

Delphi Study Phase Two: Controlled Feedback

This second phase of the Delphi Study, known as controlled feedback, occurred between March 7th – 23rd, 2022. This stage of the Delphi Study maintained anonymity for the participants while reducing the effects of "noise", with Hsu and Sandford (2007, p. 2) defining "noise" as the "communication which occurs in a group process which both distorts the data and deals with group and/or individual interests rather than focusing on problem-solving". The objective of the controlled feedback stage was to check that the researcher authentically and correctly captured the views of the Panel of Participants in the design of the student questionnaire.

Participants used the Qualtrics XM Platform to rate their agreement or disagreement with each statement and to provide other feedback on the first draft of the student questionnaire.

Participants used the free-text comment box to provide additional feedback (see Appendix B for a sample from the Qualtrics XM Platform). The feedback received from each participant, including their rating of the statements and overall comments, was referred to as a validation certificate. Once every member completed this process, the validation certificates were reviewed and considered, resulting in alterations to the student questionnaire.

Delphi Study Phase Three: Consensus

This third and final phase of the Delphi Study process saw a consensus reached on the student questionnaire. Each participant agreed that the student questionnaire reflected the proposed, co-created definition of mathematical preparedness.

3.3.2 Component Two: Student Questionnaire

Component two of the methodology built on stage one and saw the publication of the student questionnaire from the Delphi Study Panel of Participants (Appendix D). This stage of the methodology addressed research question two: How do students' experiences of Transition Year, from three sample schools, reflect this definition of mathematical preparedness? This component of the research methodology contains details of the student questionnaire, piloting, research schools, and analysis strategy.

3.3.2.1 The Student Questionnaire

The student questionnaire consisted of five sections. Section one included the biographical overview of students, including questions on gender, age, level of mathematics studied for Junior Cycle/Certificate and the level of mathematics chosen for Leaving Certificate. The remaining four sections followed the same organisational structure as the literature review (section 2.5) and agreed by the Delphi Study Participants, based on the four quadrants of mathematical preparedness. Quadrant One (Academic Preparedness) and Quadrant Two (Social Preparedness) both contained 18 statements, while Quadrant Three (Emotional

Preparedness) contained 16 statements and Quadrant Four (Skill-Based Preparedness) contained 17 statements. Students used a Likert scale to give their opinions on each statement.

3.3.2.2 Student Questionnaire Piloting

Following the validation of the student questionnaire by the Delphi Study Panel of Participants, a pilot test was conducted on April 5th, 2022. Hassan et al. (2006) advise that a pilot study can help researchers to identify and modify any potential problems and deficiencies with research instruments before the full rollout of the instrument. Doody and Doody (2015) highlighted the essential features of a pilot study, including providing the researcher with an overview of the timing, personnel, material, and resources necessary for data collection. These insights assisted the researcher in planning the broader data collection phase. As this study consists of working with students, it was valuable to understand the time students took to complete the questionnaire and ensure that the language was appropriate for students aged 15-19 years. As the researcher opted for a digital student questionnaire, access to the internet and password-protected computers in the research schools were considered. This pilot study provided an opportunity to rectify and pre-empt any future challenges.

The pilot study group consisted of nine students from one of the sample schools. Each student had completed or was completing TY. None of these students participated in the finalised student questionnaire. Peterson and Panofsky (2020) suggest that researchers should include a reflection on the changes and improvements made to their research instruments because of conducting a pilot study. In doing so, researchers contribute to meta-research and advance knowledge. The pilot study highlighted two main observations, one based on access to the student questionnaire and the second on the potential bias between the researcher and students in one of the three schools:

1. Some pilot members needed help remembering their unique login credentials to access the password-protected school computers. Students were encouraged by their teachers to retain their credential details in their student journal. Hence, before starting the student questionnaire, some students had to return to class to get their student journals, resulting in a delay. On reflection, the researcher decided to pre-load the questionnaire onto all the computers before students started the questionnaire. Additionally, in the two other sample schools, one is a school that uses iPads, and the second is a fee-charging school where students have access to their electronic devices and mobile data; a generated QR code (quick response code) resulted in swifter access to the questionnaire.
2. Secondly, some pilot members revealed that students might be reluctant to respond honestly to the questionnaire if administered by one of the Deputy Principals in their school. Hence, to address this potential situation, another teacher from a different subject department administered the questionnaire in the researcher's school.

The pilot study group commented positively on the accessibility of the student questionnaire, finding it easy to follow and enjoyable.

3.3.2.3 Research Schools Profiles, Participant Recruitment and Sampling

Three schools, with the pseudonyms of The School of Athens, The Lyceum and The Academy, completed the questionnaire:

- The School of Athens is a large co-educational, public multi-denominational school, with TY optional for students.
- The Lyceum is a large co-educational, public multi-denominational school, with DEIS status (Delivering Equality of Opportunities in Schools), with TY optional for students.

- The Academy is a medium-sized all-boys, fee-charging Catholic school, with TY compulsory for students.

Due to the constantly changing landscape during the global pandemic, the researcher opted for voluntary sampling from three schools. Students from TY, 5th and 6th year were recruited during terms two and three of the academic year 2021/2022. Between March 24th – May 18th 2022, the researcher received $n = 248$ completed student questionnaires.

3.3.2.4 Analysis Strategy

Data from the student questionnaire was analysed using the IBM SPSS (Statistical Package for the Social Sciences) programme. The analysis included descriptive (such as modes of central tendency, variability, and distribution) and inferential statistics. Furthermore, statistical tests were conducted, including the Kruskal-Wallis test, to examine if there are statistically significant differences between the data sets.

3.3.3 Component Three: Semi-Structured Teacher Interviews

This third component of the methodology focused predominantly on the opinions of TYM teachers on mathematical preparedness. Through a case study, $n = 13$ mathematics teachers participated in semi-structured interviews, sharing their insights and perceptions on mathematical preparedness and TY. This third and final stage of methodology addressed research question three: What key issues must be considered to mathematically prepare students during Transition Year?

This stage outlines the research methodology, rationale, and methods for this phase. It will provide an overview of the interview schedule, details on piloting, limitations, and the analysis strategy for this stage.

3.3.3.1 Research Methodology: Exploratory Case Study

Yin (2014) subcategorises a case study into three groupings: descriptive, explanatory and exploratory. Zainal (2007) offers the following definition for an exploratory case study: “to

explore any phenomenon in the data which serves as a point of interest to the researcher" (p.3). Although Yin (2014) and Zainal (2007) warn that this form of case study usually results in further questions about the phenomena emerging, the researcher tackled this by selecting a corresponding suitable research method. In addressing the research objective, the researcher selected a single case study approach. The rationale for this decision was that the research objective aimed to explore the key issues faced by teachers in mathematically preparing students during TY. As two of the research questions (RQ2 and RQ3) focused on the TYP, it was logical to utilise a single case study, where the case itself was TY and the units of analysis were teacher interviews.

3.3.3.2 Research Method: Semi-Structured Interviews

In keeping with the research methodology of a case study, the researcher selected semi-structured interviews as the research method for this phase. This decision stemmed from the overall research rationale of capturing the insights of a small sample of teachers on the concept of mathematics preparedness. Although the researcher considered other options, such as observation and focus groups, special consideration was given due to the impact of the global pandemic. Classroom observation at the time of data collection increased the exposure of the researcher to other schools, staff, and students, and vice-versa. Similarly, focus groups might have deterred some teachers from partaking due to the large gathering of people. Hence, the researcher conducted online or individual face-to-face interviews with the participants based on their preferences. Pathak and Intratat (2012) support the use of interviews as a research method, stating that two-way communication between conversational participants can elicit more information in a research study.

Kvale (1994), as cited in Hobson and Townsend (2010), described interviews as "construction sites for knowledge" (p.14) where "the outcome is a co-production of the interviewer and the [research] subject" (p.xvii). Kvale (1994) further describes interviews

as a shared process between two people with similar interests. This mutual interest fosters a natural approach to interviews, which enables the participants to feel comfortable and to openly share their opinions with the researcher in a natural manner (Griffee, 2005). This natural setting aligns with Yin (2014), who encourages using interviews as a research method in a case study. Although there are several types of interviews, the researcher decided on the semi-structured approach, which is "designed to ascertain subjective responses from persons regarding a particular situation or phenomenon they have experienced" (McIntosh & Morse, 2015, p. 1).

Furthermore, semi-structured interviews enabled participants to answer as they wish, empowering the researcher to probe their responses. This approach is particularly important as teachers take different approaches to class formation, selecting topics and teaching approaches, and have different viewpoints on the purpose of TYM. McIntosh and Morse (2015) support semi-structured interviews, stating that they assist the researcher is gaining full coverage of their agenda, while also ensuring that the interviewee gets the opportunity to talk about the significant points from their perspective.

3.3.3.3 Interview Schedule

Guided by the work of McIntosh and Morse (2015) and Adams (2015), the researcher produced an interview schedule (Appendix E), which started with an introduction to the research study and customary pleasantries to establish rapport. Next, the interview schedule progressed into a series of open and closed questions, with supporting probing questions on the case of TYM. The researcher selected the questions carefully to gather the participants' unstructured responses and initiate a conversation on the case. Although the researcher had developed a structure for the interview format, he maintained the interview flow based on the participant's answers. Semi-structured interviews allow such freedom (Irvine et al., 2013).

The pre-prepared questions focused on the broader outline of teacher opinions of TYM. These included the purpose of TYM, teachers' willingness to teach this programme, topics chosen, planning and assessment, and the research questions. The timeline for conducting and collecting this data ran from May 11th until June 21st, 2022, with $n = 13$ teachers participating in single 40-minute interviews. Eleven interviews were held online via Microsoft Teams, with two in-person interviews.

3.3.3.4 Piloting

The researcher followed the six self-reflection steps in piloting the interview schedule process (Abdul Majid et al., 2017; Chadwick et al., 1984). The researcher ensured that the interview schedule included all the necessary questions in a logical manner, with meaningful language for the participant. The pilot occurred on May 5th and 6th, 2022, with three mathematics teachers who did not partake in the research study. This piloting ensured that no language misinterpretations or double meanings were attached to a single question. Furthermore, the piloting provided an overview of the timing, pace and motivation needed. Based on the feedback from the pilot study, the interview schedule did not require any changes.

3.3.3.5 Analysis Strategy

Qualitative data analysis can take many forms, and the process of selecting one form of analysis can be a daunting task. Patton (2002, p. 432) states, "qualitative analysis transforms data into findings. No formula exists for that transformation. Guidance, yes, but no recipe. Direction can and will be offered, but the destination remains unique for each inquirer, known only when – and if – arrived at". The researcher considered two analysis strategies for this phase of the methodology, namely Thematic Analysis and Content Analysis. Thematic Analysis involves actively and clearly finding repeated meanings

across a data set (Xu & Zammit, 2020). It acts as a mechanism for searching the data for important emerging themes that describe the phenomena.

In contrast, Content Analysis "validates or extends conceptually a theoretical framework or theory… it provides predictions about the variables of interest or about the relationships among variables, thus helping to determine the initial coding scheme or relationships between codes" (Hsieh & Shannon, 2005, p.1281). However, while both strategies are similar, Vaismoradi et al. (2013) claim that the main difference "lies in the opportunity for quantification of data. It means that measuring the frequency of different categories and themes is possible in content analysis" (p. 398). Hsieh & Shannon (2005) state that Content Analysis starts its coding schemes with a theory or relevant research findings to guide initial codes. As this study follows the theory of social constructivism and uses a quadrant structure of describing mathematical preparedness derived from the literature, this strategy of Qualitative Content Analysis was the format selected for the data analysis of this phase.

Qualitative Content Analysis

Qualitative Content Analysis (QCA) can be described as a research method for making replicable and valid inferences from data to their context, with the purpose of providing knowledge, new understandings, a depiction of evidence and a practical guide to action (Mayring, 2023). QCA proposes three approaches: Conventional Qualitative Content Analysis, Direct Content Analysis and Summative Content Analysis. These three approaches are independent of the next. Direct Content Analysis starts initial coding by following a theory of relevant research findings. In contrast, Summative Content Analysis starts with counting words and manifesting content into extended meanings and themes (Shava et al., 2021). Conventional Qualitative Content Analysis (CQCA), on the other hand, is described as a process that codes data which is "derived directly and inductively from raw data…used where a study design, whose aim is to describe a phenomenon…where

researchers immerse themselves in the data to allow new insights to emerge" (Shava et al., 2021, p. 554).

This research study followed an Inductive Conventional Qualitative Content Analysis approach. The rationale for selection stemmed from Hsieh and Shannon (2018), who claim that "when existing knowledge around a phenomenon of interest is largely absent and the purpose of a study is to create knowledge, an inductive approach or conventional qualitative content analysis is appropriate where codes and themes are generated directly from the data" (p.2). Furthermore, Thomas (2006) describes inductive analysis as "using detailed readings of raw data to derive concepts, themes, or a model through interpretations made from the raw data by an evaluator or research" (p.238). TY is unique to Ireland, and mathematical preparedness is relatively understudied internationally. Therefore, this approach adequately addressed the research question by using the data from the teacher interviews to understand TY's role in mathematical preparedness.

Inductive Conventional Qualitative Content Analysis (ICQCA)

As outlined by Elo and Kyngäs (2008), the researcher structured the ICQCA into three phases: preparation, organising, and reporting. All teacher interviews ($n = 13$) were transcribed and reviewed during the preparation phase before being uploaded to the NVIVO 12 software package. Initially, the researcher conducted a read-through of all interviews, which assisted the researcher in developing a sense of the responses. The initial units of analysis (categories and codes) also started to emerge from the data. A second read-through then followed. The researcher completed the read-through of all interviews promptly to ensure a consistent approach to data analysis.

Following the preparation phase, the organising phase saw the application of opening coding in NVIVO 12. The initial codes were grouped and placed into a suitable emerging category before each category was categorised and named.

This final stage of the process was reporting. Krippendorff (1980), as cited in Elo and Kyngäs (2008, p. 108), describes this phase as "making replicable and valid inferences from data to their context, with the purpose of providing knowledge, new insights, a representation of facts and a practical guide to action". This reporting phase consisted of a conceptual system that presented the emerging categories, nodes, and sub-nodes. This concept system will help to structure the findings for this methodology phase during chapter five.

3.4 Ethics Consideration

At level two, ethics approval was requested and granted by the Research Ethics Committee in the School of Education at Trinity College Dublin on July 21st, 2021. The confirmation of approval status is included in Appendix C. This ethical approval covered all three components of this MMR study, including gathering data from those under eighteen. The following sections outline the ethical considerations for each of the three components of this MMR study.

3.4.1 Ethical Considerations for Component One: Delphi Study

Before the commencement of this stage, the researcher provided each member of the Panel of Participants with detailed information about the Delphi Study process. The researcher also obtained informed written consent from each panellist (see Appendix A).

3.4.1.1 Confidentiality and Anonymity

As previously mentioned, phase one (discussion) of the Delphi Study process could not protect the identity of the participants, as it was conducted via the Zoom platform. However, as each participant is a teaching professional, the researcher emphasised the importance of professional confidentiality. The researcher reminded each participant that they were free to leave the Delphi Study discussion without explanation. Furthermore, participants were

reminded that their participation represented their views, and not the views of their organisation. Participants were given up to seven days to withdraw before transcription occurred and their names were anonymised.

3.4.2 Ethical Considerations for Component Two: Student Questionnaire

The student questionnaire was constructed and hosted on the Microsoft Office platform of MS Forms. However, students were not required to log in to Microsoft Office to access the questionnaire but accessed the questionnaire by a published website link or a QR code. The researcher did not collect IP (Internet Protocol) addresses during this data collection activity. All data was stored in line with the Trinity College Dublin's Ethics Guidelines on the researcher's student TCD password-protected Microsoft Office account. Data encryption was the standard Microsoft Office: Transport Layer Security/Secure Sockets Layer (TLS/SSL), Internet Protocol Security (IPSec), and Advanced Encryption Standard (AES).

3.4.2.1 Insider Research Reflexivity

As the researcher conducted research in the school where he is employed, it was essential to consider this position carefully. Bell and Nutt (2012), cited in Brooks et al. (2014), state that "ethical dilemmas are especially likely to occur when researchers who are also practitioners are faced with multiple responsibilities and sensitives" (p.5). Although the researcher works in one of the research schools, conducting research with a sample of students in a large school of 1,000 students is possible. Fleming (2018) highlights that "a researcher may be investigating parts of the organization previously unknown to them and collecting data from complete strangers, even though they are members of the same organisation" (p.311).

3.4.2.2 Informed Consent

Permission was granted, by the Board of Management in each of the three research schools, along with the Principal and Class Teacher, before contacting the students regarding participation in the research. Students received detailed Participation Information Leaflets (PILs) about the research study, its aims and research questions. These PILs provided a user-friendly overview of the research. Students (and their parents/guardians) provided written consent for the student's participation in the student questionnaire. As some students were over 18 years of age, they independently consented to partake in the research study.

3.4.2.3 Confidentiality and Anonymity

The data collection had different identity protection levels. This study used confidentiality and anonymity procedures outlined throughout the research methodologies. The student questionnaire was anonymous, had no distinguishable factors, and students were not asked for their school's name during the questionnaire.

3.4.3 Ethical Considerations for Component Three: Teacher Interviews

All teacher participants received a Participant Information Leaflet (PIL) and informed consent form (Appendix F), which provided an overview of the research study. All participants signed the consent form prior to participating in the interview.

All teacher interviews were recorded and transcribed using Microsoft Teams. While the software package automatically transcribed the interviews, each interview was manually checked twice and verified by the researcher for clarity and accuracy. The researcher removed all personal information and data relating to the place of work from the transcripts, which was in line with the ethical guidelines of Trinity College Dublin. Transcribed data from the teacher interviews is stored on the researcher's password-protected TCD student

Microsoft Office account, where teachers were assigned unique pseudonyms to protect anonymity.

3.5 Research Limitations

All research has limitations, and this study was no different from other research in the education sector. The following three sections outline the research limitations to each of the three components of this MMR study.

3.5.1 Limitations to Component One: Delphi Study Methodology

A Delphi Study poses limitations, similar to all research techniques. The researcher identified three main limitations to this study. The researcher's approach to minimise these limitations is detailed below.

- Initially, limitations occurred in selecting the Panel of Participants. The researcher discussed the potential members of the Delphi Study with his research supervisor, and with a critical friend (MacPhail et al., 2021). Additionally, step three of the KRNW helped to minimise this limitation.
- Furthermore, as this is a modified Delphi Study, it is hoped that waiving anonymity during the discussion phase did not affect the validation of the research instrument. Hohmann et al. (2018) highlighted that using a research methodology rooted in consensus may result in the "watering down" approach of the best opinions. However, it is hoped that this dilution factor did not occur due to the careful criteria used when selecting participants. Barrett and Heale (2020) noted that Delphi Studies could be condemned due to difficulty defining and reaching a consensus. Similar to all research techniques, obtaining 100% of agreement is unlikely. Hence, a level of consensus between 51% - 100% was adhered to and reached in this study (Keeney et al., 2006).

- Of course, the impact of the global pandemic increased research barriers, including no face-to-face meetings with the Panel of Participants. However, public health guidelines and the safety of the participants were paramount to the researcher.

3.5.2 Limitations to Component Two: Student Questionnaires

The student questionnaire presented the following limitations:

- The researcher did not add a question to the student questionnaire that would differentiate the three research schools. As a result, the researcher could not analyse the results by comparing school types. The justification of this choice was not to highlight the difference between a fee-charging school and two public schools, but instead to focus on mathematical preparedness.
- Furthermore, TY is an optional programme in both The School of Athens and The Lyceum, but compulsory in The Academy. This difference made it challenging to discern global generalisations about the data.
- The sample is not evenly distributed. The majority of the respondents to the student questionnaire attended only one of the research schools. This decision was made as the researcher worked in one of the schools, and had greater access to the students. It was made in good faith due to access issues in the aftermath of the global pandemic.

3.5.3 Limitations to Component Three: Teacher Interviews

Zainal (2007) provides researchers with a balanced overview of the advantages and disadvantages of the case study approach based on the works of Yin (1984). Two weaknesses were identified in this case study: rigour and generalisability. In addressing these limitations, the researcher argues that these limitations will always be part of TYM due to the diversity and domestication of the programme. Although these issues are much bigger than the scope of this research study, the researcher tried to improve these limitations

by capturing diverse opinions and insights from teachers teaching the TYM programme. Although this sample is non-representative of every TYM teacher, the data reflects the insights of the teachers who participated in this study. By recruiting teachers from numerous different school types with different experience levels, the researcher ensured a broad understanding of mathematical preparedness in TY.

3.6 Triangulation

All three components of this MMR study triangulated the data. Morse (1991) states that the triangulation design purpose is to "obtain different but complementary data on the same topic to best understand the research problem" (p.122). Additionally, Turner et al. (2015) highlight that triangulation uses the strengths of one method, to offset the weaknesses of another.

The mixed method research approach ensured that the voices of many stakeholders were captured. Components one and two saw the formation of a Delphi Study Panel of Participants who co-constructed a student questionnaire on mathematical preparedness. In contrast, component three, teacher interviews, gathered the practitioners' knowledge of their mathematical preparedness experiences. This data source triangulation strengthened the study in achieving a more accurate and valid overview of the research phenomenon.

3.7 Methodology Summary

The chapter outlined the overall methodology processes for this Mixed Methods Research study. It focused on the three components of the methodology: a Delphi Study, a student questionnaire and semi-structured teacher interviews. This chapter outlined the process and rationale for each approach, as well as the theoretical framework and analysis strategy for each stage.

The Delphi Study Panel of Participants comprised of $n = 11$ nominated experts who co-created a definition of mathematical preparedness that was used to inform the development and subsequent validation of a student questionnaire. This questionnaire was then issued to students in TY, 5th year and 6th year, from three schools, to understand their insights on how mathematical preparedness was reflected in their experiences of TY. Finally, $n = 13$ teacher interviews occurred, which captured the teacher perspective on mathematical preparedness.

Chapter Four: Data Analysis & Findings (Stage One and Stage Two)

4.1 Introduction to Chapter

The analysis and findings of this research study will be presented in two chapters. This chapter presents the analysis and findings from Stage One (Delphi Study) and Stage Two (Student Questionnaire). Chapter Five will present the analysis and findings from Stage Three (Semi-Structured Teacher Interviews).

4.2 Stage One (Delphi Study)

This section considers the analysis and findings from the Delphi Study and is presented in two parts:

1. Part One: The analysis and findings from the discussion and controlled feedback phases of the Delphi Study. It is structured under the four areas of mathematical preparedness (Figure 2.4), conceptualised from the literature review. It includes comments from the panel of participants on the student questionnaire and the corresponding actions taken by the researcher.
2. Part Two: The analysis and findings from the consensus phase of the Delphi Study.

4.2.1 Part One: The Discussion and Controlled Feedback Phases

This section follows the structure of the outlined Mathematical Preparedness Quadrants (section 2.5) with four sub-sections of preparedness: Academic, Social, Emotional and Skills-Based. The findings from the discussion phase of the Delphi Study formed the student questionnaire statements. These statements were co-created by the researcher and the Delphi Study Panel of Participants. This co-creation process involved the researcher reviewing the Delphi Study discussion transcript, and based on the discussions between both groups, the researcher developed statements, which were then sent back to the Panel of Participants for review and consensus. Additionally, some statements were developed

directly during the session with the Panel of Participants. The researcher merged the discussion topics from the discussion phase of the Delphi Study with the corresponding literature, curriculum documents and supporting guidelines to produce the first draft of the student questionnaire.

Each Delphi Study participant reviewed the first draft of the student questionnaire on the Qualtrics XM platform. Participants' feedback on each statement, in each quadrant was achieved by the selection of one of the following: agreement, disagreement, or further comment. The controlled feedback enabled the researcher to make changes to the first draft of the student questionnaire. The researcher carefully reviewed the Delphi Study Discussion Phase transcript and translated the discussion topics into statements for inclusion in the student questionnaire. This process generated the resulting statements for each discussion topic. The controlled feedback comments from the Panel of Participants are included within each section, with corresponding actions listed. Some of the controlled feedback comments resulted in no further action. This decision emerged following a discussion with the research supervisor. Appendix G includes a series of tables (G1 to G10), which provide an overview of the Discussion and Controlled Feedback Phases of the Delphi Study. These tables outline the steps taken for each quadrant.

4.2.2 Part Two: The Consensus Phase

The end of part two of the Delphi Study resulted in edits to the student questionnaire. A third draft of the student questionnaire was emailed to all participants for approval. No further feedback or comments were received at this phase. Hence, consensus was reached. This version of the student questionnaire was then given to a cohort of students.

4.3 Stage Two (Student Questionnaire)

Students from TY, 5th Year and 6th Year, ranging in age from 15 to 19 years, from three schools in Ireland, were invited to respond to an anonymous questionnaire on mathematical

preparedness and their experiences of TYM. Students consented to participate in this study. In addition, parental consent was collected for students under 18 years of age. 248 responses were recorded. Students completed the questionnaire using the Microsoft Office application of MS Forms. Statistical analyses (descriptive and inferential) were used to understand the responses to the student questionnaire. These analyses included:

1. A heat map for each of the four quadrants based on the total responses ($n = 248$). Each heat map illustrated the students' experiences of mathematical preparedness, using the definition co-created by the Delphi Study and the researcher. Strongly Disagree will be illustrated in red, while Strongly Agree will be green. Heat Maps were selected as the most effective way to visually capture students' responses to mathematical preparedness.
2. Heat maps representing each year group, for each of the four quadrants. As the Delphi Study did not refer to gender and mathematical preparedness, the analysis will not investigate any potential relationship between gender and mathematical preparedness. Gender will, however, be included in the demographics of the students who completed the questionnaire, as two of the three research schools are coeducational.
3. A summary table of all statistically significant statements in each quadrant with the Kruskal-Wallis H values, the degrees of freedom, and significance level is presented.

An additional section, which presents the demographics of the students, is included to contextualise the data.

The questionnaire data was inputted into IBM SPSS 12 for analysis. The findings from this analysis addresses research question two: How do students' experiences of Transition Year, from three sample schools, reflect this definition of mathematical preparedness?

4.3.1 School and Student Demographics

Three schools were selected using convenience sampling. The researcher knew teachers working in these schools and the researcher also works in one of these schools. Additionally, these schools represent different TY experiences for students, with Table 4.1 providing an overview of each school and its respective TYP.

Table 4.1: Comparison table of the three research schools.

	TY Status	**Mathematics Class Formation**	**TY Cost**	**DEIS Status**	**Sector**
School of Athens	Optional	Mixed-Ability	€300	Non-DEIS	C&C
Lyceum	Optional	Streamed	€400	DEIS	ETB
Academy	Compulsory	Streamed	€6,913 (+€580)	Non-DEIS	Voluntary (Fee-Charging)

The breakdown of the participant's age and gender was as follows: 54% (133 participants) identified as male, 44% (108 participants) identified as female, and the remaining 3% (7 participants) preferred not to respond to this question. In terms of the participants' year of study and their age, the majority of the participants in TY were 16 years old (69 participants out of the 94 sampled, representing 73%). Similarly, the majority of 5th year students were aged 17 years old (58 participants out of the 76 sampled, representing 76%) and the majority of 6th years were aged 18 years old (62 participants out of the 78 sampled, representing 80%).

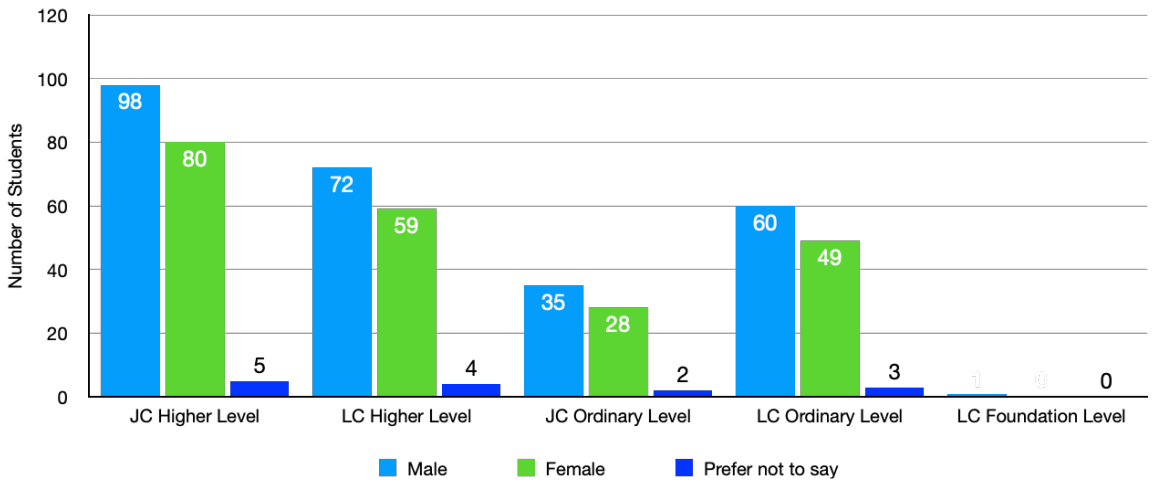


Figure 4.1: Comparison of Level of Mathematics and Gender.

Overall, TY students accounted for 37.9% of all responses (94 participants), 30.6% of students were in 5th year (76 participants), and the remaining 31.5% of students were in 6th year (78 participants). Figure 4.1 above presents the breakdown of gender and level of mathematics studied at both Junior Cycle and Leaving Certificate levels. Initially, 98 male students studied JCHL Mathematics, this figure was reduced by 18 male students (18%) who moved down levels after completing TY. Similarly, female participants saw a drop of 21 students (26%).

4.4 The Preparedness Quadrants

The co-created Mathematical Preparedness Quadrants were presented to students through a questionnaire. Under each of the four quadrants students responded to numerous statements, using a 5-point Likert Scale (1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, and 5 = Strongly Agree). For the purpose of analysis, there will be times when agree and strongly agree will be pooled together under the term “in agreement/agree” and likewise, disagree and strongly disagree will be pooled under the term “disagreement/disagree”. Results of the analysis will be presented under the four headings relating to the Mathematical Preparedness Quadrants. Each heading will present the overall findings from the questionnaire before expanding on the statistically significant statements.

4.4.1 Quadrant One – Academic Preparedness

The Delphi Study identified 11 discussion topics for the quadrant on Academic Preparedness, which produced 18 statements in the student questionnaire. Figure 4.2 provides a heat map of students' responses to their experiences of TY and Academic Preparedness. Responses from TY, 5th, and 6th year students resulted in approximately 50% of the students sampled, agreeing or strongly agreeing, with the following three statements: 1.4, 1.7 and 1.14. Furthermore, students' responses indicated that respondents did not find TYM academically challenging. 8.4% of students reported that they found TY Maths challenging (Statement 1.5), while only 14.2% of students agreed or strongly agreed that TY Maths was very interesting (Statement 1.8).

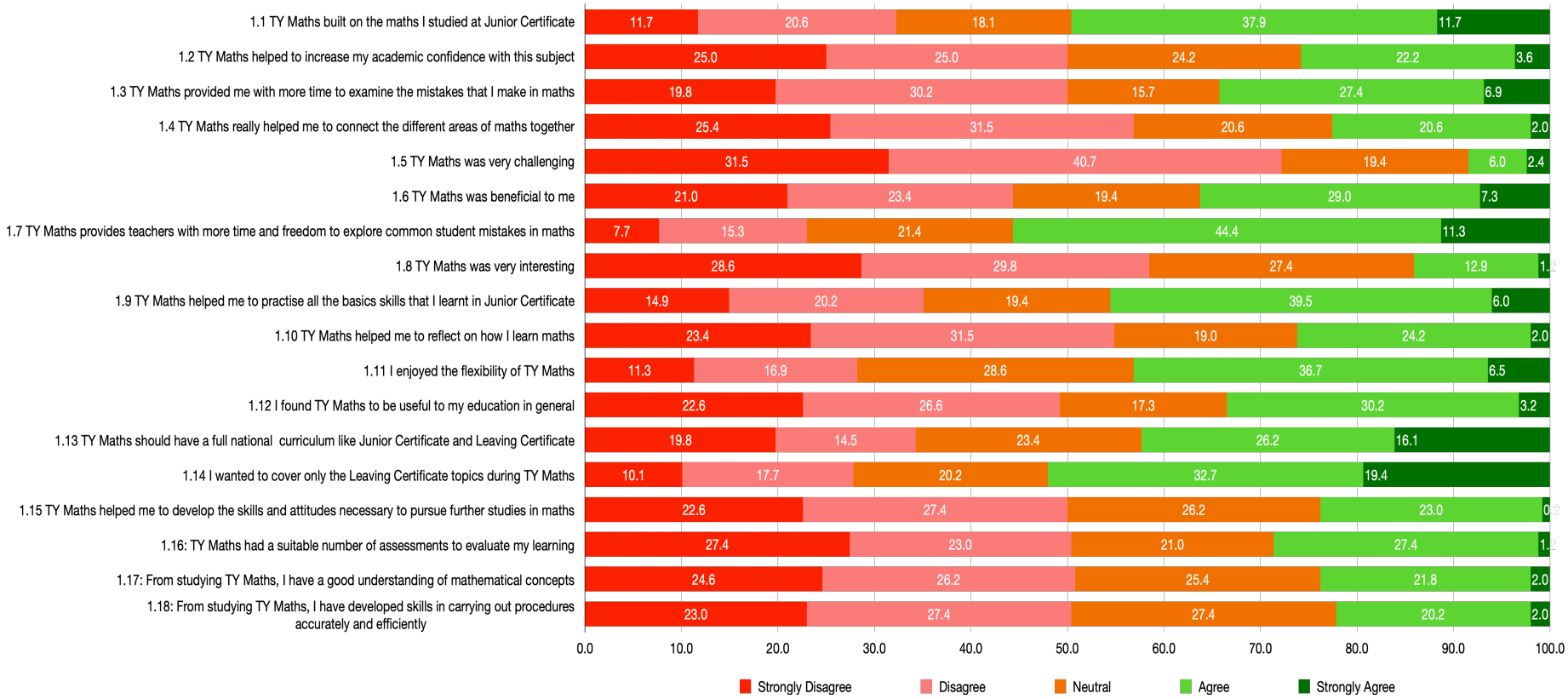


Figure 4.2: Heat Map of the students' responses to the statements in Quadrant One: Academic Preparedness[2].

[2] For comparison purposes, Statement 1.6 was changed from "TY Maths was not beneficial to me" to "TY Maths was beneficial to me". Responses to this statement were reversed.

TY students' responses are depicted in Figure 4.3. Student agreement was at 50% or above from eight statements: 1.1 (TYM built on JCM), 1.3 (TYM provided time to examine mistakes), 1.6 (TYM was beneficial for students), 1.7 (TYM provided freedom), 1.9 (TYM reinforced the practising of basic skills), 1.11 (flexibility of TYM), 1.12 (Usefulness of TYM), and 1.16 (TYM had suitable assessments). However, lower levels of agreement were evident from students in senior years than those currently in TY (Figures 4.4 and 4.5). Fifth year students reported agreement of 50% or above with only one statement, which was that students only wished to cover LCM materials during TYM (1.14). Similarly, 6th year students identified two statements, with over 50% agreement, that TYM should have a national curriculum (1.13) and to cover only LCM material during TYM (1.14). The heat maps for Figures 4.4 (5th year) and 4.5 (6th year) illustrate that students in 5th and 6th year reported lower levels of perceived academic preparedness than their TY counterparts, in comparison to Figure 4.3 (TY). Students in 6th year agreed that TYM did not help them to develop the skills and attitudes necessary to pursue further studies in maths (Statement 1.15), it also did not contain a suitable number of assessments to evaluate their learning (Statement 1.16), nor did it develop a solid understanding of mathematical concepts (Statement 1.17) or efficiency in carrying out procedures (1.18). The responses from 5th year students reported a similar picture.

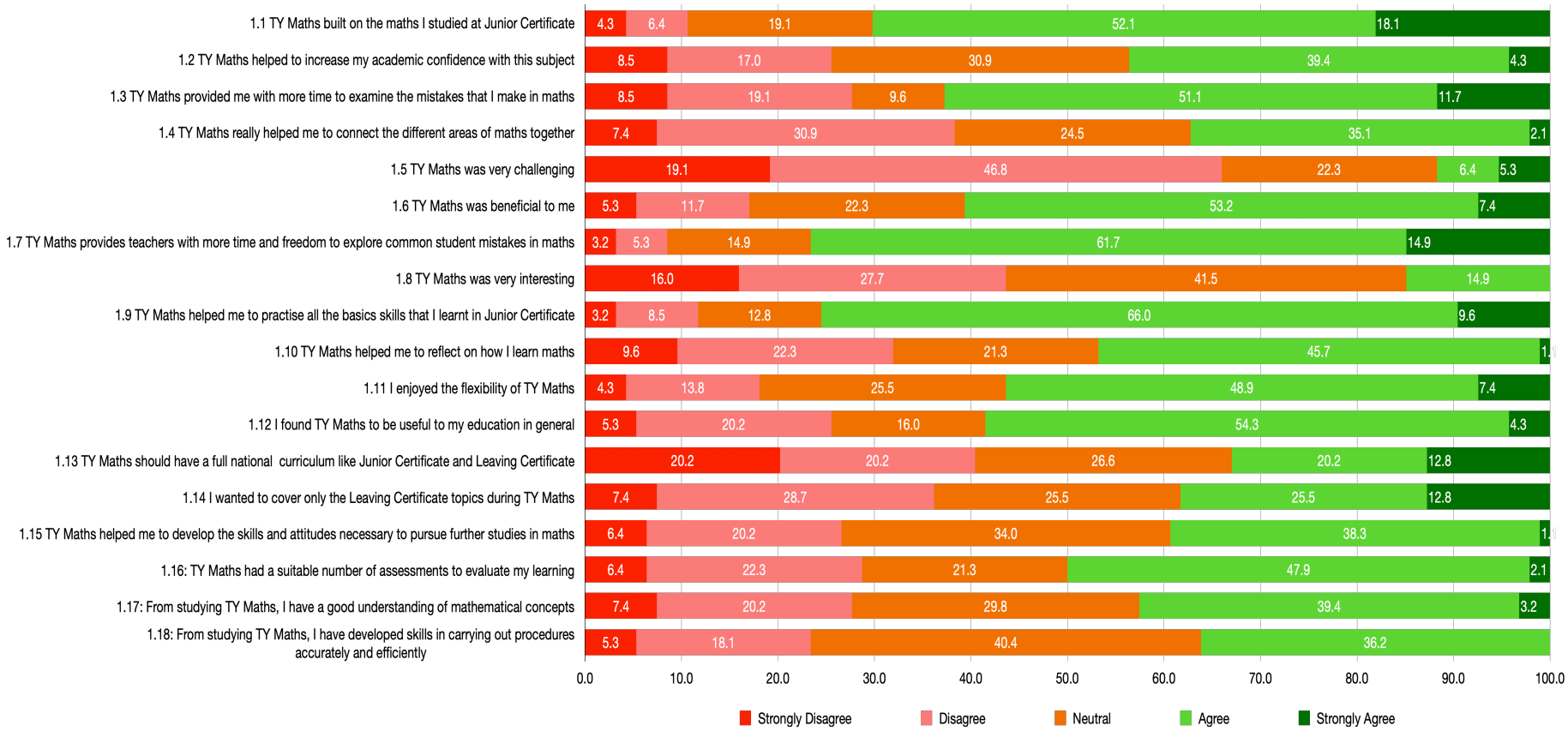


Figure 4.3: Heat Map of Transition Year students' responses to the statements in Quadrant One: Academic Preparedness.

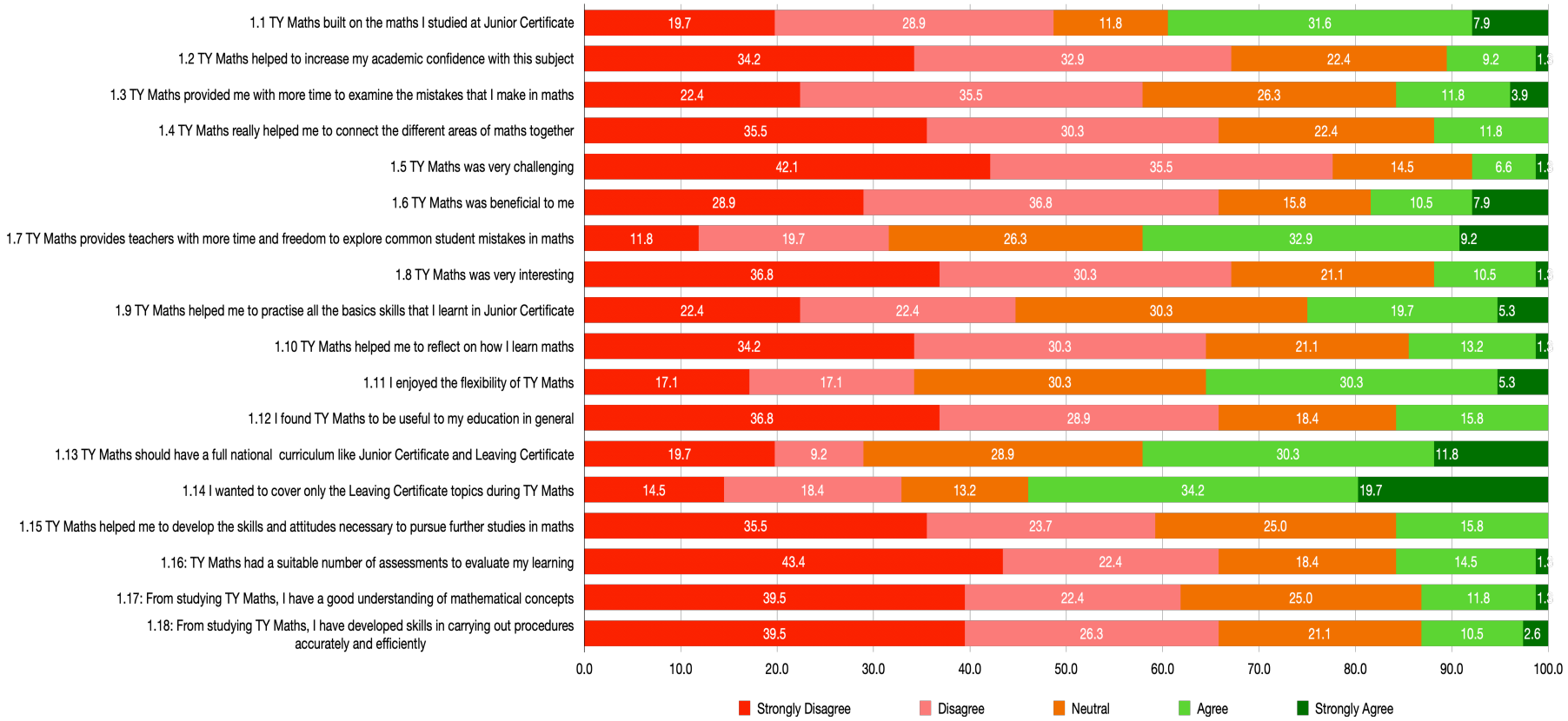


Figure 4.4: Heat Map of 5th year students' responses to the statements in Quadrant One: Academic Preparedness.

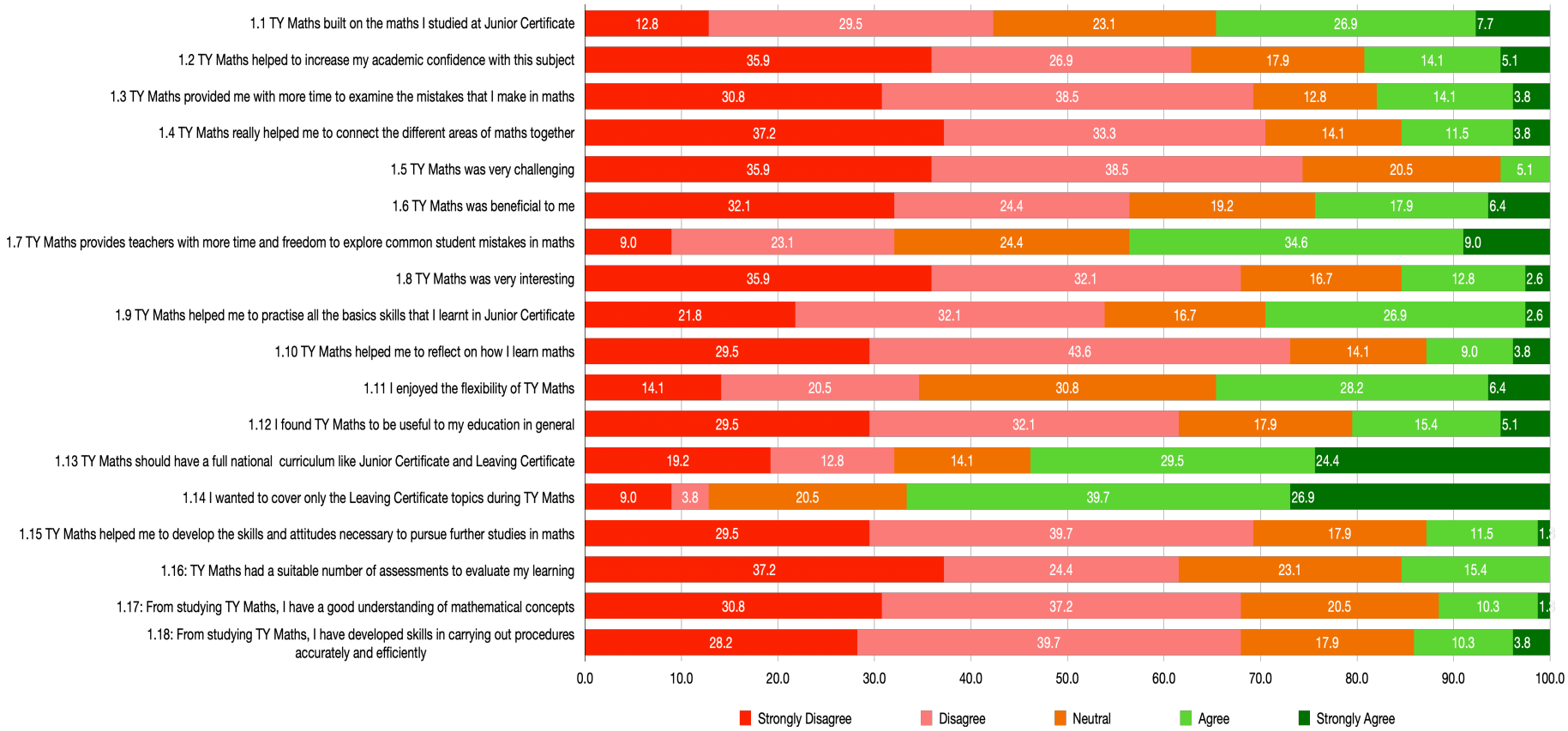


Figure 4.5: Heat Map of 6th year students' responses to the statements in Quadrant One: Academic Preparedness.

Table 4.2 below shows the statistically significant results of the Kruskal-Wallis H test on the statements in Quadrant One (Academic Preparedness), with the mean rank score of students' experiences in TY, 5th, and 6th year. The comparison of the median results from year groups revealed statistically significant differences for 17 of the 18 statements. The only statement that did not have a statistically significant result when comparing mean results in this quadrant was Statement 1.13: "TY Maths should have a full national curriculum like Junior Certificate and Leaving Certificate". The sub-sections below will expand on some of the statistically significant statements.

*Table 4.2: The results of the Kruskal-Wallis H test on the statements in Quadrant One on Academic Preparedness (** represents statistical significance).*

	Kruskal-Wallis H	**df**	**Asymp. Sig.**	**Mean Rank**		
				TY	**5th**	**6th**
1.1: TY Maths built on the maths I studied at Junior Certificate	31.731	2	0.000**	156.11	104.03	106.35
1.2: TY Maths helped to increase my academic confidence with this subject	39.968	2	0.000**	160.09	98.83	106.62
1.3: TY Maths provided me with more time to examine the mistakes that I make in maths	43.762	2	0.000**	161.51	107.26	96.70
1.4: TY Maths really helped me to connect the different areas of maths together	32.495	2	0.000**	156.63	105.56	104.23
1.5: TY Maths was very challenging	9.883	2	0.007**	141.47	110.61	117.59
1.6: TY Maths was beneficial to me	44.705	2	0.000**	86.71	150.68	144.53
1.7: TY Maths provides teachers with more time and freedom to explore common student mistakes in maths	24.666	2	0.000**	151.92	106.93	108.58

1.8: TY Maths was very interesting	12.610	2	0.002**	144.41	111.30	113.37
1.9: TY Maths helped me to practise all the basics skills that I learnt in Junior Certificate	52.341	2	0.000**	164.93	101.07	98.61
1.10: TY Maths helped me to reflect on how I learn maths	37.331	2	0.000**	158.93	104.61	102.38
1.11: I enjoyed the flexibility of TY Maths	12.088	2	0.002**	143.95	112.28	112.97
1.12: I found TY Maths to be useful to my education in general	47.952	2	0.000**	163.13	94.99	106.71
1.14: I wanted to cover only the Leaving Certificate topics during TY Maths	12.919	2	0.002**	108.25	122.11	146.41
1.15: TY Maths helped me to develop the skills and attitudes necessary to pursue further studies in maths	38.977	2	0.000**	159.68	105.23	100.88
1.16: TY Maths had a suitable number of assessments to evaluate my learning	45.822	2	0.000**	162.61	98.45	103.96
1.17: From studying TY Maths, I have a good understanding of mathematical concepts	42.691	2	0.000**	161.44	101.64	102.26
1.18: From studying TY Maths, I have developed skills in carrying out procedures accurately and efficiently	43.481	2	0.000**	161.60	98.58	105.04

4.4.1.1 The Junior Cycle and Leaving Certificate Mathematics Objectives

The Junior Cycle and the Leaving Certificate Mathematics syllabus state that there are five mathematical shared objectives: conceptual understanding, productive disposition, adaptive reasoning, strategic competence and procedural fluency. However, strategic competence was not deemed a discussion topic by the Delphi Study. Strategic competence

refers to a student's ability to formulate, represent and solve mathematical problems in various contexts. The absence of this mathematical objective will be discussed in Chapter Six. Thus, the other four mathematical objectives and their respective key findings are presented below.

Procedural Fluency (Statements 1.9 and 1.18)

- 66% ($n = 62$) of TY students reported that their experience of procedural fluency centred on practising the skills from the JC programme. However, LC students (5th and 6th year) offered a different perspective, with 44.7% ($n = 34$) of 5th year student, and 53.8% ($n = 42$) of 6th year students disagreed that TYM helped them to practise their basic skills from JC (Statement 1.9).
- Most TY students agreed that TYM developed their capacity to carry out procedures accurately and efficiently. However, LC students reported otherwise, with 65.8% ($n = 50$) of 5th year students and 67.9% ($n = 53$) of 6th year students disagreeing with this statement (Statement 1.18).

Conceptual Understanding (Statements 1.3, 1.7 and 1.17)

- Students reported that TYM provides teachers with more time and freedom to explore common mistakes in mathematics (Statement 1.13). However, they also reported that TYM did not provide them with time to explore their common mistakes in mathematics (Statement 1.7). Hence, while there is agreement regarding time and freedom in TYM, there may be an issue around structure. The desired structure ensures that students have the time and access to a teacher to discuss and address challenging concepts.
- Over half of the students sampled, 50.8% ($n = 126$) reported that TYM did not increase their conceptual understanding. Fewer than 1 in every 4 students (23.8%) agreed with Statement 1.17. 48.9% ($n = 47$) of 5th year students and 67.9% ($n =$

53) of 6th year students reported that TYM did not provide them with a solid understanding of mathematical concepts.

Productive Disposition (Statements 1.6, 1.8, 1.12 and 1.15)

- Students currently in TY supported the idea that TY Maths was beneficial to them, with 60.6% ($n = 57$) of students either strongly agreeing or agreeing with this statement (1.6). Contrastingly, a different landscape emerged when the same question was posed to students in 5th year and 6th year, with 65.7% of 5th year students ($n = 50$) disagreeing or strongly disagreeing with this statement. Similarly, 56.5% of 6th year students ($n = 44$) disagreed or strongly disagreed with the statement.
- 58.4% ($n = 145$) of students disagreed that TY Maths was very interesting (Statement 1.8), 49.2% ($n = 122$) of students disagreed that TYM was useful to their education (Statement 1.12) and 50% ($n = 124$) of students disagreed that TYM helped them to develop the skills and attitudes necessary for further studies in mathematics (Statement 1.15).
- A Pearson Chi-Square test revealed a statistically significant between Productive Disposition and year grouping: Statement 1.8 TY Maths was very interesting ($\chi^2(8) = 22.932, p < 0.05$), Statement 1.12 I found TY Maths to be useful to my education in general ($\chi^2(8) = 56.039, p < 0.05$), and Statement 1.15 TY Maths helped me to develop the skills and attitudes necessary to pursue further studies in maths ($\chi^2(8) = 45.629, p < 0.05$).
- Furthermore, Table 4.3 below provides the results of the median test for these three statements. This table shows the differences in the median between students in TY and those in 5th and 6th year for these three statements.

Table 4.3: Median Test for Statements 1.8, 1.12 and 1.15.

	Statement 1.8		Statement 1.12		Statement 1.15	
	$> Median$	$\leq Median$	$> Median$	$\leq Median$	$> Median$	$\leq Median$
TY $n = 94$	53 (56.4%)	41 (43.6%)	55 (58.5%)	39 (41.5%)	69 (73.4%)	25 (26.6%)
5th Year $n = 76$	25 (32.9%)	51 (67.1%)	12 (15.8%)	64 (84.2%)	31 (40.8%)	45 (59.2%)
6th Year $n = 78$	25 (32.1%)	53 (67.9%)	16 (20.5%)	62 (79.5%)	24 (30.7%)	54 (69.3%)

Over 50% of both 5th and 6th year students reported that TYM was not useful to their general education, suggesting a lack of Productive Disposition in their respective TYM programmes. Similiarly, over 50% of LC students reported that TYM did not help them to develop the skills and attitudes necessary to pursue further studies in mathematics. This suggests that TYM fails to have a specific purpose to its curriculum.

Adaptive Reasoning (Statements 1.5 and 1.10)

- 66% ($n = 62$) of TY students, 77.6% ($n = 59$) of 5th year students and 74.4% ($n = 58$) of 6th year students sampled either strongly disagreed or disagreed that TYM was very challenging (Statement 1.5).
- 31.9% ($n = 30$) of TY students disagreed/strongly disagreed that TYM helped them to reflect on their mathematics learning. However, this figure doubled in both LC groups, with 64.5% ($n = 49$) of 5th year students, and 73% ($n = 57$) of 6th year students expressing this opinion (Statement 1.10).

In addition to the five shared mathematical objectives, this quadrant also included the discussion topics of the Unifying Strand and Contextualised Situations. The key findings for both of these are detailed below.

4.4.1.2 The Unifying Strand (Statements 1.1 and 1.4)

- Almost half of the students sampled, 49.6% ($n = 123$), agreed that TY built on the mathematics studied from JC (Statement 1.1). However, a sizeable proportion of students, 32.3% ($n = 80$), disagreed or strongly disagreed with this statement.
- Similarly, the findings for Statement 1.4 revealed that while 22.3% ($n = 56$) of students agreed that TYM helped them to connect the different topics of mathematics together, 56.9% ($n = 141$) of students either disagreed or strongly disagreed with this statement.
- Statistically significant differences between those students sampled in TY and LC were noted. 37.2% ($n = 35$) of TY students sampled responded that TY maths helped them to connect the different areas of maths together (Statement 1.4). However, LC students offered a different viewpoint on this statement, with only 11.8% ($n = 9$) of 5th Year and 15.3% ($n = 12$) of 6th year students agreeing or strongly agreeing with this statement.

4.4.1.3 Contextualised Situations (Statements 1.13 and 1.14)

Students responded positively to Statement 1.13: "TY Maths should have a full national curriculum like Junior Certificate and Leaving Certificate". Table 4.4 provides a breakdown of year groupings in relation to this statement. Interestingly, perceptions differed across year groups, with 33% of TY students, 42.1% of 5th Year students, and 53.9% of 6th Year students calling for TY Maths to have a national curriculum.

Table 4.4: Comparison of year group and the responses to Statement 1.13: "TY Maths should have a full national curriculum like Junior Certificate and Leaving Certificate".

Year	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
TY	20.2%	20.2%	26.6%	20.2%	12.8%
5th	19.7%	9.2%	28.9%	30.3%	11.8%
6th	19.2%	12.8%	14.1%	29.5%	24.4%

4.4.1.4 Key Findings from Quadrant One

KFS1.1 There is a missed opportunity to build students' procedural fluency during TYM. A majority of students reported that they did not feel that their TY experience had supported their development of this aspect of mathematical competency.

KFS1.2 Three out of every five students in TY, 5th and 6th year did not feel that they were adequately challenged mathematically during TY.

KFS1.3 The majority of students in Leaving Certificate reported that TYM was not beneficial to them.

4.4.2 Quadrant Two – Social Preparedness

Introduction

The Delphi Study discussion identified eight discussion topics on this quadrant on Social Preparedness, resulting in 18 statements in the student questionnaire. Figure 4.6 provides a heat map of students' responses to their experiences of TY and Social Preparedness. Four statements saw approximately 50% of the students sampled agreeing or strongly agreeing: 2.2 (Group work as a core element of TYM), 2.12 (mistake making in TYM), 2.13 (group project in TYM) and 2.14 (building positive relationships with classmates).

Most students (50% or above) disagreed or strongly disagreed with six statements: 2.7 (comparing themselves to others), 2.10 (improved social confidence), 2.11 (competitive environment), 2.15 (future careers), 2.17 (engaging with extra-curricular/co-curricular mathematics) and 2.18 (ability to solve hard mathematics questions). These responses indicate that the students' experiences of TYM do not fully reflect this definition of Social Preparedness. It is interesting to note that while students wish to work in groups and complete projects, they do not like a competitive environment, nor do they like to be compared to their classmates. Overall, these results suggest that TY Maths did not support or challenge students to deal with hard mathematical questions. Additionally, the students sampled reported that their social confidence did not increase during TYM.

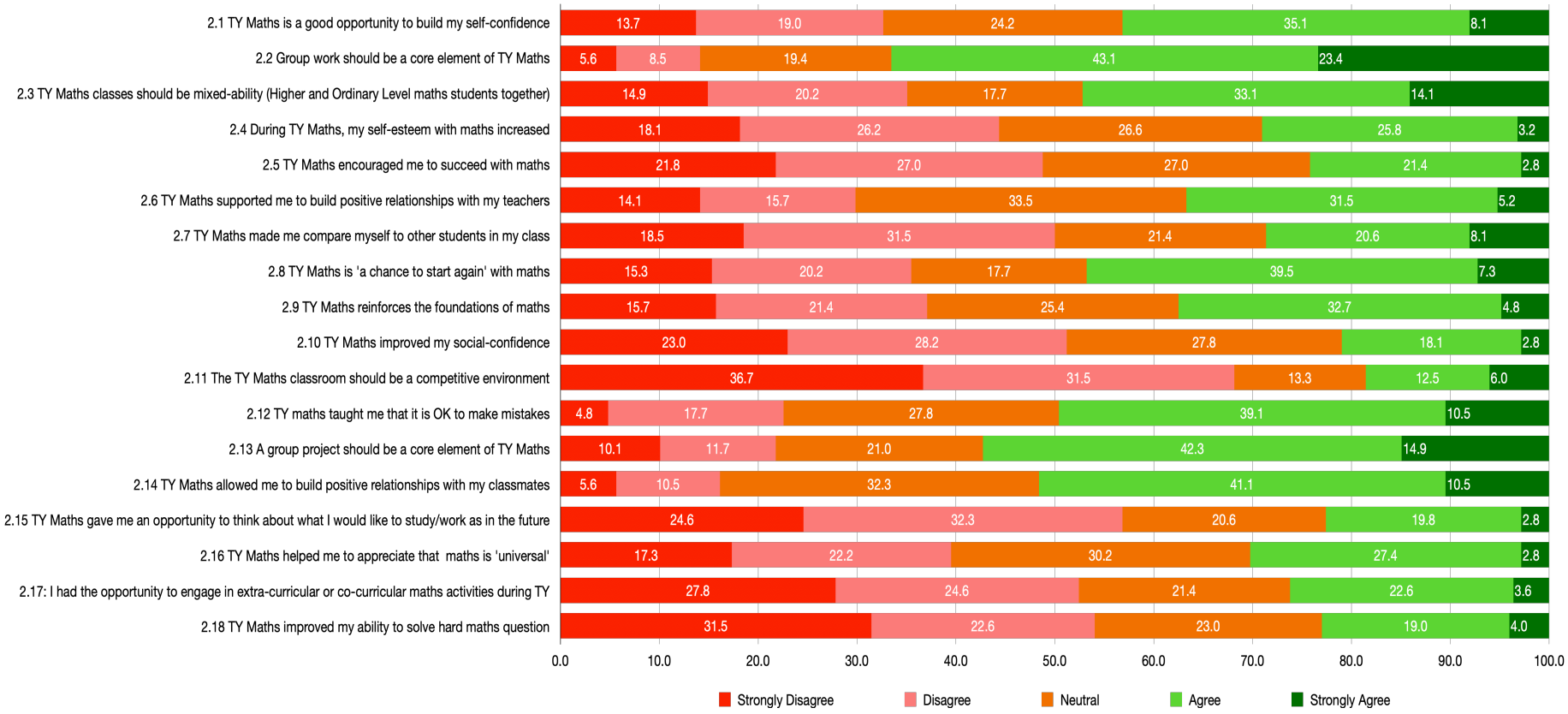


Figure 4.6: Heat Map of students' responses to the statements in Quadrant Two: Social Preparedness[3].

[3] For comparison purposes, Statement 2.11 was changed from "The TY Maths classroom should not be a competitive environment" to "The TY Maths classroom should be a competitive environment". Responses to this statement were inverted.

Figure 4.7 illustrates the strengths of the TYM programme, as experienced by the current TY students. Students noted the importance of including group work (Statement 2.2) and a group project (Statement 2.13) in TYM. They also highlighted the opportunity that TYM provides to reinforce the basics of mathematics (Statement 2.9), the chance to start again with mathematics (Statement 2.8), and that it is OK to make mistakes in mathematics (Statement 2.12).

Figures 4.8 and 4.9 showcase the experiences of the 5th year and 6th year students sampled. Both groups of LC students identified the same three strengths of the programme: group work (Statement 2.2), a group project (Statement 2.13) and the opportunity to build positive relationships with their classmates (Statements 2.14). However, both groups also identified several deficiencies in the TYM programme including the lack of opportunities to succeed (Statement 2.5), comparing students in the classroom (2.7), a lack of improved social confidence (Statement 2.10), a dislike of a competitive classroom environment (Statement 2.11), a lack of discussion about future studies/careers in mathematics (Statement 2.15), limited opportunities to participate in extra-curricular or co-curricular mathematics activities (Statement 2.17) and a failed opportunity to teach students to solve hard mathematics questions (Statement 2.18). Additionally, on average, 5th year students claimed that their experience of TYM did not increase their self-esteem with mathematics (Statement 2.4), nor did it reinforce the foundations of mathematics (Statement 2.9).

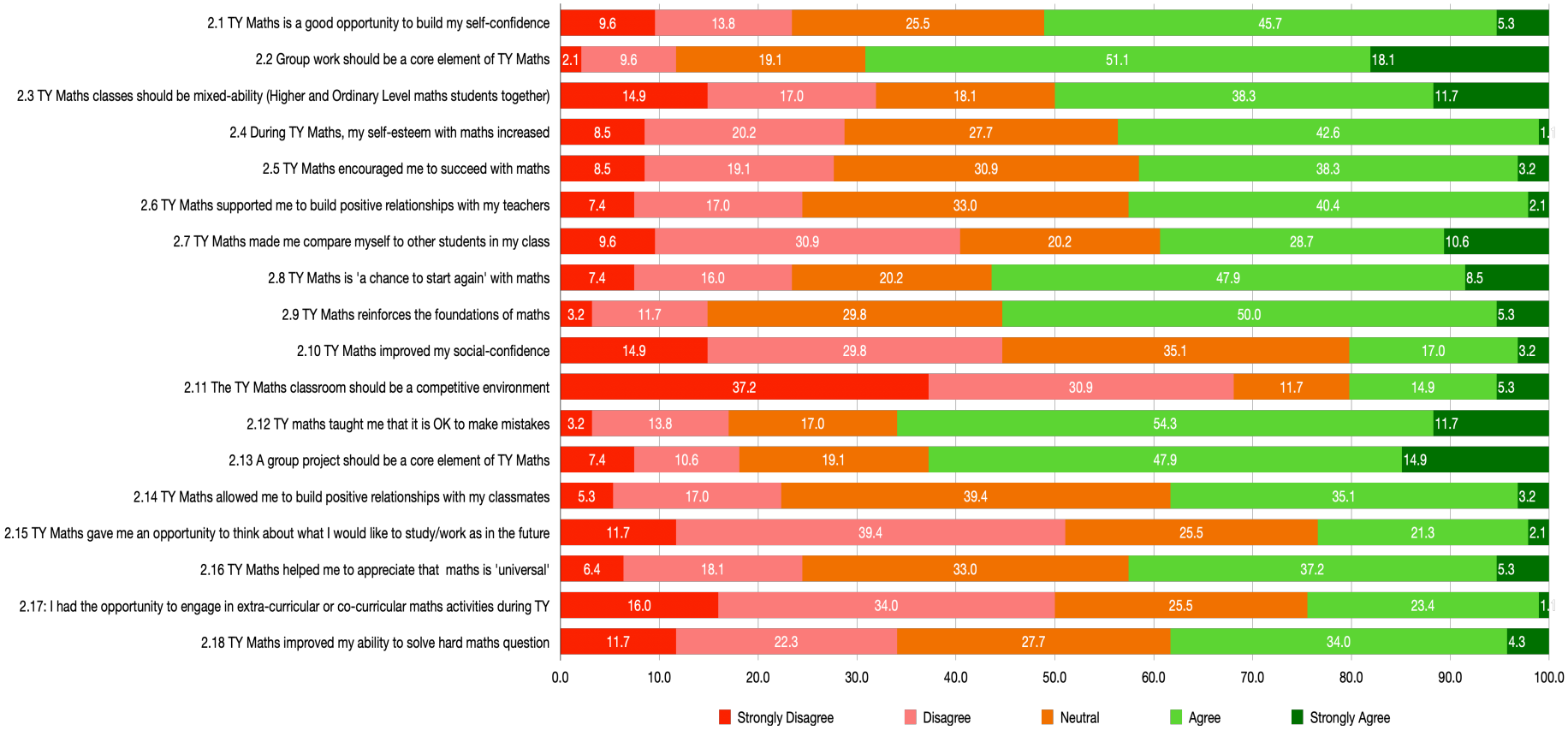


Figure 4.7: Heat Map of Transition Year students' responses to the statements in Quadrant Two: Social Preparedness.

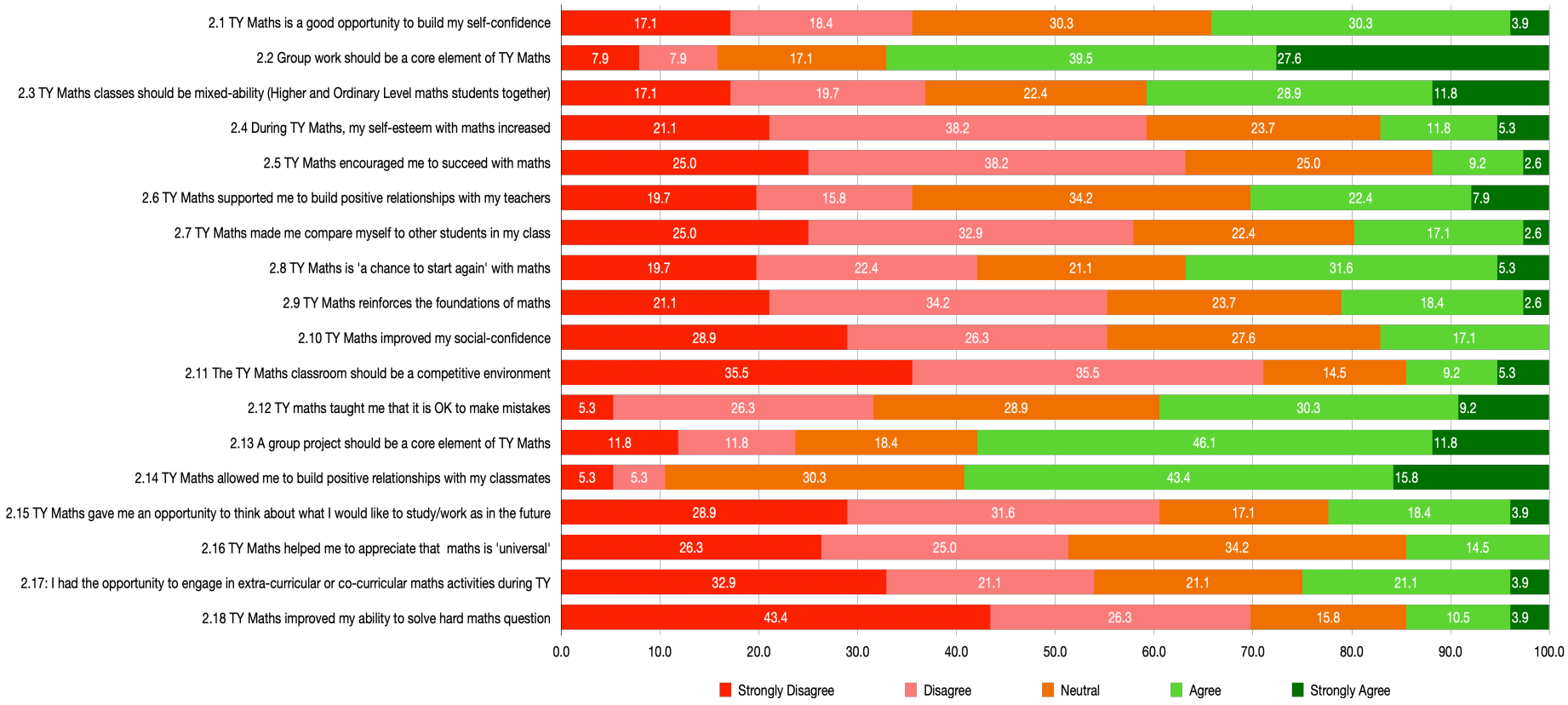


Figure 4.8: Heat Map of 5th year students' responses to the statements in Quadrant Two: Social Preparedness.

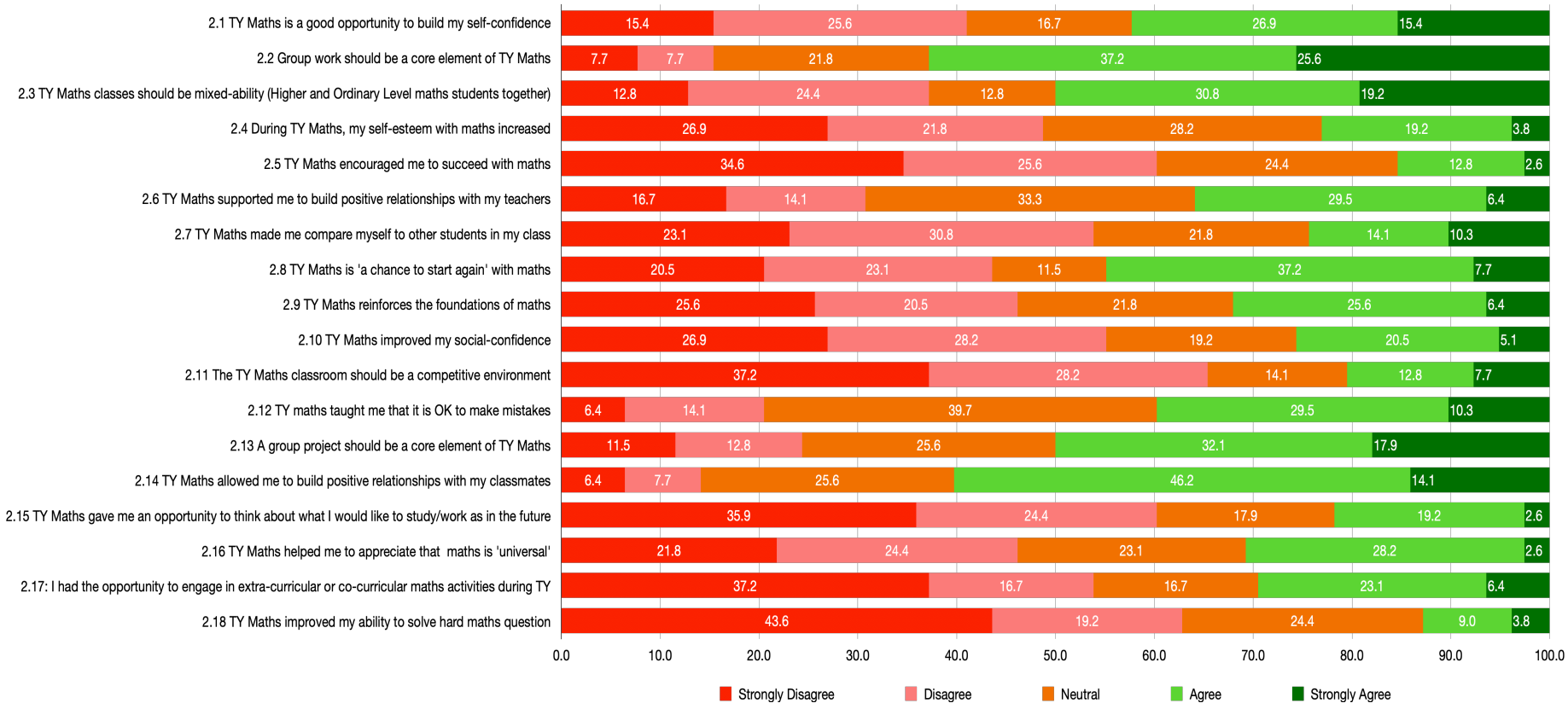


Figure 4.9: Heat Map of 6th year students' responses to the statements in Quadrant Two: Social Preparedness.

Table 4.5 below shows the statistically significant results of the Kruskal-Wallis H test on the statements in Quadrant Two (Social Preparedness), with the mean rank score of students' experiences in TY, 5th and 6th year. The comparison of the median results, by year group, for each of these statements revealed statistically significant differences for nine of the 18 statements. The following subsections expand on the student's experiences of TYM under this quadrant on Social Preparedness.

*Table 4.5: The results of the Kruskal-Wallis H test on the statements in Quadrant Two on Social Preparedness (** represents statistical significance).*

	Kruskal-Wallis H	df	Asymp. Sig.	**Mean Rank**		
				TY	**5th**	**6th**
2.4: During TY Maths, my self-esteem with maths increased	18.779	2	0.000**	148.74	106.15	113.17
2.5: TY Maths encouraged me to succeed with maths	33.410	2	0.000**	157.17	105.45	10.69
2.7: TY Maths made me compare myself to other students in my class	11.110	2	0.004**	142.83	108.78	117.73
2.8: TY Maths is 'a chance to start again' with maths	9.202	2	0.010**	141.19	111.24	117.31
2.9: TY Maths reinforces the foundations of maths	32.929	2	0.000**	156.20	98.64	111.49
2.12: TY maths taught me that it is OK to make mistakes	10.752	2	0.005**	142.43	110.11	116.91
2.14: TY Maths allowed me to build positive relationships with my classmates	13.212	2	0.001**	104.49	137.86	135.60
2.16: TY Maths helped me to appreciate that maths is 'universal'	22.119	2	0.000**	149.39	100.10	118.28
2.18: TY Maths improved my ability to solve hard maths questions	33.287	2	0.000**	157.05	103.16	106.06

The following sub-sections highlight the key findings in this quadrant, including resilience, self-esteem, attitudes and confidence, culture, relationships, and parental attitudes.

Resilience (Statements 2.8, 2.12 and 2.18)

Nearly half of all the students sampled, 46.8% ($n = 116$), acknowledged that TYM provided them with an opportunity to "start over" with mathematics (Statement 2.8). In contrast, Statement 2.18: "TY Maths improved my ability to solve hard maths questions" saw 54.1% ($n = 134$) of the total students sampled disagree or strongly disagree. In addition, although most students reported that it did not improve their ability to manage complex questions, 49.6% ($n = 123$) of the students sampled agreed with Statement 2.12: "TY Maths taught me that it is OK to make mistakes".

Self-Esteem (Statements 2.4 and 2.7)

- Overall, 44.3% ($n = 110$) of students disagreed that TYM caused their self-esteem to increase, while 28.6% ($n = 71$) of students agreed.
- On further analysis, 43.6% ($n = 41$) of TY students agreed that TYM increased their mathematical self-esteem, compared to 17.1% ($n = 13$) of 5th Year students and 23.1% ($n = 18$) of 6th year students.
- An analysis of a Kruskal-Wallis H test revealed a statistically significant difference ($H = 18.779, df = 2, p = 0.000$) between the three groups (TY students, 5th year students and 6th year students) in response to Statement 2.4 on self-esteem. TY students had a mean rank score of 148.74, compared to 5th year students with a mean rank score of 106.15, and 6th year students with a mean rank score of 113.17. The majority of 5th and 6th students claimed that TYM did not improve their self-esteem with mathematics, with TY students reporting higher self-esteem levels with mathematics during TYM. Table 4.6 provides the comparison median values by year groups for this statement:

Table 4.6: Median Test for Statement 2.4: "During TY Maths, my self-esteem with maths increased" with the breakdown by year groupings.

	$> Median$	$\leq Median$
TY $n = 94$	41 (43.6%)	53 (56.4%)
5th Year $n = 76$	13 (17.1%)	63 (82.9%)
6th Year $n = 78$	18 (23%)	60 (77%)

Attitudes and Confidence (Statements 2.1, 2.10, 2.16)

While 43.1% ($n = 107$) of students claimed that TYM is a good opportunity to build their self-confidence (Statement 2.1), only 21% ($n = 52$) of students agreed that TYM improved their social confidence (Statement 2.10). The analysis indicates that while TYM may increase a student's own confidence, this does not necessarily translate into a student's social confidence. The Spearman's Rank correlation coefficient between self-confidence and social confidence in TYM is $r = 0.559, p < 0.05$, this suggests that there is a relatively strong, positive association between these two constructs in TYM.

Culture (Statements 2.2, 2. 3, 2.5, 2.11, 2.13, 2.17)

A Kruskal Wallis H test identified a statistically significant difference ($H = 33.410, df = 2, p < 0.05$) between TY, 5th year and 6th year students experiencing a culture of success during TYM (Statement 2.5). Table 4.7 illustrates that nearly half of the sample (48.8%), claimed that TY did not encourage them to succeed mathematically, with only one in every four students, 24.1% ($n = 60$), agreeing that TYM encouraged them in this way (Statement 2.5). Furthermore, 41.5% ($n = 39$) of TY students sampled were above the median. Whereas, only 11.8% ($n = 9$) of 5th years, and 15.4% ($n = 12$) of 6th year students, were

above the median. Overall, the majority of each year group is less than or equal to the median, with larger differences noted for 5th and 6th year students, than TY students. This suggests that students' perception of TY, as an environment that supported their ability to succeed, were not high in all year groups, but that the LC students reported particularly low levels of agreement.

Table 4.7: Median Test for Statement 2.5: "TY Maths encouraged me to succeed with Maths" with the breakdown by year groupings.

	$> Median$	$\leq Median$
TY $n = 94$	39 (41.5%)	55 (58.5%)
5th Year $n = 76$	9 (11.8%)	67 (88.2%)
6th Year $n = 78$	12 (15.4%)	66 (84.6%)

Figure 4.10 below highlights that 66.5% ($n = 165$) of students agreed that group work should be a staple component of TYM (Statement 2.2). Similarly, 57.3% ($n = 142$) of students suggested that a group project be a core element of TYM.

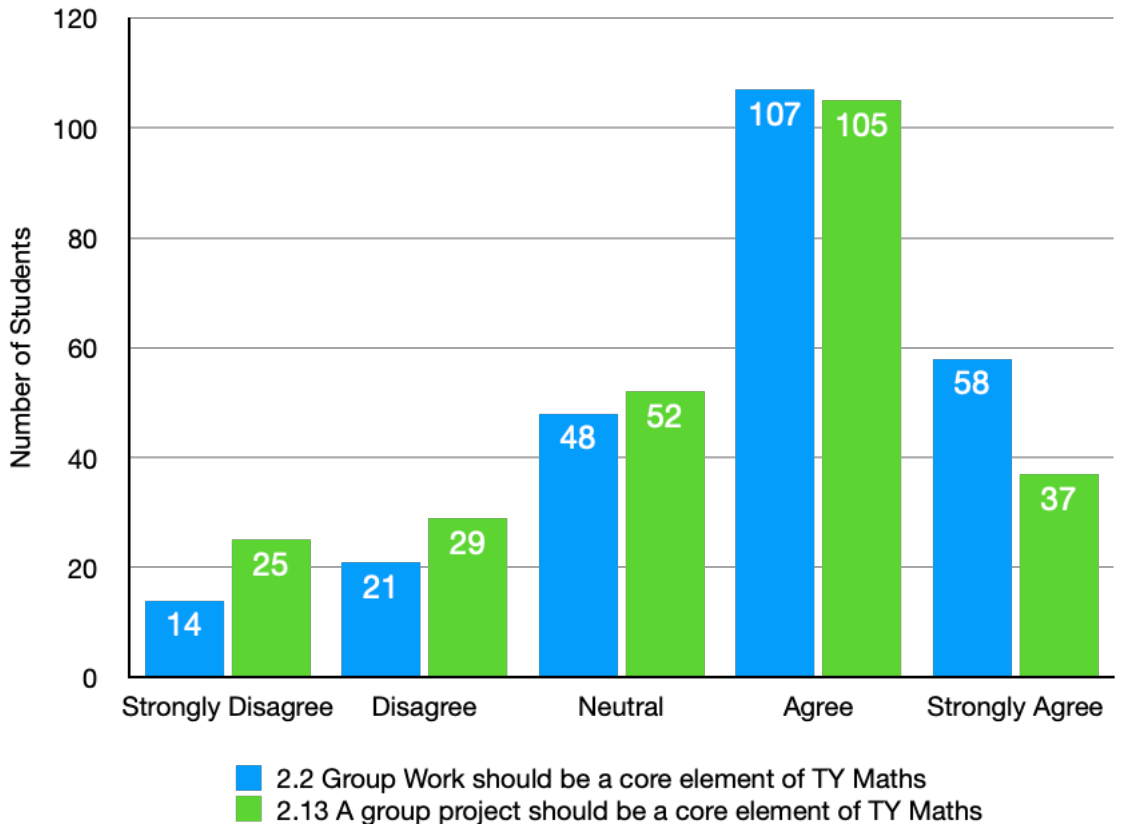


Figure 4.10: Responses to Statement 2.2: "Group work should be a core element of TY Maths" and Statement 2.13: "A group project should be a core element of TY Maths".

A majority of students (68.1%, $n = 169$) of students strongly disagreed or disagreed with Statement 2.11: "The TY Maths classroom should be a competitive one", with 47.1% ($n = 117$) of students reported that they prefer to have mixed-ability class formation during TYM. This is in comparison to 35% ($n = 87$) of students who disagreed with this statement (Statement 2.3).

Relationships (Statements 2.6 and 2.14)

Figure 4.11 illustrates the students' responses to Statements 2.6: "TY Maths supported me to build positive relationships with my teachers" and 2.14: "TY Maths allowed me to build positive relationships with my classmates". From analysing students' responses to these statements, it is evident that TY provides students with the freedom to enhance both types of relationships. 36.7% ($n = 91$) of students agreed that TY Maths supported the building

of positive relationships with their teachers. Similarly, 51.6% ($n = 128$) of students agreed with Statement 2.14 that TY Maths allowed the building of positive relationships with classmates.

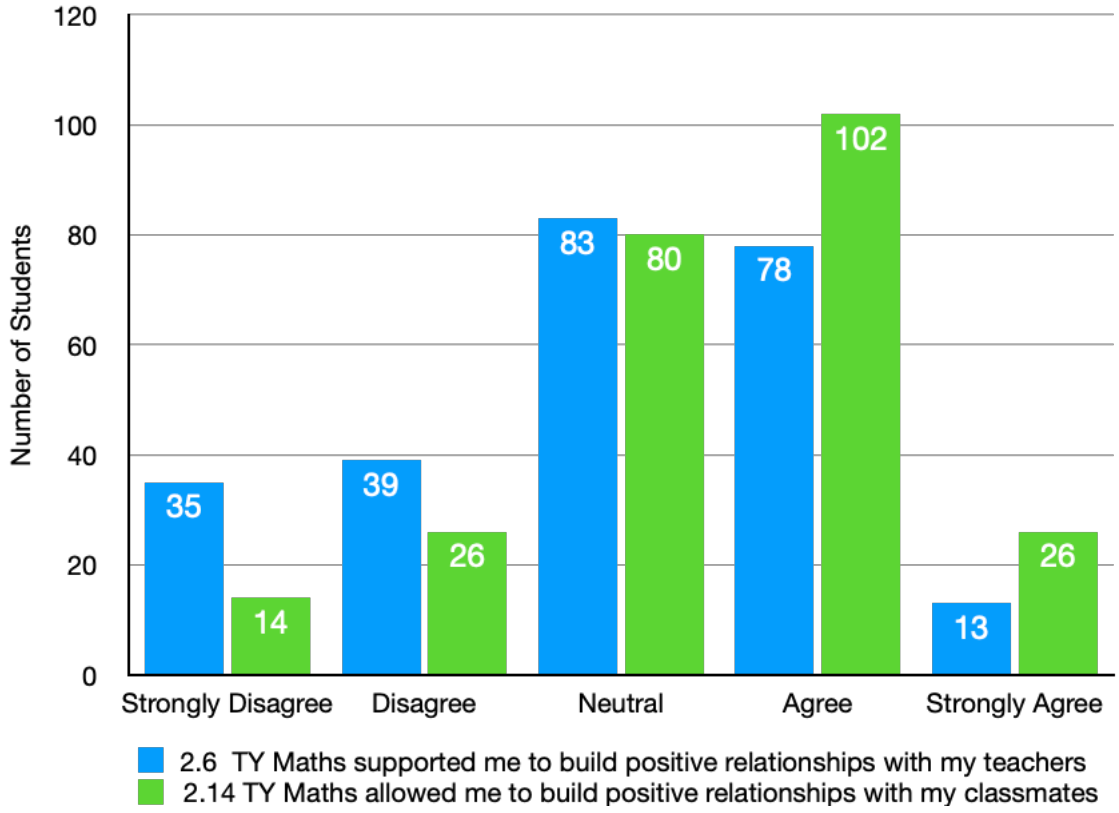


Figure 4.11: Responses to Statements 2.6: "TY Maths supported me to build positive relationships with my teachers" and Statement 2.14: "TY Maths allowed me to build positive relationships with my classmates".

Students reported on the importance of feedback from their teachers, with 64.1% ($n = 159$) of students in agreement with the statement: "I reflect on my teacher's feedback in Maths". Furthermore, 54.8% ($n = 136$) of students reported that their mathematics teacher influenced their opinions of mathematics. This suggests that teachers have the capacity to alter the direction of a student's experience with mathematics at TY level.

Parental Attitudes (Additional Two Statements)

Figure 4.12 below illustrates the responses to two additional questions: "My Parent's attitude towards mathematics is negative" and "My Parents/Guardians are interested in what I am studying in school".

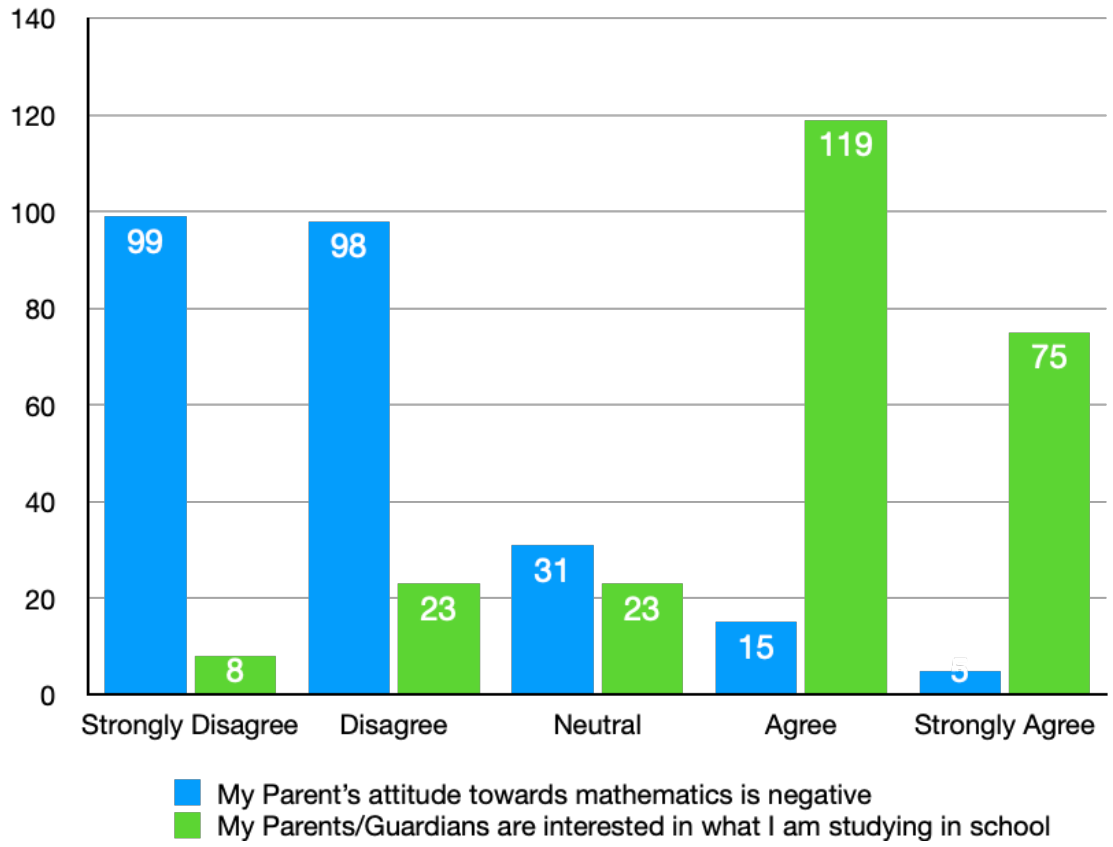


Figure 4.12: Responses on Parents' Attitudes towards Mathematics and Learning.

79.4% ($n = 197$) of students disagreed with the statement: "My Parent's attitude towards mathematics is negative". Conversely, 78.2% of students ($n = 194$) relayed that their parents were interested in what they studied at school.

4.4.2.5 Key Findings from Quadrant Two

KFS2.1 TYM supports and encourages students to build positive relationships with their peers and teachers. This culture can be supported by the inclusion of group work and group projects during TYM.

KFS2.2 Teachers should avoid a culture of competition during TYM. Nearly 70% of all students advised against having a competitive element in TYM. Furthermore, the majority of students favoured a mixed-ability class formation during TYM.

KFS2.3 Students did not see TY as a year that bolstered their self-confidence.

4.4.3 Quadrant Three – Emotional Preparedness

The Delphi Study discussion identified three discussion topics for this quadrant, resulting in 16 statements in the student questionnaire. Figure 4.13 provides a heat map of students' responses on their experiences of TY and Emotional Preparedness. Nine statements (3.1, 3.2, 3.3, 3.4, 3.7, 3.9, 3.11, 3.12, and 3.14), showed approximately 50% of the students sampled agreeing or strongly agreeing. The students' responses provided an insight into the important emphasis that they place on learning mathematics. Students want to develop fluency with algebra, to experience more "eureka" moments, be challenged to step out of their comfort zones and to study mathematics relevant to real-life. Students stressed the importance of relationships in their responses, commenting that they feel comfortable asking their peers questions and that the teacher/student relationship is critical to their learning.

Most students (50% or above) disagreed or strongly disagreed with three statements (3.6, 3.8, and 3.15), highlighting that students' experiences of TYM do not fully reflect this definition of Emotional Preparedness. Interestingly, three out of every four students sampled claimed that TY did not increase their motivation to study mathematics. This lack of motivation may be responsible for the "doss" year label that is often attributed to TY by students.

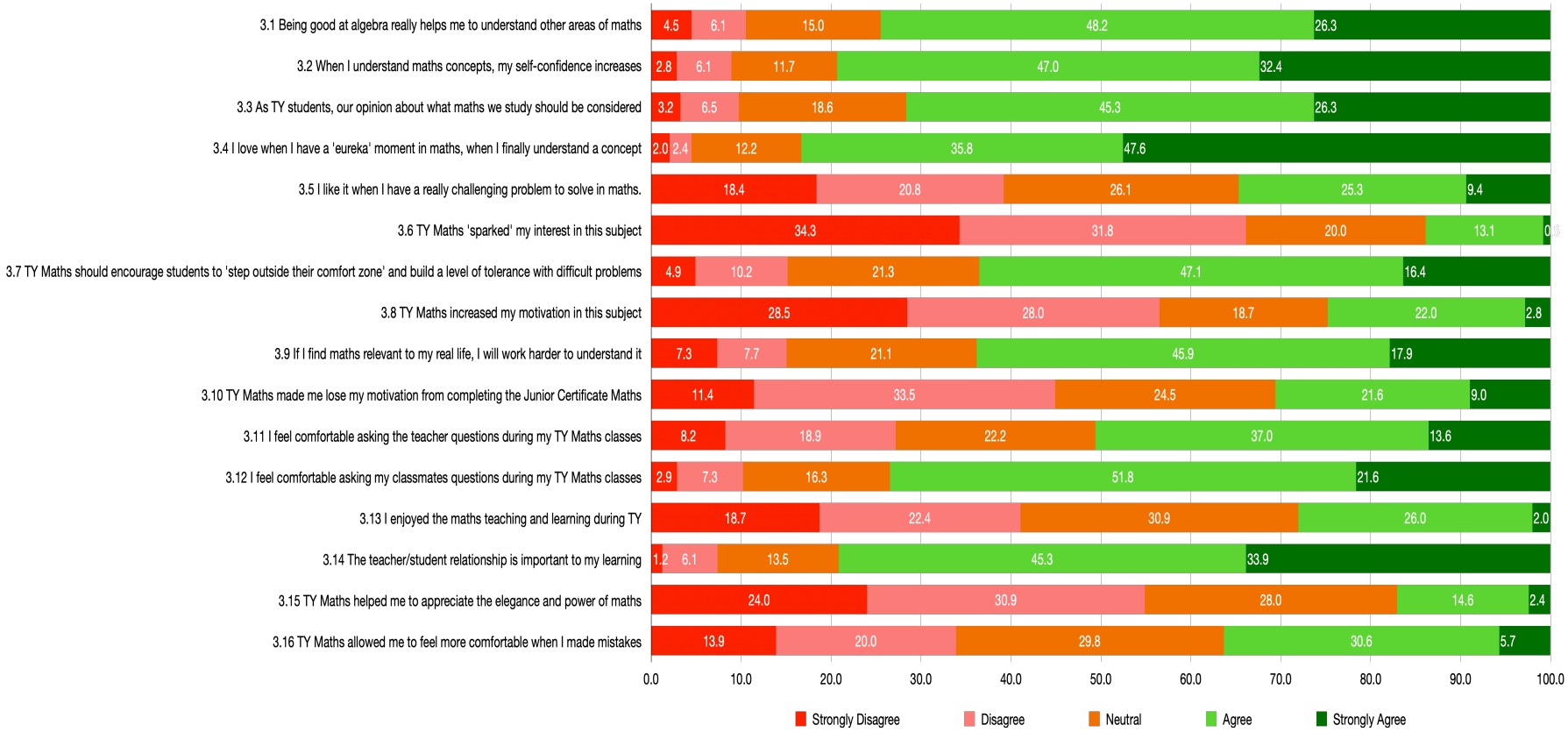


Figure 4.13: Heat Map of students' responses to the statements in Quadrant Three: Emotional Preparedness.

Figure 4.14 illustrates the strengths of the TYM programme from the experiences of the current TY students. Students noted the importance of algebra to their learning (Statement 3.1), the link between conceptual understanding and self-confidence (Statement 3.2), the importance of including the student voice in TYM (Statement 3.3), the importance of the "eureka" moment in mathematics (Statement 3.4), the desire to step outside their comfort zone (statement 3.7), the importance of teaching "real-life" mathematics in TY (Statement 3.9), a sense of comfort in asking their peers and teachers questions (Statements 3.11 and 3.12), the criticalness of the teacher/student relationship (Statement 3.14) and the acceptance of making mistakes (Statement 3.16). On the other hand, the TY students sampled refuted the idea that TYM was responsible for a decline in their mathematical motivation (Statement 3.10).

Figures 4.15 and 4.16 showcase the experiences of the 5th year and 6th year students sampled. Both groups of LC students identified the same strengths of the programme as the TY students, except for two statements (3.11 and 3.16). However, both groups of LC students also identified several perceived deficiencies in the TYM programme. 5th year students emphasised that TYM did not spark their interest in the subject (Statement 3.6), nor did it demonstrate the power and elegance of mathematics (Statement 3.15). Further to this, 6th year students highlighted that TYM did not increase their motivation in the subject (Statement 3.8), with half of the 6th year students responding that they did not enjoy the teaching of TYM (Statement 3.13).

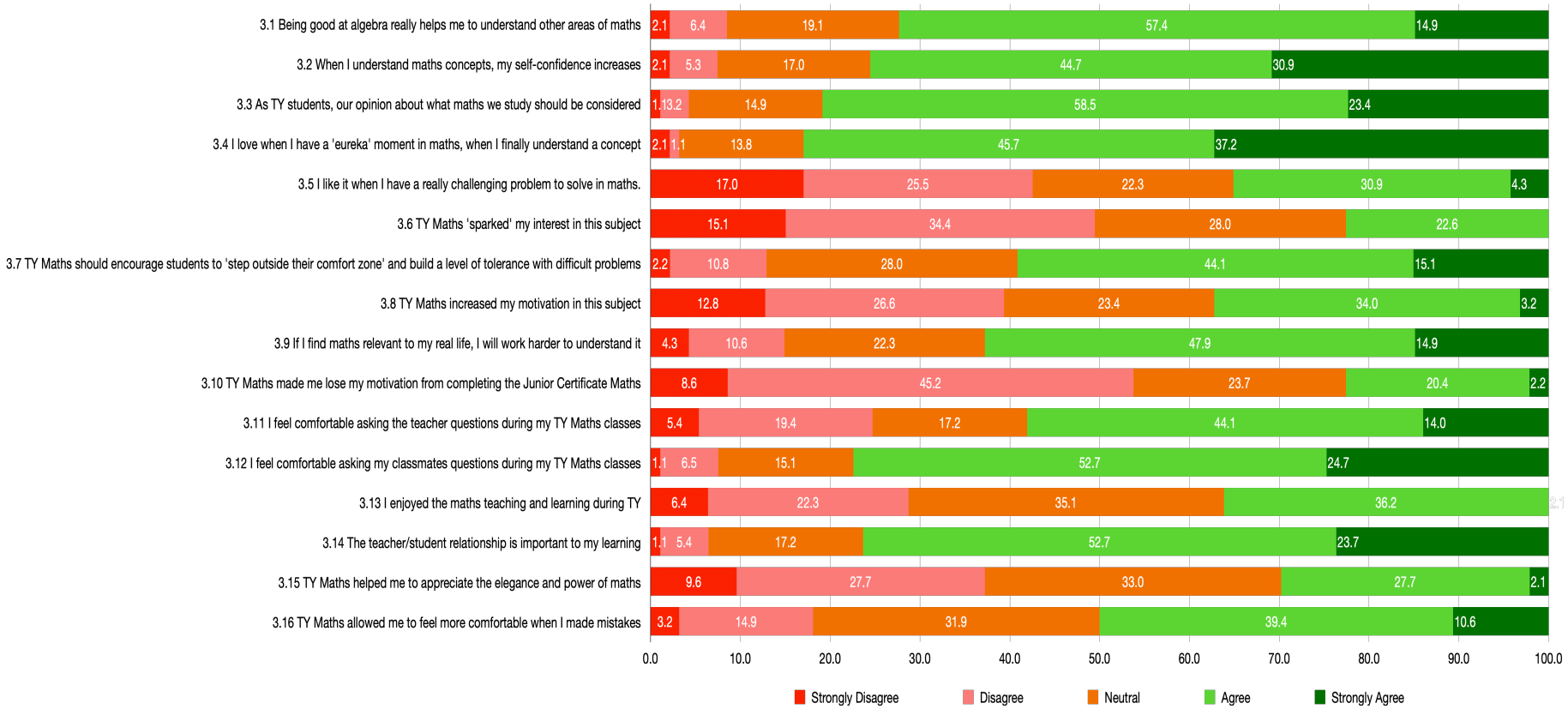


Figure 4.14: Heat Map of Transition Year students' responses to the statements in Quadrant Three: Emotional Preparedness.

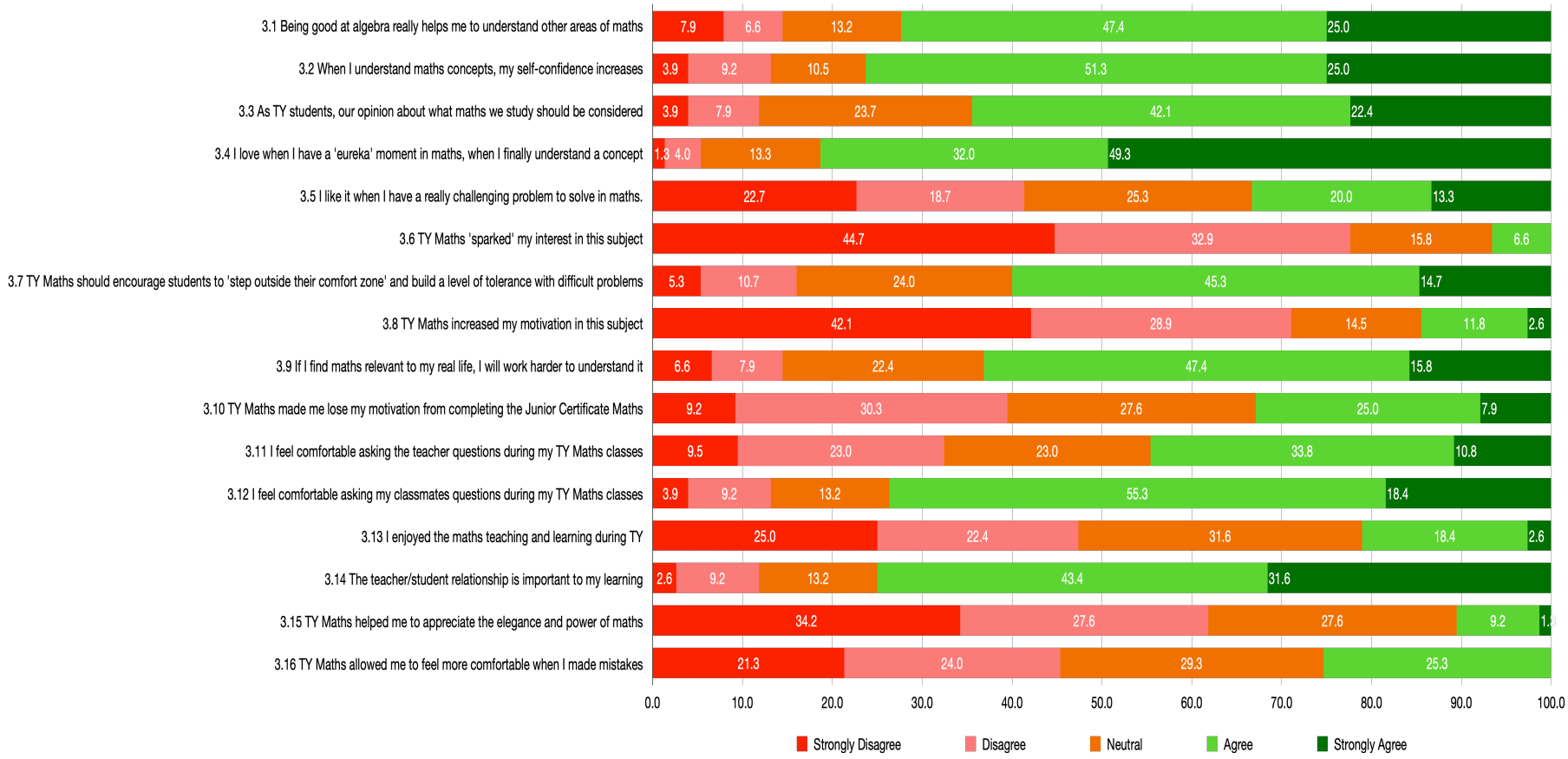


Figure 4.15: Heat Map of 5th year students' responses to the statement in Quadrant Three: Emotional Preparedness.

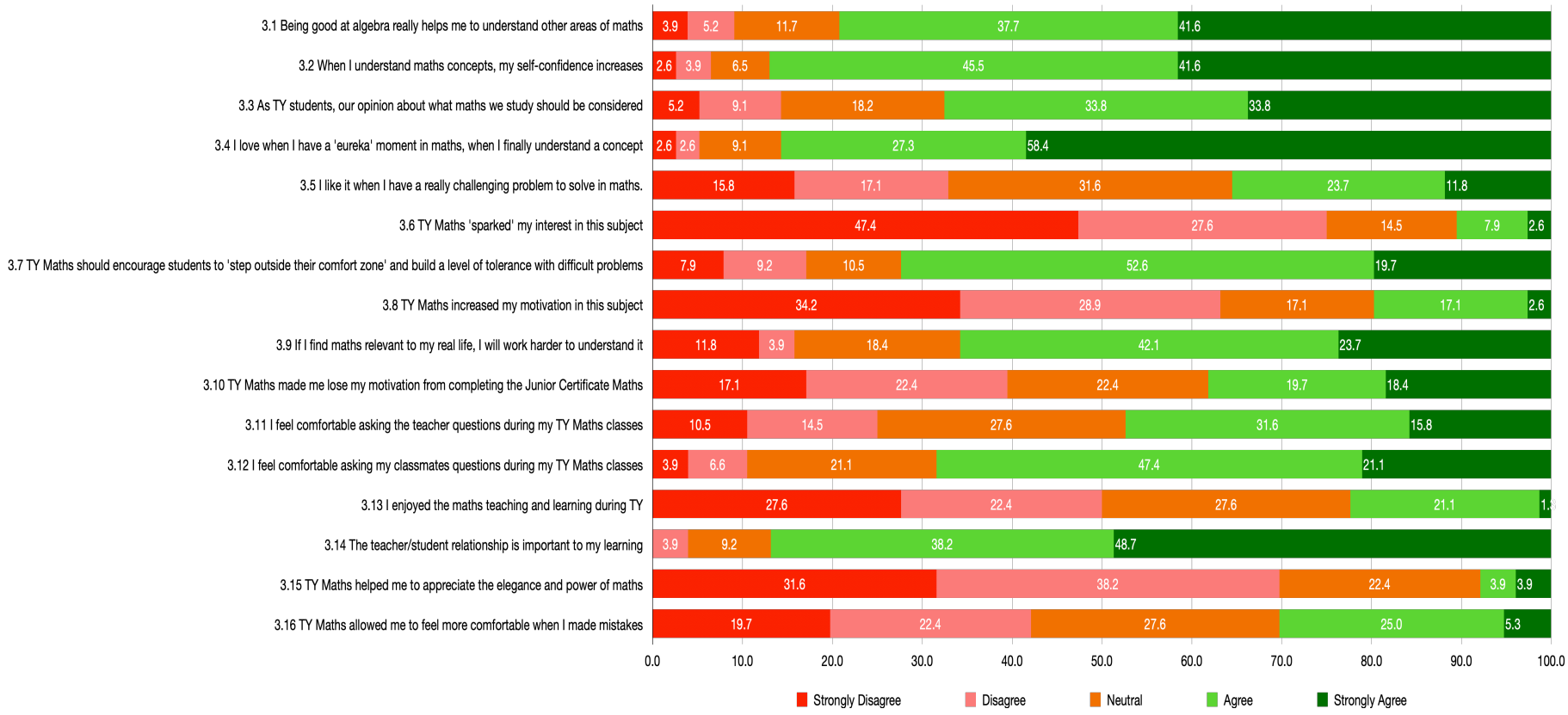


Figure 4.16: Heat Map of 6th year students' responses to the statements in Quadrant Three: Emotional Preparedness.

Table 4.8 below shows the statistically significant results of the Kruskal-Wallis H test on the statements in Quadrant Three (Emotional Preparedness), with the mean rank score of students' experiences in TY, 5th and 6th year. The comparison of the median results by year group for each of these statements revealed statistically significant differences between TYM and LCM for eight statements. The following subsections expand on the students' experiences of TYM in the Emotional Preparedness quadrant.

*Table 4.8: The results of the Kruskal-Wallis H test on the statements in Quadrant Three on Emotional Preparedness (** represents statistical significance).*

	Kruskal-Wallis H	df	Asymp. Sig.	Mean Rank		
				TY	5th	6th
3.1: Being good at algebra really helps me to understand other areas of maths	8.808	2	0.012**	112.64	119.66	142.16
3.2: When I understand maths concepts, my self-confidence increases	6.224	2	0.045**	120.12	113.50	139.10
3.6: TY Maths 'sparked' my interest in this subject	28.421	2	0.000**	152.54	104.13	105.72
3.8: TY Maths increased my motivation in this subject	24.786	2	0.000**	150.59	100.42	113.08
3.13: I enjoyed the maths teaching and learning during TY	14.912	2	0.001**	145.01	111.49	108.91
3.14: The teacher/student relationship is important to my learning	11.237	2	0.004**	111.27	116.55	143.80
3.15: TY Maths helped me to appreciate the elegance and power of maths	27.548	2	0.000**	152.63	107.88	103.10
3.16: TY Maths allowed me to feel more comfortable when I made mistakes	23.219	2	0.000**	149.38	102.24	110.86

The following sub-sections highlight the key findings on this quadrant, including students' self-beliefs, attitudes, and emotions.

Students' Self-Beliefs (Statements 3.1, 3.2, 3.3, 3.5, 3.6, 3.8 and 3.10)

Starting with Figure 4.17, 56% ($n = 139$) of students reported that TYM did not increase their motivation. It also did not "spark" their interest in mathematics, with 65.3% ($n = 162$) of students strongly disagreeing or disagreeing with Statement 3.6. The Spearman's rank correlation coefficient between both statements on "sparking" interest and motivation is $r = 0.757, p < 0.05$. This illustrates a strong positive relationship between motivation and interest. A Kruskal-Wallis H test showed that there was a statistically significant difference between 'sparking' interest (Statement 3.6) and year groupings ($H = 24.9, df = 2, p < 0.05$), with a mean rank 'sparking' interest score of 152.54 for Transition Year students, 104.13 for 5th year students and 105.72 for 6th year students. Similarly, A Kruskal-Wallis H test showed that there was a statistically significant difference between increased motivation (Statement 3.8) and year groupings ($H = 28.421, df = 2, p < 0.05$), with a mean rank increased motivation score of 150.59 for Transition Year students, 100.42 for 5th year students and 113.08 for 6th year students. Given that the percentage above the mean was higher for the TY group, this illustrates a statistically significant difference in opinion between the groups, with the senior cycle students' responses reflecting lower motivation and interest than their TY counterparts.

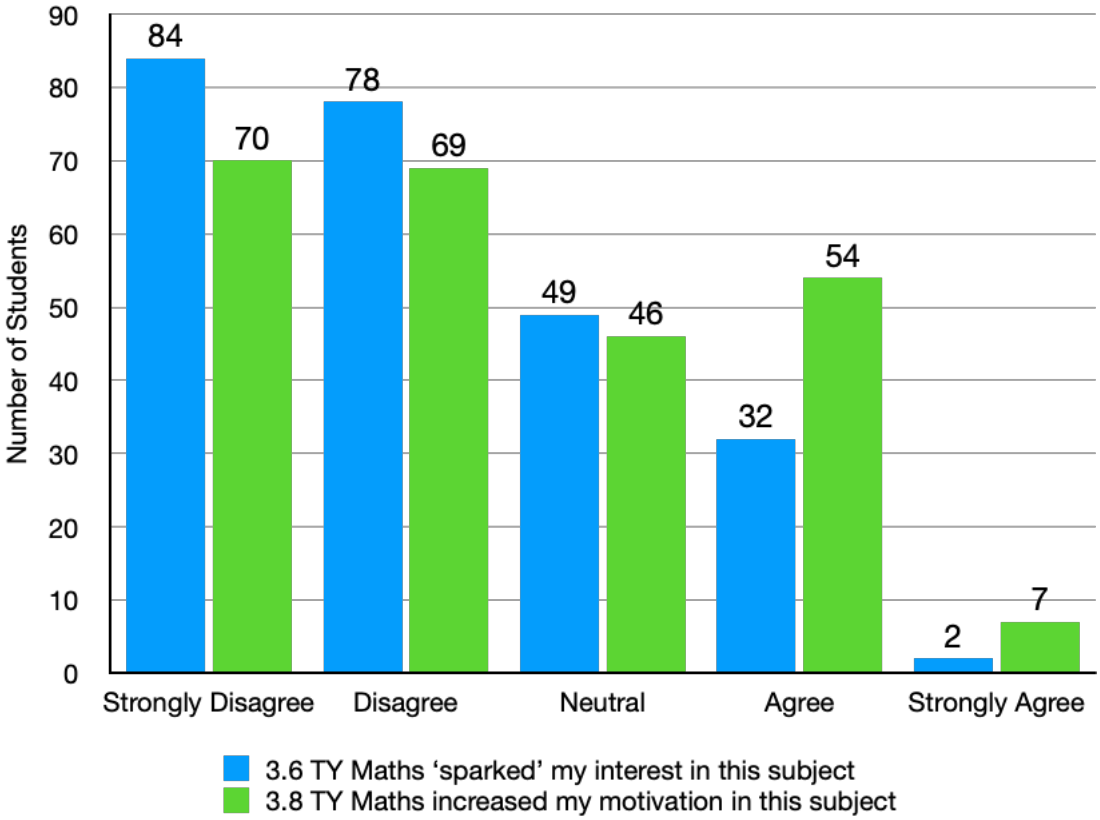


Figure 4.17: Comparison of responses to Statements 3.6: "TY Maths 'sparked' my interest in this subject" and 3.8: "TY Maths increased my motivation in this subject".

Table 4.9 below compares the median values for both statements.

Table 4.9: Median Test for Statements 3.6: "TY Maths 'sparked' my interest in this subject" and 3.8: "TY Maths increased my motivation in this subject".

	Statement 3.6: "TY Maths 'sparked' my interest in this subject"		Statement 3.8 "TY Maths increased my motivation in this subject"	
	$> Median$	$\leq Median$	$> Median$	$\leq Median$
TY $n = 94$	47 (50%)	47 (50%)	57 (60.6%)	57 (39.4%)
5th Year $n = 76$	17 (22.4%)	59 (77.6%)	22 (28.9%)	54 (71.1%)
6th Year $n = 76$	19 (25%)	57 (75%)	28 (36.8%)	48 (63.2%)

From this comparison table, it is clear to see that differences occur between TY and LC. Other key findings on students' self-beliefs included:

- 73% ($n = 177$) of students agreed or strongly agreed that their voice should be included in the development of their school's mathematics programme (Statement 3.3).
- 79% ($n = 196$) of students agreed or strongly agreed that when they understand maths concepts that their self-confidence increases (Statement 3.2).
- The findings from Statement 3.10: "TY Maths made me lose my motivation from completing the Junior Certificate Maths", showed that 44.4% ($n = 110$) of students disagreed with this statement, implying that by completing TYM there was no depreciation in their mathematical motivation. However, three out of every ten students, 30.6% ($n = 75$) did agree with this statement. This raises questions about the retention levels of student motivation between JC mathematics and LCM.

Student Attitudes (Statements 3.4, 3.7, 3.9, 3.13, 3.14 and 3.16)

Figure 4.18 below presents the comparison of Statement 3.7: "TY Maths should encourage students to 'step outside their comfort zone' and build a level of tolerance with difficult problems" and Statement 3.16: "TY Maths allowed me to feel more comfortable when I made mistakes". Students acknowledged that TYM is moving in a positive direction towards being transformative in a student's mathematics learning and reducing some of the stress and anxiety attributed to mathematics learning. 63.5% of students ($n = 155$) stated that TYM provided them with the opportunity to step outside their comfort zones and build tolerance for tackling difficult questions.

Furthermore, the findings for Statement 3.16 revealed mixed views. 33.9% ($n = 83$) of students disagreed that TY Maths allowed them to feel more comfortable when making mistakes in mathematics. Similarly, 36.3% ($n = 89$) of students agreed with the statement.

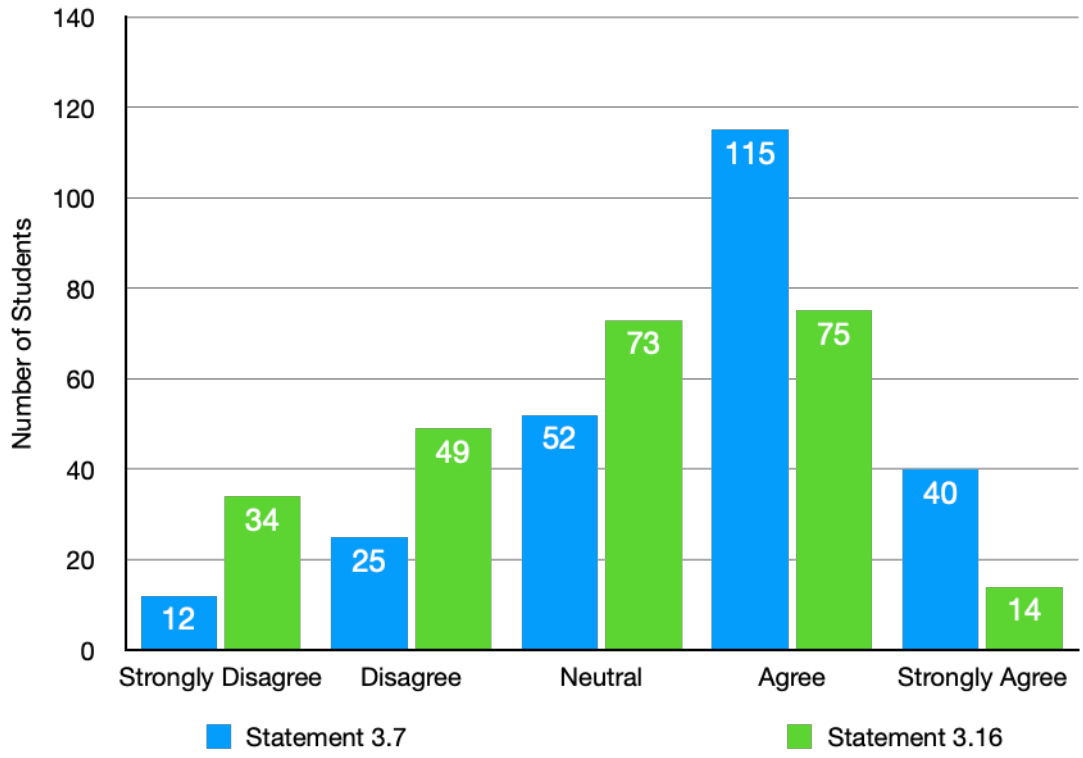


Figure 4.18: Comparison of results to Statement 3.7: "TY Maths should encourage students to 'step outside their comfort zone' and build a level of tolerance with difficult problems" and Statement 3.16: "TY Maths allowed me to feel more comfortable when I made mistakes".

These mixed responses highlighted that students may need more encouragement to try mathematics problems, and to understand that it is OK to try, even if they are unsure. This development of problem-solving skills, as well as the confidence to feel comfortable when making mistakes in mathematics will be beneficial for students as they prepare for LC.

The findings for Statement 3.4: "I love when I have a 'eureka' moment in maths, when I finally understand a concept" saw 83.3% ($n = 205$) of students agree or strongly agree. These "eureka" moments can be powerful turning points in a student's relationship with mathematics. Eureka moments may positively influence a student's attitude towards mathematics.

The analysis revealed that relationships, not only between students, but also between students and teachers, are required for students to be psychologically prepared for learning mathematics. Figure 4.19 below presents the findings from Statements 3.13: "I enjoyed the

maths teaching and learning during TY" and Statement 3.14: "The teacher/student relationship is important to my learning". The findings for Statement 3.14 revealed that 45.3% ($n = 111$) of students agreed and a further 33.9% ($n = 83$) of students strongly agreed that the teacher/student relationship is important to their learning.

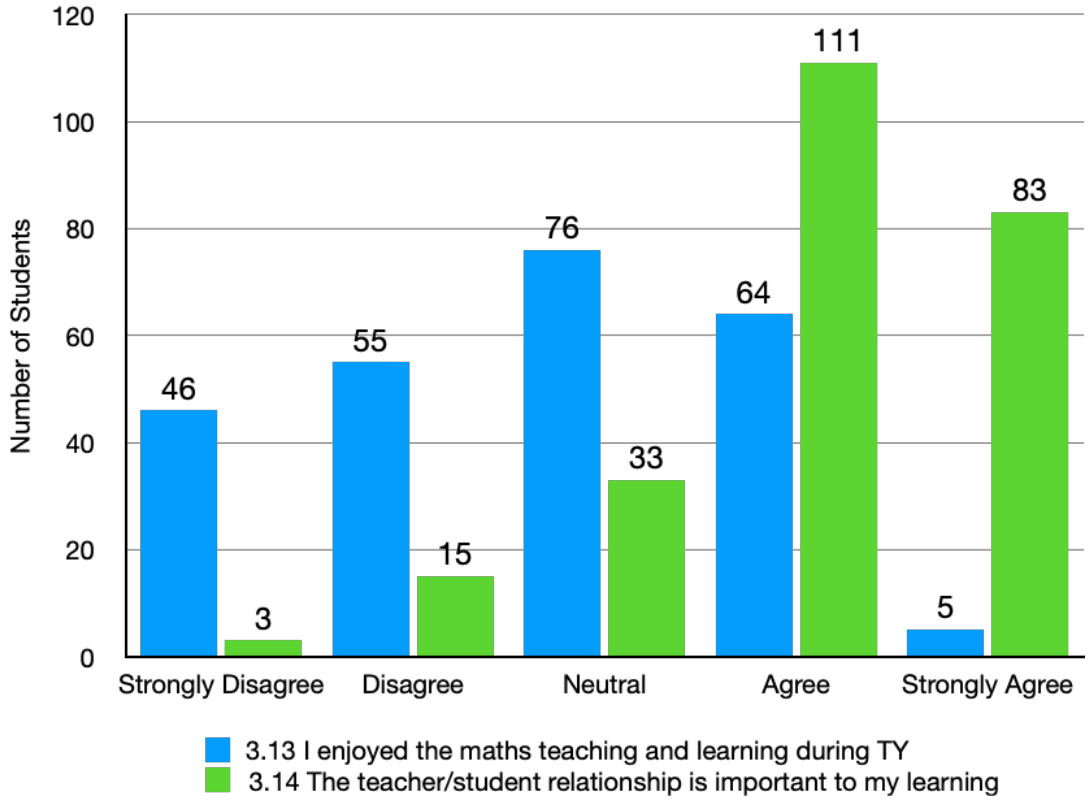


Figure 4.19: Comparison of Statement 3.13: "I enjoyed the maths teaching and learning during TY" and Statement 3.14: "The teacher/student relationship is important to my learning".

However, although 80% of students ($n = 194$) reported that the teacher/student relationship is important to their mathematical learning, over 40% ($n = 101$) of students reported not enjoying the teaching and learning of mathematics during TY (3.13). This figure highlights the negative impact that TYM may have on a student's perception of mathematics education as they prepare for LCM and life. The data analysis is unable to pinpoint if this non-enjoyment of mathematics begins prior to or during TY. Nevertheless, it presents a worrying scenario.

Student Emotions (Statements 3.11, 3.12 and 3.15)

Figure 4.20 illustrates the students' responses to Statement 3.11 and Statement 3.12. The findings draw attention to the fact that students feel comfortable to ask either their peers or their teacher for mathematical support. Over half of all students sampled, 50.2% ($n = 123$) indicated their comfort in seeking support from a teacher. Likewise, three out of every four students, 73.5% ($n = 180$), reported their comfort in seeking the support of a classmate during mathematics class.

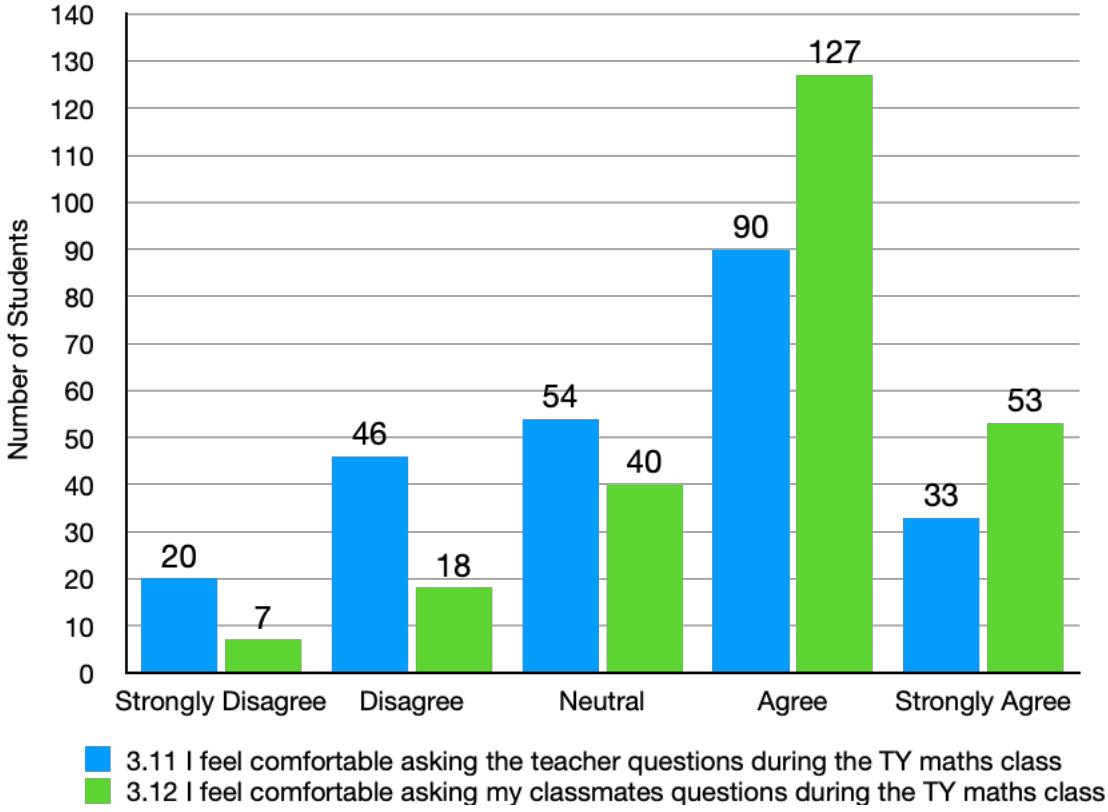


Figure 4.20: Comparison of responses to Statement 3.11: "I feel comfortable asking the teacher questions during the TY maths class" and Statement 3.12: "I feel comfortable asking my classmates questions during the TY maths class".

4.4.3.1 Key Findings from Quadrant Three

KFS3.1 Overall the majority of students reported that TYM is not interesting to them, nor is it increasing their motivation. However, student wished for their voices to be heard in the planning of this domesticated programme.

KFS3.2 Overall, students are not enjoying the teaching and learning of mathematics during Transition Year.

KFS3.3 Students feel confidence in seeking the support from their peers and teachers when unsure in their learning.

4.4.4 Quadrant Four – Skills-Based Preparedness

This final section presents the analysis and findings of the student questionnaire responses on the Skills-Based Preparedness Quadrant. The Delphi Study process identified five discussion topics for this quadrant, resulting in 17 statements in the student questionnaire. Figure 4.21 provides a heat map of the students' responses to their experiences of TY and Skills-Based Preparedness. None of the responses to these statements reached 50% agreement. This is unlike the three other quadrants, where numerous statements scored above 50% agreement. This implies that there may be a consensus that the key skills are not being adequately addressed within the TYM classroom. Figure 4.21 shows that neutral is the most common student response to the statements in this quadrant.

Most students (50% or above) disagreed or strongly disagreed with three statements (4.6, 4.10, and 4.11), highlighting that students' experiences of TYM do not fully reflect this definition of Skills-Based Preparedness. It is interesting to note that students' experiences of TYM indicated a shortfall in problem-solving and communicating mathematically. Furthermore, students claimed that TYM did not empower them with knowledge and skills for everyday mathematics.

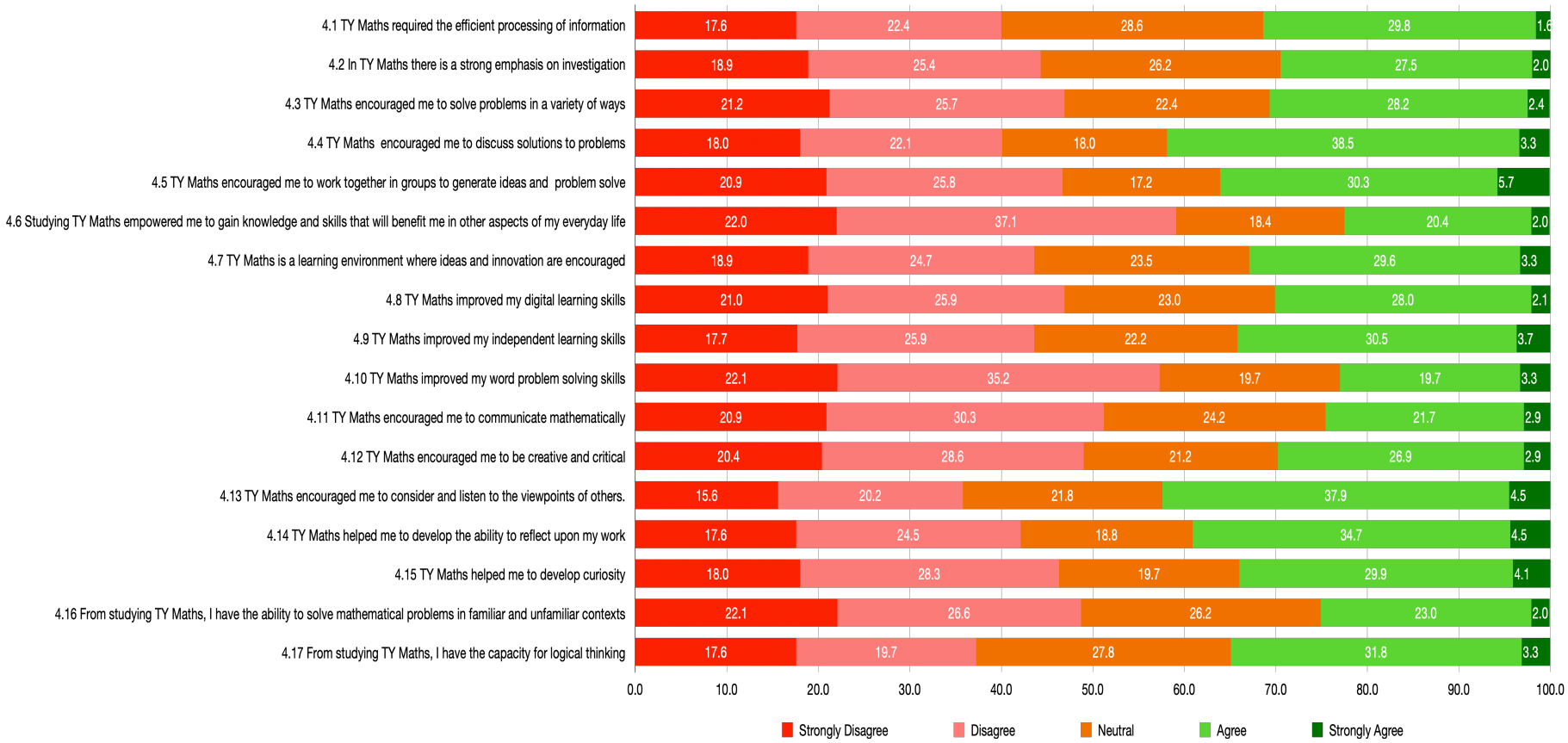


Figure 4.21: Heat Map of students' responses to the Statements in Quadrant Four: Skill-Based Preparedness.

Figure 4.22 identified the strengths of the TYM programme from the experiences of the current TY students. Students noted that from their experiences of TYM, there was an inclusion of the mathematical objective of information processing (Statement 4.1), a focus on problem-solving and discussing solutions (Statements 4.3 and 4.4), the promotion of ideas and innovation, and listening to the viewpoints of others (statement 4.7 and 4.13), and a focus on reflection and logic (Statements 4.14 and 4.17). However, Figures 4.23 and 4.24, showcase the experiences of the sampled 5th and 6th year students. These students identified no strengths in the programme under this quadrant. In fact, the majority of 5th and 6th year students disagreed or strongly disagreed with nearly all statements. This highlights that there are severe deficiencies in Skill-Based Preparedness in TYM.

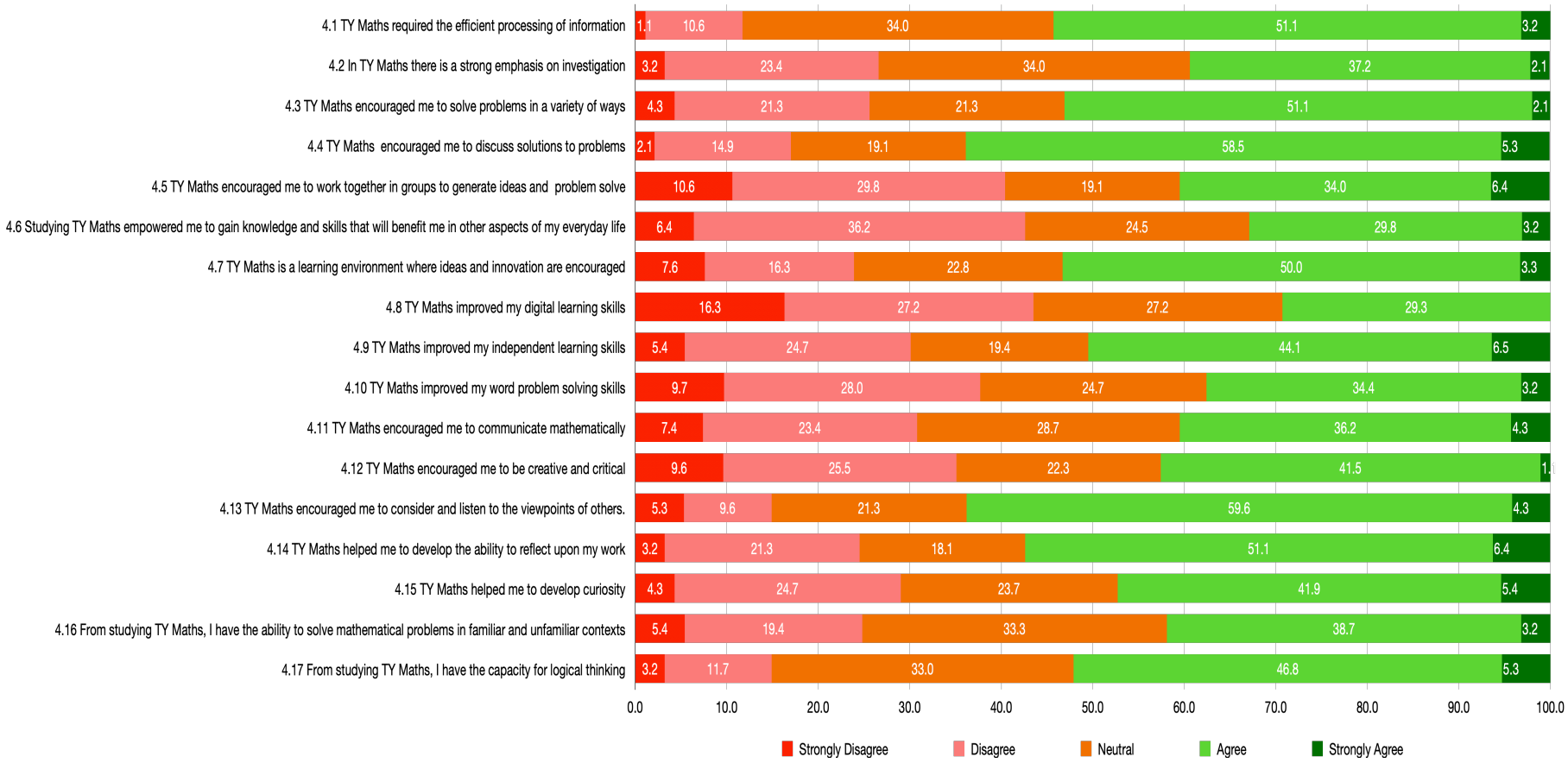


Figure 4.22: Heat Map of Transition Year students' responses to the Statements in Quadrant Four: Skill-Based Preparedness.

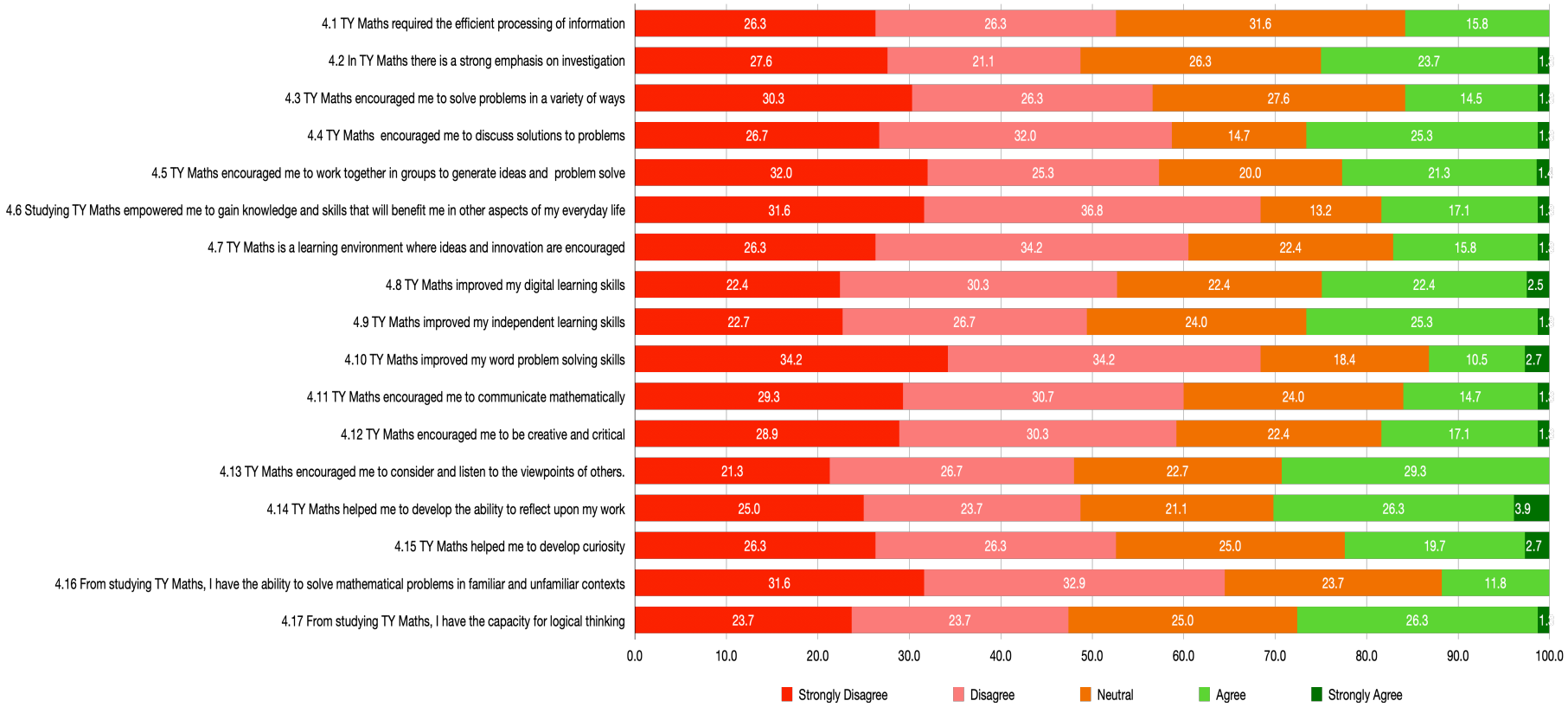


Figure 4.23: Heat Map of 5th year students' responses to the Statements in Quadrant Four: Skill-Based Preparedness.

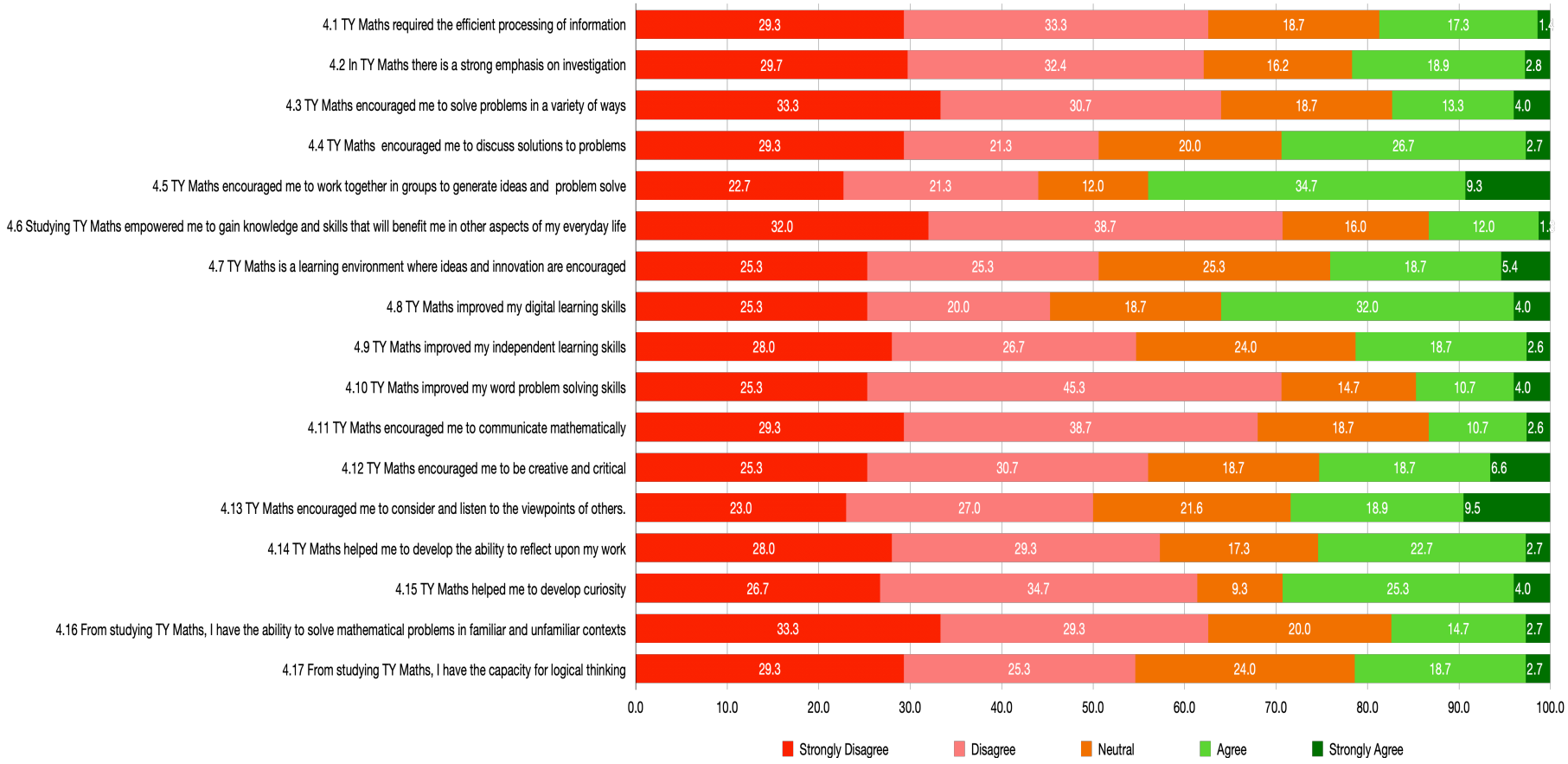


Figure 4.24: Heat Map of 6th year students' responses to the Statements in Quadrant Four: Skill-Based Preparedness.

Table 4.10 below shows the statistically significant results of the Kruskal-Wallis H test on the statements in Quadrant Four (Skill-Based Preparedness), with the mean rank score of students' experiences in TY, 5th and 6th year. The comparison of the median results by year group for each of these statements, revealed statistically significant differences for all statements apart from one (Statement 4.8: TY Maths improved my digital learning skills). The following subsections expand on students' experiences of TYM and the five key skills under this quadrant on Skills-Based Preparedness.

*Table 4.10: The results of the Kruskal-Wallis H test on the statements in Quadrant Four on Skills-Based Preparedness (** represents statistical significance).*

	Kruskal-Wallis H	df	Asymp. Sig.	Mean Rank		
				TY	5th	6th
4.1: TY Maths required the efficient processing of information	59.488	2	0.000**	165.69	99.00	93.82
4.2: In TY Maths there is a strong emphasis on investigation	23.266	2	0.000**	148.57	111.76	100.42
4.3: TY Maths encouraged me to solve problems in a variety of ways	42.638	2	0.000**	159.27	102.50	98.32
4.4: TY Maths encouraged me to discuss solutions to problems	41.949	2	0.000**	157.87	97.77	102.90
4.5: TY Maths encouraged me to work together in groups to generate ideas and problem solve	11.046	2	0.004**	134.47	100.89	129.11
4.6: Studying TY Maths empowered me to gain knowledge and skills that will benefit me in other aspects of my everyday life	25.891	2	0.000**	150.98	107.69	103.45

4.7: TY Maths is a learning environment where ideas and innovation are encouraged	31.182	2	0.000**	152.64	97.20	109.55
4.9: TY Maths improved my independent learning skills	22.708	2	0.000**	148.06	110.25	101.44
4.10: TY Maths improved my word problem solving skills	27.511	2	0.000**	151.48	101.76	107.58
4.11: TY Maths encouraged me to communicate mathematically	32.255	2	0.000**	153.74	106.13	99.71
4.12: TY Maths encouraged me to be creative and critical	16.243	2	0.000**	144.84	104.36	114.52
4.13: TY Maths encouraged me to consider and listen to the viewpoints of others.	31.430	2	0.000**	152.58	101.51	103.95
4.14: TY Maths helped me to develop the ability to reflect upon my work	29.328	2	0.000**	152.58	109.54	99.57
4.15: TY Maths helped me to develop curiosity	22.508	2	0.000**	148.94	106.47	105.96
4.16: From studying TY Maths, I have the ability to solve mathematical problems in familiar and unfamiliar contexts	41.717	2	0.000**	158.49	98.23	102.46
4.17: From studying TY Maths, I have the capacity for logical thinking	35.837	2	0.000**	155.75	107.99	97.17

Critical and Creative Thinking (Statements 4.2, 4.3, 4.7, 4.10, 4.12, 4.15)

Figure 4.25 below provides a comparison of the three statements (4.2, 4.3, and 4.10) linked to the key skill of Critical and Creative Thinking.

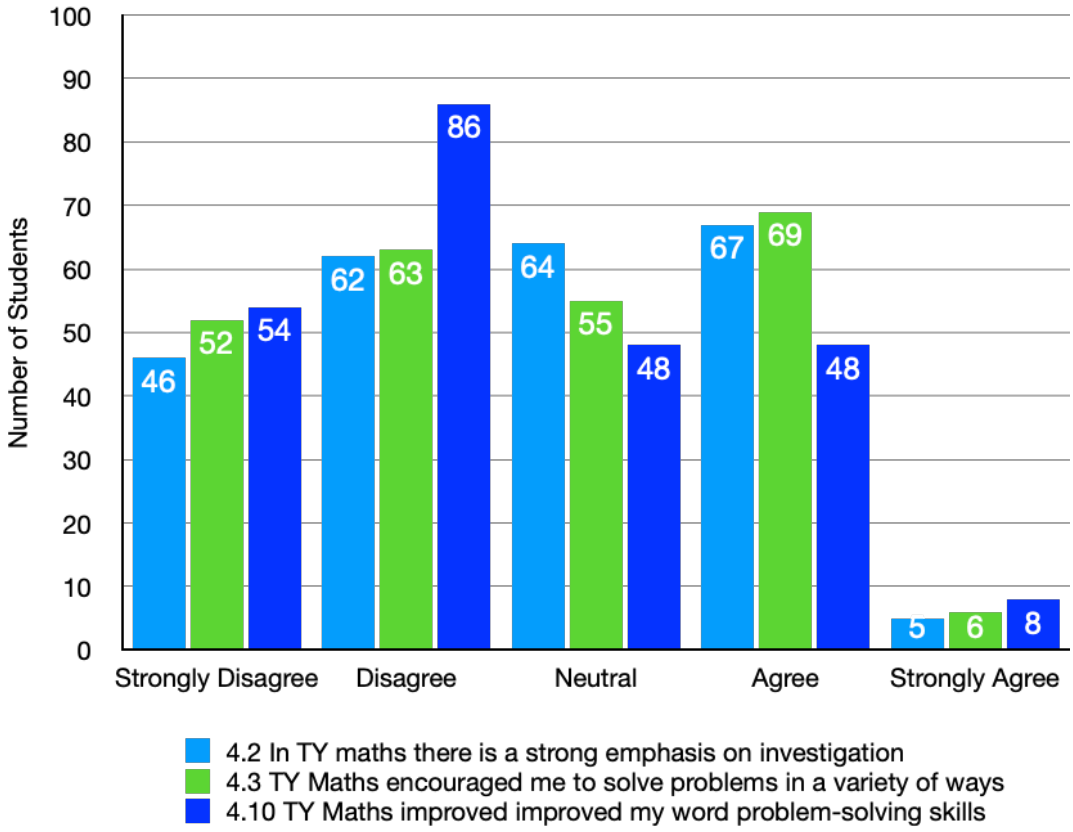


Figure 4.25: Comparison of responses to Statements 4.2, 4.3 and 4.10 in relation to problem-solving.

These results suggest that TYM is not, from the perspective of the students, centring on problem-solving or mathematical investigations. This is despite teachers' freedom to create mathematical investigations that support students' problem-solving skills and the wide range of extra-curricular competitions available to students during TYM.

Further analysis of this key skill under the Kruskal-Wallis H test (see Table 4.11) showed that all three statements (4.2, 4.3 and 4.10) result in a statistically significant difference between year grouping, at the $p < 0.05$ level. The Kruskal-Wallis H test indicated that the mean rank for TY students is higher than Senior Cycle students, in terms of the emphasis on investigation, the encouragement to utilise problem-solving, and the ability to work with word problems during TYM.

Table 4.11: Kruskal-Wallis H Test for Statements 4.2, 4.3 and 4.10 on Critical and Creative Thinking.

Statement	Kruskal-Wallis H Value	Degrees of Freedom (df)	p value	Mean Rank		
				TY	5th	6th
4.2	23.216	2	$p < 0.05$	148.57	111.76	100.42
4.3	42.638	2	$p < 0.05$	159.27	102.50	98.32
4.10	27.511	2	$p < 0.05$	151.48	101.76	107.58

Finally, the findings from Statement 4.12: "TY Maths encouraged me to be creative and critical" revealed that 49% ($n = 120$) of students disagreed or strongly agreed with this statement, highlighting a shortfall in the students' perceptions of its development.

Communication (Statements 4.4 and 4.11)

Students reported mixed opinions regarding Statement 4.4: "TY Maths encouraged me to discuss solutions to problems" with 40.2% ($n = 98$) disagreeing with this statement and 41.8% ($n = 102$) agreeing. This lack of clarity on the reality of mathematical discussion in the classroom is difficult to interpret solely from this statement. However, Statement 4.11: "TY Maths encouraged me to communicate mathematically" provided further insight into the mathematics classroom during TY. Results showed twice as many students disagreed with this statement 51.2% ($n = 125$), than agreed, 24.6% ($n = 60$) (see Figure 4.26 below).

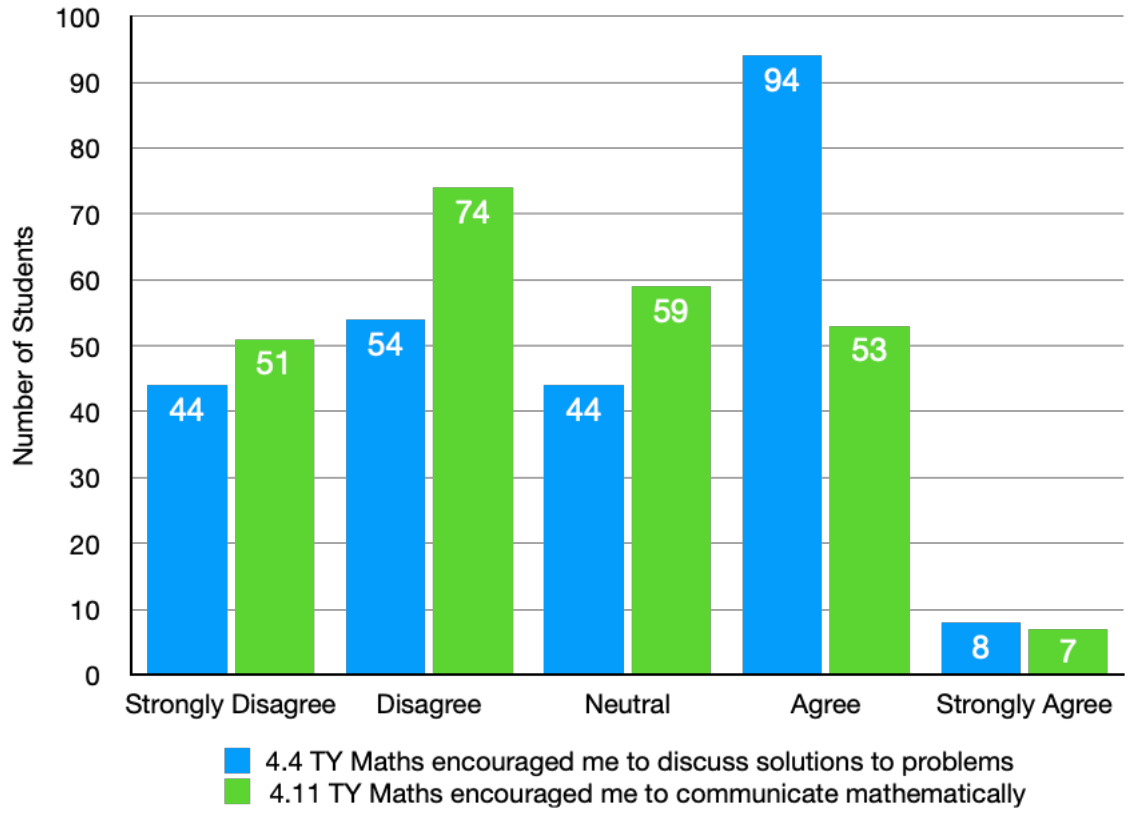


Figure 4.26: Comparison of Responses to Statements 4.4 and 4.11 in relation to the Key Skill of Communication.

Working with Others (Statements 4.5 and 4.13)

Statement 4.5: "TY Maths encouraged me to work together in groups to generate ideas and problem solve" recorded 46.7% ($n = 114$) of students disagreeing, in contrast to 36% ($n = 88$) of students agreeing. Nearly half of the students sampled acknowledged that TYM did not foster a classroom culture that encouraged them to work together on mathematical problems. A Kruskal-Wallis H test showed that there was a statistically significant difference between working in groups to generate ideas and problem solve (Statement 4.5) and year grouping ($H = 11.046, df = 2, p < 0.05$), with TY student having a mean rank score of 134.47, 5th year students having a mean rank score of 100.89, and a mean rank score of 129.11 for 6th year students. Table 4.12 provides the frequencies of the participants for Statement 4.5. Interestingly, the difference seems to occur among the 5th year students.

Table 4.12: Median Test for Statement 4.5: "TY Maths encouraged me to work together in groups to generate ideas and problem solve".

	$> Median$	$\leq Median$
TY $n = 94$	38 (40.4%)	56 (59.6%)
5th Year $n = 75$	17 (22.7%)	58 (77.3%)
6th Year $n = 75$	33 (44%)	42 (56%)

Statement 4.13: "TY Maths encouraged me to consider and listen to the viewpoints of others" revealed that nearly half of the participants, 51.2% ($n = 125$), agreed with this statement.

Being Personally Effective (Statements 4.6, 4.9, and 4.14)

- 34.1% ($n = 83$) of students acknowledged that TY Maths improved their independent learning skills (Statement 4.9). At the same time, 43.6% ($n = 106$) of students disagreed that TYM had helped them improve their independent learning skills required for the LCM programme.
- 42% ($n = 103$) of students disagreed or strongly disagreed that TY improved their ability to reflect on their learning (Statement 4.14).
- The analysis of the effects of independent learning and reflection in TYM shows a strong positive correlation between both variables. The Pearson correlation coefficient between Statements 4.9 and 4.14 was $r = 0.622, p < 0.05$. This strong positive correlation highlights the connection between independent learning and personal reflection.

Information Processing (Statements 4.1, 4.8, 4.16 and 4.17)

Two statements in this key skill of Information Processing yield statistically significant results, under a Kruskal Wallis H test.

- Statement 4.16: "From studying TY Maths, I have the ability to solve mathematical problems in familiar and unfamiliar contexts" $(H = 41.717, df = 2, p < 0.05)$, with TY students having a mean rank of 158.49, in comparison to a mean rank score of 98.23 for 5th year students, and 102.46 for 6th year students.
- Statement 4.17: "From studying TY Maths, I have the capacity for logical thinking" $(H = 35.837, df = 2, p < 0.05)$, with TY students having a mean rank of 155.75, in comparison to a mean rank score of 107.99 for 5th year students, and 97.17 for 6th year students.

The analysis of Statement 4.16 indicates that students in TY perceived that their TYM experience enhanced their ability to solve mathematical problems in both familiar and unfamiliar contexts in comparison to those students in 5th and 6th year. The statistically significant differences suggest that the curriculum or educational experience in TY has a notable impact on students' self-assessed problem-solving skills. Furthermore, the analysis of the mean rank scores for Statement 4.17 indicates that TY students perceive themselves as having a higher capacity for logical thinking due to their current TY mathematical experience compared to those students in 5th and 6th year.

4.4.4.1 Key Findings from Quadrant Four

KFS4.1 TYM is not currently preparing students with the appropriate skills required for problem-solving and mathematical investigations.

KFS4.2 Students do not feel that they are being supported in developing the key skill of communication.

KFS4.3 Students reported that TYM did not improved their personally effective skills, with the majority of students reporting that TYM did not improve their independent learning skills or their ability to reflect on their learning. As students prepare for LCM, these skills will be vitally important.

4.5 Conclusion

This chapter started by establishing the findings of the Delphi Study Discussion Phase. These findings were analysed, resulting in a series of tables which provided an overview of the discussion topics and the generation of the corresponding statements for inclusion in the student questionnaire (Appendix G). The Panel of Participants refined and validated these statements, before they were administered to students from the three research schools. Following the structure of the four quadrants of mathematical preparedness, the analysis and findings of each section were completed. A series of descriptive and inferential statistical methods were applied to the data, to develop an understanding of students' experiences of the co-created definition of mathematical preparedness in TY. At the end of each quadrant, the key findings, from the student's perspective, were summarised in textbooks outlined in blue. Students reported that academically, their experience of TYM did not develop their procedural fluency. Most students claimed that TYM lacked a sense of academic challenge, and from their perspective, TYM was not deemed to be academically beneficial to students. Socially, students reported that TYM provided them

with a platform to build positive relationships with teachers and their peers. Students stated overwhelmingly that TYM should be an environment free from competition. Emotionally, the findings suggest that students perceived TYM to be an uninteresting programme, which does not increase their confidence. Finally, most students reported a deficiency in key skills during TYM. In particular, the student responses suggest that TYM should focus on problem-solving, communication, and independent learning skills. These findings will be discussed within the context of the literature, and the teacher results in chapter six, the discussion chapter.

Chapter Five: Data Analysis and Findings (Stage Three)

5.1 Introduction to Chapter

This chapter presents teachers' perspectives on mathematical preparedness; it portrays the qualitative findings and data analysis from 13 semi-structured interviews conducted with practising mathematics teachers in Ireland. The chapter addresses research question three: What key issues must be considered to mathematically prepare students during Transition Year?

The analysis strategy for this stage is Inductive Conventional Qualitative Content Analysis (ICQCA). This strategy enables the researcher to create knowledge on the key issue of mathematical preparedness, where the codes and themes were generated directly from the teacher interview transcripts. Starting with the raw transcript data, the researcher read through the transcripts on three occasions. The researcher refined the themes and codes on each cycle, drawing connections and noticing patterns among the teachers' responses. In due course, four finalised categories emerged. These categories are Identity, Before and Beyond, The Teacher, and The Preparedness Quadrants.

Figure 5.1 below illustrates an overview of the concept system, plotting out these four areas and their numerous branches. The purpose of this concept system is to provide the reader with a visual representation of the findings and their interconnectedness in addressing research question three. This chapter starts with an overview of the profile of the teachers who participated in the semi-structured interviews. It then reports the key findings and themes from the teacher interviews.

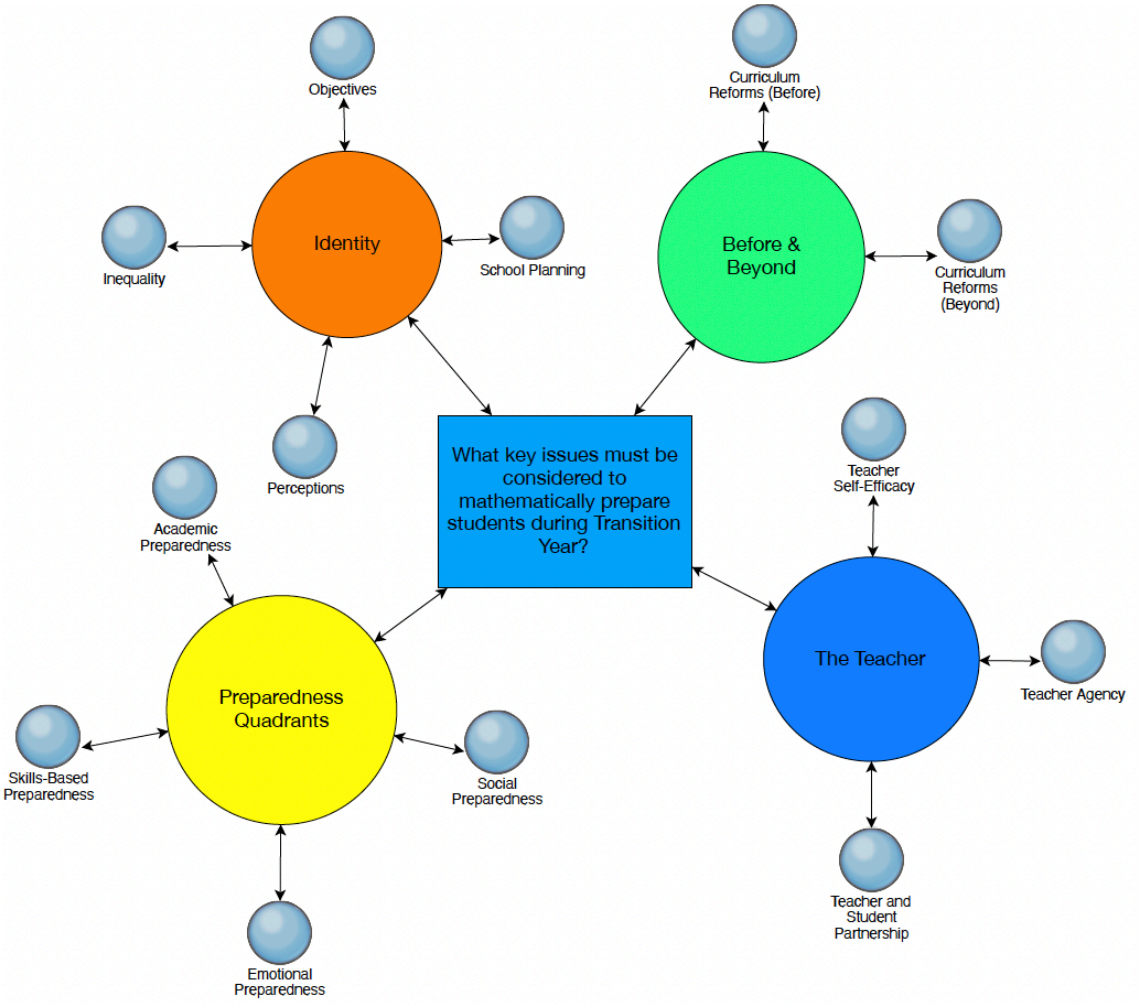


Figure 5.1: Concept System for Data Analysis and Findings of Stage Three.

5.2 Teacher Profiles

As TY is a domesticated programme, it is crucial to have an overview of the school context of each teacher participant. Tables 5.1 and 5.2 help contextualise each school's Transition Year Programme (TYP). Table 5.1 is a legend key for Table 5.2, the Teacher Profiles. Table 5.1 consists of three colour-coded pillars based on the following:

- The teacher's practice (in green).
- The teacher's school type (in blue).
- The organisation of Transition Year in the teacher's school (in yellow).

Table 5.1: Overview of Three Pillars for the Teacher Profile Table.

Pillar (Colour- Coded)	**Legend**			
Teacher Gender	F – Female	M – Male		
Teaching Experience	1: < 5 years	2: $6 \leq 10$ years	3: $11 \leq 15$ years	4: > 15 years
School Sector	CC – Community and Comprehensive	ETB – Education and Training Board	Vol – Voluntary School	
Fee Status	F – Fee Charging	P – Publicly Funded		
Religious Ethos	C – Catholic	M – Multi-denominational		
DEIS Status	N – Non–DEIS	Y – DEIS		
Pupil Gender	C – Coeducational	F – Female	M – Male	
School Size	S – Small (>400 pupils)	M – Medium (400-700 pupils)	L – Large (>700 pupils)	
TY Status	C – Compulsory	O – Optional		
Class Formation	B – Banded	M – Mixed-Ability	S – Streamed	

To protect the identity of teachers, the researcher applied pseudonyms of famous mathematicians.

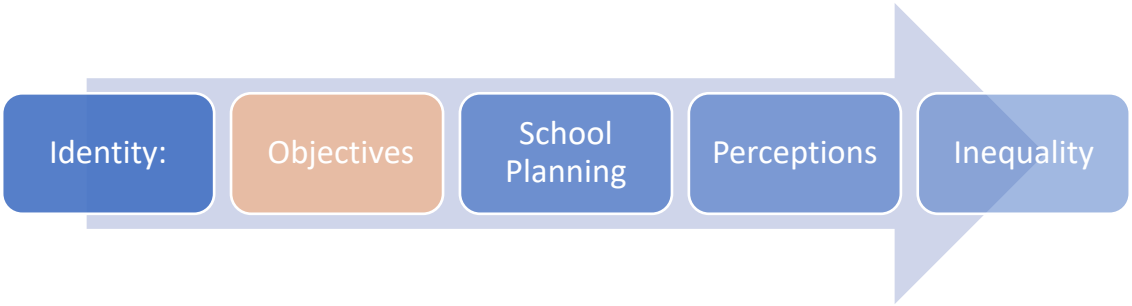
Table 5.2: Teacher Profile Table.

Teacher	Gender	Years Teaching	School Type	Fee Status	Ethos	DEIS	Pupil Gender	School Size	TY Status	Class Formation
Cantor	F	2	ETB	P	M	Y	C	M	O	M
Erdös	M	2	CC	P	M	N	C	M	C	S
Euler	M	2	ETB	P	M	N	C	L	O	M
Hamilton	F	3	Vol	P	C	Y	F	S	O	S
Johnson	F	2	Vol	F	C	N	M	M	C	S
Kepler	F	2	CC	P	M	N	C	M	C	S
LaPlace	M	2	ETB	P	M	Y	C	M	O	M
Leibniz	F	4	Vol	F	C	N	M	M	C	S
Maxwell	F	2	CC	P	M	Y	C	M	C	B
Newton	F	2	Vol	P	M	N	C	M	O	M
Pascal	F	3	CC	P	M	N	C	L	O	M
Pythagoras	M	3	Vol	P	C	N	M	M	O	S
Turing	F	4	CC	P	M	N	C	L	O	M

5.3 Reporting on Category One: Identity of the TY Programme

Identity, as a category, comprises of four codes: Objectives, School Planning, Perceptions, and Inequality. The analysis and findings of each of these codes are presented in this section.

5.3.1 Objectives



5.3.1.1 Transition Year Programmes – Guidelines for Schools (1994)

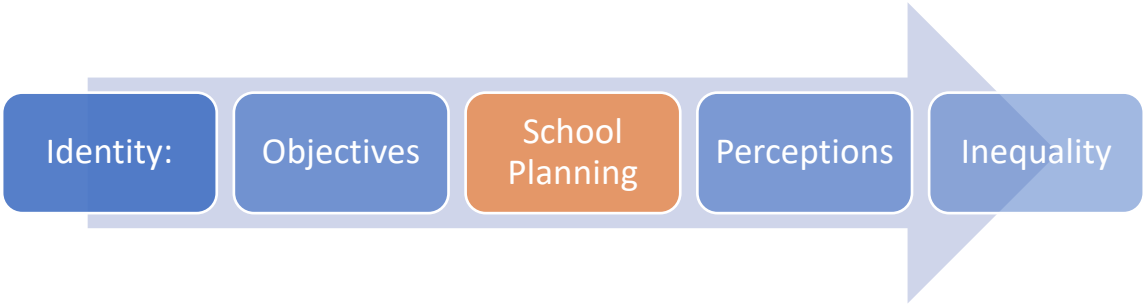
The analysis revealed that teachers of TYM feel limited in creating a unique domesticated programme due to the vagueness of the current programme objectives. Specifically, teachers refer to the lack of objectives in these guidelines, describing them as outdated: *"there's no real set goal… when you are going into Transition Year, it's all very vague, or there's no real targets to be hitting" (Erdös).* Teachers commented that TYM needs an official start and end point. This ambiguity results in difficulties for teachers in understanding their role in designing a suitable programme.

5.3.1.2 The Broader Objective

The analysis unearthed a broader problem. Several teachers questioned the main objective of post-primary mathematics education in Ireland. Turing, disclosed that the objective is to prepare students for assessment purposes rather than for life mathematically: *"In our society, (the objective of) Leaving Cert Maths is the exam".* Euler, commented that the identity issues of TYM are placing teachers in a difficult situation, where they are torn between trying something different or starting the LC curriculum early: *"On one hand, we can talk about TY, as you know, being an opportunity to prepare for the Leaving Cert. On the other hand, it's a year where students are given a chance to explore different learning*

styles". However, Pythagoras, proposed an alternative model for ensuring equity of common objectives for all schools to follow while planning their domesticated TYM programme: *"So you can probably break it down into 10 or 12 topics and they might be picking 8 out of those… maybe a prescribed curriculum with a bit of choice built into it".*

5.3.2 School Planning



Teachers reported that school planning is essential for the success of the TYP. However, teachers warned that overburdening schools with administration tasks and the preparation of students for state examinations, results in limited time for innovation in TY.

5.3.2.1 A 'laissez-faire' mentality of Transition Year School Planning

Euler, spoke of the vital role that school planning and management have in protecting core academic subjects, such as mathematics, during TY. While Euler, agreed that TY is about the growth and development of students in many ways, the need to protect tuition time for mathematics was highlighted: *"what you might find is one teacher might have their TY Maths on a Monday first class, which might be rarely hit".* The term "hit" refers to missed tuition time due to other elements of the TYP, such as trips, musicals and outings. Euler, claims that these elements are eroding tuition time for mathematics due to a 'laissez-faire' approach to TY school planning. Similarly, Pascal, called for external activities (field trips, activities and work experience) to be timetabled. Hence, maximising the teaching time for mathematics.

5.3.2.2 Maximising Expertise and Maintaining Priorities

The analysis further highlighted school management issues. Pythagoras, noted concerns about the appointment of teachers to this alternative programme. This teacher claimed that planning for TY only happened once exam years (3rd and 6th year) received appropriate staffing and resources. Furthermore, Pythagoras, claimed that teaching TY is not a role that many teachers relish: *"there's very few on that staff ... who actively want the TY maths class in general. In terms of the timetable, it's usually left to last. You know, like you are plugging gaps".*

Euler, expressed concerns about teacher shortages and how this is impacting the TYP, claiming that school management is allocating inexperienced, or even unqualified teachers to TYM classes: *"we would have some teachers who are maybe not fully qualified to teach maths been asked, can you take that TY class? Sure, you've got a junior science class, you'd be alright".*

5.3.2.3 Class Structure

The analysis revealed two options, modular or standard, for structuring TYM classes. A modular approach refers to dividing TYM into specific time intervals, generally between 8-11 weeks, where students complete several specific mathematics units. In comparison, the standard approach refers to one teacher teaching the same class for the academic year. Eight schools reported a modular approach, compared to five schools who applied a standard approach to TYM. Euler claimed that a modular structure helps students condense their learning and be periodically assessed during an often-disrupted, busy TYP: *"I think modules work fantastically…to be able to focus on certain aspects for a set amount of time and then to be examined on it".* Kepler noted that teachers can develop their domesticated modules with different lenses to best support the weaker student or to challenge the more able student: *"so I kind of delivered the same module like three times. But obviously, I had*

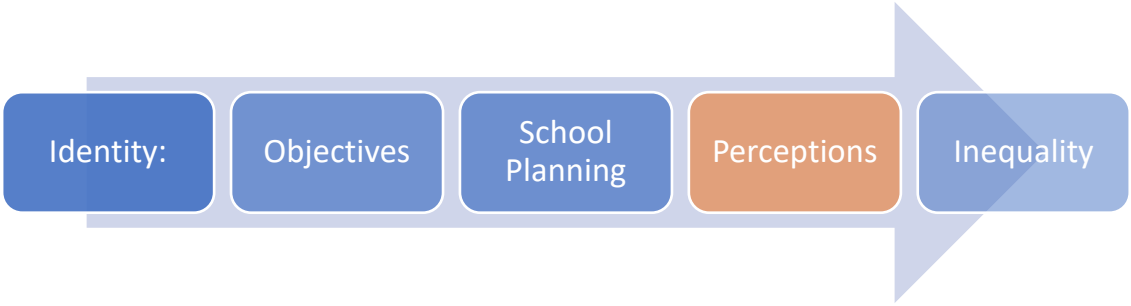
to edit it based on whether I had higher level or ordinary level students in front of me and what their kind of understanding of the concepts would have been". Furthermore, Pascal, highlighted the importance of the rotational element of the modular approach, claiming that it supports, builds and develops professional relationships between students and teachers without the added pressure of the LC.

5.3.2.4 Class Composition

The teachers interviewed reported different approaches to class composition in their respective schools (see Table 5.2), with banding classes reported as the least common method and mixed-ability as the most popular. However, several teachers appealed for a change to the mixed-ability class formation. Newton stated that *"if I teach to the higher level, the weaker kids are lost and confused… so you kind of have to appeal to the masses",* while Turing stated that: *"there's always, I think, a saturation point to the mix…it depends on how heavy you are with top kids, or how heavy you are with weak kids, you don't always get the balance that they say mixed-ability gives you".*

One teacher suggested trialling a new model of streaming for TYM based on mathematical interest and ability. It would aim to fully support and prepare students for their selected level at LCM: *"I would like to be able to stream the classes… I don't mean higher, ordinary or foundation, but split them even into mathematically interested, mathematically uninterested, mathematically able, and mathematically I just need help to get the basics" (Hamilton).*

5.3.3 Perceptions



Perceptions of TYM held by teachers, students and parents may impact the programme's identity. Furthermore, the analysis suggested that the status of TY significantly impacts the programme's identity.

5.3.3.1 Multiple Perceptions: The Top-Down Approach

Intense frustrations among teachers emerged during the analysis. The lack of clear objectives for teaching TYM resulted in teachers questioning the government's role in developing the identity of TYM: *"I just think if the department set down better guidelines, more support for us, more in-service, because it's a very valuable year wasted otherwise" (Turing).* This absence of governmental direction filters into classrooms. Several teachers stated that they are battling against a culture of negativity and a high rate of student absenteeism in schools: *"I would find it harder to battle against the culture of TY, as in, "This is the year we do not have to do anything", "Why do we have to do maths? It is TY" (Hamilton).* Further concerns emerged with Johnson highlighting that there is a disconnect between the teacher's aims and the student's perceived needs for this middle year:

> *"It is just the sheer, like, doing what you want, no one caring kind of vibe that kills me…"What am I going to get from this?". Now to me, I'm like, you're getting the excitement of numbers and the beauty of maths but, like, it doesn't always sell, do you know what I mean?".*

Euler, also identified that parents can foster a relaxed perception of TYM that can have harmful implications for students as they progress onto LCM: *"it's just TY…. 'ah sure it is just a year for them to relax' in between the Leaving Cert and they put no pressure on".*

5.3.3.2 TY Status

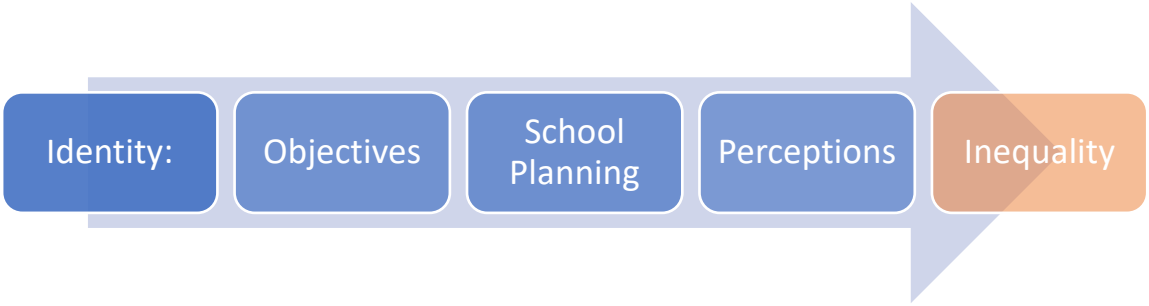
Although TY is an optional programme, schools can make it compulsory. In multiple interviews, teachers narrated that the status of TY in their schools shaped its character and identity. Leibniz, who works in a school where TY is compulsory, used a metaphor of a

stone in a river to capture the perceptions of TYM teachers: *"it feels sometimes like, like a stone in the middle of a river. You know, you're just hopping along…it doesn't have a massive impact, we'll enjoy it, but it doesn't really matter".*

Euler, suggested that if TY was a compulsory programme, that it would vastly improve the perception of this unique middle year: *"at least it would be consistent for the entire student body and that's the thing, that can be frustrating, and we can build on things in TY and we can kind of touch on some things that might feature in the Leaving".*

Establishing TY as compulsory may assist in furthering a continuous approach to mathematics education in Ireland. Schools have the autonomy to make TY compulsory, grounding this unique and diverse year to benefit students.

5.3.4 Inequality



The analysis identified significant challenges in equality between the fee-charging and public sector schools and even within the different school types in the free education sector.

5.3.4.1 Domesticated Disadvantaged vs. Domesticated Advantaged

It is interesting to note the different concerns of mathematics teachers from schools serving diverse socio-economic areas. In one of the Delivering Equality of Opportunities in Schools (DEIS) schools, LaPlace, revealed they start LCM curriculum during TY to prepare their students from lower socio-economic backgrounds: *"we don't get the whole syllabus done though, but what we do get is the areas that we found in 5th year that are known to cause a problem…".* With a smaller cohort of students and a traditional lack of uptake at LCHL mathematics, LaPlace takes advantage of the lack of a formal, prescribed curriculum in TY

to boost the standards of LCHL within DEIS schools by covering the complex topics of LCM during TYM.

However, DEIS schools are not the only ones utilising TY to benefit students by explicitly covering LC content. All thirteen teachers acknowledged that they started the LC curriculum topics during TYM. However, the two participating fee-charging schools admitted to covering only the LC material during TYM. Hence, using TY ensures that students are well-prepared to take the higher level and ordinary level LCM courses. The two teachers in the fee-charging sector acknowledged that there is pressure to ensure that students score well in LCHL, and also pressure to ensure progression for those students taking the OL course: *"There is no such thing as foundation level in my school, with enormous pressure. There are children who just cannot do it"(Leibniz).*

5.3.5 Key Findings on Category One: Identity of the TY Programme

KFT1.1 There is no clear identity or purpose to Transition Year Mathematics. Teachers identified that they need a clear vision for this unique year, to maximise its benefits and to best prepare students for the demands of LCM.

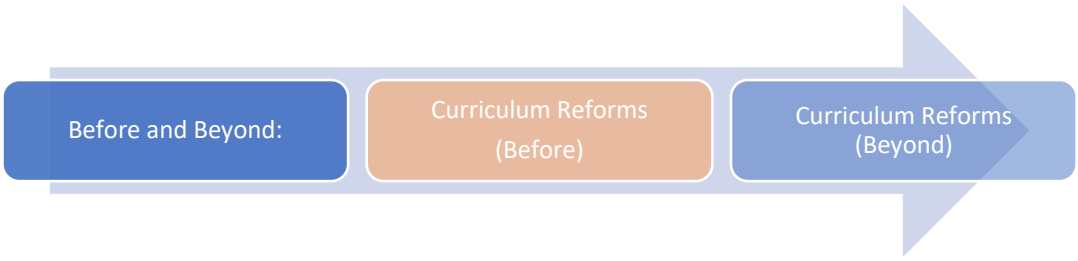
KFT1.2 Many teachers interviewed were supportive of a modular approach to TYM. However, barriers occur when students are in mixed-ability classes. Several teachers reported difficulties in teaching mixed-ability mathematics classes during TYM. In particular, the gap between JCM and LCM may be further responsible for the need of streaming in TYM. Other options should be considered.

KFT1.3 In addition, the absence of a clear identity, can lead to inequalities in the teaching and learning of TYM, with some schools utilising TYM as an additional year of LCM. This stems from the programme's lack of identity and may lead to some students gaining an unfair advantage in the preparation for LCM.

5.4 Reporting on Category Two: Before and Beyond

The second category, "Before and Beyond", refers to the journey that mathematics teachers have experienced over the last decade due to repeated curriculum reforms. Throughout the interview process, teachers noted the changes in their practices due to the Project Maths curriculum for both Junior Certificate and LC, along with the more recent Junior Cycle Mathematics Specification. Teachers commented on how these changes altered their approaches and practices in TYM regarding teaching, learning, and assessment. The analysis revealed that teachers grapple with the multiple changes introduced through reforms. Although the interview transcripts fail to capture tone, emotion, or intensity, Johnston, expressed frustration about these numerous reforms: *"like, we have only just got on board the old Project Maths, and then now, it's Junior Cycle"*. This section captures the positive and negative findings of the teachers' perspectives on past mathematics reforms and their suggestions for future reforms to TYM.

5.4.1 Curriculum Reforms (Before)



5.4.1.1 Assessment Practices

LaPlace, raised concerns about the new assessment format for JC mathematics, claiming that the implementation of Classroom Based Assessments (CBAs) reduced the teaching time at JC. Hence it is placing enormous pressure on teachers to catch up on missed material during TYM. Furthermore, while one of the primary aims of the JC model is to promote wellbeing among students, by reducing the weighting of the final terminal examination into a more manageable continuous assessment model, Euler, questioned if the shift towards

this was impinging on the wellbeing of students: *"if you do a CBA after Christmas, you're not supposed to have a summer exam. I would find that has a counterproductive effect on our students…we don't want the students to end up not having that exam because the experiences of sitting those exams builds resilience".*

5.4.1.2 TY as the Forgotten Middle Child of the Curriculum?

Despite the multiple reforms to mathematics education in Ireland, teachers highlighted frustrations that TY guidelines have not been upgraded in nearly thirty years. Failing to seize the opportunity to reform TY and sandwiching it between two highly reformed programmes earns TYM the title of Forgotten Middle Child: *"I do think the TYP has been just forgotten" (Newton).* All thirteen teachers reiterated that the Department of Education needs to make this unique year a priority focus. Teachers angrily revealed that TYM receives limited attention from the Department of Education & Skills: *"there's no time spent on anything to do with TY Maths or developing any curriculum there" (Erdös).*

5.4.1.3 Curricular Content, Pace and Progression

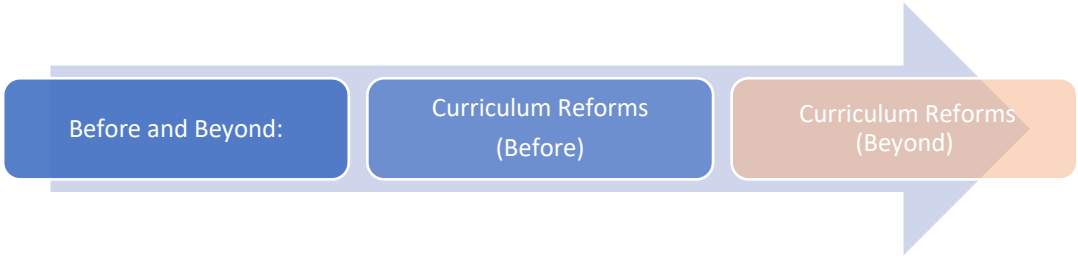
While teachers called for a reduction in the JC curriculum content to match the single terminal examination, in contrast, the analysis revealed the negative impact of removing parts of the older mathematics curriculum at the LC level. Erdös, stressed that as students' progress onto third-level courses in Science, Technology, Engineering and Mathematics (STEM), they are grossly unprepared: *"When students entered STEM third level subjects, such as engineering and things like that, they were at a bit of a loss having never seen vectors and never having seen matrices and things like that".* Kepler, emphasised time as a crucial factor in implementing the changes outlined in reforms. These curricular modifications make teachers feel unsure of the pace required to teach the curriculum: *"It can be quite frustrating as the teacher because you're trying to maybe get them to discover*

and understand, and have that fluency in their understanding, but sometimes it is a case of, okay, I need to move on".

Furthermore, Johnson reported that TY provides a unique opportunity for teachers to move outside their comfort zones and try different teaching and learning methods and assessment practices:

> *"If you want to try something with your 3rd or 5th years or whatever year… but you can't afford time for it to go wrong. So definitely the approach is kind of going into TY saying right, how will these react to it, and then we'd base everything else off them for the other years".*

5.4.2 Curriculum Reforms (Beyond)



5.4.2.1 The Future is Bright

Remarkably, this code had the highest references, featuring fifty-one times throughout the coding process, emphasising that teachers are ready to welcome changes to TYM. All teachers offered suggestions for reforming TYM: *"if it was just a bit of a framework, a bit of a guidance, not a heap of stuff thrown in there because we want the freedom to be able to do what our students want to do and how we can engage your students" (Cantor).*

Most teacher participants echoed the idea of an updated and lenient framework rather than a strict set of prescribed guidelines. Euler, emphasised the need for structural guidance to any reforms of TYM, to foster the transition from JC to LC: *"guide the teacher across various different topics of what depth you might look at something and how much time to give it and how to make those connections between Junior Cert and Leaving Cert".*

5.4.2.2 Borrowing from the Sister Programmes

The analysis suggests that the Department of Education should look to the successful elements of other sister programmes, when considering future reforms to TY. Hamilton, called for approaches similar to the Junior Certificate School Programme (JCSP) [4] Mathematics and LCA[5] to be featured in the updated version of TYM:

> *"With regards to topics, maybe a list of topics that they could do like. Similar to the Junior Certificate School Programme. For each module, there are certain learning outcomes that need to be obtained, and the learning outcomes are obtained depending on the ability of the child".*

> *"if you look at the Leaving Cert Applied at the minute, you give credits or key assignments, based on the individual ability of the student, so the work that's produced by one student might not even be 1/3 as good as what another student has produced, but if that's their ability, then they deserve to get the award the same…but if TY was based on something like…it still is helping students to progress for their Leaving Cert, but it's also ensuring that you're not having people just sitting there wasting the time".*

Furthermore, in terms of the assessment element of the TYM programme, Pythagoras, suggested the inclusion of a similar Classroom Based Assessments (CBAs) model in TY to continue with the skills that students have developed in their JC programme: *"maybe we were a bit ahead of ourselves because certainly a CBA similar project is something that we would have always included over the course of the year in TY Maths".*

[4] https://ncca.ie/en/resources/the_revised_jcsp_programme_statement_/
[5] https://www.curriculumonline.ie/Senior-cycle/LCA/

5.4.2.3 Teacher Resistance

The analysis identified that a lack of understanding of previous reforms led to a resistance to change. Euler recommends that unless teachers understand what it means to prepare students mathematically during TY, any future remodelling of TYM may fail: *"Transition Year may not ever get used to its full effect. Unless schools approach TY correctly".*

Successful programme reforms require the input and commitment of all stakeholders. Pythagoras, inferred that some teachers need direction with choice and freedom in order for curricular reforms to be successful: *"we have to be realistic and there is a certain number of teachers who do need direction… then whatever methodologies they use or whatever, can be left to the discretion of the teacher".*

It can be inferred from the analysis that participants hope for changes in TYM while wishing to retain the freedom at the heart of the programme. Therefore, future reforms must empower teachers as they choose topics that enhance mathematical education and prepare students to seamlessly transition to the next step in exploring mathematics education. Hence, preparing students for life and living.

5.4.3 Key Findings on Category Two: Before and Beyond

KFT2.1 All 13 teachers called for the Department of Education to make TY mathematics a key priority for reform. They all reported that TYM has been "forgotten" despite the multiple curriculum reforms to mathematics in Ireland.

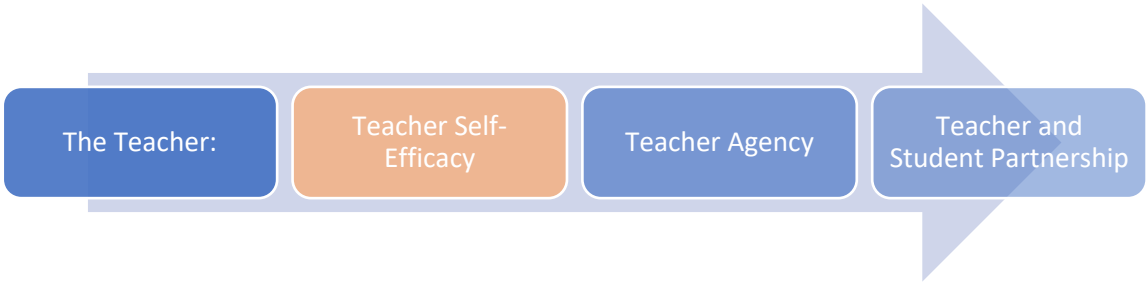
KFT2.2 Despite the multiple professional development courses undertaken for the reforms to Junior Cycle and Leaving Certificate Mathematics, teachers identified the need for more specific CPD for teaching TYM. Furthermore, teachers reported a willingness to engage with all and any training.

KFT2.3 Some teachers highlighted that there is a lack of confidence in their ability to design alternative programmes for TYM. Hence, specific supports from the IMTA and teacher-training institutions may be required to support teacher self-efficacy and creativity in designing domesticated programmes.

5.5 Category Three: The Teacher

The third category to emerge from the analysis is "The Teacher". This category highlighted the vital role that teachers play in the development of TYM. As TY is a domesticated programme, teachers have significant autonomy and agency to mathematically prepare students during this unique year. Teachers have ownership of the topic selection, the teaching and learning strategies and the assessment practices. This category contains three codes, each referring to the positionality of the teacher: Teacher Self-Efficacy, Teacher Agency, and Teacher and Student Partnership. These codes are interconnected and share several common characteristics. This section will present the analysis and findings for these three codes.

5.5.1 Teacher Self-Efficacy



The analysis of the interviews revealed a common theme of self-efficacy among teachers and a belief in their capacity to construct and execute a suitable TYM programme. Teachers reported a miscellany of frustrations regarding TYM, including a need for more professional development, a scarcity of teaching resources, and teacher isolation.

5.5.1.1 Professional Development

The analysis revealed that while teachers were inundated with professional development for the introduction of both Project Maths and Junior Cycle Maths, there needs to be more TY professional development. This deficiency is a source of incredible frustration for mathematics teachers. Turing, the most experienced teacher participant, stated that this lack of professional development for TYM is not a new issue but a historical one: *"Any in-service I did have was in the early years (1990s), and it wasn't really worth talking about. You got some ideas that would last for maybe two class periods and that was it".*

5.5.1.2 TY Planning and Resources

The analysis revealed that the need for more professional development impacted a teacher's ability to plan for TYM. While teachers reported constructing various projects in TYM, typically covering The History of Mathematics or participation in the Central Statistics Office's John Hooper Medal for Statistics, Erdös, commented negatively about their competency to construct distinctive modules for domesticated TYM programmes: "*I suppose my creativity isn't my strong point. So while I'd like and I have all these lovely ideas, I'm not good at implementing them".*

Furthermore, despite Erdös, stating that they are not good at implementing projects, this teacher did outline a home-grown module entitled "The Life Project". This module explores the funding and planning of the post-Leaving Certificate holiday for students, the calculation of purchasing a first car and its costs, managing finances to maintain a household in conjunction with taxes and incomes, and the ultimate planning for a private pension in later life. This project is mathematically rich in Productive Disposition, using relevant life-appropriate scenarios. Reflecting on the delivery of this innovative project, Erdös, stated:

> *"I was just guessing, trying to do it and again, I was delivering it poorly, so it all fell asunder. But again, if I saw something like that implemented…if there was PDST in-service, we're going to do this project with you for a day, then I might be able to do that now for a full year".*

Although this teacher had experience leading an alternative module during TYM, a lack of self-efficacy led to doubt, uncertainty and, in this case, failure. This teacher openly acknowledged the vital need for support for teachers of TYM.

5.5.1.3 Teacher TY Frustrations and Leaving Certificate

Teachers conveyed vexation when seeking support and direction for TYM. Kepler spoke about a fundamental lack of understanding of the role of the teacher in teaching the programme: *"I don't even know the exact layout of what, if there is something you should or shouldn't be teaching in TY maths, because I certainly have never seen it before".* Similarly, Turing and Newton, emphasised that teachers need a timeline, structure, guidance, and support to ensure that they can create meaningful mathematical modules for TYM. Warning that the freedom of domestication does not always equate with positive results:

"So you can do what you want, when you want for how long you want and that isn't necessarily the best thing with Transition Year" (Turing).

"Like the freedom is nice in lots of different ways and like that, I could probably not try push the TYs as much and have a nice life for myself. But do you know what? I don't think this kind of right either, that you could take it back foot on it all together and they do nothing for the year and then you go into 5th year and their skills are on the absolute floor".

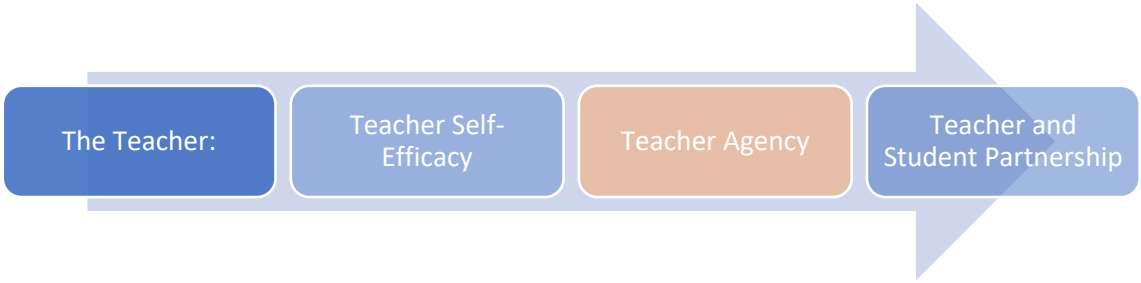
While some teachers reported frustrations with the uncertainty of what to do during TYM, other teachers reported avoiding these frustrations by doing what they know best and commencing the LCM curriculum during TY, simply because they viewed it as a wasted opportunity otherwise: *"It feels like there's a massive, wasted opportunity in TY, when it's not really used to maximise that advantage of having that extra year to help prepare for the Leaving Cert" (Euler).*

Teachers described succumbing to frustration at some point in their careers due to the uncertain nature of TYM. This annoyance results in teachers maximising TY as an additional year of LC preparation for students. From analysing the interview transcript, some teachers focused solely on the LCM academic content, while others concentrated on applications of LCM content and developing a deeper understanding of LCM material. However, each participant claimed that starting the LCM curriculum in TY was to help students:

- LaPlace, reported using TYM as an opportunity to cover between 25-31% of the LCHL material during TYM: *"TY gives us that time, so rather than us going in and doing 32 topics for the Leaving Cert, higher level maths, we will take 10 or 8 or whatever it is we do and we do in detail for those ones".*

- Hamilton, informs that the focus is on teaching the applications of the LC course to students: *"Do the basics of say complex numbers, functions, calculus, so that way students have seen the applications, but also have done some of the basic groundwork for the Leaving Cert"*.
- Johnson, focuses on teaching limited topics from the LCM curriculum in TYM, but instead, covers the perceived complex topics of LCM in depth: *"one of the reasons we actually choose the module real numbers is definitely to get them trying exploring it and actually understanding the beauty of numbers"*.

5.5.2 Teacher Agency



Teacher Agency gives teachers the choice and flexibility to make professional decisions about the teaching and learning in their TYM classrooms. Ten of the teachers interviewed used their knowledge of the TY guidelines, of their students and of their subject, and treated TY as a "bridging year". Kepler, excitedly described TY as a space to discover diverse content in mathematics between the JC and LC:

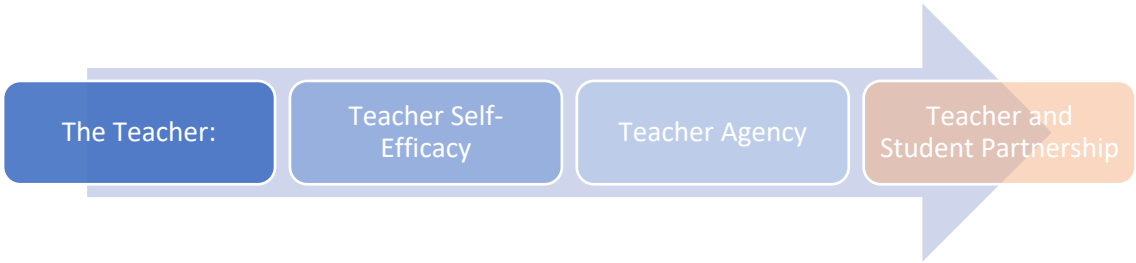
> *"I think it has a brilliant place, because it can act as a great kind of bridge between Junior Cycle and Leaving Cert, not just to catch up on this material, but actually to discover other things that isn't on the course, that actually, you know, when you're in class, you think, oh god, I'd love to bring in matrices or something like that and we don't have time to do it in the normal classroom".*

However, six teachers perceived that this chasm between JC and LC needs to be narrower to be bridged during TY. Teachers believe that the new JC curriculum is widening the gap between the two examination programmes. Leibniz, asserts concerns about the scope of teacher agency in TYM: *"I don't know where that leaves us going into Leaving Cert being honest. Also, I don't know how Transition Year is going to bridge that gap. My big fear is that they become disillusioned too young and I can't bring them back"*. Furthermore, Maxwell used the phrase "*The Lion's Den*" to describe the situation where a mathematics teacher arrives at a TYM class without having a solid plan.

Teacher agency was limited for Johnson and Leibniz, who are employed in fee-charging schools. Both teachers taught only topics from the LC curriculum during TYM. Johnson, taught advanced algebra, specifically indices and logarithms, coordinate geometry and trigonometry. In contrast, Leibniz, taught algebra, trigonometry, coordinate geometry, probability, statistics, and arithmetic. It seems that teacher agency in the fee-charging sector may be limited to focusing on the LC programme, rather than on the vision for TY.

Teacher agency also impacted student outcomes in TYM. Eight participating teachers acknowledged that they were at a loss with TYM. They reported struggling to plan effectively for classes. The remaining five participating teachers willingly embrace the opportunity to develop topics and methodologies that enhance students' preparedness for LC. The analysis revealed that teachers utilised numerous methodologies for teaching mathematics, with pair and group work being the most popular methodology. Leibniz, commented that without the external pressures of looming state examinations, they can develop student confidence and fluency towards the LCHL curriculum while also supporting student confidence by using group work: *"I might hit them with a Leaving Cert higher level question and just get them in groups and get them working on it"*.

5.5.3 Teacher and Student Partnership



The analysis highlighted the importance of the Teacher and Student Partnership. Although some teachers lack the confidence, or are too constrained by the traditional fears of the school inspector to incorporate the student voice within TYM, other teacher reports some apprehensions about including the student voice in their classroom and planning:

> *"I definitely would say that I would (include the student voice), but it would generally be once I have my unit of learning covered. It is remarkable to note that the external fear of the dreaded inspector would be seen as a limiting fear of asking the students what they wish to study, explore and develop on. Like, everyone wants to make sure they have their schemes done and, you know, tick their boxes for the inspectors and stuff like that" (Euler).*

Teachers observed that the level of interest displayed by some TYM students is often less than that of JC or LC students. Erdös, claimed that if students were co-leading the domesticated mathematics programme, motivation and interest levels might increase: *"It'd definitely increase their interest levels and if they have autonomy on what they're doing. So when it comes to why are we doing this, it is you who voted to do this, you wanted to do this, I often love all these student driven ideas".* The evolution of TYM needs to ensure that the relationship between teacher and student develops early in the academic year. Hence, this may place students in the best position to discuss their learning with their teachers in preparation for LCM.

Teachers reported that there needs to be more awareness about who is and who should be contributing to the building of the TYM programme. This is despite the initial TY guidelines, stating that stakeholders, such as teachers, parents and students, should build a school's domesticated programme. However, this vision tends to be something other than a reality. Some teachers disclosed that there is no fixed plan in place for TYM in their schools: *"it's time to nearly design our own curriculum as to what our students require…if it's done properly, the maths department can even look at the cohort that's coming in, decide what areas that they would be kind of be interested in" (Kepler).*

Hamilton expressed trepidations about the inability of students to access the language necessary to express themselves. This diminishes a student's ability to inform the teacher of what they would like to cover, and they become co-authors of TYM: *"At the minute, I think there's a big focus on student voice, which I agree to a certain point and a lot of our students, in our school, in particular, wouldn't actually be able to vocalise what chapter they would like to be revisited".* LaPlace, spoke about the positive impact that the inclusion of the student voice can have on the teacher-student relationship: *"the relationship between the Senior Cycle students and the teacher is getting stronger and better all the time".*

The inclusion of past students' experiences of TYM emerged during the interview analysis. The ability to reflect and learn from students who have participated in TYM and then progressed onto LCM may provide teachers with knowledge of a secret ingredient to mathematics preparedness. However, this depends on teachers having the courage and confidence to reach out to past pupils for their insights into their tuition during TYM. It would also require teachers to have built positive professional relationships with these students. Maxwell, recognised and acknowledged the input that students who have completed TYM can have on the next cohort of students:

"You could have students who have now gone on and graduated out of college, and are just older and are more articulate in what they can say, that would be very helpful, you know, ask them what would have been helpful in TY maths if you could go back?".

The influence of the student voice, both past and present, on the curriculum can be a powerful tool in planning and supporting learning for all students in the TYM programme.

5.5.4 Key Findings on Category Three: The Teacher

KFT3.1 Teachers favoured the autonomy of TYM and the freedom that it provides them to develop their domesticated courses. However, over half of the teachers interviewed reported being at a loss with the TYM programme. This was mainly due to the lack of structure of TYM. Teachers sensed to have a lack of awareness of their agency in developing a suitable programme for their students.

KFT3.2 Teachers identified that they are willing to step back from the dominant role in the mathematics classroom, leading to a paradigm shift towards student voice in the classroom. This shift may also support the building of positive relationships between teachers and students. Furthermore, the teacher and student partnership may foster productive disposition, in students selecting relevant and applicable topics for their learning.

5.6 Category Four: The Preparedness Quadrants

This last qualitative data category focuses on the co-created Four Quadrants of Mathematical Preparedness. During the interview process, the researcher presented each teacher with a visual illustration of the Four Quadrants of Mathematical Preparedness (Figure 2.4) to gather their opinions and thoughts on this model. Initial reactions from the teacher participants were quite positive, with Cantor stating: *"All of them are really*

important in order for them to progress, not just in maths but life". Likewise, Erdös, responded: *"I've almost been motivated to go back to school, looking at them, honestly, like, it's like, it's everything I want to say in fairness"*.

Newton, stated: *"I think you have really hit the nail on the head with all four of them like (quadrants). They complement each other, none is without the other"*. The following sections will explore the analysis and findings of each quadrant from the teachers' perceptions.

5.6.1 Academic Preparedness



This section is divided into four codes: Academic Focus, Academic Resilience, Academic Practice and Academic Decision-Making.

5.6.1.1 Academic Focus

Teachers reported needing clarity around the academic focus of TYM. This uncertainty resulted in teachers preparing students differently. Some teachers described using TYM to prepare students with the numeracy needed for life, while others regarded it as preparing students for LCM. Alternatively, Johnson reported spending this year filling the perceived academic preparedness void between the new Junior Cycle Mathematics Specification and LCM:

> *"It should be a much higher priority for people, to either get your strong basics, get a bit of interest going, catch up on whatever has been missed and again, just with the new Junior Cycle in particular, I think it's going to be fundamental in how we survive 5th and 6th year".*

Years of experience teaching mathematics may provide a different lens to the academic focus on TYM. The familiarity and knowledge crafted over years of teaching may results in a deeper understanding of post-primary mathematics. Over time, teachers also develop tried and tested methods for preparing students. Turing, who has more than 15 years of teaching experience, acknowledged that while TYM should be focused on mathematics for life, they focus on preparing their students for the terminal LC examination:

> *"I would love to say it's beyond for life, but it's not, it is always the exam for me, it's always making sure my students achieve as much as they can…but in having it exam focused, if the exam is designed well, then they are being prepared for life".*

In addition to this, Turing articulated that teachers must encourage students to be confident in their approaches to unknown questions: *"Like I said earlier, you need the tools, you need proficiency, that has to be one of the things that you do with them, so that they're prepared".*

5.6.1.2 Academic Resilience

A primary concern in the analysis revealed that there may be an assumption that all TYM students have a similar standard of mathematics when starting this programme. However, with students studying mathematics at specific levels for JC, and then joining a common level for TY, this results in difficulty for some students to try and adapt to a different pace and level of challenge. Throughout the analysis, teachers highlighted the need for students to be more mathematically resilient in TY. Euler, spoke at length about this need for resilience:

> *"Maths is one, that students love to give up immediately, soon as they don't like part a, then I'll just not do the rest of the question. But it is the idea of if you tried one approach, let's try another that type of thing. So resilience would always be kind of a natural key ingredient to maths*

class. You know, if you're doing problem solving, and you're, you're not willing to make a mistake, or take the wrong route towards an answer, then it's not really ever going to work out for you in maths in general".

Maxwell, highlighted that there is a certain attitude among some mathematics teachers about the level that students should attain. Maxwell, stated that some teachers cast blame on students when they do not know the content:

"I'd be brutally honest and I don't think that it is right. You know, there's almost like, it's an attitude thing, well they (students) should be able to do this. I was like, well, it's okay, that they can't, but it's up to us to lead them there. Okay, they might only get halfway, but they're further than what they were, you know, it's bringing them along".

This attitude may develop as students are expected to understand concepts and topics before TYM. There is a presumption that students have reached a minimum standard in mathematics. However, this assumption can restrict students' learning, impede their progress and damage their mathematical preparedness. Pascal, believes that teachers of TYM should learn to manage their expectations for students due to schools choosing a mixed-ability approach to their formation of TYM classes:

"You are dealing with mixed ability, like across ordinary level and higher level in that class. So you do have kids then who it is just kind of beyond them, or you know, the rate that the class can move at, they just can't keep at that rate. So you do have kids that are going to have to work at a much slower rate, or just not be as academic as some of the other kids. So, you just kind of have to manage your expectations for them".

5.6.1.3 Academic Practice

Teachers reported positioning algebra as a keystone of the TYM programme. Understandably, mathematics teachers highlighted that students need a certain level of fluency and be familiar with practising algebra to be prepared for LCM. Erdös, stressed the importance of a good grounding in algebra at the TYM level before progressing onto the LCM programme: *"so to be prepared for Leaving Cert Mathematics, you have to be proficient in algebra, algebra is everything"*.

Turing, acknowledged the critical role of TYM to practise, explore misconceptions, build techniques and grasp concepts. They claimed that TYM may greatly assist in academically preparing students for LCM:

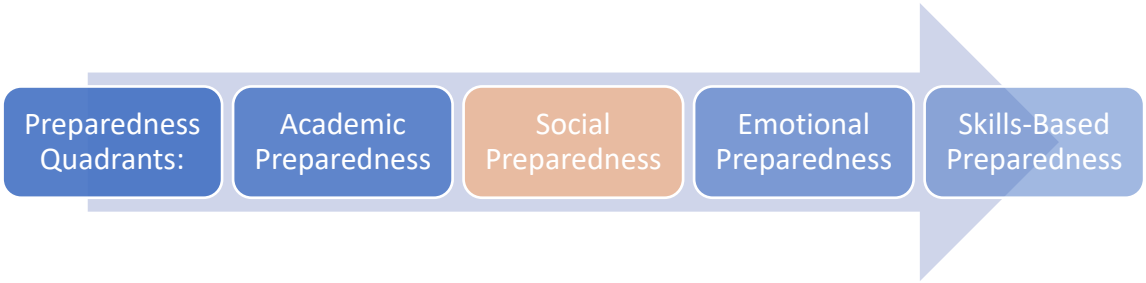
> *"Practice is a huge part of it, you have to, you know, you have to, you can't allow the brain to be trying to draw something out, you've got to have it ready, and there because there's so many other processes that your brain needs to handle. So therefore, practice is a huge skill for mathematics"*.

5.6.1.4 Academic Decision Making

The analysis noted several teachers continuously referring to the LC through the interview. Instead of focusing on the present TYM, teachers were focused on the terminal examination. Hence, teacher decision making during TYM tends to always revert to the best outcome for students when they start the LC programme. These decisions included content, class formation and conversations with students. Leibniz, spoke honestly about the vital role that TYM plays in teachers' decisions for forming LCM classes: *"we take it (TYM) as five modules, and a percentage of their grade in Transition Year overall and the Junior Certificate, form the basis for the streaming in 5th year. So that's how they know it's serious"*.

This case may assist students in making better judgements on their future mathematics level and empower both students and teachers to make better decisions.

5.6.2 Social Preparedness



The findings on this quadrant of Social Preparedness revealed three important areas: culture, confidence, and mathematical wellbeing.

5.6.2.1 Culture

Pythagoras, spoke about building a positive classroom culture for TYM. This teacher claims that when students are actively engaged in discussing mathematics with their peers, it helps to break down learning barriers and encourages students to work together to improve learning:

> *"We put a huge emphasis on peer learning in TY. The whole idea of students being set problems and getting up out of their seats and moving around the room helping each other, you know, and then we would see that day being replicated later at Senior Cycle, you know, whereby the students are willing to support each other".*

5.6.2.2 Mathematical Confidence

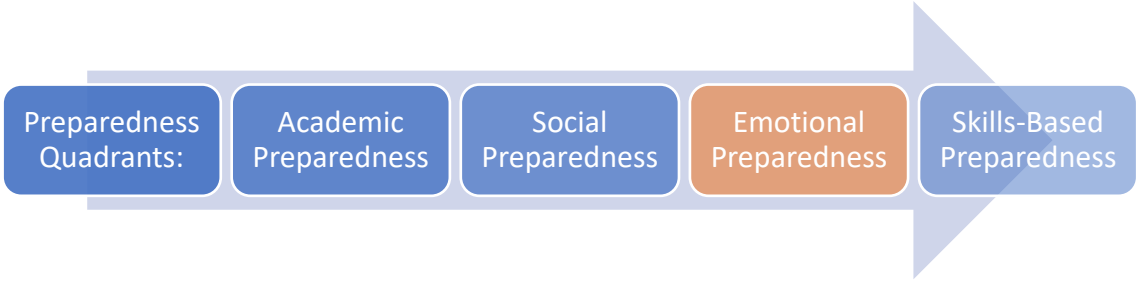
Throughout the analysis, differing opinions on class formation arose. While many teachers favoured streaming over mixed-ability, Pascal spoke about the importance of the mixed-ability setting in socially preparing students by developing their mathematical confidence. Pascal specifically refers to the celebration of successes in TYM as a way of improving a student's confidence. Building self-confidence without the pressure of deadlines,

Classroom Based Assessments (CBAs) and looming state examinations, provides students with a safe space to develop their mathematics skills and self-confidence, before entering the LC programme.

5.6.2.3 Mathematical Wellbeing

Teachers revealed that this unique year could sometimes damage students' mathematical wellbeing. Euler, feared the impact that TYM may have on students: *"It can mean that a student ultimately may or may not have done almost any maths throughout the year in TY".* While TY may provide students with different and diverse opportunities for their holistic development, it is also essential to ensure a continuum of mathematics learning throughout this programme. Grippingly, Leibniz, raised the impact that TY ordinary and foundational mathematics can have on a student's mathematical wellbeing in the fee-charging school sector: *"The other thing I experienced is, I'm in a (fee-charging) school and just this huge kind of wrap up with maths and being male. Being in the weaker classes, they start to tag themselves.* This labelling may lead to a more significant impact on a student's learning.

5.6.3 Emotional Preparedness



This section will examine the multiple and different findings on the quadrant of Emotional Preparedness. It covers various emotional aspects, including attitude, stress, motivation, determination, satisfaction and self-efficacy.

5.6.3.1 Maintaining Interest and Challenge

Erdös, highlighted concerns about the unchallenged student mind at the TYM level and the negative impact that this can have as students prepare to progress onto LC*: "I think with a*

full year of not being challenged, it can have a negative impact". To ensure that students remained challenged during TYM, Erdös, utilises an end-of-module assessment as a stimulus to evaluate learning.

Johnson, questioned whether or not teachers are to blame for a classroom of uninterested students. Highlighting that teaching topics such as financial mathematics during TYM, might harm a student's interest levels. Instead, Johnston, links the interest and maturity levels of students to mathematics learning during TYM. They suggest moving away from rigid topics and being more relevant, focusing on loans for student holidays and cars.

5.6.3.2 Parental Influences

Newton and Turing, spoke candidly about their experiences of working with parents. Newton, recalls numerous conversations with parents who informed the teacher of their poor mathematical abilities: *"the amount of parent-teacher meetings and I get the 'I'm no good at maths' story".* This negativity may not be helpful to hear, nor is it helpful to the student trying to learn mathematics. Turing suggests that there should be a focus on the growth mindset when preparing students for LCM. Students need to feel encouraged and guided by both teachers and parents.

5.6.3.3 Self-Confidence

The analysis revealed that TY can be a good platform for students to build confidence. LaPlace, supports the application of smaller class sizes in TYM and exploits this opportunity to build on student confidence and maintain professional relationships with students: *"if you've got the time and in TY as well, you build up a good relationship with them because the classes are small and they feel a bit more comfortable to tell you, actually I never got that".*

Additionally, Maxwell, described using different teaching and learning strategies to build student confidence during TYM, including encouraging students to participate in group

work, peer learning and corrections at the board: *"I try to get more interaction from the children up to the board or sharing your answers".*

Kepler, echoed the vital opportunity that TY provides teachers and students to develop confidence. TYM provides a simple opportunity for students to explore: *"don't be afraid of messing things up and giving them a class to actually work with, let's say matrices, and just mess around with it and see what happens. Instead of that kind of constant thing of, we need to move on".*

Lastly, Turing, summarised the critical role of the teacher during TY to build confidence:

> *"If you're not confident in maths, no matter how smart you are, if you lack the confidence, and I've experienced that myself, you won't be able to think under the pressure. So you need, you need a lot of practice and you need a lot of competence building from your teacher to take you to the next level".*

Building a student's confidence requires the selection of material that all students can achieve at TYM level and the opportunity to support those learners who may need more confidence. Turing, suggested that as a result of the crammed curriculum at LC, TYM is the only opportunity at the Senior Cycle level for students to develop confidence before the constant worry of the LC.

5.6.3.4 Motivation

Erdös, discussed a decline in motivation as students pass through the programme: *"TY Maths in September and October is great. You get loads out of them, they're interested to learn new things, and fascinated, but by the time May comes around, they just want to throw a paper at the bin and do a probability test".* Hamilton, echoed this sentiment, noting a diminishing lack of student motivation in TYM:

"I would find it harder to battle against the culture of TY, as in, 'this is the year we don't have to do anything', 'why, do we have to do maths, it is TY'. There is a perception for some, that it is a gap year. So I find it hard going into a TY class and a student might have no pen or a copy or interest or motivation, that is the hardest part of teaching TY students".

This battle can be disconcerting towards the teaching and learning of mathematics at the TY level. One teacher facing thirty unmotivated students is an unbalanced equation. However, Leibniz and Newton, use assessment to limit a lack of student motivation by combining the weighting of TY assessment with entry to LCHL Maths. Newton, stated that: *"I do think the assessment provides structure. I think unbeknownst to the kids, they kind of like it, because I do think it provides them with the push for them or their bit of motivation."*.

5.6.4 Skills-Based Preparedness



When preparing students for LCM, the key skills must be developed further during TYM. However, the analysis highlighted that this theory does not match the practice. Kepler, said: *"I do not think I would ever think about it (key skills), though, to be honest, when I'm actually in the class or planning for a lesson"*. At the same time, including the key skills may already form part of this teacher's subconscious planning for TYM. Other teachers reported that they are not including all five key skills in TYM. Maxwell stated that "apart from working with others, we have not been able to do so much", similarly Newton stated

that *"I do some group work with, with my maths class like, but not as much as I do with my other classes"*.

Johnson, highlighted that while they assumed that students have the required key skills for working together, this is only sometimes the case: *"I go in, I suppose, assuming they have it (group work skills), and then I find out very quickly that they most definitely do not have it…"*. It seems that there is an underlying assumption that students have the skills to work together without explicit instruction from the teacher.

5.6.5 Key Findings on Category Four: The Preparedness Quadrants

KFT4.1 Overall, teachers acknowledged that there is more to teaching mathematics than just the academic factors. Teachers supported the introduction of the Preparedness Quadrants as a mechanism of support for planning their classes for TYM and for better preparing their students for LCM. This is especially important, as students are arriving to TYM with different levels of understanding of the material from JCM.

KFT4.2 Teachers reported a deficiency in the explicit teaching of the required key skills, with some teachers acknowledging that there is an under-lying assumption that students are already equipped with the necessary skills and tools for mathematics learning. Hence, teachers are not formally teaching students the key skills as part of their mathematics learning.

5.7 Conclusion

This chapter presented the analysis and findings from the semi-structured teacher interviews. Overall, this chapter captured a snapshot of the views, perspectives and opinions of thirteen teachers of TYM. The data analysis revealed four themes in these interviews: Identity of the TYP, Before and Beyond, The Teacher, and The Preparedness

Quadrants. At the end of each quadrant, the key findings, from the teacher's perspective were summarised in textboxes outlined in green. Teachers reported concerns about understanding the true identity of the TYP. This lack of understanding resulted in teachers tackling TYM in different ways, which can develop inequality in the teaching of TYM between schools. As some schools focused on the Leaving Certificate Mathematics material during TYM rather than focusing on alternative learning intentions.

Furthermore, teachers suggested that a modular approach to TYM may help to provide structure to the programme. The second theme, Before and Beyond, saw all 13 interviewed teachers calling for reforms to TYM, with specific professional development needed for all teachers. Theme three, The Teacher, reported that while teachers enjoy the flexibility and freedom of TM, the absence of a clear identity of the TY blocks their ability to develop a suitable programme. Teachers favoured fostering a teacher-student partnership in the development of a domesticated programme for TYM. Finally, teachers commented on the Preparedness Quadrants, reiterating that there is more to preparedness than academics.

Chapter Six: Discussion

6.1 Introduction to Chapter

Chapter Six discusses the findings, situating the results in the context of relevant literature in the field. This chapter is structured in three sections, where each section addresses one of the research questions:

- Section 6.2 addresses Research Question One: "What does it mean to be mathematically prepared, in the context of Transition Year Mathematics?".
- Section 6.3 addresses Research Question Two: "How do students' experiences of Transition Year, from three sample schools, reflect this definition of mathematical preparedness?".
- Section 6.4 addresses Research Question Three: "Which key issues must be considered to mathematically prepare students during Transition Year?".

In addressing these three research questions, a triangulation approach will be applied. The literature will be combined with the input and opinions of the Delphi Study Panel of Participants, the student experiences from the student questionnaire, and the insights offered by the 13 teachers during the interview process. References will be drawn from the Key Findings from Students (KFS) and Key Findings from Teachers (KFT), as outlined in Chapters Four and Five. This triangulation approach results in a comprehensive definition for mathematical preparedness in the context of Transition Year Mathematics.

6.2 Addressing Research Question One

"What does it mean to be mathematically prepared, in the context of Transition Year Mathematics?"

In addressing research question one, it was critical to address mathematical preparedness through the lenses of multiple different stakeholders to provide an accurate and complete view of this concept. Chapter Two, the literature review, presented the empirical and

theoretical viewpoints of many stakeholders (Section 2.5), as well as the curricular and policy viewpoints. This included the perspectives of the Irish government and its agencies (Department of Education and Skills, 2011; National Council for Curriculum and Assessment, 2015), third-level educators (Grannell et al., 2011; Kirkland, 2012), and students (Economic and Social Research Institute, 2023; Lundy, 2007). However, while each group views mathematical preparedness from a specific perspective, no universal definition encompassed all stakeholders' views. This section strives to merge the empirical, theoretical, curricular and policy stances on mathematical preparedness from the literature review with the insights of curricular experts, students and teachers to produce a comprehensive definition of mathematical preparedness.

The Delphi Study offered a unique aspect to this research study, as it provided a collective solution to the research problem. This Delphi Study united different individuals from mathematics education through discussion, structured communication and controlled feedback to develop a definition for mathematical preparedness. This definition supports that there is more to mathematical preparedness than just a focus on the academic aspects, but that mathematical preparedness is more holistic, encompassing social, emotional, and skills-based factors. The resulting definition of mathematical preparedness is not linear, not confined, but suggestive and evolving. It can be used as a tool for mathematics teachers when planning and preparing lessons. The initial product of the Delphi Study consists of Four Quadrants of Mathematical Preparedness (Figure 6.1), formed from the literature and the professional practice of the researcher. Quadrant One focuses on Academic Preparedness, including curricular, governmental guidance and international best practices. Quadrant Two, Social Preparedness, features self-esteem, resilience, and wellbeing. Quadrant Three, Emotional Preparedness, centres on attitudes, beliefs and emotions. Finally, Quadrant Four, Skills-Based Preparedness, includes Ireland's five identified Key

Curricular Skills and the broader skills required for life and work in the 21st century. Each quadrant offers multiple subsections for preparedness, which will be expanded further in sections 6.2.1 to 6.2.4. These sections will further discuss and develop this model of mathematical preparedness from its original model.

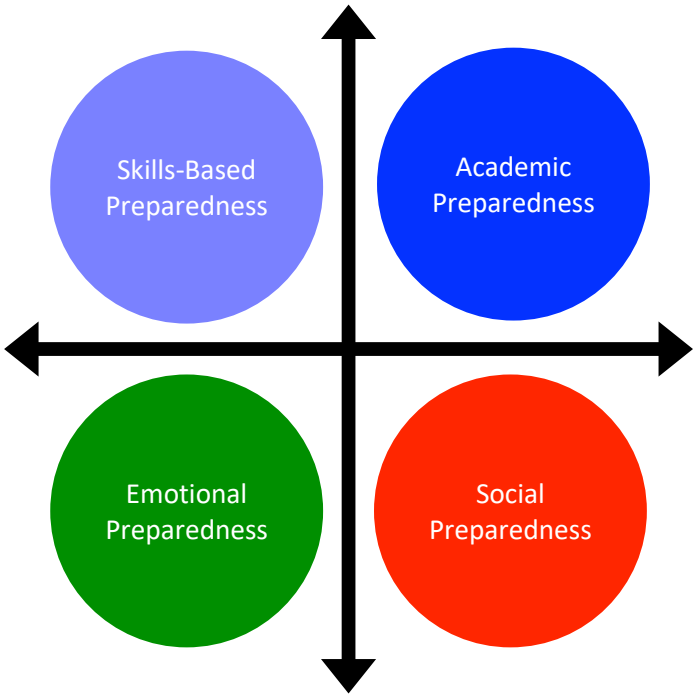


Figure 6.1: The Four Quadrants of Mathematical Preparedness.

6.2.1 Academic Preparedness

The literature on Academic Preparedness focused on the curriculum and policy documents from the Department of Education in Ireland. These included the TY Mission Statement and Guidelines for schools (Department of Education and Skills, 1994), the Junior Cycle Mathematics Specification (Department of Education and Skills, 2017), and the Leaving Certificate Mathematics curriculum (Department of Education and Skills, 2015). Additionally, the International Baccalaureate Middle Years Programme for Mathematics was included as a comparison to an international curriculum (International Baccalaureate Organization, 2021). The following sections will discuss this literature on Academic

Preparedness, along with the analysis and findings from the multiple stakeholders in this research study.

The Delphi Study Panel of Participants, the teachers interviewed, and the students, in their responses to the questionnaire, all acknowledged the importance of the five mathematical objectives (Adaptative Reasoning, Productive Disposition, Strategic Competence, Conceptual Understanding, and Procedural Fluency) when academically preparing students. The Delphi Study Panel of Participants (DSPOP) emphasised that Academic Preparedness should and will vary between schools and students. This view aligns with the literature and the importance of the domestication of the TYM programme in each school; as teachers and students in each respective school are best placed to understand their preparedness needs, rather than a mandatory and prescriptive curriculum being imposed by the policymakers. The academic needs of one class will not be the same as those of another. However, teachers must have the knowledge and sound judgement to assess and reassess their situation periodically, to ensure they are academically preparing their students. However, the teachers interviewed stressed their concerns about preparing students without having a clear vision for the programme. Similarly, LC students stated that their experience of Transition Year Mathematics was not beneficial to their learning (KFS1.3). It seems that a clear academic vision is needed for teachers to best academically prepare their students. Similarly, if teachers are provided with a clearer vision for TYM, which aligns with the mathematics skills needed for LCM, this may also ensure that students see the benefit of the mathematics experienced during TYM.

6.2.1.1 Mathematical Objectives

The Delphi Study Panel of Participants aligned their definition of Academic Preparedness with the shared mathematical objectives of the JC and LCM curricula. These shared mathematical objectives, based on the work of Kilpatrick et al. (2001), follow on from the

purpose of mathematics education outlined by American Mathematics Educator, William A. Brownell (Groves, 2012). Brownell's purpose of mathematics education is defined as going "far beyond the establishment of mechanical skills. The ideas, principles, generalisations, and relationships which are taught, as well as the skills, are intended for purposes outside themselves and for use in situations quite unlike those in which they are learned…in a word, we strive to teach understandings" (Brownell, 2006, p. 30). His perspectives on mathematics education date back to the mid-1940s and remain relevant today, with the discussion with the DSPOP focusing on the importance of multiple elements to academically prepare students.

In particular, the DSPOP acknowledged that students' confidence in mathematics increases when they engage with the mathematical objectives. This view coordinates with Brownell's purpose for mathematics education, which is that when students understand the content, they are truly learning (Brownell, 2006). The importance of student self-confidence and self-efficacy were addressed in the literature review with Paraskeva et al. (2008) and Hosein and Harle (2018) stating that mathematical confidence is one of the most important psychological structures in a student's mathematical achievement. Despite the critical importance of these five objectives, only four mathematical objectives; Procedural Fluency, Productive Disposition, Conceptual Understanding, and Adaptive Reasoning, were featured in the DSPOP discussion, with the mathematical objective of Strategic Competence not emerging. However, in defining the quadrant of Academic Preparedness, this definition is inclusive of each of the five mathematical objectives. Each objective contributes a different aspect to the overall academic learning of mathematics.

Procedural Fluency

The DSPOP agreed with the importance of procedural fluency, defined as the "skill in carrying out procedures flexibly, accurately, efficiently, and appropriately", when

mathematically preparing students (Department of Education and Skills, 2015, p. 6). The Panel specified that TYM offers a unique opportunity to build on the skills of the JC and connected this fluency to building confidence in mathematics. The DSPOP stressed that a student's fluency correlates to increased confidence and self-efficacy in mathematics. The Panel acknowledged that TYM could play an essential role in developing Procedural Fluency from the JC and that this element of Academic Preparedness can positively affect the other quadrants. The DSPOP also agreed that TYM contains the flexibility for teachers to use this opportunity to support students' learning by creating suitable, engaging and meaningful curricula to meet the needs of all students during TY. By focusing on a student's Procedural Fluency, teachers are also building a student's mathematics wellbeing. Hill and Seah (2023) claim that when students work on cognitive tasks, such as practising skills and applying knowledge, this improves their mathematical wellbeing. However, in practice, the students sampled reported that TYM was a missed opportunity to build on the objective of procedural fluency (KFS1.1). This unfortunate and missed chance to build on students' procedural fluency skills, may stem from the lack of understanding that teachers have of the vision for TYM.

Productive Disposition

The DSPOP highlighted that Productive Disposition may be the most crucial objective in academically preparing students. The DSPOP noted that students need to understand what they are doing to see mathematics as valuable and worthwhile. Based on the descriptor for this objective, it suggests that when academically preparing students if they have a Productive Disposition, their sense of perseverance and self-efficacy in mathematics should increase. A positive experience of Productive Disposition may help to yield a higher level of confidence in their mathematics learning. Warwick (2008) outlined the four factors leading to an individual's experience of their self-efficacy. Claiming that successful

attainment in mathematical assessments, positive vicarious experience and positive verbal persuasions all assist in building a student's mathematical self-efficacy. Hence, if teachers structure their domesticated programmes in a Productive Disposition manner, that promotes positive interactions and positive affective and psychological states, then students may develop more positive relationships with mathematics.

Furthermore, this objective of Productive Disposition aligns with the first aim of the International Baccalaureate's Middle Year Programme for Mathematics, which aims to encourage and empower students to enjoy their mathematics learning by developing curiosity and an appreciation for the power and elegance of the subject (International Baccalaureate Organization, 2021). The IB curriculum reinforces that students need to see authentic examples of mathematics, its uses and the applications of mathematics in their everyday lives. This mathematical objective also supports the inclusion of the student voice. If teachers give students the chance to share their opinions on what they learn, this may improve their ability to view mathematics as valuable, sensible and worthwhile. The inclusion of the student voice in the domestication of the TYM programme was widely supported by students in their responses. Also, there is a willingness from teachers to foster their relationship in the planning of TYM. Kiwanuka et al. (2020) also suggest that when students have a positive involvement with their learning, this leads to increased levels of enjoyment and confidence in the subject.

Conceptual Understanding

Although the curriculum states that this objective is about comprehending mathematical concepts, operations, and relations, the DSPOP viewed it as an opportunity for differentiating concepts. The DSPOP claimed that TYM can be utilised to discuss misconceptions and to differentiate concepts based on the school culture and context. The DSPOP expressly referred to teachers in DEIS schools, where students may have

difficulties reading a question or understanding the keywords associated with the topic. Hence, TYM may provide equity between students in different schools.

In contrast to the IB curriculum, the DSPOP noted that the Department of Education and its agencies should compose supporting guidelines for teachers on explicitly teaching for conceptual understanding. This sentiment was also echoed by the teachers interviewed. Unlike the Irish curriculum, the IB curriculum supports teachers in developing a student's conceptual understanding by providing a breakdown of the critical components that teachers must incorporate into their planning and lessons. These components include a focus on Form, Relationships and Logic. In contrast, the Irish curricular documents provide teachers with only one line of information about this objective, stating the need for comprehension of concepts, operations, and relations in mathematics (Department of Education and Skills, 2015). To improve the preparedness of students, teachers must have a comprehensive knowledge of the concepts that they should be educating their students on throughout TYM. The DES should consider devising a clear set of concepts that may be explored throughout TYM. One of the key student findings (KFS1.2) acknowledged the need for TYM to contain more challenging concepts and materials, with three out of every five students responding that TYM lacked academic challenge. An increase in academic challenge will not only expand students' subject knowledge and depth but better prepare students for the demands of the LCM course.

Adaptive Reasoning

While the LCM curriculum description for this mathematical objective states that students should have the "capacity for logical thought, reflection, explanation, justification and communication" (Department of Education and Skills, 2015, p. 4), the DSPOP stated that this is not the reality in mathematics classrooms. In particular, the DSPOP referred to the need for reflection, stating that students must be appropriately supported in developing this

skill. The DSPOP suggested that TY can allow teachers to teach students how to reflect on their work; otherwise, this is unlikely to occur due to the constraints of the prescribed curriculum and examinations.

Strategic Competence

The mathematical objective of Strategic Competence, although introduced to the DSPOP by the researcher, only emerged during the controlled feedback phase of the Delphi Study. The Junior Cycle and the Leaving Certificate curricula state that Strategic Competence refers to a student's ability to "formulate, represent, and solve mathematical problems in both familiar and unfamiliar contexts" (Department of Education and Skills, 2017a, p. 4). While problem-solving is stated as being one of the significant properties of the Project Maths curriculum (Close et al., 2011), it is interesting to note that the DSPOP did not view problem-solving as part of Strategic Competence but rather as an overlap with part of Quadrant Four on Skills-Based Preparedness. The DSPOP included problem-solving as part of the key skill of Creativity and Critical Thinking. This positionality places problem-solving, not exclusively as part of quadrant one but also within the quadrant of Skills-Based Preparedness. The absence of Strategic Competence (problem-solving) from quadrant one on Academic Preparedness does not imply a lack of importance. However, it may suggest a need for more understanding of the core foundation of Strategic Competence in comparison to problem-solving.

6.2.1.2 Revisioning the Mathematical Objectives

The five mathematical objectives, unreferenced in Irish curricula documents (Department of Education and Skills, 2015, 2017a), but initially authored by Kilpatrick et al. (2001), aimed to explain mathematical proficiency. The original graphic (Figure 2.1) featured five intertwined strings – highlighting the connection between the five objectives. Although the DSPOP agreed with including these objectives as part of Academic Preparedness, the

DSPOP favoured an emphasis on the objective of Productive Disposition. This perspective and sentiment were also reiterated by students and teachers in their contributions to this study. The DSPOP stressed that Productive Disposition empowers students to see the purpose, value, and relevance of their mathematical learning. The literature emphasises the crucial importance that mathematical attitudes and values (Zan & Di Martino, 2007), self-efficacy (Liu & Koirala, 2009), and self-confidence (Ciftci & Yıldız, 2019) play in mathematics learning. Hence, if teachers initially focus on the mathematical objective of Productive Disposition when academically preparing students, this may assist in developing the other four mathematical objectives, thereby, better preparing students.

Based on the insights from the Delphi Study Panel of Participants, in conjunction with the perspectives of the students and teachers, the researcher offers a critical contribution to knowledge by offering a revision to the original mathematical objectives as outlined by Kilpatrick et al. (2001) (Figure 6.2).

This revision, illustrated as a wire of interconnected strands insulated by the Productive Disposition objective, suggests that Conceptual Understanding, Adaptive Reasoning, Procedural Fluency and Strategic Competence should emerge from Productive Disposition. If teachers prepare students in a manner that supports the development of Productive Disposition (defined as the "habitual inclination to see mathematics as sensible, useful and worthwhile") (Department of Education and Skills, 2015, p. 6), this may help to provide students with a clearer understanding of the purpose of their learning. The researcher believes that if students understand the "why" of what they are learning, then their Conceptual Understanding, Procedural Fluency, Adaptive Reasoning, and Strategic Competence in mathematics will all advance, thus increasing a student's overall Academic Preparedness.

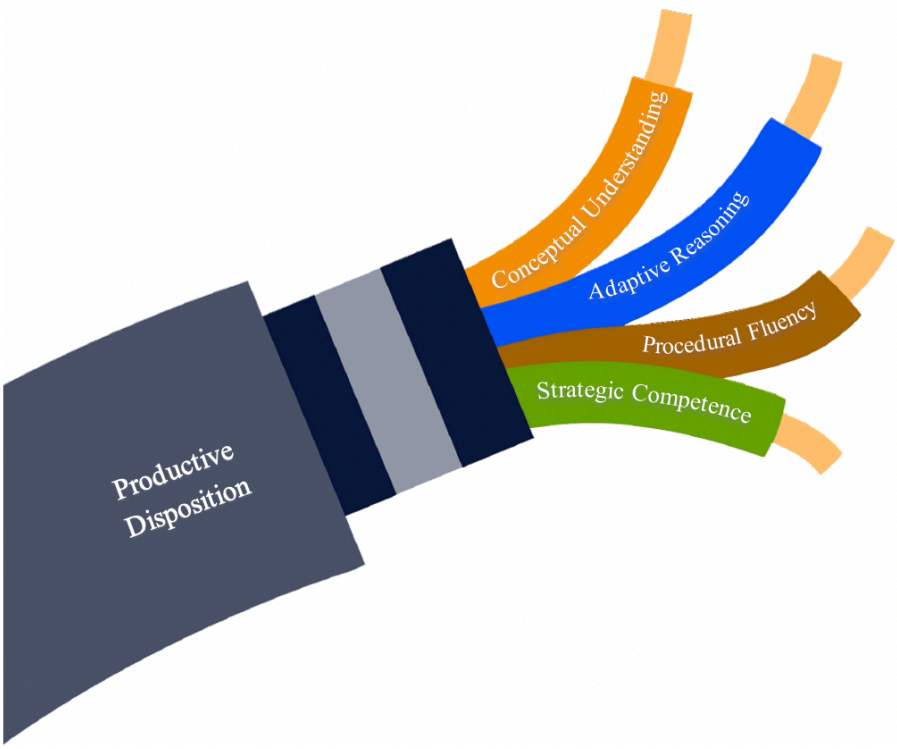


Figure 6.2: Revision of Mathematical Proficiency by Kilpatrick et al. (2001).

This view is in line with the literature from the Junior Cycle Mathematics Specification, which states that if students are to develop conceptual understanding, procedural fluency, strategic competence, and adaptive reasoning abilities, they must believe that mathematics is understandable, not arbitrary; that with diligent effort, it can be learned and used; and that they are capable of figuring it out.

Kilpatrick et al. (2001) suggest that teachers must spend equal time teaching each objective, as all five objectives are interwoven and interconnected. However, the DSPOP stressed that teachers are best placed to understand the needs of their students based on their unique contextualised situation, and it should be OK to spend more time on one objective than the other. This approach supports the idea that while objectives are connected, it is acceptable for teachers to focus on one objective more than another. The DSPOP feedback suggests that teachers must find a balance between each of these objectives in their teaching. This assists in the academic preparation of students. Teachers are provided with this flexibility

during the TYM Programme – to focus on specific parts of these objectives based on their context and situation.

Interestingly, and this will be discussed in further detail later in this chapter, when the researcher asked the teachers about their understanding of the five mathematical objectives during the interview phase of data collection, none of the teachers interviewed could list all of these objectives. Indeed, one teacher could not list any of these five mathematical objectives. This demonstrates a gap between the underlying theory and the practice of developing mathematical proficiency in schools. This deficiency in understanding and applying these mathematical objectives suggests a need for further teacher professional development. The compulsory CPD teachers received after introducing both Project Maths and Junior Cycle Mathematics acknowledged these objectives. However, this compulsory CPD failed to instil curriculum changes based on these mathematical objectives, instead, there was an emphasis on teaching the curriculum content.

6.2.2 Social Preparedness

The literature on Social Preparedness focused on the curriculum and policy documents from two main sources: Singapore's Mathematics Curriculum Framework (Ministry of Education Singapore, 2023) and Ireland's Wellbeing Guidelines (National Council for Curriculum and Assessment, 2017). The following sections will discuss this literature on Social Preparedness, along with the analysis and findings from the multiple stakeholders in this research study.

Research clearly indicated that there is more to the teaching and learning of mathematics than preparing for the academic elements (Elias, 2009; Kress et al., 2004; Mahoney et al., 2018). This perspective was supported by the DSPOP and the teachers interviewed in this research study, and it aligns with the mission statement of Transition Year, which is to develop a student's social ability and to prepare them for their role in society (section 2.3.6).

This quadrant on Social Preparedness highlights the need for students to build resilience, confidence, and relationships with their teachers, their classmates, and the subject of mathematics. However, these qualities should not occur in isolation but in conjunction with their academic learning and preparedness. In addressing what it means to be mathematically prepared, the Delphi Study Panel of Participants reviewed two significant pieces of policy before their discussions on this quadrant on Social Preparedness: Singapore's Mathematics Curriculum and Ireland's Four Aspects of Wellbeing (Ministry of Education Singapore, 2023; National Council for Curriculum and Assessment, 2017). Although Ireland's position on the inclusion of wellbeing has advanced since the introduction of the Aspects of Wellbeing into the JC curriculum, Ireland does not have a formal set of guidelines or supporting documents for teachers on social learning as part of the TY or LC curricula. Singapore, on the other hand, has merged social learning with mathematics throughout the curriculum. Hence, it provides an overview of the potential that social learning may have in mathematics.

6.2.2.1 Mathematical Resilience

The DSPOP specifically referenced the importance of developing a culture of resilience in the mathematics classroom as a premise for preparedness. Classroom Culture is also a core element of the Aspects of Wellbeing within the JC curriculum (National Council for Curriculum and Assessment, 2017). Resilience, in this quadrant, refers to the fact that students must develop the ability to respond to and adapt to challenging mathematical situations (Johnston-Wilder & Lee, 2010). Of course, this resilience overlaps with Academic Preparedness, as students respond to the academic content and build a tolerance level. The DSPOP posited that resilience is connected to the mathematical objective of Productive Disposition, which states that students should believe that their investment in learning mathematics is worthwhile and that there are benefits to their perseverance with

this subject (Department of Education and Skills, 2017). The Panel noted that when students develop mathematical resilience, this empowers them to tackle more challenging questions and builds confidence while advancing their academic knowledge. This viewpoint positions resilience as not just part of the Social Preparedness Quadrant, but also in the Academic Preparedness Quadrant.

Of course, in developing resilience, students must make mistakes with their academic learning. However, there is value in examining students' mistakes, not only for students to deepen their understanding of a topic but also for teachers to develop a sense of pedagogical richness and reflection (James et al., 2018). The DSPOP also emphasised that teachers should encourage learning from mistakes in mathematics. They claim that when students address minor mistakes and learn from these, their resilience, self-confidence and self-efficacy increase. Interestingly, the DSPOP was adamant that competition should not be a feature in mathematically preparing students. This view was also mirrored by over 70% of students in their responses to the student questionnaire (KFS2.2). The DSPOP asserted that a competitive classroom instils a culture that only some can achieve in mathematics, limits opportunities for all students to succeed, and reduces resilience. The Panel linked a classroom culture of competition to an environment lacking support, empathy and self-esteem. While the literature did not focus on competition per se, it did highlight the difficulties due to competition, explicitly the introduction of the Bonus Point Initiative in Ireland (Gil et al., 2006; O'Meara et al., 2020). From the perspective of the DSPOP, the students, and the teachers, this initiative requires that students are better prepared in resilience, due to the increase in students opting for the Higher Level LC course. The Chief Examiner of Mathematics has also cautioned that the BPI is resulting in students opting for the incorrect level in mathematics. This will be discussed later in section 6.2.3.2, in the Emotional Preparedness Quadrant and decision making.

Warwick (2008) also acknowledged that feelings of inadequacy, which occur when students compare themselves to their classmates, can undermine a student's self-efficacy. The DSPOP noted that teachers, in preparing students, should endeavour to build the skill of tolerance, suggesting that students should have their emotional intelligence developed as part of learning mathematics. One of the DSPOP members emphasised the need for students to experience certain discomfort when learning mathematics. The rationale for this level of discomfort is to ensure that students remain active, vigilant and alert in their learning of mathematics, rather than passive.

6.2.2.2 Relationships

The importance of relationships was a core feature of the Delphi Study's discussion on this quadrant of Social Preparedness. This focus on positive relationships, one of the four Aspects of Wellbeing, aligns with the literature of the Junior Cycle Wellbeing guidelines, which aims to foster a sense of belonging and acceptance for students (National Council for Curriculum and Assessment, 2017). The DSPOP acknowledged that the school years are an essential developmental milestone for students, not just in terms of formal learning but also for students to learn how to socialise. Schools and teachers should seek opportunities to develop students' confidence in parallel to teaching mathematics. The DSPOP specifically referenced the importance of TY and the development of a teenager. This unique year provides a platform for self-discovery and the confidence that comes from socialisation. These views are reflected in the TY guidelines, which state that schools are responsible for students' social development. However, research by Clerkin (2016) noted several criticisms of Ireland's ability to prepare students for life beyond formal school education. He reported Ireland's shortfalls in preparing students with the social skills needed to become active societal participants and strengthen interpersonal relationships (Hannan & Shortall, 1991; Kellaghan et al., 2004; Smyth & Calvert, 2011).

Furthermore, Clerkin (2016) speculated that the prevailing factor in post-primary education is the influential LC examination and the points system, rather than the broader educational experience. Apriliyanto et al. (2018) mirror these concerns, claiming schools prioritise learning activities, which in turn prioritise knowledge and skills, rather than social learning. Stressing the need for academic learning in mathematics to include social interactions, he claims that social interactions are an important factor in learning mathematics, as students get the chance to be expressive of their thoughts, which acts as a reflection of their subject knowledge.

TY provides an opportunity to design and develop different learning opportunities to help rebalance mathematics education, connecting social learning with the academic learning of mathematics. Smyth (2015) supports this merging of social development into academic learning, stating that learning relationships are strongly associated with several student outcomes, including wellbeing, social belonging and academic achievement. A student's self-image can be influenced by the quality of the teacher-student relationship, with positive relationships resulting in better student outcomes. The demands of the curriculum and exam pressures in secondary schools can impact these relationships. However, TY provides the space to develop and nurture positive learning relationships. The analysis and findings from the student questionnaire showed that TYM allows students to build positive relationships with their classmates and teachers. Hence, students who partake in TYM will likely develop better relationship skills, better preparing them for social learning. One of the key findings from the analysis of the student questionnaire (KFS2.1) was that students highly value the ability to build positive relationships with their teachers and classmates during TYM. This value aligns with the literature of the newly reformed Junior Cycle, which emphasises the importance of building relationships and developing a classroom culture. These guidelines state that positive relationships among teachers and students, and

students and their peers, are the primary aspects of wellbeing during the school years (National Council for Curriculum and Assessment, 2017).

6.2.2.3 Parental Influences

Peers and teachers are not the only groups affecting students' relationships with mathematics; the DSPOP also highlighted the importance of parental influences. Hence, in mathematically preparing students, teachers may have to challenge and dispel myths that parents have developed from their own experiences of mathematics. The DSPOP stressed that parents play a fundamental role in supporting their children with mathematics. However, they also noted that parents could view TY with uncertainty in the continuum of their child's education. This programme can be seen as a time diversion, as it is divergent from the typical traditional school programmes of the JC and LC (Clerkin et al., 2022). Participation in TY generally represents an additional financial burden for parents. However, Clerkin et al. (2022) describe TY as "an outward- and forward-looking year… where individual wellbeing is seen as being enhanced through social engagement… in this vision, a student should emerge from TY as a more rounded, confident, competent, and socially participatory individual" (p.6). This vision is hard to dispute. Meaningful partnerships with teachers, peers, and parents ensure that students have the best opportunity to be socially prepared for mathematics by engaging in TY. Students reported that their parents had a strong interest and commitment to their learning (Figure 4.12), with 80% of students reporting that their parents are interested in what they are learning. Strong parental support, combined with a teacher's guidance, may lead to better mathematical outcomes for students.

6.2.2.4 Class Structure

The DSPOP discussed the essential role that class structure plays in socially preparing students. While a mixed-ability class ensures that students with different academic abilities

are roughly equally dispersed throughout a year group, the DSPOP also stated that mixed-ability classes often result in students comparing themselves to their classmates. The DSPOP suggested that some students may compare themselves to their lower-achieving peers and not challenge themselves. This is despite the Department of Education's priority of ensuring that the teaching of mathematics is done in a mixed-ability setting (Department of Education and Skills, 2014). Similarly, Smyth (1999) concluded on the benefits of mixed-ability teaching, claiming that mixed-ability class formation is likely to raise students' academic achievement. On the other hand, students may lose confidence by comparing themselves to their higher-achieving peers. Overall, the analysis of the students' responses to mixed-ability class structure offered varying views, with roughly half the students favouring mixed-ability classes and a third of students against mixed-ability class formation.

The DSPOP highlighted that striking an appropriate balance with mixed-ability classes is challenging. However, structured group work strategies (such as Cooperative Learning) may help to balance mixed-ability classes. The construction of teams, with some more able and some less able students, working together to achieve a shared learning goal, should see students of all abilities supporting each other (Johnson & Johnson, 1999; Razzouk & Johnson, 2012).

The literature from the Department of Education Inspectorate (Table 2.4) clearly shows that the view of the Inspectorate is that all TYM classes should be mixed ability. However, there needs to be a clear rationale made for this viewpoint, especially as students sit both the JC and LCM examinations at a particular level. The Inspectorate wants students to move from a specific level (higher/ordinary) at JC to a common approach in TY, and then to a specific level at LC. While the Department of Education is advocating for mixed-ability teaching in TY, and also at JC with the removal of the foundation level option, there is

room for improvement in the support and training of teachers to manage their students' varying levels and differentiation techniques in TY.

Although the literature does not specify the best class structure for students in mathematics, two of the four Junior Cycle Aspects of Wellbeing, Curriculum and Policy & Planning highlight the importance of the teacher making decisions for their students. These guidelines state that in thinking about learning for wellbeing, schools must consider not only the content in which students learn but also how students learn it (National Council for Curriculum and Assessment, 2017). Furthermore, these guidelines stress how important it is for teachers to create a space to share their dialogue and vision for wellbeing. If the class structure is affecting students' wellbeing, then the decision for the class structure should be left to those professionals who know the cohort of students in front of them to make the decision. Interestingly, the teachers interviewed practised mixed-ability teaching but were uncertain if this was their favoured approach to class formation.

6.2.2.5 Learning from Singapore

Unlike Ireland, Singapore's Mathematics Curriculum Framework incorporates aspects of social learning as part of the mathematics curriculum. In particular, Singapore's mathematics curriculum focuses on metacognition and attitudes to problem-solving while encouraging teachers to adapt pedagogies that maximise group work to meet these skills. Teachers in Singapore mainly use three pedagogical approaches to support social learning: activity-based, inquiry-based, and direct instruction (Ministry of Education Singapore, 2023). It is interesting to note that Singapore's Mathematics Framework, initially introduced in 1990 and updated in 2006, contains similarities to Kilpatrick, Swafford and Findell's (2001) five intertwining strands of mathematical proficiency. Groves (2012), references Kilpatrick (2011), who commented on the similarities between his work and Singapore's Mathematics Framework, stating: "both their framework and our strand model

get at the same notion: that proficiency in mathematics is more than simply skill or understanding and that learners need to develop all five components simultaneously" (p.11). Singapore's approach to improving metacognitive awareness is for students to experience "opportunities to solve non-routine and open-ended problems, discussing solutions, to think aloud and reflect on what they are doing" (Ministry of Education Singapore, 2023, p. 17). This approach works well in the social environment to promote students' abilities to work with their classmates to problem-solve, discuss mathematics and advance their learning. This inclusion of social learning within the curriculum framework of mathematics in Singapore may act as a reminder for teachers to teach in a manner that promotes socialisation. The approach may also help to explain Singapore's high standings in comparative tables. This is because Singapore focuses on the affective aspects of learning mathematics, in conjunction with the processes of learning mathematics. Dindyal (2006) asserts that as a result of the Singapore Curriculum Mathematics Framework, students have higher affective aspects. These include a positive attitude to mathematics learning and a higher level of self-confidence. Ireland should consider the intertwining of social learning and mathematics. However, from the teacher interviews, it is apparent that teachers in Ireland will need to be provided with the training and tools to embed a similar culture in Ireland's mathematics classroom. An ideal opportunity for this lies in TY. Social learning, through thinking aloud in groups and group reflection on non-routine problem-solving tasks during TYM, may improve students' ability to tackle complex mathematics problems. Hence, preparing students for the demanding context and application questions on the LCM course.

6.2.3 Emotional Preparedness

The literature on Emotional Preparedness focused mainly on the empirical and theoretical aspects of mathematics education, rather than the curricular and policy aspects. The

literature included mathematical motivation (Boaler, 2020; Bray & Tangney, 2017; Wang et al., 2017), mathematical attitudes and values (Dowker et al., 2019; Kiwanuka et al., 2020) and self-beliefs (Liu & Koirala, 2009; Paraskeva et al., 2008; Warwick, 2008). There is an overlap between the concepts of Social Preparedness and Emotional Preparedness in both the literature and the discussion of the DSPOP. This is unsurprising, considering that the literature links Social and Emotional Learning together (Gil et al., 2006; Kress et al., 2004). The following sections will discuss the literature on Emotional Preparedness, along with the analysis and findings from the multiple stakeholders in this research study.

6.2.3.1 The Power of the Eureka Moment

The DSPOP acknowledged the emotional power that emerges when students are successful with a difficult question in mathematics. There is no formal name to describe this situation, but this study will refer to it as a "eureka" moment. Capitalising on these moments can be a powerful tool for teachers when trying to prepare students for the emotional challenges of mathematics. The DSPOP spoke about the importance of these moments in mathematics class, encouraging teachers to strategically build these moments into their lessons. Kiwanuka et al. (2020) claimed that students develop a positive attitude to learning mathematics when they enjoy, understand, and have confidence in the subject. During Transition Year Mathematics, teachers have the scope and freedom to ensure that students get the opportunity to achieve a "eureka" moment. In addition, teachers can celebrate the achievements of their students at this time. The DSPOP noted that the more challenging a problem, the greater the moment of celebration. Of course, teachers must ensure that they build on students' skills in the lead-up to such a challenge. While the DSPOP spoke so highly of these opportunities, the students reported a different reality, reporting that TY lacked challenge and that overall, they did not enjoy the teaching and learning of mathematics during TY (KFS3.2). Given that 80% of respondents acknowledged liking the

experience of a “eureka” moment, it is likely that they do not see such experiences as a significant aspect of TY. Wen & Dube (2022) highlighted the importance of attitudes in mathematics learning, warning that poor mathematical attitudes may have a detrimental effect on students’ conceptual understanding and their performance. In preparing students for the emotional aspect of mathematics learning, teachers should strive to include, either naturally occurring or structured, “eureka” moments, as these can be transformative for students. Teachers may seize the opportunity of these moments and link them to the principles of Self-Determination Theory (Ryan & Deci, 2020), empowering teachers to build intrinsic motivation and student confidence in their students.

6.2.3.2 Decision-Making

The DSPOP warns that due to the pressures of the LC examination, students can be reactive to their emotions rather than proactive. Hence, after the JC, students can quickly decide to “drop” levels for LC. The DSPOP claimed that a student's lack of confidence, combined with the increased difficulty of LCM and the temptation of the Bonus Points, may result in students opting for an inappropriate level. The Delphi Study Panel warn that this decision may have later implications for a student's future choice of study, and may hinder the government's development of the knowledge economy. Therefore, in preparing students for this quadrant, teachers should aim to manage students’ emotional responses, including challenging decisions for moving levels and implementing supports to ensure an appropriate uptake of LCHL mathematics.

The student sample in this study saw 54% of the total student sample opting for LCHL mathematics ($n = 135$) which is above the desired 30% outlined in the National Strategy to Improve Literacy and Numeracy 2011 – 2020 (Department of Education and Skills, 2011). This percentage is likely to reduce as students continue through LCM. Furthermore, an analysis of levels taken by students estimates an 18–26% drop rate from JCHL to LCOL.

This is despite students studying an additional year of mathematics. While this drop seems sharp, the analysis of the teacher interviews revealed that it is not that there are too many people dropping levels but that the reasons for some students changing levels may be due to an inappropriate emotional response. For others, however, there is a different problem: Students continuing to study mathematics at HL due to the lure of the Bonus Point Initiative. This initiative can also result in a negative emotional response, with students of lower mathematics ability placing enormous stress on themselves to stick at higher level mathematics, hence harming students' wellbeing. Su (2020) articulates that developing a student's emotional intelligence should also improve the student's mathematical wellbeing. The Chief Examiner for Mathematics Report in 2015 echoed a similar concern about mathematical wellbeing, cautioning that students may not be accessing the correct level of mathematics, stating that not all students who take the higher level curriculum are making the optimum choice (State Examinations Commission, 2015).

6.2.3.3 Student Self-Belief and Emotional Relevance

The DSPOP emphasised teachers' critical role in "humanising" mathematics. The Panel worried that students may be unable to see the human aspect of mathematics, instead viewing mathematics in isolation from human development. The DSPOP discussed the importance of sparking a student's interest in mathematics, claiming that teaching the history of mathematics in parallel to mathematics concepts, may demonstrate to students that mathematics is a human-derived subject based on solving problems in the real world. They promoted the inclusion of discovery learning when mathematically preparing students. This approach may encourage students to see the purpose of their learning and can also build a student's level of confidence. The Panel suggest that when students discover something relevant in mathematics, their confidence will increase. One Panellist used the term "emotional relevance" to describe the situation when students understand the

importance of what they are learning, and this transfers into a positive emotional response to learning. TY can have an influential role in shifting mindsets, challenging assumptions, and emotionally preparing students for the demands of the LC. The importance of the content of their learning also links to the mathematical objective of Productive Disposition. The literature highlighted the definition for this objective, which states that students should believe in their diligence, perseverance, and self-efficacy (Department of Education and Skills, 2015).

6.2.3.4 Student Voice

The DSPOP noted the importance of including the student voice within this quadrant of Emotional Preparedness. The Panel claims that students become more emotionally involved when they have input into their learning and suggests that TY offers a safe space to voice their input. They encourage teachers to elicit their students' attitudes, feelings, and motivations and to utilise these to construct a suitable and authentic learning experience for all. This approach to learning mirrors the mathematical objective of Productive Disposition. The suggestion that the student voice can be linked to the habitual inclination of students is an exciting point. Capitalising on the student voice may give students a sense of ownership of their learning content, and influence how they engage with it. One of the DSPOP members suggested that the student voice links to the Design Thinking Process (Müller-Roterberg, 2018). In particular, the first stage of empathising with the learner. This process may offer an approach for teachers as they seek to develop a worthwhile and authentic TYP that caters to the needs of all their students.

The importance of the student voice in mathematically preparing students was also emphasised by the students themselves. KFS3.1 suggests the need for students to have a direct input into their learning. The inclusion of the student voice in the classroom is widely supported by Lundy (2007). Of course, students must develop and use their communication

skills to voice their opinions and insights into their learning. To establish an authentic student voice, teachers must ensure they build a student's mathematical literacy within their teaching. This provides an overlap between the key skill of Communication, and student voice. Asserting student voice within the classroom also increases a student's ability to be personally effective in their learning.

6.2.4 Skills-Based Preparedness

The literature on Skills-Based Preparedness focused on the curriculum and policy documents from Ireland, the European Union, and the United States of America. These documents included the European Union's Key Competencies Framework (European Commission, 2019), The Partnership for 21st Century Learning (Partnership for 21st Century Skills, 2009) and Ireland's Key Curricular Skills Framework (National Council for Curriculum and Assessment, 2009). The following sections will discuss this literature on Skills-Based Preparedness, along with the analysis and findings from the multiple stakeholders in this research study.

The key skills apply to all parts of the Senior Cycle curriculum (an umbrella term encompassing TY and LC). The NCCA maintains that the key skills are essential to the teaching and learning across the Senior Cycle programmes in Ireland, in ensuring that students reach their fullest potential (National Council for Curriculum and Assessment, 2009). The NCCA encourages teachers to embed and nurture these key skills within their teaching and learning, stating that it will "improve their (students) present and future access to learning, their social interaction, their information and communication abilities and their ability to work collaboratively" (p.2). However, the DSPOP claimed that Ireland's Key Curricular Skills are ill-defined, lack clarity and are not implemented to their fullest due to the pressures of examinations. This is despite the OECD claiming that "competencies can improve assessment of how well-prepared young people and adults are for life's challenges,

as well as identify overarching goals for education systems and lifelong learning" (Organisation for Economic Co-operation Development, 2005, p. 4). Teachers alluded to a lack of confidence in the knowledge of applying the key skills to specific students. Furthermore, there was an underlying sense that the key skills were less important to teachers than the teaching of the curriculum. Teachers seemed to view the key skills as a separate entity to the mathematics, rather than running in parallel with each other. This sentiment was also echoed by the students, who stated that TYM had not promoted the development of the key skills. In particular, all three of the Key Findings from Students (KFS4.1, KFS4.2 and KFS4.3) demonstrated weaknesses in the development of problem-solving, communication, and personal effectiveness during TYM.

6.2.4.1 Communication

The Delphi Study Panel spoke about technology's vital role in preparing students for the 21st century. The DSPOP noted a shift in the classroom practices for teachers, moving away from drawing diagrams on the whiteboard to constructing diagrams via dynamic software programmes. In particular, teachers discussed the transition in communication practices in the mathematics classroom, highlighting that students need to be familiar with digital mathematical skills as part of their preparedness journey. The DSPOP claim that teachers can utilise the teaching of digital skills as part of independent or group work. However, some members commented that there is a difference in the resources available for students and schools. Although students in one school may have high-quality personal devices and excellent internet access, other schools may be less fortunate. The overall responses to the student questionnaire revealed that only one in every four students felt that TYM encouraged them to communicate mathematically. In particular, the senior students revealed that from their experience of LCM, after completing TYM, they are not prepared to communicate mathematically.

Furthermore, the DSPOP noted that digital communication skills are linked to the interests and abilities of the classroom teacher. If a teacher is digitally literate, this will likely transfer into their teaching practices. However, this is only sometimes the case. Some teachers may not favour including digital communication skills in learning mathematics, hence hindering the skills students need to work efficiently and effectively in the 21st century workforce. Ireland's Senior Cycle key skills framework must be updated to reflect the ever-changing digital world. This framework, published in 2009, fails to include any reference to digital communication and only makes one reference to the use of ICT in the classroom (National Council for Curriculum and Assessment, 2009). These guidelines are also outdated in comparison to the European Commission's Eight Competencies for Lifelong Learning, which includes both Numerical Skills and Digital and Technology-Based Competencies

6.2.4.2 Being Personally Effective

Again, the DSPOP linked the key skill of Being Personally Effective to the mathematical objective of Productive Disposition, stating that students become more conscientious learners if they see the relevance and value in their learning. The DSPOP highlighted the importance of this key skill as a priority for teachers, suggesting that Being Personally Effective also links to Quadrant Three on Emotional Preparedness. The DSPOP claims that students will have increased resilience and motivation if teachers focus on teaching this key skill. This opinion aligns with the literature for this key skill, which states that students should be well-equipped to be resilient to feedback, identify areas for improvement, and set realistic personal goals for their learning (National Council for Curriculum and Assessment, 2009). Furthermore, the DSPOP emphasises that students are more accountable for their work if they have the skill of being personally effective. Hence, students will be better equipped to participate in group work and will likely have better mathematical communication levels. The students portrayed that TYM did help them to

become more personally effective, with one in every three students agreeing that their experience improved their independent skills in mathematics and developed their ability to reflect on their work. However, as students prepare to transfer from TYM to LCM and beyond, it is evident that being personally effective becomes a vital requirement. This skill needs to be enhanced and increased to ensure that students are prepared for their future endeavours.

This key skill also encourages teachers to prepare students to assert confidence and have their voices heard appropriately (National Council for Curriculum and Assessment, 2009). Including the student voice is an appropriate method of reaching this objective, as it empowers students to be confident and voice their opinions in their learning. The teachers indicated a willingness to trial more student voice strategies in the planning and preparations for TYM.

6.2.4.3 Information Processing

Although the DSPOP acknowledged this key skill, they did not expand on its properties. However, the DSPOP noted that every aspect of mathematics is processing information, and it is a given that this key skill would be an essential feature in preparing students. The DSPOP emphasised the connection between the key skill of Information Processing, and Academic Preparedness. The policy for this key skill does not focus on the numerical sense of information processing but rather a broader range of skills, including accessing information, discriminating between sources, reliability, and presenting information (National Council for Curriculum and Assessment, 2009). According to the LCM Curriculum: "successful mathematics learning requires the efficient processing of the information that defines the mathematical tasks" (Department of Education and Skills, 2015, p. 9). Overall, approximately 30% of students reported that they were required to

process information efficiently in TYM. This low statistic may be linked to a deficiency in academic challenge during TYM.

6.2.4.4 Critical and Creative Thinking

Critical and Creative Thinking is predominantly viewed as problem-solving in mathematics. This view suggests a solid connection between Critical and Creative Thinking and Academic Preparedness. The DSPOP raised concerns about the level of mathematical literacy students need to succeed with complex mathematics problems. They claimed that a deficiency in mathematical literacy is becoming a barrier to students' ability to engage with critical and creative thinking. The introductions of Project Maths and the reformed Junior Cycle Mathematics Specification require students to be more skilled at reading the questions and deciphering the core crux therein. Students' responses to the questionnaire further emphasised that there is a need for teachers to develop this key skill. Students acknowledged that TYM did not fully nurture a sense of problem-solving or creative approaches to solving problems. Teachers must ensure that they build on a student's mathematical literacy ability and focus on the keywords, terms and definitions in their teaching. TY provides an opportunity to maximise mathematical literacy and explore problem-solving while building a student's resilience with mathematics. In preparing students for this quadrant and this key skill, it is evident that teachers need to develop a student's toolkit with strategies they can utilise when facing complex problems.

6.2.4.5 Working with Others

This final key skill focuses on the skills students need to work with others, in groups or teams, to achieve shared goals. The DSPOP acknowledged that students need to be familiar with the other key skills before effectively working with others. Although the key skills Framework instructs teachers to include this skill within their lessons, it fails to address how teachers should explicitly teach students the skills of working together, such as

communicating in a team, listening, and team leadership. The DSPOP stated that there needs to be a more precise definition for this key skill. Interestingly, the students indicated that TYM provides them with a fantastic opportunity to develop interpersonal relationships with their classmates and teachers. Building relationships was viewed as one of the critical benefits of participating in TYM. Teachers should maximise this opportunity to ensure that students have the correct social skills to work with others. However, the DSPOP warned that teachers may view this as a task that takes up tuition time, and it is likely that teachers may not invest the proper amount of time needed to master this key skill.

6.2.5 A refined definition for Mathematically Preparedness

In combination with the expertise of the Delphi Study Panel of Participants, the insights of the students, the wisdom of the mathematics teachers, and the literature (both empirical and theoretical, and policy and curricular), the researcher offers a series of contributions under each of the four quadrants. All parties agreed that there is more to mathematical preparedness than just academic factors. The DSPOP, the teacher participants, and the literature all acknowledged that students need to be prepared in social, emotional and skill-based skills, in tandem with their academic learning. Initially, the different strands of the literature were conceptualised as a diagram (Figure 2.4). However, the researcher now offers an updated and more complex version of the Mathematical Preparedness Quadrant. This discussion chapter highlighted that there are several overlapping elements between each of the quadrants, with some elements being shared across all four quadrants. Hence, the researcher has re-imagined the Four Quadrants of Mathematical Preparedness into a Venn Diagram, clearly illustrating the areas of intersection. This new diagram (Figure 6.3) offers a visual representation in response to Research Question One. It is important to note that the size of each quadrant is not to scale – in some situations, teachers may need to focus more on one quadrant than the next. However, this is down to the individual teacher,

their students, and their context. This view aligns with the freedom and flexibility of the domesticated nature of the Transition Year Programme.

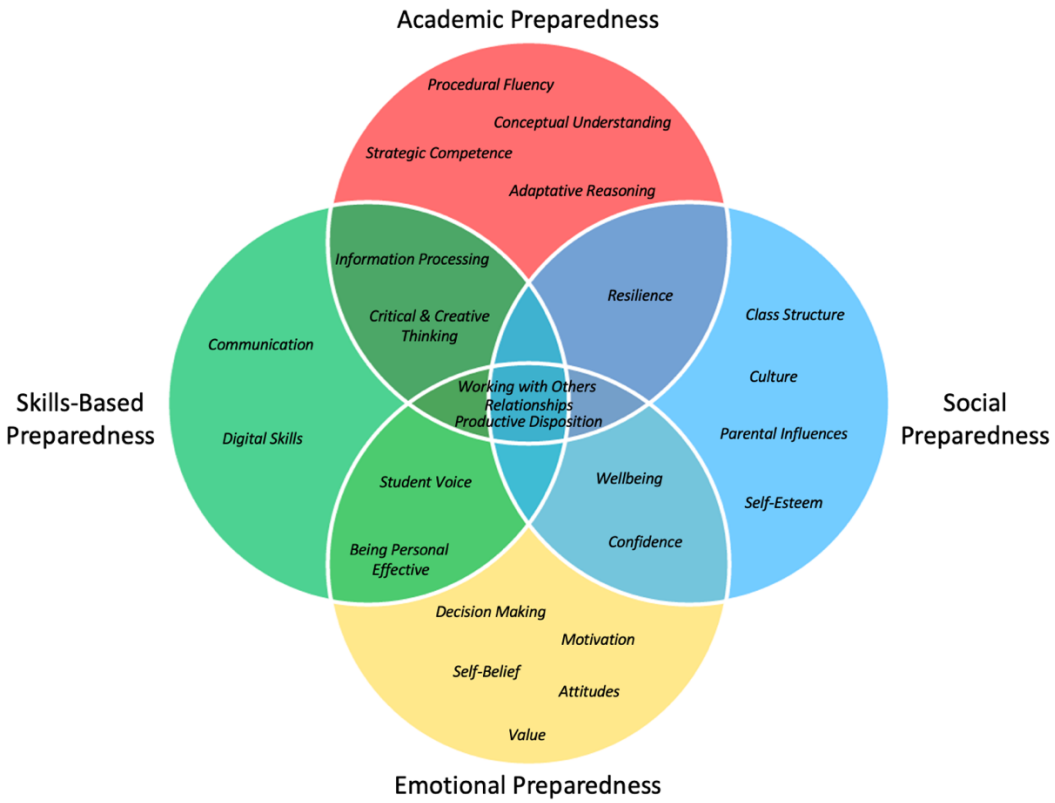


Figure 6.3: Re-imagined Four Quadrants of Mathematical Preparedness.

The following subsections will offer the refined description of each of the four quadrants. It will start by exclusively focusing on the elements that are unique to that quadrant, before discussing the shared elements between two neighbouring quadrants. Finally, the discussion will conclude with a description of the three shared elements of all four quadrants, namely the key skill of Working with Others, the mathematical objective of Productive Disposition, and the social and emotional learning key factor of Relationships.

Academic Preparedness

In terms of Academic Preparedness, this research suggests that teachers should be retrained or offered increased levels of support in the mathematical objectives of both Junior Cycle and Leaving Certificate, including Procedural Fluency, Conceptual Understanding, Strategic Competence, and Adaptative Reasoning. These curriculum objectives offer the

basis of academic preparedness, empowering teachers with a clear vision for mathematics teaching, and supporting students as they prepare to learn mathematics. In particular, teachers should ensure to focus on Productive Disposition, as this objective grounds students to see the relevance and purpose of their learning. In academically preparing students, teachers should consider grounding their lessons in a productive disposition manner, informing students of the worthwhileness of the topic and its application. Furthermore, teachers must ensure that students are well versed in the objective of Procedural Fluency during TYM, as they prepare to progress onto LCM. This objective instils students with confidence and efficiency in routine aspects of mathematics.

Social Preparedness

In terms of Social Preparedness, the research suggests that elements such as class structure, culture, parental influences, and self-esteem play a critical role in socially preparing students for mathematics learning. School management and teachers must ensure that they are choosing a suitable class structure for their students that prepares, supports, challenges and encourages all learners to develop. Students favoured learning in a mixed-ability classroom, with teachers also favouring this model of class composition. However, some teachers warned that there is a saturation point for mixed-ability teaching of mathematics. Further suggestions for class structure will be presented later. The analysis of the research data showed that students were overwhelmingly against the use of competitions in TYM. Hence, teachers should consider avoiding a classroom culture which focuses on competition. In doing so, this may help to increase students' self-esteem in mathematics.

Emotional Preparedness

In terms of Emotional Preparedness, the research suggests that teachers should strive to build students' motivation during TYM. In selecting suitable and interesting lessons, teachers can ensure that the TYM domesticated curriculum is accessible to all students, and

they may use this optional year as a springboard to better outcomes in LCM. Transition Year Mathematics also offers teachers the perspective of challenging students' attitudes and values towards mathematics. Teachers should consider designing their classes to provide opportunities for the inclusion of many "eureka" moments during TYM. These moments act as powerful agents of change in a student's emotional relationship with mathematics, promoting students' understanding and celebrating their learning. Furthermore, both students and teachers alike recognised the important role that the active inclusion of the student voice plays in mathematics education. The inclusion of student voice positions students as equal partners in the learning paradigm and can help to improve their attitudes, values, engagement and interest.

Skills-Based Preparedness

In terms of Skills-Based Preparedness, it emerged that teachers need subject-specific guidance on the inclusion of the five key skills of Communication, Information Processing, Critical and Creative Thinking, Working with Others, and Being Personally Effective. Teachers recognise that each skill is critical in preparing students. However, they lacked confidence in their interpretation and ability to combine these skills into their planning. In preparing students, teachers should ensure that students are becoming literate in the language of mathematics. The research suggests that teachers should also focus on including Digital Skills when preparing students. This is to ensure that students are prepared for the demands of the 21st century world.

Shared Elements of the Four Quadrants of Mathematical Preparedness

All four quadrants shared elements with other quadrants.

- Resilience emerged as a vital element needed to both academically and socially prepare students for their mathematics learning. In preparing students, teachers should consider building a student's tolerance for challenging problems during

TYM. This tolerance does not need to be developed in isolation, but can occur when students work together to solve problems and develop strategies.

- Confidence and Wellbeing emerged as shared elements in both the Social and Emotional Quadrants. In preparing students, teachers should ensure that they are optimising TYM as a platform to build a student's confidence. Hence, also improving their mathematical wellbeing.
- Student Voice and Being Personally Effective emerged from the research as being shared across both the Emotional and Skills-Based Quadrants. In striving for the inclusion and input of student voice in the classroom, teachers must ensure that students have the communication skills, as well as the self-belief to speak out and provide their opinions and ideas.
- Information Processing and Critical & Creative Thinking overlapped between the Skills-Based and Academic Preparedness Quadrants. The DSPOP were adamant that all aspects of mathematics require students to be prepared in information processing. Hence, teachers need to teach students this skill before applying it to academic questions and problems. Similarly, Critical & Creative Thinking aligns with problem-solving and logical thinking. In preparing students, teachers must ensure they are teaching students problem-solving strategies before assigning students mathematical problems.

Intersecting Elements of the Four Quadrants of Mathematical Preparedness

At the heart of Mathematics Preparedness are three essential and intersecting factors across all four quadrants. These are Working with Others, Relationships, and the mathematical objective of Productive Disposition. In preparing students for learning mathematics, teachers should ensure that all three of these elements are central to their planning, preparations, and teaching approaches. From the analysis of the student's responses, they

stressed that one of the benefits of participating in TYM was the additional year to build and nurture relationships with their peers and teachers. In developing these relationships and working with others, students are being prepared not only for the demands of LCM but for life. Teachers should ensure to teach with the mantra of 'connections before curriculum', ensuring that they develop positive and professional working relationships with students. These relationships ensure that students have a sense of belonging in the mathematics classroom, which can yield higher levels of confidence, self-esteem, and a better attitude towards mathematics learning. However, students need to be supported in the key skill of Working with Others, and they should be explicitly educated in the social skills required to cooperate with other people. Teachers may consider Cooperative Learning strategies to teach their subject content and the required social skills.

Finally, the DSPOP stressed the need for students to see the value in their learning through Productive Disposition. Hence, in preparing students, teachers should strive to teach with a purpose, to explain the applications of mathematics, and to include the student voice in their planning.

Definition for Mathematical Preparedness

In combination and triangulation of multiple sources of the research data, with the research literature, the researcher offers the following definition for mathematical preparedness:

> Mathematical Preparedness combines academic, social, emotional, and skills-based factors into a series of four interconnecting quadrants. These four quadrants merge the mathematical objectives of Strategic Competence, Adaptive Reasoning, Conceptual Understanding and Procedural Fluency, with the social and emotional learning elements of mathematical resilience, self-confidence, wellbeing, attitudes and motivation. These elements are developed, practiced and applied in conjunction with the key skills of Information Processing, Critical and Creative Thinking, Communication, and Being Personally Effective. At its core, Mathematical Preparedness centres on working with others, to build, nurture, and develop relationships while learning mathematics through a productive disposition lens.

6.3 Addressing Research Question Two

"How do students' experiences of Transition Year, from three sample schools, reflect this definition of mathematical preparedness?"

Based on the comprehensive definition of mathematical preparedness produced by the research data, there is no clear picture emerging from the student data about whether their experience of TY, in the three research schools, was supportive of their development of mathematical preparedness. Analysis of the student data provided clarity about two related areas:

1. Students' beliefs around what the TYM programme "should be".
2. Their "actual" experience of their TYM programme.

This chapter will refer to the Heat Maps of the student responses to the questionnaire as illustrated in Chapter Four. This first section (6.3.1) will discuss students' beliefs about the TYM programme, providing a cross-quadrant overview of what students deem to be the important aspects that should be considered for TYM. The second section (6.3.2) will discuss each of the Heat Maps for the Four Quadrants of Mathematical Preparedness. Both sections will include the relevant literature and insights from the DSPOP, where appropriate.

6.3.1 Students' Beliefs about the Transition Year Mathematics Programme

On review of the Heat Maps, it was evident that students' perceptions of the statements that directly related to their experiences of TY tended to be different from those statements which referred to their belief about what TYM should be. In total, fourteen statements on the student questionnaire referred to such beliefs. Based on this vision for the TYP, students wished that TYM would be structured with their opinions in mind, would promote success in their learning, and that teaching and learning would centre on building positive relationships.

In terms of the content for TYM, over 70% of students called for the inclusion of the student voice in the development of the TYM programme. Most students believed that TY should act as an additional year, preparing them for the demands of the LCM curriculum, particularly about algebra. Most students acknowledged the importance of "habitual inclination" in mathematics, with over 60% of students stating that when they find mathematics relevant to life, they are more likely to put in more effort.

Importantly, students shared insights into how they mathematically develop. They believed that the "eureka" moment is critical for student morale when learning mathematics. The importance of this was also highlighted by the Delphi Study Panel, who stated that they are fully in agreement with this aspect of the quadrant. Over 80% of the students sampled

reported that this sense of achievement spurred them to work hard with their learning and to continue in the face of difficulty. This celebratory moment may also be linked to the fact that students reported that when they understand a concept, there is a growth in their self-confidence (Ciftci & Yıldız, 2019). Even though students recognised the need for the development of tolerance with mathematics, 40% of the respondents disagreed that they enjoy solving challenging mathematical problems. It is interesting to note that while students may wish to develop a tolerance to difficulties in mathematics, many of them do not like the challenging problems that may generate this. Caviola et al. (2017) articulate that when students have a negative attitude (e.g. dislike toward problem solving), this may lead to worry, concerns, and distracting thoughts, which can impair a student's working memory. Hence, teachers should prepare students in a scaffolded approach to problem solving, using the strategies from their Project Maths CPD (draw a diagram, look for a pattern, use a table, eliminate possibilities) to lead to "eureka" moments in the classroom. These opportunities may be critical in developing students' positive attitudes to mathematics.

The student responses also provided an insight into their preferred approaches to teaching and learning mathematics in TY. Students favoured activities that promote group work and group projects. Such activities provide students with opportunities to build relationships with their peers while having additional support to learn mathematics. However, although students preferred group-based approaches to learning, more than 70% of students stated that TYM should not be a competitive classroom. It is apparent that while students advocate for group work, competition should not be included. Again, this view was supported by some members of the DSPOP. Weissberg et al. (2015) recognise the importance of group work in the development of the social and emotional learning skills of students. Stating that when students actively participate in group work, they get to apply their knowledge,

manage their emotions, set and achieve goals, and manage workloads (Weissberg & Cascarino, 2013). Furthermore, participation in group work can assist students in developing the key skills (National Council for Curriculum and Assessment, 2009). The Department of Education, along with the NCCA, should consider the inclusion of a group work project, similar to the CBA process at JC level, in TYM. This may provide students with the prospect of researching a topic, developing their key skills of Working with Others and Critical and Creative Thinking, while also fortifying their mathematical communication skills.

Overall, students believe that TYM should have a national curriculum, be structured to encourage mixed-ability teaching and learning, avoid competition but promote group-based learning, and include the student voice in the selection of topics. This is very much in line with the vision of mathematical preparedness from the DSPOP. In addition, this view aligns with the teacher's requirement for a clear vision and parameters of the TYM programme.

6.3.2 Students' Experiences of the Transition Year Mathematics Programme

From the data analysis, it was evident that students in TY reported a different experience to those in LC (5th and 6th year). This section will discuss three cohorts of students: those in TY, 5th Year, and 6th year, and their experiences of mathematical preparedness by examining each of the four quadrants, from the three research schools.

6.3.2.1 Transition Year Student Experiences

From the analysis of the student data, the current TY students presented a more positive view of their experience compared to those students in 5th and 6th year. It is important to note that these students participated in this research during their first term in TY. Hence, students are presenting an initial view of the TYM programme.

Quadrant One – Academic Preparedness

Figure 4.3, the Heat Map of TY students' responses to Quadrant One on Academic Preparedness, had eight statements that reached over 50% in agreement (Statements: 1.1, 1.3, 1.6, 1.7, 1.9, 1.11, 1.12, and 1.16). This suggests that most TY students reported mixed experiences of Academic Preparedness. In particular, this cohort of students reported a strong connection between their experience of TYM and the content from the Junior Cycle Mathematics Specification. This strong connection aligns with the LCM curriculum, which states that "the way in which mathematics learnt at different stages links together is very important to the overall development of mathematical understanding" (Department of Education and Skills, 2015, p. 7). The fact that most TY students reported building on their knowledge from the JC suggests that students are experiencing the mathematical objective of Procedural Fluency during TYM.

Students indicated that they did not experience a very challenging TYM programme, nor did they enjoy the teaching and learning of the chosen TYM topics. This exposure to a lack of challenging material during TYM may result in students being underprepared for the demands of the LCM curriculum. This was also noted by the DSPOP, and the teachers, who highlighted the vast academic difference between Junior Cycle Mathematics and Leaving Certificate Mathematics. This absence of challenging and exciting mathematics lessons fails to match the required related learning for the LC, which states that "as learners progress through their education, mathematical skills, concepts and knowledge are developed when they work in more demanding contexts" (Department of Education and Skills, 2015, p. 7)

Quadrant Two – Social Preparedness

Figure 4.7, the Heat Map of TY students' responses to Quadrant Two on Social Preparedness, had six statements that reached over 50% in agreement (Statements: 2.2, 2.3,

2.8, 2.9, 2.12, and 2.13). On the other hand, this quadrant had three statements that reached over 50% in disagreement (Statements 2.11, 2.15, and 2.17). This suggests that overall, most TY students reported positively about their experiences of Social Preparedness during TYM. In particular, students noted that their experiences with TYM enabled and encouraged them to build and nurture relationships with their teachers and classmates. These positive relationships are a critical component in developing Social Preparedness (Weissberg & Cascarino, 2013). Furthermore, these results align with research conducted by the Irish Second-Level Students Union (ISSU), reporting that the relaxed and calm environment of TY promotes a sense of partnership between teachers and students (ISSU, 2014). Despite most students speaking positively about their experience of relationship development during TYM, 45% of the TY cohort reported that their experience of TYM did not provide adequate opportunities to build students' social confidence. This result goes against one of the main aims of the TY Guidelines, which states that: "the aim should be to identify and eliminate weaknesses, and to develop the confidence and attitudes of pupils" (Department of Education and Skills, 1994, p. 4).

Quadrant Three – Emotional Preparedness

Figure 4.14, the Heat Map of TY students' responses to Quadrant Three on Emotional Preparedness, had ten statements that reached over 50% in agreement (Statements: 3.1, 3.2, 3.3, 3.4, 3.7, 3.9, 3.11, 3.12, 3.14, and 3.16). However, most of these statements referred to students' beliefs about TYM rather than their experiences of TYM. Three statements on students' experiences of TYM reached over 50% in agreement. Each of these three statements centred on a sense of comfort in TYM. Students reported feeling comfortable asking their classmates and teachers for support, and they were also comfortable when they made mistakes in mathematics. It is refreshing to see that the NCCA's Draft TY Programme document recognises this sense of comfort, stating that students must be able

to learn from their mistakes and exit their comfort zone (National Council for Curriculum and Assessment, 2023).

Quadrant Four – Skills-Based Preparedness

The TY cohort reported positive experiences of this quadrant on Skills-Based Preparedness. Figure 4.22, the Heat Map of TY students' responses to Quadrant Four on Emotional Preparedness, had eight statements that reached over 50% in agreement (Statements: 4.1, 4.3, 4.4, 4.7, 4.9, 4.3, 4.14, and 4.17). It was interesting to note that the majority of TY students did not disagree with any of these seventeen statements. This may suggest that their experiences with TYM included all of the five Key Curricular Skills (National Council for Curriculum and Assessment, 2009).

6.3.2.2 Fifth Year Student Experiences

Students in 5th year presented a different view of their experience of TYM than the TY cohort. This section will discuss the 5th year students' responses to each of the four quadrants.

Quadrant One – Academic Preparedness

Figure 4.4, the Heat Map of 5th year students' responses to Quadrant One on Academic Preparedness had only one statement with over 50% in agreement, that was Statement 1.14: "I wanted to cover only the Leaving Certificate topics during TY Maths". However, as highlighted in section 6.3.1, this statement refers to students' beliefs about TYM rather than their experiences with TYM. Hence, it seems that most 5th year students, in retrospect, feel that their time would have been better spent preparing them for the upcoming Leaving Certification Mathematics examinations. The responses to this statement suggest that the majority of 5th year students thought that this additional year would better prepare them for the academic demands of the LCM course by covering the LCM topics during TYM. This viewpoint, from the students' perspective, suggests that like the teachers, 5th year

students wish that TYM focused on the academic material that students will experience at the Senior Cycle level. Hence, better preparing students for the academic demands of LCM. It is interesting to note that the current TYM guidelines are against this stance (Department of Education and Skills, 1994). However, these TY guidelines were released over two decades before the current JC and LC reforms. Highlighting that the current guidelines are no longer fit for purpose. This difference between students' beliefs and experiences may help to explain why over 40% of the cohort suggests the need for TYM to have a national curriculum. The introduction of a national curriculum for TYM might also reduce the concerns expressed by Jeffers (2007), in Moran et al. (2013), some warned that some parents, students, and teachers noticed that students tend to drift away from the academic focus in TY, which has a knock-on effect in the LCM examination.

The analysis of this cohort's experiences of TYM is concerning. Overall, the 5th year students disagreed or strongly disagreed with twelve of the eighteen statements in the quadrant, with over 75% reporting a lack of challenge in TYM, over 65% revealed that TYM was deficient in developing Procedural Fluency, and more than 60% said that TYM did not provide them with enough opportunity to develop Conceptual Understanding. These results reflect perceived shortfalls in how the participants feel TY prepared them academically for the demands of LCM. This is a worrying reality, especially as the Leaving Certificate Mathematics curriculum specifically states that the assessment of LCM is based on these five mathematical objectives (Department of Education and Skills, 2015).

Quadrant Two – Social Preparedness

Figure 4.8, the Heat Map of 5th year students' responses to Quadrant Two on Social Preparedness, had three statements above 50% agreement. However, two of these statements referred to students' beliefs about the TYM programme (Statements: 2.2 and 2.13). Nine statements reached over 50% disagreement (Statements: 2.4, 2.5, 2.7, 2.9, 2.10,

2.15, 2.16, 2.17 and 2.18). Most of this cohort of students reported that their experiences of TYM did not increase their self-esteem with mathematics, nor did it improve their social confidence. Furthermore, over 60% of this cohort of students reported that TYM did not encourage them to succeed with mathematics, and 70% of students stated that TYM did not improve their ability to solve hard mathematics questions. Based on these 5th year responses, there may be a disconnect between the social preparedness of TY and LCM programmes. The LCM curriculum claims that the mechanism in which mathematics is taught at different stages of learning is fundamental for students to link concepts together in their overall development of mathematical understanding (Department of Education and Skills, 2015). Also, this piece of literature states that "the study of LCM encourages learners to use the numeracy and problem-solving skills developed in early childhood education, primary mathematics and Junior Cycle mathematics" (Department of Education and Skills, 2015, p. 7). However, once again, TY is forgotten in this mathematics education continuum. Perhaps this omission is because TY is an optional programme. Yet, it caters for over 45,000 students annually.

5th year students' experiences of this quadrant were not all negative, with nearly 60% of all 5th year students agreeing that their experience of TYM allowed them to build positive relationships with their peers. This perspective may also explain this cohort's preference for group work and group projects in TYM. Samuelsson (2023) recognises the critical and positive role that group work plays in developing students' intrinsic motivation. Furthermore, Moran et al. (2013) and Jeffers (2011b) both acknowledged that participation in TY leads to enriched teacher-student relationships, which positively impact students' learning and attainment.

Quadrant Three – Emotional Preparedness

As noted earlier, the questions concerning this quadrant centred on students' beliefs about what TYM "should be", rather than their experiences of TYM. Over 70% of this cohort of students stated that TYM did not improve their motivation for mathematics learning. Furthermore, 32.9% of this cohort reported that TY Maths made them lose their motivation between JC and LC. This reduction in motivation may be detrimental to their attainment in LCM. Some teachers spoke about this situation, highlighting that they have decided to introduce formal assessments to TYM. This is mainly due to the value students place on terminal examinations such as LCM for motivation. Additionally, students might link their enjoyment of the TY programme to their motivation levels. Hence, if they do not think that they are enjoying their learning, this may lower motivation. Boaler (2020) advises that when students develop an interest in the ideas that they are learning, this results in increased motivation and achievement. Hence, if teachers include the students' topics of interest in TYM, this may likely result in higher levels of motivation and achievement (Lundy, 2007).

Quadrant Four – Skills-Based Preparedness

Figure 4.23, the Heat Map of 5th year students' responses to Quadrant Four on Skills-Based Preparedness had no statement reach over 50% in agreement. This showcases a vast difference from that of the TY cohort's experience of this quadrant. However, twelve of the seventeen statements reached over 50% disagreement. This lower level of agreement may be a cause for concern or may indicate that this year's teachers are doing a better job. It may be hypothesised that this different response from the TY students represents an increase in dissatisfaction as students progress into the more formal landscape of the LC. However, as addressed in the literature, the Key Skills Framework is specific to the Senior Cycle in Ireland, which encompasses Transition Year. Despite this fact, it is also interesting

to note that this piece of literature, published by the NCCA, makes no specific reference to Transition Year (National Council for Curriculum and Assessment, 2009).

Interestingly, while the TY cohort referenced the key skill of Critical and Creative Thinking, most 5th year students (approximately 70%) stated that TYM did not improve their problem-solving ability. It may be hypothesised that TYM does not equip students with the problem-solving skills required for LCM.

6.3.2.3 Sixth Year Student Experiences

The experiences of the 6th year students are similar to those of the 5th year students. This section will discuss the 6th year students' responses to each of the four quadrants.

Quadrant One – Academic Preparedness

Figure 4.5, the Heat Map of 6th year students' responses to Quadrant One on Academic Preparedness, had two statements reach over 50% in agreement. Interestingly, both of these statements refer to the two belief statements for this quadrant (Statement 1.13 and Statement 1.14). This indicates that students want TYM to have a prescribed curriculum that focuses on the terminal examination of the LC. The reason for this may be due to the academic pressure that students experience when in 6th year, facing the LCM examinations. Overall, the analysis of this cohort's responses suggests that TYM is not effectively academically preparing students. This cohort disagreed or strongly disagreed with thirteen of the eighteen statements in this quadrant. In particular, over 70% of the cohort disagreed that TYM helped them to unify the different areas of mathematics together, or to help them reflect on their learning process. Thankfully, the reforms to the JC go some way to address these concerns relating to Adaptive Reasoning with the introduction of the Unifying Strand. This strand aims to permeate the JC curriculum by "developing students' ability to think logically, strategically, critically, and creatively" (Department of Education and Skills, 2017, p. 9).

Like the TY and 5th year cohorts, the 6th year cohort called for a higher level of challenge in the content taught as part of the TYM programme, with three out of every four students reporting a low level of challenge in their experience of TYM. This requirement to prepare students for the challenging demands of the LCM examination is essential, especially with the recent media attention on LCM (Casey, 2023; Donnelly, 2023; Foxe, 2023).

Both groups of LC students also called for the increased emphasis on assessments (over 60% of both cohorts) as part of TYM. This increase in assessment may help to create a more formal structure in TYM, and better prepare students for the topic and assessment model of LCM. The inclusion of formal term assessments was also advocated for by several teachers during their interviews. The teachers claimed that the inclusion of formal assessments helps to give TYM a formal structure and acts as an appraisal for students.

Quadrant Two – Social Preparedness

6th year students reported a similar experience as their 5th year counterparts, concerning the quadrant on Social Preparedness. Figure 4.9, the Heat Map of 6th year students' responses to Quadrant Two on Social Preparedness, had four statements reach over 50% in agreement. Interestingly, three of these statements refer to the belief statements for this quadrant (Statements: 2.2, 2.3, 2.13). The remaining statement acknowledged that TYM provided for positive relationships between students.

6th year students highlighted six statements with a majority of 50% in disagreement (Statements: 2.5, 2.7, 2.10, 2.15, 2.17, and 2.18). These six statements also elicited disagreement from the majority of 5th year students, but that was not the case among the TY cohort. The responses to these statements suggest that the 6th year cohort found that TYM did not improve their social confidence, lacked encouragement, and did not prepare students to manage and solve difficult mathematics questions.

Quadrant Three – Emotional Preparedness

The 5th and 6th year cohorts had similar experiences of TYM and Emotional Preparedness. However, most 6th year students revealed that TYM did not increase their motivation (over 60%), interest (over 70%), or enjoyment (50%) of mathematics. These three components can be linked to a student's wellbeing, with the JC Wellbeing guidelines stating that "teaching and learning that is supportive of student wellbeing…takes into account the diverse needs and interests of individual students" (National Council for Curriculum and Assessment, 2017, p. 32). This suggests that perhaps the role of inclusion of the student voice is overlooked within TYM. This view aligns with the students' beliefs for this quadrant – with over 65% of this cohort of students stating that their opinions about what mathematics they are learning should be considered. The inclusion of the student voice within TYM may impact student's motivation, interest and enjoyment and aligns with the rationale of LCM, which states that "mathematics education should be appropriate to the abilities, needs and interests of learners and should reflect the broad nature of the subject and its potential for enhancing their development" (Department of Education and Skills, 2015, p. 7)

Quadrant Four – Skills-Based Preparedness

Figure 4.24, the Heat Map of 6th year students' responses, revealed worrying results about their level of Skills-Based Preparedness. Their responses saw fifteen of the seventeen statements reaching 50% in disagreement. The analysis of these results suggests that as students edge closer to the terminal LCM examination, they do not think that their TYM experience developed these key skills.

6.4 Addressing Research Question Three

"What key issues must be considered to mathematically prepare students during Transition Year?"

The third and final research question will discuss the concerns and key issues raised from the teachers' perspectives on mathematically preparing students. The following sections will discuss how the lack of understanding of the identity and other factors of the TYM programme are impacting teachers with their capacity to mathematically prepare students.

6.4.1 Purpose and Identity

At the core of the issues raised by the teachers interviewed was the identity of TYM (KFT1.1). The analysis and findings also revealed a broader lack of understanding of the purpose of mathematics education in Ireland. Although teachers emphasise and acknowledge the broader educational objective of life-long learning, and the role of mathematics therein, they view their role in Ireland's mathematics education as ultimately determined by ensuring students' success in the terminal examination of the Leaving Certificate.

6.4.1.1 Purpose of Mathematics Education in Ireland

Turing, one of the teachers interviewed, reflected the opinions of several others in this research study, stating that: "*In our society, (the objective of) Leaving Cert Maths, is the exam*". This quote captures the weighting that the government places on mathematics education within the development of the knowledge economy. The purpose of mathematics education has culturally and socially altered over the last decades, shifting towards success in international comparison tests (Ernest, 2009; Kirwan, 2017). Mathematics teachers also bear the pressure of ensuring that students pass mathematics to gain entry into apprenticeships or gain enough points to enter high-point and competitive courses at third-level education (Oldham, 2001). The teacher participants revealed that they were

disappointed to be teaching for an examination rather than teaching students the problem-solving and mathematics skills required for life. However, teachers revealed that they had to think strategically, always aware that the LC examination is the primary focus for teachers and students. This view aligns with the work of Clerkin (2012) who claims that Ireland's education system is dominated by the Leaving Certificate examination. This sole focus on the terminal examination may be impacting the quality of teaching, focusing on teaching for the examination rather than for understanding, even in TY.

6.4.1.2 Identity of Transition Year Mathematics

Teachers reported struggling to know what content to focus on and how to approach their planning and preparation for this unique year. The domestication of the TYP, while providing freedom and autonomy for teachers, reportedly confuses teachers due to an absence of suitable and modern guidelines. Teachers asserted concerns about only being allowed to teach a certain percentage of the LC course (rumoured to be between 20– 40%) during TY. This idea is neither supported by legislation, nor recorded in TY guidelines, but it appears to function as an unwritten rule among teachers. Furthermore, teachers expressed frustrations over the outdated TY guidelines, which were scripted in the early 1990s and still active in 2024.

The analysis and findings revealed that when teachers have difficulties understanding the identity of TYM, they revert to teaching the LC course. Jeffers (2011a) claims that teachers "whose identities are closely linked to their students' achievements in examinations admit to finding teaching a TY class especially challenging" (p.8). This challenge may be exacerbated by the lack of structure in TY and a fear of failure. Some teachers would likely benefit from formal support to assist them in developing a change in their practice, supporting them to shift their focus from the LC to a more student-centred and creative approach to teaching TYM.

6.4.1.3 The Identity Crossroads

The analysis and findings highlighted that TYM is at a crossroads due to the JC and LC reforms. Teachers expressed concerns about the reduction in teaching time at JC, due to the new assessment model that incorporates two Classroom-Based Assessments (CBAs), which each take three weeks to complete (National Council for Curriculum and Assessment, 2020). Teachers reported that this reduction in "instruction" time leaves them to cover some of the missed academic material from the JC during TY. Furthermore, the analysis of the findings revealed that teachers are concerned about the growing academic gap between the JC and LCM. Teachers are concerned that the reforms to the JC do not fully align with the aims and skills required for LCM. Hence, TYM may be explicitly used to revisit and recover topics from the JC, preparing students before they progress into LCM. The radical changes to the JC examination formation, from two papers of two and a half hours to one single two-hour paper, without any considerable reduction in the curriculum at JC, are challenging for teachers to manage. The impact of these reforms on students' comprehension and application to mathematics will not be fully realised for several years. Despite this reduction in summative examination and classroom teaching time, teachers must still go on to prepare their students for the LCM examination, comprising two papers, totalling five hours. Teachers also expressed trepidations about the future reforms to LCM with the Government's proposed reform plans to have students taking Paper One of LCM at the end of 5th year (Department of Education, 2022a). Leibniz stated: "*If they go down the road of bringing the exams in for 5th year, suddenly, Transition Year becomes a whole different ballgame*". This comment suggests that schools and teachers would have less freedom to explore other aspects of mathematics in TYM. Instead, teachers would likely exclusively focus on the LC curriculum to ensure students would be prepared for the state examination at the end of 5th year. However, this issue raises further questions about the

equity of opportunities for students who do not participate in TY. According to the Education Indicators Report, published by the Department of Education in February 2023, students doing TY as a percentage of the previous third year cohort for 2021 was 73.8% (Department of Education and the Department of Further and Higher Education, 2023). This is despite the Department of Education stating that 98% of all schools offer the TYP (National Council for Curriculum and Assessment, 2023). This means that less than three out of every four students partake in the alternative programme, despite the vast majority of schools offering the TYP. If these proposals for the reformed LC are introduced, one in every four students might likely be deemed less prepared for the LC than their peers who completed TY.

6.4.1.4 Proposal of a National Curriculum for Transition Year Mathematics

The findings and analysis revealed that all 13 teachers are calling for reforms to TYM (KFT2.1), they are open to change and optimistic about the future of TYM. However, they require the DES to explicitly prescribe a list of topics for inclusion in TYM, with each topic having clearly defined parameters detailing precisely what can be covered during TYM, while not interfering with the LCM curriculum. This suggestion would empower schools to select topics suitable to students' interests and needs and may lead to a more equitable outcome for TYM across all schools. One teacher suggested that the list of prescribed topics should follow a similar approach to the modular structure of the Leaving Certificate Applied Mathematics programme[6], including the assessment model of Key Assignments. Based on the analysis of the teacher interviews, and for the purpose of discussion, aspects concerning the level, structure and content choice have been extracted and combined to offer a reimagined TYM programme for discussion. One teacher, Hamilton, suggested that

[6] Leaving Certificate Applied Mathematics Programme: https://www.curriculumonline.ie/Senior-Cycle/LCA/Mathematical-Applications/

schools should offer a three-tiered approach to mathematics modules during TY: Basic Mathematics (Level 1), Mathematically Interested (Level 2) and Mathematically Able (Level 3). This grading system based on differing levels of difficulty would empower students to select modules based on their interests and abilities. By offering choices to students, this model may be deemed to be inclusive of the student voice within TYM (KFT3.2). Also, this proposed model supports the students' preference for mixed-ability class structure by specifically letting students select different modules based on varying levels of challenge. Furthermore, Moran et al. (2013) recommend the use of mixed-ability class formation during TYM, once teachers receive more training on mixed-ability training methods.

Figure 6.4 illustrates a sample of the proposed reimagined National Curriculum for TYM, developed by the researcher based on the analysis of the data. La Place suggested that if teachers received a list of approved topics from the Department of Education, in consultation with their school and students, they could select the topics relevant to their context. This DES would group mathematical topics from this list, and publish a *Combination Table* from which schools would select suitable modules for inclusion in their TYM programme. This approach, as favoured by teachers (KFT1.2), would ensure more significant order and equity for schools, as teachers select from the same national Combination Table. Based on the suggestion from Erdös in section 5.5.1.2, this proposal contains a group project called the "Life Project". The project is structured to promote the mathematics applications that students will experience in life, such as buying a car, planning a holiday and pensions. This project also aligns with the mathematical objective of Productive Disposition. Lastly, this proposal still protects domestication as teachers can include modules (such as game theory, computational thinking, and cryptography) highlighting teacher autonomy to construct modules based on their mathematical interests.

This proposed model encompasses a foundation of algebra for all students, as suggested by Turing, and the importance of which is recognised by students. The rationale for this selection is due to the critical importance of algebra for LCM. The proposed model is constructed by three rotations, where students select a module and rotate every term, with an assessment during each module.

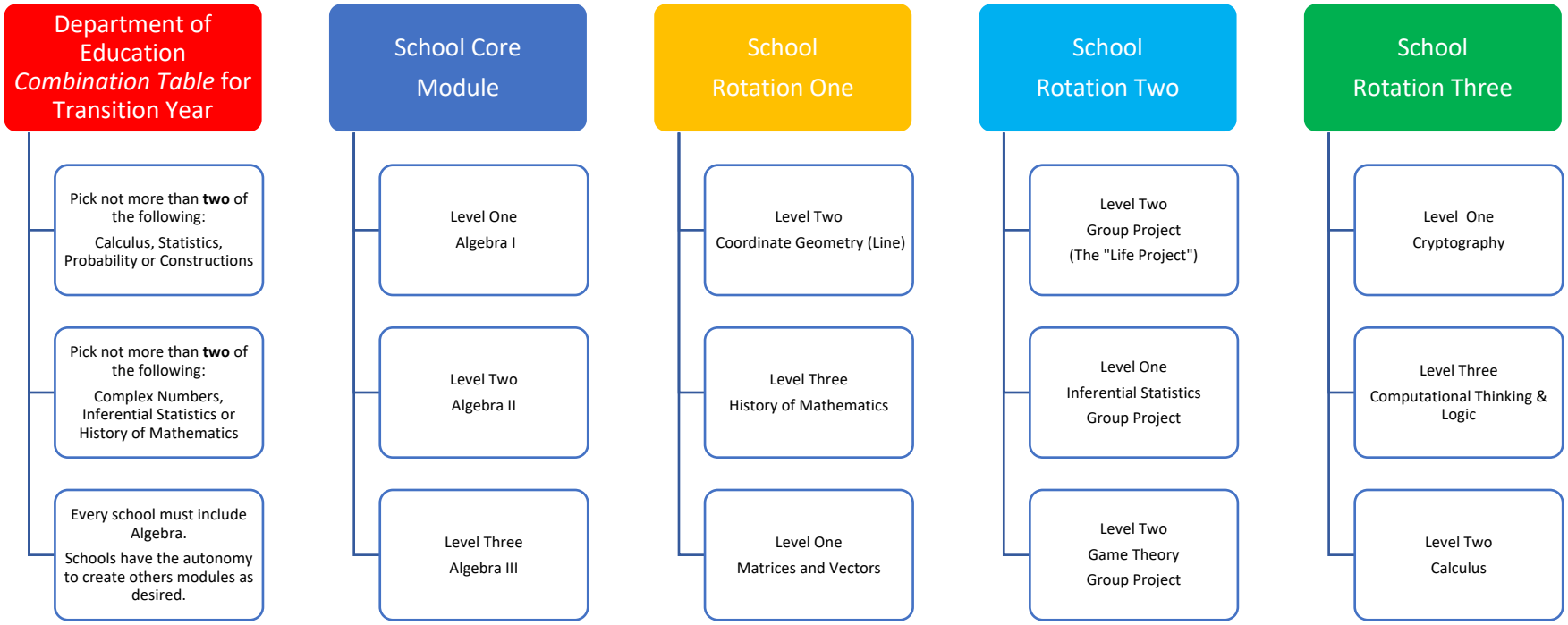


Figure 6.4: Sample of a Proposed National Curriculum for Transition Year Mathematics.

6.4.2 The Teacher

6.4.2.1 Professional Development

Teachers believe there is a dearth of Continuous Professional Development courses relating to TYM (KFT2.2). This unique programme has been overshadowed by the reforms to both the JC and LC, rendering TYM the "*forgotten middle child*" of mathematics education in Ireland. This lack of support and development is blighting teachers' experiences. The analysis and findings illustrated that mathematics teachers are unaware of the five mathematical objectives described in the JC Mathematics Specification and the LCM curriculum (Department of Education and Skills, 2015, 2017). If teachers are unaware of these objectives, it suggests that they may not give their development adequate consideration within their teaching. However, these objectives underpin the programme assessment for the LC curriculum, which specifically states that "assessment for certification will be based on the aim, objectives and learning outcomes of the syllabus" (Department of Education and Skills, 2015, p. 44). Furthermore, it is again interesting to note that the 'Mathematics in Transition Year: Insights of Teachers from PISA 2012' report by Moran et al. (2013) fails to include any reference to the five mathematical objectives.

The fact that teachers are unfamiliar with these objectives may highlight that the professional courses they have received to date may not be structured on the objectives, nor do they assist teachers in planning classes. An audit of the published Project Maths Workshops, Seminars, and Courses, conducted by the researcher, from 2008-2015 [7] supports this point. Each of these resources, used as part of teacher CPD, focused on activities and the learning of the content, rather than an explicit focus on the mathematical objectives and how teachers may include these within their lessons. The analysis also

[7]All supporting resources are located at: https://www.projectmaths.ie/for-teachers/events/workshop-resources/

illustrated that teachers need to be more familiar with the key curricular skills and how to include them in their planning. The audit of Project Maths supporting material also noted the absence of reference to explicit teaching of the key skills, and how they might be integrated into teaching and learning, as part of these suggested resources. Although group activities are provided for teachers, these resources fail to instruct on how to include the key skills required for group work. From the analysis, it may be extrapolated that until there is a shift in professional development for mathematics teachers, centring on the inclusion of the mathematical objectives and the key curricular skills, then the lack of inclusion of these elements in mathematics classrooms across Ireland may continue.

KFT2.3 suggested that the subject association for Irish Mathematics Teachers, the IMTA, might be in the best position to support teachers in developing suitable material for TYM, to provide professional development courses, and to instil confidence in teachers in their ability to be creative in TYM.

6.4.2.2 Teacher Self-Efficacy

Teachers must feel confident and supported in their approach to TYM, for rich and diverse topics to feature during this unique year. A teacher's perceived lack of self-efficacy will likely result in the teacher reverting to covering other mathematics material that they are familiar with, and it will result in students missing out on the potential richness and diversity of TYM (Jeffers, 2008). In general, it seems that this perceived lack of self-efficacy may stem from frustrations with the government's lack of guidance and support for teachers, combined with unmotivated students viewing TY as a "doss year". This may result in teachers choosing the path of least resistance. This "efficacy-deficiency" leads to a course of action, where mathematics teachers begin the prescribed LC curriculum during TYM. The analysis highlighted that participants had higher confidence and self-efficacy in teaching the prescribed LCM course, rather than trying to compose an alternative and

domesticated mathematics course for TY. Furthermore, all 13 teachers reported utilising TYM to give their students an advantage for LC. While this advanced preparation is unfair to students who do not participate in the optional TYP, all participating teachers reported covering parts of the LC curriculum during TYM.

The analysis revealed two main reasons for this coverage of the LCM curriculum during TYM. Firstly, it is because teachers are motivated by the exam-driven system of the LC (O'Leary & Scully, 2018). Participants indicated they wanted to best prepare students for the intense LCM course. This is central to the LCHL Bonus Points Initiative (BPI) and its impact on entrance to third-level institutions (O'Meara et al., 2020; Treacy, 2018). Secondly, teachers commenced the LCM curriculum during TY as they are familiar with and confident in planning and developing this material. In addition, numerous supports exist for LCM, such as professional development, published resources and a curriculum. This is in comparison to the limited supports for TYM. This focus on LCM was referenced 48 times in the interview transcripts, demonstrating that the LC remains the core objective for teachers in preparing students in our schools throughout Ireland.

6.4.2.3 Teacher Professionalism: Resisting Temptation and Reducing Inequality

Oscar Wilde once said, 'I can resist anything, except temptation'. This quote is accurate for many mathematics teachers in Ireland as they utilise TY to maximise students' exposure to LCM. This leads to forming a three-year LCM course instead of a prescribed two-year course. Eleven teachers treated TYM as an opportunity for an early start to LCM. In comparison, only two teachers followed the prescribed two-year guidelines for LC, opting for a different experience for their TY students. When these two teaching approaches are juxtaposed, an inequality issue arises. Teachers need to be cognisant of managing their efficacy around the uncertainty of TYM while being mindful that teachers want their

students to get a head start for LC to achieve the best grades. Unfortunately, teachers view TYM as a way of achieving this, which is against the spirit and philosophy of TY.

The analysis of the teacher interviews revealed that due to the lack of identity, monitoring and external control of the TYM programme, there are inequalities for students depending on the fee status of their school (KFT1.3). Two teachers in fee-charging schools reported the pressures placed on them from their school management, and parents alike, to ensure that their students were receiving the best possible preparations for LCM, starting in TYM. This issue was also compounded in one of the fee-charging schools, as students were not allowed to study mathematics at LC foundation level. Similarly, one of the teachers in a DEIS school reported starting the LCM content in TYM, as a means of best preparing their students for the demands of LCM. Moran et al. (2013) acknowledged that different school types utilise TY as an opportunity to impact the academic opportunities of their students. The lack of parameters in TYM results in inequalities between schools and the LCM curriculum. Although the teachers have the best of intentions, they must ensure that they abide by the guidelines for the TYM programme to ensure a level ground for all schools and all students.

6.5 Conclusion

This discussion chapter addressed each of the three research questions of the research study. Initially, defining mathematical preparedness in the context of Transition Year Mathematics. This offered definition and illustration show the interconnectedness of the Four Quadrants of Mathematics Preparedness (Academic, Social, Emotional, and Skills-Based). It is the combined product of the literature, with the key findings from the DSPOP, the student questionnaire, and the teacher interviews. This definition is offered as a tool for teachers to consider and consult when mathematically preparing students.

The second part of this discussion chapter reviewed the students' experiences of TYM. It revealed and highlighted the differences between Transition Year and Leaving Certificate students in each of the four quadrants of mathematical preparedness. Overall, it is hoped that these insights will be beneficial to teachers and policymakers.

Lastly, section 6.4 presented a discussion of the key issues that teachers face in mathematically preparing students in Transition Year Mathematics. Section 6.5 offers support and guidance to teachers in tackling some of these key barriers. Teachers described several barriers when mathematically preparing students, including the lack of a clear identity and vision for TYM, the absence of suitable professional development in teaching TYM, and a perceived deficiency in teachers' efficacy. However, the teacher participants did complement the use of the Four Quadrants of Mathematical Preparedness as a tool to assist them in the mathematical preparations of students. Based on the suggestions of the teacher participants, the researcher offered a sample proposal for a national curriculum for TYM (see Figure 6.4). This proposal encompasses a Department of Education populated combination table for teachers to choose several topics to teach in their domesticated programmes. This modular approach also suggests the ranking of TY modules into different levels to support all learners.

It is clear from this discussion that, for teachers of TYM to best prepare students, they must be better supported by the Department of Education. This department and its agencies must publish updated guidelines for teachers, offer relevant support in terms of CPD and encourage the development of teacher-designed modules. If these needs are not addressed, TYM will continue to be regarded and utilised as an additional year, a top-up for the LCM programme, which goes against Richard Burke's vision of TY as a year away from the academic treadmill.

While the aim of TY is not exclusively to prepare students for LC, the guidelines draw inference to the fact that "pupils entering the LC programme on completion of a TY should be better equipped and more disposed to study than their counterparts who did not have the benefits of this year" (Department of Education and Skills, 1994, p. 3). Despite the TY guidelines stating that schools are responsible for setting appropriate goals and objectives for TY, 44% of the student sample responded that TYM was not beneficial to them. As reported from the student perspective and interpreted by the researcher, this worrying statistic highlights the need for urgent reforms in TYM at both the local and national levels. TY should act as a springboard to further prepare students for LCM, and this year must not hinder a student's mathematics education.

Chapter Seven: Conclusion

7.1 Introduction to Chapter

This research study aimed to explore the concept of mathematical preparedness, particularly emphasising the unique role that TY plays in mathematically preparing students. The research study aimed to address three main research questions:

1. What does it mean to be mathematically prepared, in the context of Transition Year Mathematics?
2. How do students' experiences of Transition Year, from three sample schools, reflect this definition of mathematical preparedness?
3. What key issues must be considered to mathematically prepare students during Transition Year?

In addressing these research questions, this study centred on connecting the voices of many stakeholders from mathematics education to develop a definition of mathematical preparedness. The Delphi Study Panel of Participants provided various experiences and perspectives on this phenomenon. However, combining these opinions, with the literature, revealed that there is more to mathematical preparedness than the academic component. This co-created definition of mathematical preparedness consists of four overlapping quadrants: Academic, Social, Emotional, and Skills-Based. Based on this definition of mathematical preparedness, the student questionnaire captured students' experiences of TYM in relation to this definition. Lastly, this research study gathered perspectives from mathematics teachers on the key issues to be considered when mathematically preparing students during TY. This one-of-a-kind programme was selected because it is a "blank slate" for teachers to develop their domesticated course of study for students. TY offers time for teachers to better prepare students for the challenges of mathematics to come. Furthermore, as the researcher has spent many years questioning the best approach to TYM,

it was hoped that this research would offer suggestions to teachers and the wider mathematics education community in Ireland.

This chapter will present some of the limitations of this research study and summarise the main findings before offering recommendations for policy and practice. Finally, this chapter will propose an overview of further research into mathematical preparedness and TY, and a personal reflection on the researcher's experience with this research.

7.2 Limitations to the Study

As the research study spanned four years, from November 2019 – November 2023, it is fair to acknowledge the detrimental role the global pandemic placed on this research and the researcher. The COVID-19 virus and its multiple strains altered the course of the research on more than one occasion. Multiple school closures, the move to online teaching and learning, and the fear of conducting research in the direct aftermath of the pandemic, all placed vast numbers of additional challenges and limitations on this research. However, it is essential to take the good with the bad. The kindness, generosity, resilience and adaptability of Ireland's students and teachers testify to the strength and determination of Ireland's education community. As a result of the global pandemic, this study was small-scale, with the researcher's school featured as the leading school for data collection. This was mainly due to inter-school access issues during the pandemic. Of course, as a teacher in the school, my position as an 'insider' may have influenced the lens through which the students completed the questionnaire. To combat this effect, the administration of the student questionnaire in the researcher's school was supervised by a non-mathematics colleague. Nonetheless, these results cannot be generalised. Also, while it was desired to host the Delphi Study discussion and the teacher interviews in person, due to the health risks associated with face-to-face settings, it was decided to host all activities online to ensure the health and safety of both the researcher and the participants.

7.3 Major Findings

Based on the data analysis and findings from the Delphi Study and the Student Questionnaire (Chapter Four), along with the data analysis and findings from the Teacher Interviews (Chapter Five) and the discussion of all findings (Chapter Six), the following are identified as major findings for this research study:

- Mathematical preparedness refers to more than academic knowledge. Students need to be prepared in academic and non-academic elements. The resulting product of this research study offers the following definition for mathematical preparedness: *Mathematical Preparedness combines academic, social, emotional, and skills-based factors into a series of four interconnecting quadrants. These four quadrants merge the mathematical objectives of Strategic Competence, Adaptive Reasoning, Conceptual Understanding, and Procedural Fluency, with the social and emotional learning elements of mathematical resilience, self-confidence, wellbeing, attitudes and motivation. These elements are developed, practiced and applied in conjunction with the key skills of Information Processing, Critical and Creative Thinking, Communication, and Being Personally Effective. At its core, Mathematical Preparedness centres on working with others, to build, nurture, and develop relationships while learning mathematics through a productive disposition lens.*
- This definition of mathematical preparedness is based on Four Quadrants of Academic, Social, Emotional and Skills-Based Preparedness (Figure 7.1). The student and teacher data also confirmed this co-created definition of mathematical preparedness.
- At the centre of mathematical preparedness, there are three identifiable elements. The importance of relationships and working with others was apparent from the

data analysis of this study. This study recommends a "connections before curriculum" approach to the teaching and learning of mathematics. Students highly value these relationships with their teachers and their classmates. Additionally, the mathematical objective of Productive Disposition emerged as the most critical objective, and it is suggested that teachers should always aim to establish productive disposition before and while teaching the curriculum.

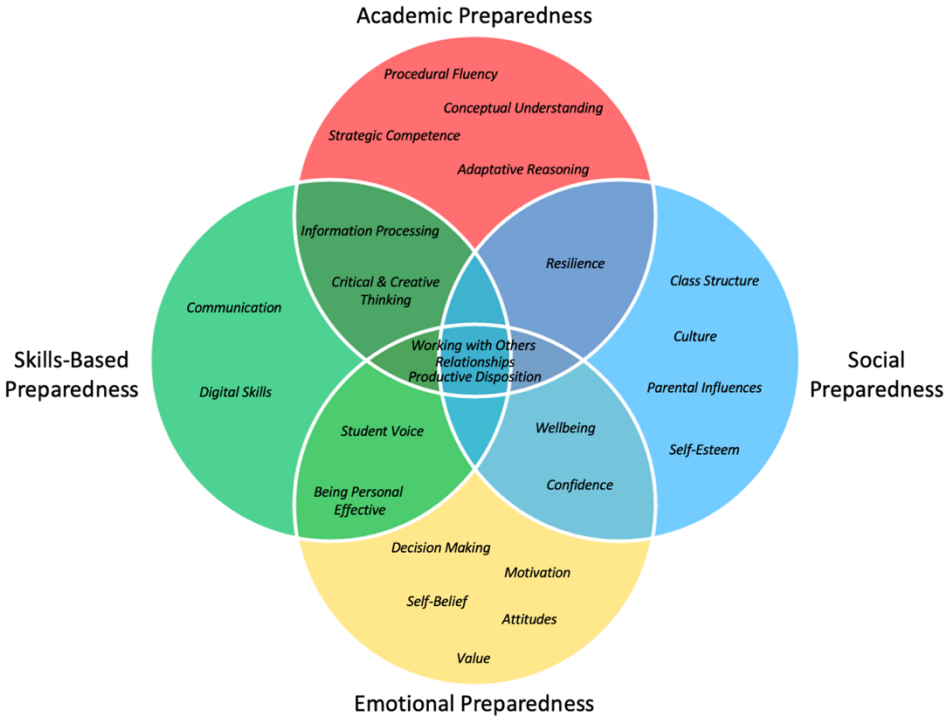


Figure 7.1: Four Quadrants of Mathematical Preparedness.

- Each quadrant is not rigid but flexible, meaning that teachers can focus on one quadrant for longer than another. Hence catering for all the needs of their students.
- The Four Quadrants model of Mathematical Preparedness offers teachers a tool to consider when planning and preparing mathematics classes for TY and LCM.
- The findings suggest that TY students may have had a different and more positive experience of TYM at the time, than in retrospect, during the final two years of the Senior Cycle. It is hypothesised that TY students may have an unrealistic sense of

the chasm between the Junior Cycle and LCM. Hence, teachers should utilise TYM to bridge this gap.

- Teachers need to be better supported to understand the identity of TYM. A lack of clarity in this regard can result in teachers not supporting the spirit of TYM but instead solely focusing on teaching the LCM topics during TYM.
- This research study offers a revision to the work of Kilpatrick et al. (2001), suggesting that Conceptual Understanding, Adaptive Reasoning, Procedural Fluency and Strategic Competence should emerge from Productive Disposition (Figure 6.2).

7.4 Recommendations

This research study has identified several recommendations for teachers, schools, and policymakers. The following two sections will present these recommendations, at a local and national level.

7.4.1 Recommendations at a local level

- Teachers must ensure that they familiarise themselves with the mathematical objectives of the JC and the LCM curriculum. There is an expectation from the JC and LCM curriculum that students will be assessed on these five shared objectives (Department of Education and Skills, 2015). Hence, in preparing students for the JC and LC, teachers should ensure that students are familiar with these objectives. This focus on the mathematical objectives should improve students' understanding of the relevance of the topic, their fluency with procedures, their understanding of concepts, and their ability to apply logic when problem-solving.

- The findings emphasise the importance of including the student voice in the TYM course. Teachers should engage with students to understand where they are mathematically before developing the mathematics course for TY.
- Students have emphasised the importance of mixed-ability teaching groups at TY level. However, teachers have favoured clearly defined levels for TYM. The multiple-level approach to TYM, as discussed in Section 6.4.1.4, may offer a compromise for both parties. This approach may best support learners and should be considered by classroom teachers and school management. Alternatively, more support should be provided for teachers to effectively design and manage mixed-ability classes. Approaches such as Universal Design for Learning (UDL) may be worth considering.
- Teachers should embed and foster a culture of success in TYM. This culture should seek to support all learners by structuring learning opportunities that lead to "eureka" moments. Teachers have the freedom to ensure that students develop a positive relationship with mathematics during TYM.
- Schools should consider including group work and group projects as a significant part of the TYM programme. Students emphasised that they favoured a group approach to learning mathematics. Hence, teachers should consider including Cooperative Learning in classes (Razzouk & Johnson, 2012). Cooperative Learning may help teachers formalise structured group work and link the Key Curricular Skills into the mathematics classroom.

7.4.2 Recommendations for Policy and Practice

- The Department of Education should consider reviewing the impact of the five mathematical objectives and the key skills, with a particular focus on how these are implemented in mathematics classrooms. Such a review may provide interesting

feedback for policymakers. As part of this review, the Department of Education should consider a re-alignment of the five mathematical objectives (Figure 6.2), that places productive disposition at its core. This approach may support learners to have a "habitual inclination" regarding the content for learning, before experiencing the other four objectives.

- Teachers have identified the need for Continuous Professional Development for the non-academic elements of mathematical preparedness. These courses should focus on integrating the key skills and the mathematical objectives in the planning and preparation of TYM.
- Students and teachers have both suggested that TYM needs more structure and clarity. The NCCA and the DES should consider the Proposed National Curriculum for TYM (Figure 6.4), in parallel to the proposed TY reforms. This proposal includes all suggestions from mathematics teachers and students.
- The DES and the NCCA should consider using a Delphi Study approach for future research into mathematics education, as this technique captures the voices of all stakeholders in dealing with complex problems.

7.4.3 Recommendations for Teachers to Better Prepare Students

In addressing some of the barriers teachers experience in mathematically preparing students, the researcher offers the following advice and strategies from the literature. The issues for teachers are well documented, with many strategies presented in the literature for improving students' attitudes and values towards mathematics, developing mathematical wellbeing, nurturing self-confidence, and including the key skills within the mathematics classroom.

Attitudes and Values (Emotional Preparedness)

For teachers to prepare students with a positive attitude toward mathematical learning, Hwang and Son (2021) offer the following advice:

- Teachers should consider preparing interesting mathematical tasks that engage and interest their students.
- School management may provide additional resources and professional development to assist teachers with instructional strategies.
- Parents, in conjunction with teachers, may offer feedback and support to students in acquiring mathematical knowledge.
- Teachers should consider adjusting the complexity of mathematical tasks to ensure that they are appropriate for each student.
- Teachers and parents should highlight the critical role that mathematics plays in a student's present and future life.

Suan (2014) reminds teachers that they can revolutionise students' attitudes towards mathematics through discussions, real-life applications and by integrating the importance of mathematics in their teaching and learning approaches. However, teachers must avoid surrendering to students' negative attitudes, and instead, they should constantly strive to improve students' attitudes. Zan and Di Martino (2007) call for teachers to remain open to changing students' attitudes towards mathematics. Transition Year Mathematics may act as a catalyst for change in students' attitudes towards mathematics, as it provides the time and space for students to develop.

Mathematical Wellbeing (Social and Emotional Preparedness)

In preparing students for the social and emotional aspects of mathematics learning, teachers may consider applying strategies from Wellbeing Theory to help students to flourish (Huppert & So, 2013), such as:

- The PERMA five wellbeing dimensions is an acronym for Positive Emotion, Engagement, Positive Relationships, Meaning, and Accomplishment (Seligman, 2011). This approach may support teachers to select meaningful topics for teaching, provide opportunities for success, and foster a sense of belonging.
- The EPOCH measure of adolescent wellbeing is an acronym for Engagement, Perseverance, Optimism, Connectedness, and Happiness (Kern et al., 2016). This approach may assist teachers in selecting interesting and challenging topics, that encourage perseverance.

Self-Confidence (Social and Emotional Preparedness)

To prepare students to increase their self-confidence in mathematics, Nuttall et al. (2001) suggest that teachers should select activities that involve students interacting with other people, confronting challenges, and making decisions. Problem-based learning is offered as one such approach that may increase a student's self-confidence (Jonassen, 2011; Nila Farida et al., 2020). This approach requires students to work with a contextualised problem, to define and organise learning tasks, to seek explanations and solutions, and to analyse and evaluate the process and outcome. Additionally, Chin et al. (2010) claim that the utilisation of Cooperative Learning in the mathematics classroom results in higher levels of student self-confidence. This may be because Cooperative Learning requires students to be active participants in their learning and promotes the values of honesty, cooperation, mutual respect, responsibility, and tolerance.

Inclusion of the Key Curricular Skills (Skills-Based Preparedness)

In teaching the 21st century skills in the classroom, Saavedra and Opfer (2012) offer nine lessons from the Science of Learning to support teachers in their planning and preparation:

- Make it relevant.
- Teach through the disciplines.

- Simultaneously develop lower and higher-order thinking skills.
- Encourage the transfer of learning.
- Teach students to learn to learn.
- Address misunderstandings directly.
- Teamwork is an outcome and promotes learning.
- Exploit technology to support learning.
- Foster students' creativity.

7.5 Further Research

This research occurred at a timely juncture with the Minister for Education, Norma Foley, announcing changes to the Transition Year Programme and the Leaving Certificate Programme in the coming years (Department of Education, 2022a; National Council for Curriculum and Assessment, 2023). The new TY guidelines will probably provide teachers with broad objectives, rather than subject-specific guidance. However, further research could be explored on the publication of subject-specific guidelines and support for teachers of TYM on how best to prepare students for mathematics.

As this research study offers an approach for mathematically preparing students, further research may help develop and finetune the four quadrants.

7.6 Personal Conclusion and Reflection

On reflection, the planning, conducting and reporting on this research study has been challenging yet rewarding. This study has rekindled my passion for and rejuvenated my interest in mathematics education and learning. It has taken me out of my comfort zone and challenged me to view mathematical preparedness from the perspectives of many stakeholders. At times, this experience has been challenging. This was especially the case

due to the global pandemic's impact on my doctoral experience and research study. However, these challenges have fortified my resilience and determination.

The process has empowered me to explore teaching and learning through a new lens. Unfortunately, this can sometimes be overlooked in school leadership, with the enormity of administration tasks. However, being an insider researcher has given me an insight into my school and the broader teaching of mathematics in other schools and contexts.

7.7 Closing Insights

"Begin Again, Begin Better"

This quote, adapted from the poem 'Begin' by Brendan Kennelly, reminds all teachers to continuously adapt, develop and strive for excellence in their craft. Mathematically preparing students is not a destination, but a continuous process. In the words of Kennelly, "something that will not acknowledge conclusion, insists that we forever begin". To the mathematics teachers of Ireland, I hope when you next read the famous quote by Benjamin Franklin, "By failing to prepare, you are preparing to fail", that you now have a better understanding of how to mathematically prepare your students, in your Transition Year Mathematics programme.

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Appendix Items:

A	Letter to experts inviting them to participate in the Delphi Study
B	An extraction from the Qualtrics XM Platform, where the Panel of Participants completed their review of the student questionnaire
C	Confirmation of Ethical Approval from the Research Ethics Committee in the School of Education, Trinity College Dublin
D	Copy of the Student Questionnaire
E	Interview Schedule Template
F	Ethics Consent Form for Teacher Interviews
G	Tables G1-G10 Delphi Study Discussion Findings

Appendix A: Letter sent to experts inviting them to participate in the Delphi Study

Trinity College Dublin
Coláiste na Tríonóide, Baile Átha Cliath
The University of Dublin

'Please don't forget me!' Transition Year Mathematics: The Forgotten Middle Child?
Information Leaflet

Dear XXXXX,

My name is Derek Maher and I am currently a Third Year Doctorate in Education candidate in the School of Education, Trinity College Dublin, supervised by Dr. Aibhín Bray. I would love for you to participate in my research by participating in an online Delphi Study on the topic of preparedness and mathematics. Below is an overview of my research, what I hope you achieve from this Delphi study and what would be required from you.

A Delphi study is defined as *'a method for structuring a group communication process so that the process is effective in allowing a group of individuals, as a whole, to deal with a complex problem'* (Okoli & Pawlowski, 2004). In this case, the complex problem or purpose of this group communication is to: **Identify what it means to be prepared (or well-prepared) for Leaving Certificate Mathematics, starting at Transition Year level.** It is hoped that the results of this Delphi study will inform my design and planning of questions for the student focus group, and also for the student questionnaires and teacher interviews.

My research interests centre on educational preparedness, and curriculum studies for alternative programmes. I am currently researching the area of Transition Year Mathematics, with a provisional thesis title of: **'Please don't forget me!' Transition Year Mathematics: The Forgotten Middle Child?**

My research aims to establish the potential beneficial nature of Transition Year Mathematics as a bridging curriculum between the Junior Cycle and Leaving Certificate courses. Transition Year typically sees over 45,000 registered students annually and each school has a 'domesticated' (unique to each school) programme. This means that teachers have the freedom to interpret, plan and design their own curriculum for this year, while also preparing their students for the Leaving Certificate. My research aims to answer two main research questions:

1. What does it mean to be well-prepared for Leaving Certificate Mathematics?

2. Can a Transition Year Mathematics curriculum be developed to best prepare students for Leaving Certificate Mathematics?

The terms 'prepare', 'prepared' and 'preparation' are frequently utilised by Ireland's Department of Education in their educational planning and policies, however as teachers

of Mathematics, the question occurs of what does it mean to prepare, or how to best prepare our students, for Leaving Certificate Mathematics?

While there doesn't seem to be a single universal definition of preparedness, several reports and articles refer to this term:

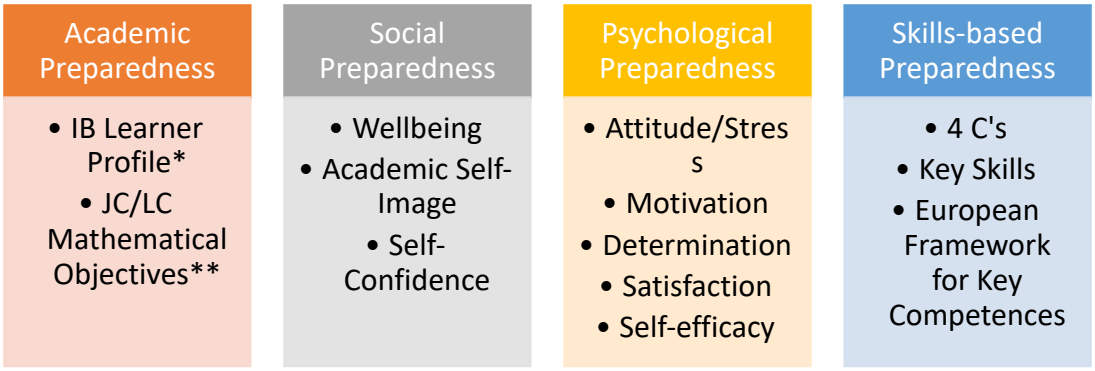
Responding to the Current Debate (NCCA, 2012) utilised the word 'prepare' in the following sense: '*There are always tensions between those who believe the new mathematics syllabus should prepare students for their further study in mathematics and mathematical related disciplines, and those who believe it should prepare students to participate fully in modern society' (p.5)*

Alternatively, **'An evaluation of the impact of Project Maths on the Performance of Students in Junior Cycle' (Shiel & Kelleher, 2017)** focuses on the word 'prepare' in connection to preparing students for examinations, preparing students for the depth and breadth of third-level mathematics courses, and the impact of PISA which aims to '*measure how well students are prepared to meet the challenges they may encounter in their future lives'* (p.41). Furthermore, this report highlights 'students' preparedness for Leaving Certificate mathematics' as one of aspects of the curriculum which are considered problematic (p.124). This study stated that '*participants felt that the Junior Cycle curriculum does not prepare students for the higher-order thinking and mathematical literacy that is required at Leaving Certificate higher and ordinary levels. As a result, participants reported using Transition year to 'bridge the gap' between the Junior Certificate and the Leaving Certificate'* (p.150).

Lastly, in **Choices and Challenges: Moving from Junior Cycle to Senior Cycle Education (Smyth & Calvert, 2011, p.36)** stated that the Transition Year programme '*is intended to encourage a variety of non-academic skills and competences, with a focus on personal and social skills, and self-disciplined/self-directed learning which acts to prepare students for adult life'*. However, the question still exists of how to best prepare students.

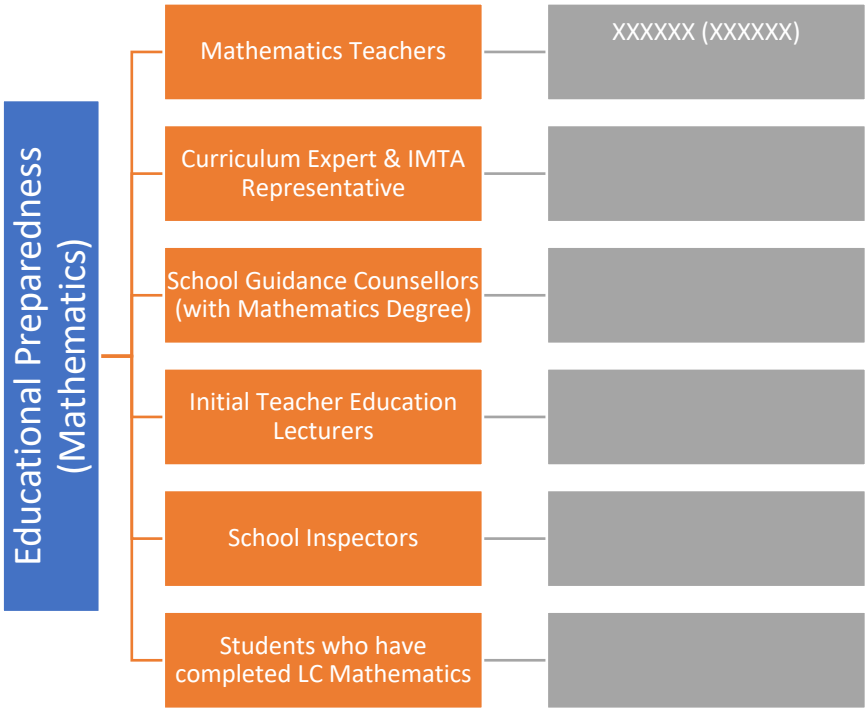
As a practitioner in the field of Mathematics Education, Mathematics Teaching, Career Guidance and Mathematics, Mathematics Initial Teacher Education and Mathematics Curriculum Policy, I am inviting you to be part of a small 'Delphi' study to assist me in my research to examine how best to prepare students for Leaving Certificate mathematics from Transition Year onwards. This Delphi Study will be conducted via the online platform of Zoom at a prearranged time and date.

Initially, I am aiming to examine 'educational preparedness' under four broad categories:



*Inquirers, Knowledgeable, Thinkers, Communicators, Principled, Open-Minded, Caring, Risk-Takers, Balanced and Reflective

**Conceptual understanding, procedural fluency, strategic competence, adaptative reasoning and Productive Disposition.



I would like to get your consent for you to participate in the following elements of this research study:

- Participate in a one-hour Delphi Study

Participating in this research is voluntary. No personal data will be recorded, apart from your name, which will be anonymised. You may change your mind and stop at any time during the Delphi Study or up to a period of seven days after the Delphi Study. After this point, the transcribing will be anonymised, and you cannot withdraw. Please note that this Zoom will be recorded and transcribed. Then it will be deleted.

You may also choose to not answer a question for any reason during the interview, and you may withdraw from the interview at any time without penalty.

No personal information will be collected and all information that is collected will be stored securely in accordance with the General Data Protection Regulations (GDPR) at Trinity College, Dublin. There may be lectures, DEd theses, conference presentations, posters and peer-reviewed journal articles written as a result of this project, however no participants will be identified. Data collected with respect to this study will retained in accordance with GDPR and the Trinity College Dublin's School of Education guidelines.

If you have any questions in relation to this study, please contact the researcher Derek Maher (maherdd@tcd.ie) or the research supervisor Dr. Aibhín Bray (brayai@tcd.ie). Furthermore, If you have any concerns in relation to GDPR, you can contact the researcher Derek Maher (maherdd@tcd.ie), the research supervisor Dr. Aibhín Bray (brayai@tcd.ie) or the Data Protection Officer in Trinity College Dublin (dataprotection@tcd.ie or Data Protection Officer, Secretary's Office, Trinity College Dublin, Dublin 2, Ireland).

Regards,

Derek Maher

D.Ed Candidate, School of Education, Trinity College Dublin.

Please check each of the following if you agree with the statement and if you consent to participate in this study:

There are 7 parts to this consent page. To proceed to the data collection stage, you need to indicate your agreement with each statement by checking the associated box, by placing your initials in each of the boxes below. Thank you for participating.	
General	**Tick box**
I confirm I have read and understood the above **Information Leaflet** for the above study. The information has been fully explained to me and I have been able to ask questions, all of which have been answered to my satisfaction.	
I understand that this study **is entirely voluntary,** and that **I do not have to take part**.	
I know how to contact the research team if I need to.	
I understand that no personal information about me will be collected in this study, apart from my full name which will be anonymised during transcription.	
I understand that **I can stop taking part in this study** at any time without giving a reason, prior to the anonymisation of the data and up to seven days after the data collection	
I agree to take part in this research study having been fully informed of the rationale in the information leaflet that was provided.	

Specific	Tick box
I agree to participate in this Delphi Study. I understand that this will be recorded (including pictures, videos and audio), and that upon transcribing, this video will be deleted.	

Participant's Name (BLOCK CAPITALS): _____

Participant's Signature: _____

Date: _____

Appendix B: An extraction from the Qualtrics XM Platform, where the Panel of Participants completed their review of the student questionnaire

The possible student responses are based on a Likert Scale: Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree.

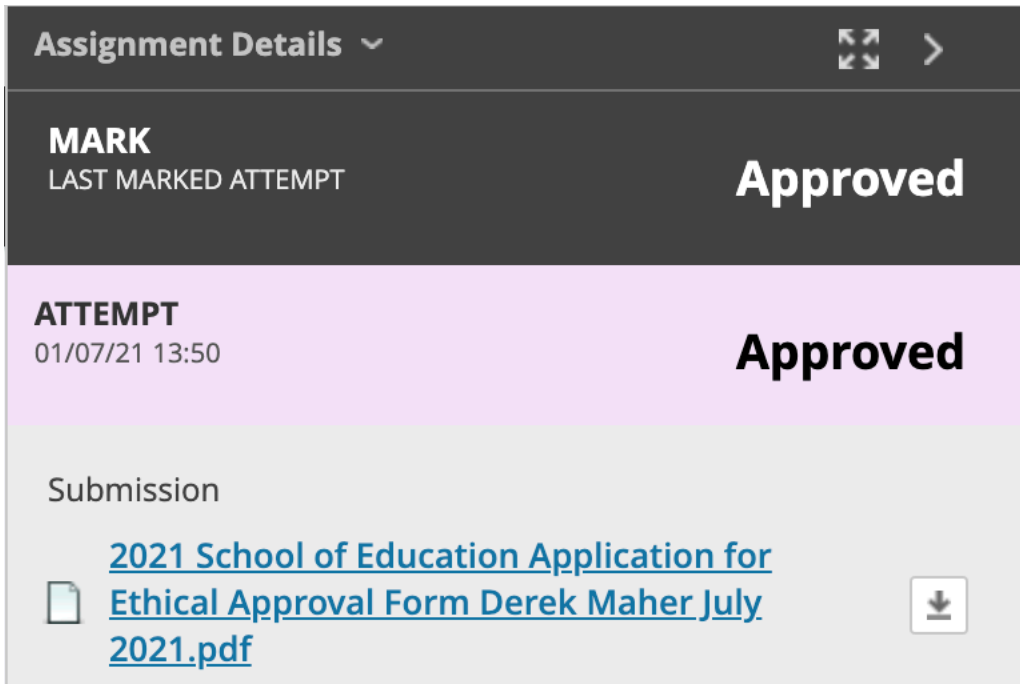
Below are statement 1.1 - 1.9, please review these statements and there appropriateness to include in the final student questionnaire.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly agree
1.1 TY Maths built on the maths I studied at Junior Cert	○	○	○	○	○
1.2 TY Maths helped to increase my academic confidence with this subject	○	○	○	○	○
1.3 TY Maths provided me with more time to examine common mistakes that I make in maths	○	○	○	○	○
1.4 TY Maths really helped me to connect the different areas of maths together	○	○	○	○	○
1.5 TY Maths was very difficult	○	○	○	○	○

Response to statements 1.1 - 1.9

I agree that statements 1.1 - 1.9 reflect the discussion from the Delphi Study on Academic Preparedness and these statements should be included on the student questionnaire	Other (please comment below on specific suggestions or queries, please quote the statement number also)
I disagree that statements 1.1 - 1.9 reflect the discussion from the Delphi Study and these statements should not be included on the student questionnaire	

Appendix C: Confirmation of Ethical Approval from the Research Ethics Committee in the School of Education, Trinity College Dublin.



Appendix D: Copy of the Student Questionnaire

'Please don't forget me!' Transition Year Mathematics: The Forgotten Middle Child?

Background Information to this study:
Mr. Maher is studying for a Doctorate of Education degree in Trinity College Dublin. He is researching what skills and topics are being taught to Transition Year maths students.

Transition Year is a very different programme than the Junior Certificate or Leaving Certificate programme, and he wishes to research if Transition Year can be used to '*bridge the gap*' between both programmes.

Benefits of your participation:
There will be no direct benefits to you as a participant, however I hope that the results of the study will help Transition Year teachers of maths to prepare lessons that will support students between the Junior Certificate and the Leaving Certificate.

Disadvantages of your participation:
There are no disadvantages to the study, apart from the time taken to participate.

Will my answer remain confidential?
Your name will not be collected, so your answers will be anonymous.

Thank you again for your help!

Mr. Maher

* Required

Student Consent



Please read the following information below, before you take the questionnaire.

1

I understand that this study is entirely voluntary, and that I do not have to take part.

I understand that I **can stop taking part in this study** at any time without giving a reason.

I agree to take part in this research study having been fully informed of the rationale in the information leaflet that was provided.

I agree to participate in this student questionnaire based on my opinions of TY maths. *

- ○ I agree
- ○ I disagree

Introductory Questions



2

What is your gender? *

- ○ Female
- ○ Male
- ○ Prefer not to say

3

What year are you currently in? *

- ○ Transition Year
- ○ 5th Year
- ○ 6th Year

4

What age are you? *

- 14
- 15
- 16
- 17
- 18
- 19

5

What does 'being mathematically prepared' mean to you? *

Enter your answer

6

Do you enjoy studying maths? *

- Yes
- No
- Unsure

7

What level of maths did you study for the Junior Certificate/Cycle? *

- Foundation
- Ordinary
- Higher

8

What level of maths do you plan on studying for the Leaving Certificate? *

- ◯ Foundation
- ◯ Ordinary
- ◯ Higher

9

For each of the following statements, please select the response that best represents your view: *

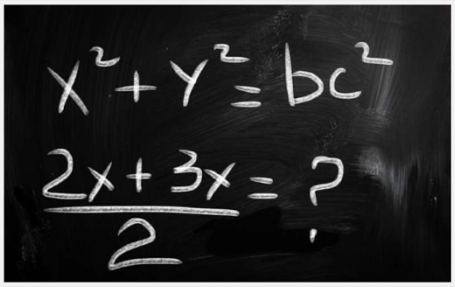
	Strongly Disagree	Disagree	Unsure	Agree	Strongly Agree
Maths is an important subject	◯	◯	◯	◯	◯
I see the value of studying maths	◯	◯	◯	◯	◯
My maths teacher influenced my opinion of this subject	◯	◯	◯	◯	◯
I know how to effectively study maths	◯	◯	◯	◯	◯
I reflect on my teacher's feedback in maths	◯	◯	◯	◯	◯
I liked the different modules of TY maths	◯	◯	◯	◯	◯
TY Maths has helped me in Leaving Certificate maths	◯	◯	◯	◯	◯

My parent's attitude towards maths is negative	○	○	○	○	○
My parent's attitude towards maths influences my attitude to maths	○	○	○	○	○
My parents/guardians are interested in what I am studying in school	○	○	○	○	○

TY Maths should be redeveloped	○	○	○	○	○
The current TY maths content is outdated	○	○	○	○	○
TY helped me to develop an understanding of the 'point' of maths	○	○	○	○	○
TY Maths helped me to apply and transfer skills to a wide range of real-life situations.	○	○	○	○	○
TY Maths helped me to appreciate the applications of maths	○	○	○	○	○

TY Maths helped me to appreciate the contribution of maths to other areas of knowledge	○	○	○	○	○

Topics covered in Transition Year Maths



10

Have you covered the following areas in TY Maths? *

	Covered in TY	Unsure if Covered	Did not cover in TY
Algebra: Factoring expressions	○	○	○
Algebra: Common factors	○	○	○
Algebra: Difference of two squares	○	○	○
Algebra: The perfect square	○	○	○

Algebra: Functions	○	○	○
Algebra: Rationalising Expressions	○	○	○
Algebra: Solving Equations (including simultaneous equations)	○	○	○
Algebra: Exploring inequalities	○	○	○
Algebra: Algebraic identities	○	○	○
Collaborative Project on Functions and Algebra	○	○	○
Trigonometric Ratios (Cos, Sin, Tan)	○	○	○

Application of the simple trigonometric ratios to solving real life experiments	○	○	○
The Unit Circle	○	○	○
Basic geometric shapes	○	○	○

11

Which of the topics below did you cover in TY maths? (You can select multiple answers) *

- [ ] Algebra
- [ ] Trigonometry
- [ ] Coordinate Geometry (Line)
- [ ] Coordinate Geometry (Circle)
- [ ] Probability
- [ ] Geometry
- [ ] Calculus
- [ ] Number Patterns
- [ ] Statistics
- [ ] Complex Numbers
- [ ] Constructions
- [ ] Area and Volume
- [ ] Functions and Graphs
- [ ] Coding
- [ ] History of Mathematics
- [ ] Other

12

What maths topics, that are not named above, would you have liked to study during TY Maths?

Enter your answer

13

For each of the following statements, please select the response that best represents your view: *

	Strongly Disagree	Disagree	Neutral	Agree	Strongly agree
1.1 TY Maths built on the maths I studied at Junior Certificate	○	○	○	○	○
1.2 TY Maths helped to increase my academic confidence with this subject	○	○	○	○	○
1.3 TY Maths provided me with more time to examine the mistakes that I make in maths	○	○	○	○	○
1.4 TY Maths really helped me to connect the different areas of maths together	○	○	○	○	○

1.5 TY Maths was very challenging	○	○	○	○	○
1.6 TY Maths was not beneficial to me	○	○	○	○	○
1.7 TY Maths provides teachers with more time and freedom to explore common student mistakes in maths	○	○	○	○	○
1.8 TY Maths was very interesting	○	○	○	○	○
1.9 TY Maths helped me to practise all the basics skills that I learnt in Junior Certificate	○	○	○	○	○
1.10 TY Maths helped me to reflect on how I learn maths	○	○	○	○	○
1.11 I enjoyed the flexibility of TY Maths	○	○	○	○	○

1.12 I found TY Maths to be useful to my education in general	○	○	○	○	○
1.13 TY Maths should have a full national curriculum like Junior Certificate and Leaving Certificate	○	○	○	○	○
1.14 I wanted to cover only the Leaving Certificate topics during TY Maths	○	○	○	○	○
1.15 TY Maths helped me to develop the skills and attitudes necessary to pursue further studies in maths	○	○	○	○	○
1.16: TY Maths had a suitable number of assessments to evaluate my learning	○	○	○	○	○

1.17: From studying TY Maths, I have a good understanding of mathematical concepts	○	○	○	○	○
1.18: From studying TY Maths, I have developed skills in carrying out procedures accurately and efficiently	○	○	○	○	○

14

For each of the following statements, please select the response that best represents your view:

*

	Strongly Disagree	Disagree	Neutral	Agree	Strongly agree
2.1 TY Maths is a good opportunity to build my self-confidence	○	○	○	○	○
2.2 Group work should be a core element of TY Maths	○	○	○	○	○
2.3 TY Maths classes should be mixed-ability (Higher and Ordinary Level maths students together)	○	○	○	○	○
2.4 During TY Maths, my self-esteem with maths increased	○	○	○	○	○
2.5 TY Maths encouraged me to succeed with maths	○	○	○	○	○

2.6 TY Maths supported me to build positive relationships with my teachers	○	○	○	○	○
2.7 TY Maths made me compare myself to other students in my class	○	○	○	○	○
2.8 TY Maths is 'a chance to start again' with maths	○	○	○	○	○
2.9 TY Maths reinforces the foundations of maths	○	○	○	○	○
2.10 TY Maths improved my social-confidence	○	○	○	○	○
2.11 The TY Maths classroom should not be a competitive environment	○	○	○	○	○
2.12 TY maths taught me that it is OK to make mistakes	○	○	○	○	○

2.13 A group project should be a core element of TY Maths	○	○	○	○	○
2.14 TY Maths allowed me to build positive relationships with my classmates	○	○	○	○	○
2.15 TY Maths gave me an opportunity to think about what I would like to study/work as in the future	○	○	○	○	○
2.16 TY Maths helped me to appreciate that maths is 'universal'	○	○	○	○	○
2.17: I had the opportunity to engage in extra-curricular or co-curricular maths activities during TY	○	○	○	○	○
2.18 TY Maths improved my ability to solve hard maths question	○	○	○	○	○

15

If you can't solve a maths question straight away, what do you do? *

- ◯ Give up
- ◯ Keep trying until you solve it
- ◯ Get help from Teacher or Classmates
- ◯ Use textbook or technology

16

For each of the following statements, please select the response that best represents your view:

	Strongly Disagree	Disagree	Neutral	Agree	Strongly agree
3.1 Being good at algebra really helps me to understand other areas of maths	◯	◯	◯	◯	◯
3.2 When I understand maths concepts, my self-confidence increases	◯	◯	◯	◯	◯
3.3 As TY students, our opinion about what maths we study should be considered	◯	◯	◯	◯	◯
3.4 I love when I have a 'eureka' moment in maths, when I finally understand a concept	◯	◯	◯	◯	◯

3.5 I like it when I have a really challenging problem to solve in maths.	○	○	○	○	○
3.6 TY Maths 'sparked' my interest in this subject	○	○	○	○	○
3.7 TY Maths should encourage students to 'step outside their comfort zone' and build a level of tolerance with difficult problems	○	○	○	○	○
3.8 TY Maths increased my motivation in this subject	○	○	○	○	○
3.9 If I find maths relevant to my real life, I will work harder to understand it	○	○	○	○	○

3.10 TY Maths made me lose my motivation from completing the Junior Certificate Maths	○	○	○	○	○
3.11 I feel comfortable asking the teacher questions during my TY Maths classes	○	○	○	○	○
3.12 I feel comfortable asking my classmates questions during my TY Maths classes	○	○	○	○	○
3.13 I enjoyed the maths teaching and learning during TY	○	○	○	○	○
3.14 The teacher/student relationship is important to my learning	○	○	○	○	○
3.15 TY Maths helped me to appreciate the elegance and power of maths	○	○	○	○	○
3.16 TY Maths allowed me to feel more comfortable when I made mistakes	○	○	○	○	○

17

Q4: For each of the following statements, please select the response that best represents your view:

	Strongly Disagree	Disagree	Neutral	Agree	Strongly agree
4.1 TY Maths required the efficient processing of information	○	○	○	○	○
4.2 In TY Maths there is a strong emphasis on investigation	○	○	○	○	○
4.3 TY Maths encouraged me to solve problems in a variety of ways	○	○	○	○	○
4.4 TY Maths encouraged me to discuss solutions to problems	○	○	○	○	○
4.5 TY Maths encouraged me to work together in groups to generate ideas and problem solve	○	○	○	○	○

4.6 Studying TY Maths empowered me to gain knowledge and skills that will benefit me in other aspects of my everyday live	○	○	○	○	○
4.7 TY Maths is a learning environment in where ideas and innovation are encouraged	○	○	○	○	○
4.8 TY Maths improved my digital learning skills	○	○	○	○	○
4.9 TY Maths improved my independent learning skills	○	○	○	○	○
4.10 TY Maths improved my word problem solving skills	○	○	○	○	○
4.11 TY Maths encouraged me to communicate mathematically	○	○	○	○	○

4.12 TY Maths encouraged me to be creative and critical	○	○	○	○	○
4.13 TY Maths encouraged me to consider and listen to the viewpoints of others.	○	○	○	○	○
4.14 TY Maths helped me to develop the ability to reflect upon my work	○	○	○	○	○
4.15 TY Maths helped me to develop curiosity	○	○	○	○	○
4.16 From studying TY Maths, I have the ability to solve mathematical problems in familiar and unfamiliar contexts	○	○	○	○	○
4.17 From studying TY Maths, I have the capacity for logical thinking	○	○	○	○	○

Appendix E: Interview Schedule Template

Hello, my name is Derek Maher. Thank you for agreeing to take part in this interview. Our aim today is to try to understand mathematically preparedness, particularly in relation to the Transition Year. I want to know this information so that I can get an overview of the teacher's perspective and opinions of Transition Year Mathematics, especially in terms of their preparation, planning, implementing and assessing of this unique year.

It is important you know that what you say here is confidential and your name/personal information will not be passed on to anyone outside of the research group.

In order for this to run smoothly there are some guidelines that we need to stick to:

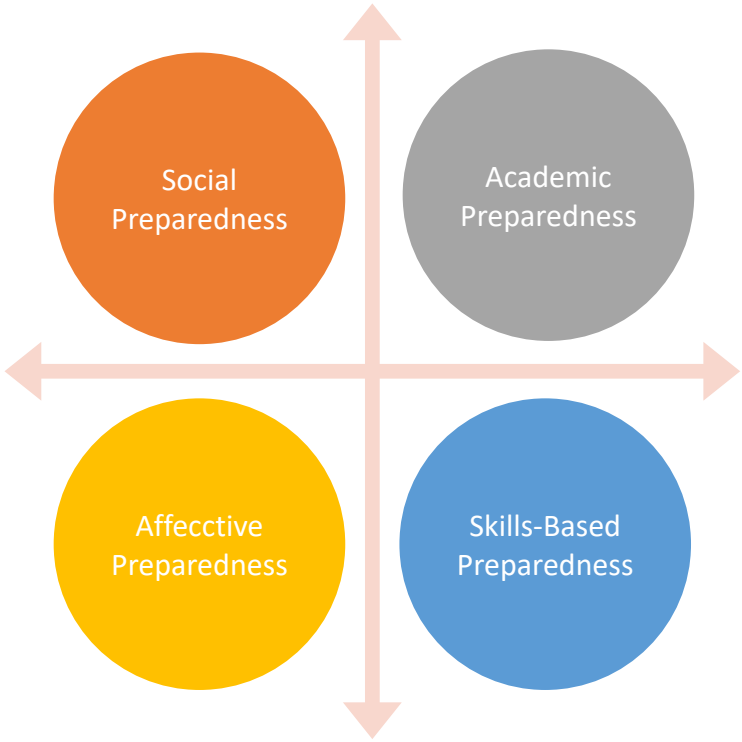
- It is important for everyone to feel comfortable, so I will respect your views and I will try not to interrupt or talk over you.
- There are no right or wrong answers, all of your views are important.
- You probably notice that this session is being recorded. I am recording this session so I do not miss any information. People often say very helpful things in these discussions and I can't write fast enough to get them all down but if for any reason you become uncomfortable and no longer want to be involved, let me know and I will end the session.
- This session will last for about 40 minutes, I will be asking questions and taking notes.
- Have you any questions before we begin?

Main Questions	Additional Questions	Probing Questions
Can you provide a description of your school?	Size/Location/Years Teaching/etc	As needed.
How do you feel about the post-primary mathematics curriculum in Ireland?	Does TY Maths have a place in the continuum of secondary education in Ireland? Does TYM causes a reduction in mathematics motivation between JC and LC? Do you think that there is a disconnection between JC and LC? Do you think that curriculum reform at JC and LC, has overlooked TY?	What do you think about the place of TYM in the over secondary mathematics education? Do you see TYM as being high stakes? How can we connect JCM to LCM, via TYM?

What do you see as the purpose of Transition Year Mathematics?	Do you feel that you have planning flexibility within TYM? What are the main positive/negatives elements of TYM? Do you feel that the goal/aim of TYM is clear and well defined?	How do you feel about the level of structure and content in TYM? *Do you use your specific training in maths to influence your teaching of TYM?*
Would you choose to teach TYM if you could?	Why? Why not? Do you think that TY maths lacks structure and content?	What elements do you agree/disagree with?
What is the rationale for you teaching specific topics during TY Maths?	Do you feel that you have been supported to teach TYM? Does TYM require more or less time and input from you the teacher?	
How do you plan for TY Maths?	Have you struggled to plan for TYM and to understand what to do with TYM students? Has your view of TYM changed over time? Did the implementation of the new Project Maths and Junior Cycle curriculum, change the way in which you approach TY Maths?	Do you have a TY plan? Who inputs into the plan? Do you like the concept of a domesticated plan? Would you let students input onto what they want to learn?
What methodologies do you utilise to teach TYM?	Do you use group work, pair work, etc? How do you assess within TYM?	Do you try and explicitly teach key skills during TYM?
<u>Research questions:</u> **What does it mean to be mathematically prepared?**	As needed.	Is proficiency in the five mathematical objectives important? What are the skills, competencies, & dispositions that enable students to be well-prepared mathematical?

How can TY support mathematical preparedness?		
With the oncoming changes to Senior Cycle in Ireland, what changes would you like to see for TYM?	Would you like to see updated guidelines for teaching TYM or a national suggested curriculum guideline for TYM? (15)	Would you like to see a Delphi Study and Student Questionnaire being used as a tool for change in TYM?

What are your opinions on the below preparedness quadrants for TYM?



Thank you so much for participating today in this research study and for providing such a valuable insight into your work and craft. I will now end the recording.

Appendix F: Ethics Consent Form for Teacher Interviews



Trinity College Dublin
Coláiste na Tríonóide, Baile Átha Cliath
The University of Dublin

Teacher Consent Form – Video Observation & Teacher Interview

Dear Teacher,

I am a Doctorate in Education student in the School of Education, Trinity College Dublin. As part of this programme, I am completing a research study in the area of Transition Year Mathematics. The provisional title of my research study is: **'Please don't forget me!' Transition Year Mathematics: The Forgotten Middle Child?**.

This research aims to establish the potential beneficial nature of Transition Year Mathematics as a bridging curriculum between the Junior Cycle and Leaving Certificate courses. Transition Year typically sees over 40,000 registered students annually and each school has a 'domesticated' (unique to each school) programme. This means that teachers have the freedom to interpret, plan and design their own curriculum for this year. Two main research questions are part of the research study:

1. What does it mean to be well-prepared for Leaving Certificate Mathematics?
2. Can a Transition Year Mathematics curriculum be developed to best prepare students for Leaving Certificate Mathematics?

I would like to get your consent for you to participate in the following elements of this research study:

- Participate in a video observation period (screen recording of your teaching via your school iPad) of 9 to 12 one-hour class periods of Transition Year Mathematics. This means that a video recorder would record audio information from your mathematics classes, as well as all the information that you share on your iPad screen while teaching.
- Participate in a one-hour teacher interview, with questions addressing the designing and planning of classes for Transition Year Mathematics.

Participating in this research is voluntary. No personal data will be recorded, apart from your name, which will be anonymised. You may change your mind and stop at any time during the video observation classes or up to a period of seven days after the final video observation class, and a period of seven days after the Teacher Interview. After this point, the transcribing will be anonymised, and you cannot withdraw.

You may also choose to not answer a question for any reason during the interview, and you may withdraw from the interview at any time without penalty.

No personal information will be collected in this survey and all information that is collected will be stored securely in accordance with the General Data Protection Regulations (GDPR) at Trinity College, Dublin. There may be lectures, D.Ed theses, conference presentations, posters and peer-reviewed journal articles written as a result of this project, however no participants will be identified. Data collected with respect to this study will retained in accordance with GDPR and the Trinity College Dublin's School of Education guidelines.

If you have any questions in relation to this study, please contact the researcher Derek Maher (maherdd@tcd.ie) or the research supervisor Dr. Aibhín Bray (brayai@tcd.ie). Furthermore, If you have any concerns in relation to GDPR, you can contact the researcher Derek Maher (maherdd@tcd.ie), the research supervisor Dr. Aibhín Bray (brayai@tcd.ie) or the Data Protection Officer in Trinity College Dublin (dataprotection@tcd.ie or Data Protection Officer, Secretary's Office, Trinity College Dublin, Dublin 2, Ireland).
Regards,
Derek Maher
D.Ed Candidate, School of Education, Trinity College Dublin.

Please check each of the following if you agree with the statement and if you consent to participate in this study:

There are 8 parts to this consent page. To proceed to the data collection stage, you need to indicate your agreement with each statement by checking the associated box. Thank you for participating.	
General	**Tick box**
I confirm I have read and understood the **Information Leaflet** for the above study. The information has been fully explained to me and I have been able to ask questions, all of which have been answered to my satisfaction.	
I understand that this study **is entirely voluntary,** and that **I do not have to take part**.	
I know how to contact the research team if I need to.	
I understand that no personal information about me will be collected in this study, apart from my full name which will be anonymised during transcription.	
I understand that **I can stop taking part in this study** at any time without giving a reason, prior to the anonymisation of the data and up to seven days after the data collection	
I agree to take part in this research study having been fully informed of the rationale in the information leaflet that was provided.	
Specific	**Tick box**
I agree to participate in the video observations (iPad screen recording) classes. I understand that these lessons will be screen recorded (including pictures, videos and audio) of my Transition Year Mathematics lessons for a period of nine to twelve lessons, as agreed with the researcher.	
I agree to participate in a one-hour teacher interview based on the designing and planning of Transition Year mathematics.	

Teacher Participant's Name (BLOCK CAPITALS): _____

Teacher Participant's Signature: _____

Date: _____



Trinity College Dublin
Coláiste na Tríonóide, Baile Átha Cliath
The University of Dublin

Teacher - Participant Information Leaflet

Dear Teacher,

My name is Derek Maher and I am a Doctorate in Education student in the School of Education, Trinity College Dublin. I am also a former teacher of mathematics at post-primary level in Ireland. As part of this programme, I am completing a research study in the area of Transition Year Mathematics. The provisional title of my research study is: **'Please don't forget me!' Transition Year Mathematics: The Forgotten Middle Child?**.

This research aims to establish the potential beneficial nature of Transition Year Mathematics as a bridging curriculum between the Junior Cycle and Leaving Certificate courses. Transition Year typically sees over 40,000 registered students annually and each school has a 'domesticated' programme. This means that teachers have the freedom to interpret, plan and design their own curriculum for this unique year.

Mathematics is one of the most highly reformed subjects in the Department of Education's portfolio. Many teachers of this subject experienced the impact of 'Project Maths' across both cycles and are also currently experiencing Junior Cycle Mathematics reform. In addition, the National Council for Curriculum and Assessment are also planning to conduct reforms at the Senior Cycle levels over the oncoming years. However, Transition Year Mathematics remains largely unreformed since its establishment. First introduced in 1974 by then Minister of Education, Richard Burke, Transition Year has only received 278 words of instruction in the 1994 Transition Year Guidelines documents.

This research aims to address this shortfall and explore the hidden potential of Transition Year Mathematics in order to best prepare students for Leaving Certificate Mathematics. Two main research questions are part of the research study:

1. What does it mean to be "well-prepared" for Leaving Certificate Mathematics?
2. Can a Transition Year Mathematics curriculum be developed to "best prepare" students for Leaving Certificate Mathematics?

It is hoped to complete a case study research methodology, which will include a mixed methods Design Based Research methodology consisted of data collection from three main sources:

1. Interviews with practising teachers of Transition Year Mathematics in the research school. This interview will be less than one hour in duration.
2. Video observation (iPad Screen Recording) of a number of Transition Year mathematics classes in the research school. This includes recording of audio and iPad screen. Between nine to twelve one-hour classes will be recorded, and then transcribed.
3. Transition Year Student focus groups and questionnaires about their experiences of Transition Year mathematics. Students in 5th and 6th year, who completed Transition Year previously will also receive a questionnaire about their experience of Transition Year mathematics.

The teacher interviews will be anonymised after being transcribed. The video recordings (iPad screen recordings) will also be anonymised after being transcribed. The research

school will not be named in the research or any names of the teacher or student participants.
It is very important to note that the purpose of the data collection is not to review the teacher or their teaching ability, but to examine the content being presented, the manner in which it is presented, and the mathematics skills being taught to the students during Transition Year Mathematics.
The concluding objective of this research study is to share the emerging mathematical topics, concepts and skills, that will in fact hopefully assist students in being 'well-prepared' for Leaving Certificate Mathematics. It is also hoped to construct a set of guiding principles for planning Transition Year mathematics. It is hoped that these guiding principles will greatly benefit teachers of mathematics.
If you have any questions on this research study or need clarifications, please contact the researcher Derek Maher at maherdd@tcd.ie or the research supervisor Dr. Aibhín Bray (brayai@tcd.ie).

Regards,
Derek Maher
D.Ed Candidate,
School of Education,
Trinity College Dublin | maherdd@tcd.ie

Appendix G: Tables G1-G10 Delphi Study Discussion Findings

Table G1: Phase One (Delphi Study) Discussion Findings on Academic Preparedness.

Discussion Topic	Resulting Statement in the Student Questionnaire
Procedural Fluency	1.9: TY Maths helped me to revise all the basic facts that I learned in Junior Cert 1.18: From studying TY Maths, I have developed skills in carrying out procedures accurately and efficiently
Confidence	1.2: TY Maths helped to increase my academic confidence with this subject
Self-Efficacy	1.16: TY Maths had a suitable number of assessments to evaluate my learning
Flexibility	1.11: I enjoyed the flexibility of TY Maths
Unifying Strand	1.1: TY Maths built on the maths I studied at Junior Cert 1.4: TY Maths really helped me to connect the different areas of maths together
Contextualised Situations	1.13: TY Maths should have a full national curriculum like Junior Certificate and Leaving Certificate 1.14: I wanted to cover all the Leaving Certificate topics during TY Maths
Productive Disposition	1.6: TY Maths was not beneficial to me 1.8: TY Maths was very interesting 1.12: I found TY Maths to be useful to my education 1.15: TY Maths helped me to develop the skills and attitudes necessary to pursue further studies in maths
Conceptual Understanding	1.3: TY Maths provided me with more time to examine common mistakes that I make in maths 1.7: TY Maths provides teachers with more time and freedom to explore common student mistakes in maths 1.17: From studying TY Maths, I have a good understanding of mathematical concepts

Adaptive Reasoning	1.5: TY Maths is very difficult 1.10: TY Maths helped me to reflect on how I learn maths

Table G2: Statement Suggestions and Actions for Quadrant One Statements 1.1 – 1.9.

Suggestion to the Statement	Action
At this distance, I cannot declare categorically that every one of the statements reflects an aspect of the discussion (but of course, I was mainly involved just with one group). However, they are consonant with my memories. All are relevant and have a place in the questionnaire. (For Statements 1.1 and 1.9: a full stop after "Cert" - or not? Consistency!)	Cert. changed to Certificate
I think 1.5 is problematic. "TY maths is very difficult" if a student is studying maths at an appropriate level it should be challenging, easy is not necessarily good.	1.5: TY Maths was very challenging
Minor Suggestions: 1.3 – I don't think this has to be limited to mistakes that "I make in maths" – I could be more general "examine common mistakes that are made in maths". In 1.9 - I would suggest basic skills rather than basic facts	1.3: TY Maths provided me with more time to examine my mistakes that I make in maths 1.9:TY Maths helped me to practise all the basic skills that I learned in Junior Certificate
I'm not sure about 1.3 and 1.7. In particular 1.3. More time to examine common mistakes that I make in maths. Do you think students would recognise "common mistakes"? Maybe gave me more opportunities to understand my mistakes?	1.3: TY Maths provided me with more time to examine my mistakes that I make in maths 1.7: TY Maths provides teachers with more time and freedom to explore common student mistakes in maths
1.9 helped me revise or "practice" in relation to procedural fluency	1.9: TY Maths helped me to practise all the basics skills that I learnt in Junior Certificate

Table G3: Statement Suggestions and Actions for Quadrant One Statements 1.10 – 1.18.

Suggestion to the Statement	Action
The same comment applies (except for the proofreading note!).	Changed as above

For Statement 1.12 maybe say “education in general” or “study of other subjects?”.	1.12: I found TY Maths to be useful to my education in general
1.14: I wanted to cover all LC maths. Maybe reword to "only" rather than "all"?	1.14: I wanted to cover only the Leaving Certificate topics during TY Maths

Table G4: Phase One (Delphi Study) Discussion Findings on Social Preparedness.

Discussion Topic	Resulting Statement in the Student Questionnaire
Attitudes	2.1: TY Maths is a good opportunity to build my self-confidence 2.10: TY Maths improved my social confidence 4 2.16: TY Maths helped me to appreciate the international dimension of maths
Self-Esteem	2.4: During TY Maths, my self-esteem with maths increased 2.7: TY Maths made me compare myself to other students in my class
Resilience	2.8: TY Maths is “a chance to start again” with maths 2.12: TY maths taught me that it is OK to make mistakes 2.18: TY Maths improved my ability to solve hard maths question
Careers	2.15: TY Maths gave me an opportunity to think about what I would like to study at University/College
Building Relationships	2.6: TY Maths supported me to build positive relationships with my teachers 2.14: TY Maths allowed me to build positive relationships with my classmates
Reinforcing the foundations	2.9: TY Maths reinforces the foundations of maths
Culture	2.2: Group work should be a core element of TY Maths 2.3: TY Maths classes should be mixed-ability (Higher and Ordinary Level maths students together) 2.5: TY Maths encouraged me to succeed with maths 2.11: The TY Maths classroom should be a competitive environment 2.13: A group project should be a core element of TY Maths 2.17: I had the opportunity to engage in extra-curricular or co-curricular maths activities during TY

Table G5: Statement Suggestions and Actions for Quadrant Two Statements 2.10 – 2.18.

Suggestion to the Statement	Action
And likewise… I do notice, cumulatively, that there aren't any very negative statements about TY; of course, respondents can "strongly disagree" with the positive ones. Maybe no negative vibes emerged from the discussion in this respect.	No Change
2.10 is focused on two different things. 2.15 not every TY student may want to progress to university. Perhaps think about their career? Will they understand what Statement 2.18 is getting at?	2.10: TY Maths improved my social confidence 2.15: TY Maths gave me an opportunity to think about what I would like to study/work as in the future 2.18: TY Maths improved my ability to solve hard maths question
2.16. I am not sure what is meant by this statement.	2.16: TY Maths helped me to appreciate that maths is "universal"

Table G6: Phase One (Delphi Study) Discussion Findings on Emotional Preparedness.

Discussion Topic	Resulting Statement in the Student Questionnaire
Self-Beliefs	3.1: Being good at algebra really helps me to understand other areas of maths 3.2: When I understand maths concepts, my self-confidence increases 3.3: As TY students, our opinion about what maths we study should be considered 3.5: I like it when I have a really challenging problem to solve in maths. 3.6: TY Maths "sparked" my interest in this subject 3.8: TY Maths increased my motivation in this subject 3.10: TY Maths made me lose my motivation from Junior Cert Maths

Attitudes	3.4: I love when I have a "eureka" moment in maths, when I finally understand a concept 3.7: TY Maths should encourage students to "seek discomfort" and build a level of tolerance with difficult problems 3.9: If I find maths relevant to my real life, I will work harder to understand it. 3.13: I enjoyed the maths teaching and learning during TY 3.14: The teacher/student relationship is important to my learning 3.16: TY Maths allowed me to feel more comfortable when I made mistakes
Emotions	3.1: I feel comfortable asking the teacher questions during my TY Maths classes 3.12: I feel comfortable asking my classmates questions during my TY Maths classes 3.15: TY Maths helped me to appreciate the elegance and power of maths

Table G7: Statement Suggestions and Actions for Quadrant Three Statements 3.1 – 3.8.

Suggestion to the Statement	Action
Much the same as above - including a possible query about relentless positivity!	No Change
I think you could word 3.3 a little simpler.	No Change
3.1 - what about those who do not perceive themselves to be good at algebra? 3.7 - maybe "step outside comfort zone" rather than seek discomfort?	3.1: No Change 3.7 Changed to: TY Maths should encourage students to 'step outside their comfort zone' and build a level of tolerance with difficult problems
Unsure about 3.1 in this quadrant.	No Change
3.7 this statement may be difficult for the student to understand. Will a level of tolerance be explained to them?	Changed to: 3.7: TY Maths should encourage students to "step outside their comfort zone" and build a level of tolerance with difficult problems

Table G8: Statement Suggestions and Actions for Quadrant Three Statements 3.9 – 3.16.

Suggestion to the Statement	Action
Ditto. I note one negative statement, 3.10! Proofreading point: 3.9 ends with a full stop (others don't); 3.10 has "Cert" without one (see earlier).	Changed to Certificate and issue with full stop rectified.
3.10 – lose the motivation I had got from completing the JC?	Statement changed
I'm wondering if 3.11, 3.12 and 3.14 should be in social preparedness as they are to do with relationships? Not sure though.	Kept in Quadrant Three (Emotional Preparedness).
Elegance of maths – will this be explained to students?	No Change

Table G9: Phase One (Delphi Study) Discussion Findings on Skill-Based Preparedness.

Discussion Topic	Resulting Statement in the Student Questionnaire
Communication	4.4: TY Maths encouraged me to discuss approaches and solutions to problems 4.11: TY Maths encouraged me to communicate mathematically
Being Personally Effective	4.6: Studying TY Maths empowered me to gain knowledge and skills that will benefit me in other aspects of my everyday life 4.9: TY Maths improved my independent learning skills 4.14: TY Maths helped me to develop the ability to reflect upon my work
Working with others	4.5: TY Maths encouraged me to work together in groups to generate ideas and problem solve 4.13: TY Maths encouraged me to consider and listen to the viewpoints of others.
Creativity and Critical Thinking	4.2: In TY Maths there is a strong emphasis on investigation 4.3: TY Maths encouraged me to solve problems in a variety of ways 4.7: TY Maths is a learning environment that is open to new ideas 4.10: TY Maths improved my word problem solving skills 4.12: TY Maths encouraged me to be creative and critical 4.15: TY Maths helped me to develop curiosity

Managing Information	4.1: TY Maths required the efficient processing of information 4.8: TY Maths improved my digital learning skills 4.16: From studying TY Maths, I have the ability to solve mathematical problems in familiar and unfamiliar contexts 4.17: From studying TY Maths, I have the capacity for logical thinking

Table G10: Statement Suggestions and Actions for Quadrant Four Statements 4.1 – 4.17.

Suggestion to the Statement	Action
Same comments! I reiterate explicitly: all items are relevant and interesting.	No change required
4.17 maybe "logical thinking" rather than "logical thought" as thinking is an active verb?	Changed to: 4.17 From studying TY Maths, I have the capacity for logical thinking
Seems to be fluctuation between past and present tense in some of the items across the various themes. 4.4 needs slight rewording. 4.10 - is this just focused on word problem solving or problem solving in general? 4.13 needs slight rewording.	4.4: TY Maths encouraged me to discuss solutions to problems 4.10/4.13 unchanged
What does it mean for an environment to be open to ideas (4.7)? Maybe rephrase to an environment in which ideas and innovation are encouraged?	4.7: TY Maths is a learning environment where ideas and innovation are encouraged.