A comparative study between rural and metropolitan contexts on student self-efficacy in secondary school mathematics

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A COMPARATIVE STUDY BETWEEN RURAL AND METROPOLITAN CONTEXTS ON STUDENT SELF-EFFICACY IN SECONDARY SCHOOL MATHEMATICS

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Abstract

As the world moves increasingly into the digital age, social commentators outline the growing importance for school graduates to have in-depth knowledge and understanding of mathematics. However, students are not embracing the need for studying the levels of mathematics required. The drop in the number of students achieving higher levels in benchmark tests is associated with the decline in participation in advanced courses. This phenomenon is considered worse for rural based students than their metropolitan counterparts.

A comparative study between rural and metropolitan based secondary school students was established to investigate the reasons for students not participating in the advanced study of mathematics. Self-efficacy in mathematics has a substantial influence on achievement and participation in mathematics. As self-efficacy is formed through a triadic reciprocal determinism between personal characteristics, behaviour and environment, it was anticipated that self-efficacy and its sources would differ between rural and metropolitan locations and explain the difference in participation and achievement in advanced mathematics. Bronfenbrenner's ecological systems were used to explore the environmental influences of student survey data.

However, the 869 student surveys from Year 7, 9 and 11 in 6 different schools showed their perceived self-efficacy across a range of mathematical strands, levels of difficulty, and sources were mainly the same for rural and metropolitan based students. These data were further informed by the commentary from 16 teachers, the principals, and the website descriptions of this sample's schools through a mixed-methods process. The outcome of this analysis indicated the drivers of the school were not based on the geolocation but the culture of the school's system, the school's organisation and the focus of the teaching and teachers. Good practice drives good schools, not geolocation.

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Declaration of Authorship and Sources

This thesis contains no material that has been extracted in whole or in part from a thesis that I have submitted towards the award of any other degree or diploma in any other tertiary institution.

No other person's work has been used without due acknowledgment in the main text of the thesis.

All research procedures reported in the thesis received the approval of the relevant Ethics/Safety Committees (where required) from the Australian Catholic University.

I am indebted to the support of Professor Shukri Sanber (Australian Catholic University for his assistance in establishing the Self-Belief in Mathematics questionnaire and the teacher semi-structured interview and for his guidance during the analysis of both elements of the exploratory-sequential mixed methods research methods. I am also highly appreciative of the assistance of Professors Jim Watters and Tania Aspland in bringing together the findings of this thesis.

I am also in debt to the principals and teachers who so willingly supported the data gathering.

Vincent Brian Connor

30 April 2021

Statement of Appreciation

This research seeks to address a complex problem that has baffled many researchers beforehand. The research path proved to be equally complex and required flexible thinking to establish the parameters for the investigation. There have been dead ends and then times of enlightenment. This journey has been many years in the making, reflecting the challenges engaged in trying to make sense of the problem.

During this time, my wife Catherine and children Chris, Kate, Paul, Ben and Sarah have provided tremendous support and given me their discerning comment. A special thank you to Chris and Kate for their proofreading.

Most of all, I cannot put into words the gratitude and appreciation to Catherine for her unswerving support over such an extended period. She never failed in her energy as I brought my latest line of thinking to her. Even in the end, her great eye for formatting gave the work a professional touch.

She is the love of my life and a fellow believer in the power of education to transform the lives of the students we teach.

Vince

Glossary

Academic Care	is a timetabled time in the school that combines pastoral care to enhance student learning.
Advanced mathematics	the advanced New South Wales mathematics course in Stage 5 is Mathematics 5.3, and in Stage 6 are Mathematics, Mathematics Extension I and Mathematics Extension II.
Collective agency	is when people have confidence that they can and do act together for the benefit of the group.
Conception of ability	is the concept one has of their ability and whether this is an acquirable skill or predetermined aptitude.
Created environment	is an operative environment that is established or created by the agent.
Cultural capital	is a resource that uses cultural knowledge as the currency used in socially directed interactions.
Enactive learning	is learning through the effects of one's actions.
Field	refers to domains of social life such as culture or politics
Fixed mindset	is the view that ability and intelligence are pre-defined and unchangeable.
Geolocation	is the geographical location determined by an agency or group
Grade	is another term used to describe the year of schooling. In New South Wales there are thirteen Grades or Years from Kinder to Grade/Year 12.
Growth mindset	is the view that ability and intelligence can be cultivated through effort.
Habitus	is a way of describing the values and orientations that determine social groupings.
High school	is another term to describe the secondary years of schooling. These range from Year/Grade 7 to Year/Grade 12
Human agency	is when people exercise influence over what they do.
Intermediate mathematics	courses of study are better than standard courses but not as complex as advanced courses. In New South Wales Stage 5 intermediate courses are identified as 5.2
Imposed environment	is an operative environment that is determined by a collective imposed on the individuals.
Individual agency	when an individual exercises control over what they do
Instructional Leader	is a senior teacher, such as a Principal, who focuses on leading instruction within the school.
Literacy	describes the elements of learning in language and is based on reading, writing, spelling, grammar and punctuation.
Mathematics syllabus	is the course of study defined by the New South Wales Educational Standards Authority (NESA). The syllabus has a rationale, aim, objectives,

	outcomes, content and assessment requirements.
Metropolitan	is a geographical description based on the Accessibility Remoteness Index Australia (ARIA) and consists of major cities and inner regional. In this case, the metropolitan students were based in Sydney (a major city), New South Wales.
Modelling	is the object of observation to assist in learning.
New Times	represents the contemporary post-modern era dominated by Gen Y, Gen Z etcetera
Non-rural	is an alternate name for metropolitan geolocation.
Numeracy	describes the elements of knowledge and skills to broadly use mathematics across other learning areas at school and globally.
Operative environments	are the environments in which agents operate. Bandura defines three operative environments: imposed, selected and created.
Outcomes expectancy	refers to the expectancy that by behaving in a particular way, the action will lead to a given outcome and considers the desirability of that outcome
Primary school	in New South Wales are the first seven years of schooling with children typically ranging in age from 5 to 12 years.
Provincial	is used in this study to refer to an outer regional city
Proxy agent	is a person who acts as an agent on behalf of another
Rural	is a geographical description based on the Accessibility Remoteness Index Australia (ARIA) and consists of outer regional, remote and very remote. In this case, the students were based in outer regional locations in New South Wales, Australia.
Secondary school	in New South Wales are the six years of schooling that followers on from primary school with children typically ranging in age from 12 to 17 years
Selected environment	is an operational environment that the agent selects.
Self-concept	describes the beliefs one holds about oneself and the responses of others.
Self-efficacy	describes a person's belief in their ability to succeed in a specific situation or accomplish a set task.
Self-regulation	describes the process of controlling personal actions or the actions of a group
Self-reflection	describes the capacity to exercise introspection and the willingness to learn more about the fundamental nature, purpose and essence of an idea or concept.
Semiotics	is the study of signs and symbols and their interpretation.
Social Cognitive Theory	posits that learning occurs in a social context and is affected by a triadic reciprocal interaction of personal qualities, environment, and behaviour.
Stages	in a NSW secondary school are pairs of Year groups, with Stage 4

	presenting Years 7 and 8, Stage 5 representing Years abstract9 and 10 and Stage 6 representing Year 11 and 12
Traffic light method	is a formative assessment method used to gain student reflection on whether they have mastered a concept (green), not grasped a concept (red) or have some understanding, but it not complete (amber)
Vicarious learning	is learning through observation and modelling.
Year Group	in New South Wales thirteen-year groups begin at Kindergarten and progress sequentially from Year/Grade 1 through Year/Grade 12. Year is a synonym for Grade

Abbreviations

AAoS	Australian Academy of Science
ABS	Australian Bureau of Statistics
ACARA	Australian Curriculum Assessment and Reporting Authority
ADGET	Australian Government Department of Education and Training
AMSI	Australian Mathematics and Science Institute
ARIA	Accessibility/Remoteness Index of Australia
ATSI	Aboriginal and Torres Strait Islander
BOSTES	Board of Studies and Teacher Educational Standards. New South Wales Educational Standards Authority (NESA) replaced BOSTES in 2017
HSC	Higher School Certificate in NSW
ICSEA	Index of Community Socio-Educational Advantage
LSAY	Longitudinal Study of Australian Youth. Since 2003 students involved in LSAY have been integrated with PISA.
LBOTE	Language Background Other Than English
NSW	New South Wales, a state in Australia.
NAP	National Assessment Program
NAPLAN	National Assessment Program in Literacy and Numeracy conducted in Year 3, 5, 7 and 9
NESA	New South Wales Educational Standards Authority and has replaced the Board of Studies and Educational Standards (BOSTES) in 2017
OECD	Organisation for Economic Cooperation and Development
OPC	Ontario Principal Council
PISA	Program for International Student Assessment
PLC	Professional Learning Community

PLT	Professional Learning Teams who work within a PLC
PWC	Price Waterhouse Coopers
SIMERR	National Centre for Science, ICT and Mathematics Education in Rural and Regional Australia
STEM	Science, Technology, Engineering and Mathematics
TIMSS	Trends in International Mathematics and Science Study
UAC	Universities Admission Centre

Chapter 1: An ongoing problem: Students' achievement in secondary school mathematics

1.1 Introduction

> The ability to make informed decisions and to interpret and apply mathematics in a variety of contexts is an essential component of students' preparation for life in the 21st century. For students to participate fully in society, they need to develop the capacity to critically evaluate ideas and arguments that involve mathematical concepts or that are presented in mathematical form.
> NSW Syllabuses for the Australian Curriculum, Rationale (New South Wales Education and Standards Authority [NESA], 2018b)

The acquisition of mathematical skills is an essential attribute for citizens of modern society, as the Rationale for the New South Wales Syllabus (NSW) describes. This sentiment is not restricted to the state of NSW but is Australia-wide, with the Australian Government Department of Education and Training (ADGET, 2015a) expressing that mathematical skills are considered crucial for the "knowledge economy" of a contemporary world. While baseline competencies are believed to be vital within general life, more profound mathematical knowledge is considered pivotal in providing the platform for studies in science, technology and economics. Modelling by Price Waterhouse Coopers (PWC), using work from Oxford University, identified that 75% of the fastest growing occupations in Australia require employees trained in Science, Technology, Engineering and Mathematics [STEM] (PWC Report, 2015).

Given the importance placed on "develop(ing) increasingly sophisticated and refined mathematical understanding, fluency, logical reasoning, analytical thought processes and problem-solving skills" (Australian Curriculum Assessment and Reporting Authority [ACARA], 2015a) it could be assumed that the number of students studying and achieving at higher levels of mathematics in Australia would be increasing. However, the Australian Mathematical and Science Institute (AMSI) research indicates that the number of students studying advanced and intermediate level mathematics in Australia at Year 12 (final year of secondary schooling) in proportion to the total cohort fell from 13.6% in 1997 to 9.2% in 2016. However, the demand for mathematical and statistical skills is greater than supply (AMSI, 2017). The report states that:

> The proportion of Australian students studying mathematics in Year 12 in some form has remained steady at 80 per cent over the past two decades. However, when we look at what mathematics subjects these students are choosing to take, the proportion of students taking more advanced, calculus-based levels of mathematics as their "highest" maths subject has

> been declining in favour of "easier" maths subjects. … Since 2012, the proportion of students taking intermediate and advanced mathematics at Year 12 has plateaued at a historic 20-year low (p. 21).

1.2 The context of this study

In Australia, the state governments monitor school education, and the research in this study was conducted within the state of New South Wales in Australia. All Australian States and Territories adhere to the Australian Curriculum for Mathematics (ACARA, 2015a). However, NSW provides, supervises and assesses its syllabuses to enact this curriculum (please see Appendix A). Mathematics is mandatory in the primary (from Kindergarten to Year 6) and the junior (Year 7 and 8), and middle secondary years (Year 9 and 10), although the mathematics courses vary within each state. Elective mathematics occurs in the senior secondary years of NSW (Years 11 and 12). In addition, students can select from a standard, intermediate and advanced mathematics course in the middle and senior secondary years.

Nationally, while 80% of students study some mathematics level in senior secondary years, students' participation in the advanced courses has decreased (AMSI, 2017). In a review of the NSW Year 12 exit credential, the Higher School Certificate (HSC), NESA found that "despite an increase in HSC candidature, total entries in advanced STEM courses have declined" (Board of Studies, Teaching and Education Standards [BOSTES], 2016, p. 10). The review argues that the current secondary school system in NSW is not producing students choosing to study STEM courses at tertiary institutions. It proposed that the results in PISA and TIMSS in the junior secondary years indicated that the "top-performing students may not be academically extended enough prior to senior secondary study" (BOSTES, p. 11). Hence, the review found that students' desire to study advanced mathematics levels is not cultivated.

The non-participation in advanced mathematics has not gone unnoticed by authorities, and many Australian based reports have investigated the issue over the past two decades. Mathematics is core to many of the STEM fields. The reports reaffirm the concern that Australian secondary school students are not being prepared well enough for a STEM-related future, and they outline strategies to improve the quality of teachers and their approaches to teaching mathematics. Some examples include: *A National Strategy for Mathematical Sciences in Australia* (*Australian Academy of Science* [AAoS], 2009), *Discipline Profile of the Mathematical Sciences* (AMSI, 2017), *Desktop Review of Mathematics School Education Pedagogical Approaches and Learning (Australian Association of Mathematics Teachers* (ADGET, 2015a), *A Smart Move: Future proofing Australia's workforce by growing skills in science, technology engineering and maths (STEM)* (PWC, 2015) and *The mathematical sciences in Australia: A vision for 2025* (AAoS, 2016). In 2008 the Australian Government also introduced a national benchmarking test for year 3, 5, 7 and 9 through the National Assessment Programme Literacy and Numeracy, commonly referred to as NAPLAN. A detailed analysis is provided annually on

NAPLAN results (National Assessment Program [NAP], 2018). A longitudinal analysis of the reports shows that student achievement in Years 3, 7 and 9 have not improved nationally. The data from NAPLAN, Program of International Student Assessment (PISA) and Trends in International Mathematics and Science Study (TIMSS) also show that numeracy results of students from rural based schools are below that of the metropolitan based school students (NAP).

1.3 Benchmark Assessments: TIMSS, PISA, and NAPLAN

To determine the relative performance of Australian students with similarly aged children from the Organisation for Economic Cooperation and Development (OECD) countries, Australia takes part in two large scale international studies on school student capabilities in literacy, numeracy and the sciences. PISA is a sample survey that tests the knowledge and skills of 15-year-olds, assessing their ability to apply knowledge and skills to real-life problems. By considering the student's ability to analyse, reason and communicate, PISA seeks to identify if they are well prepared to meet the challenges of contemporary society (Thomson, De Bortoli & Underwood, 2017). TIMSS is also a sample survey aimed at year 4 and year 8 students focusing on mathematics and science curriculums. In year 4 mathematics, students are tested in *number, geometry shapes and measures and data displays,* with Year 8 tested in *number, algebra, geometry, and data and chance.* The cognitive domains for both groups are *knowing, applying,* and *reasoning* (Thomson, Wernert, Rodrigues & O'Grady, 2017).

In summary, PISA measures application skills and knowledge in problem solving in 15-year olds, and TIMSS assesses students' knowledge in Years 4 and 8 in application and reasoning on common curriculum elements across the OECD countries. However, it is in both assessments that the Australian performances are declining.

NAPLAN provides assessment data on an annual basis for students in Years 3, 5, 7 and 9 of schooling and began in 2008. The tests assess reading, writing, grammar and punctuation, spelling and numeracy and compare each year group and growth between the year groups (NAP, 2018). The NAPLAN assessment regime is based on the Australian Curriculum and provides the government with a "benchmarking process" to judge the relative effectiveness of the Australian education system for literacy and numeracy annually and longitudinally.

The NAPLAN, PISA and TIMSS results are extensively analysed and reported to conclude that Australia's youth is underperforming in numeracy relative to the OECD countries (AMSI, 2017). Questions arise as to whether Australian students are now less scholastically able in numeracy than they once were. It is noted that numeracy measured against the Australian curriculum results through NAPLAN remains mainly unchanged across Australia (NAP, 2018). Are Australian students under-motivated and underprepared in the advanced concepts of mathematics?

1.3.1 **Reflections on Australian Students' Benchmark Data**

Many commentators are concerned that Australian students' performance in mathematical literacy has declined relative to other OECD countries since 2003. The decline has been noted with literacy and science but is more pronounced for mathematics, as shown in Figure 1.1

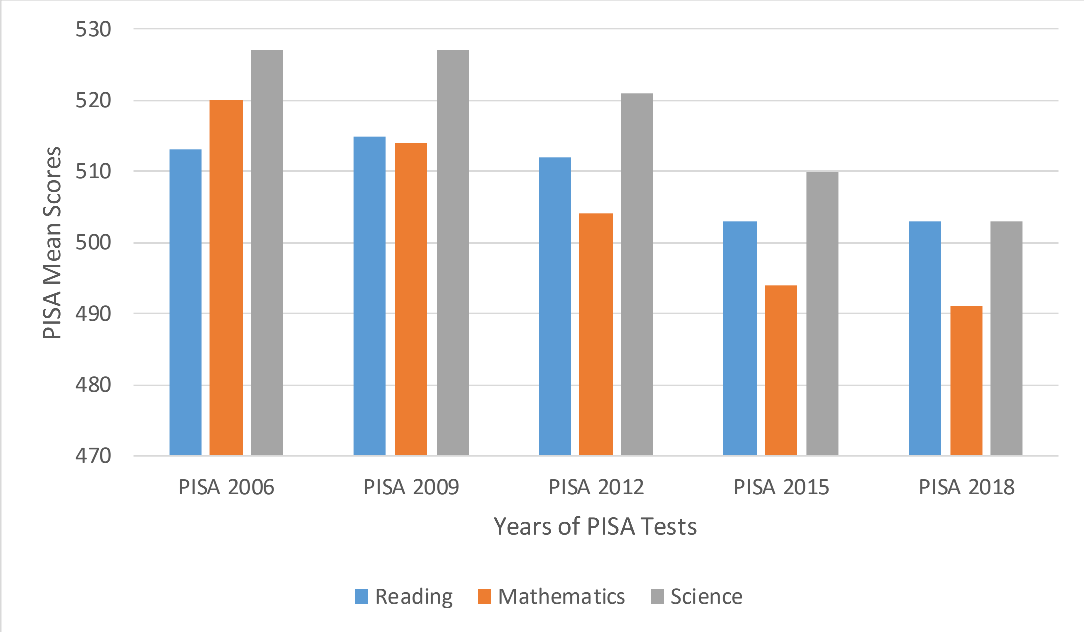

Figure 1.1 PISA Mean scores for 2006 to 2018

(Source: Thomson, De Bortoli, Underwood & Schmid, 2019)

The Australian College of Educational Research (ACER) has closely monitored the results and has regularly produced public reports. In PISA 2000, only two countries, Japan and Hong Kong China, outperformed Australia, in PISA 2003 there were four countries, Hong Kong China, Finland, Korea, and the Netherlands, and in 2006, a high point on Figure 1.1 Australia was outperformed by Chinese Taipei, Finland, Hong Kong, the Nederlands, Macao, Japan, Canada and New Zealand. PISA 2018 was on average 29 points lower in numeracy than PISA 2006 (Thomson, De Bortoli, Underwood & Schmid, 2019). Even though the Australian mean was above the OECD averages for PISA, there was a downward trend for mathematics relative to other similar countries, such as England and the United States of America (USA), with particular concern for the decline in the number of students in the higher levels.

For Year 4 TIMSS 2019, the trend is similar in mathematics, with 22 other countries outperforming Australian students, including Ireland, England, the United States, and the participating East Asian countries. In TIMSS 2019 Year 4 science, only eight countries outperformed Australia. TIMSS 2019 Year 8 mathematics Australia's achievement improved by 12 points since TIMSS 2015 with only six countries outperforming them. In TIMSS 2019 Year 8 science, Australian students had a mean score of 528, significantly higher than TIMSS 2015. While improvement is indicated both Year 4 and Year 8 mathematics as shown in Figure 1.2, science results are greater for both grades

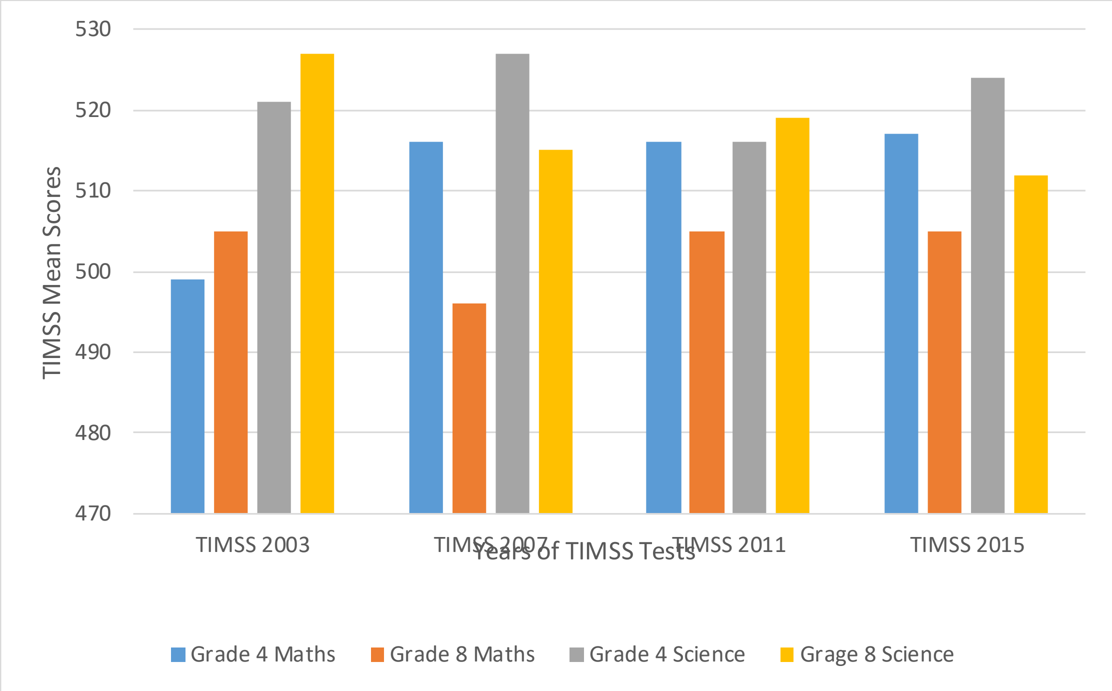

Figure 1.2 TIMSS Mean scores for 2003 to 2019

(Source: Analysis from Thomson, Wernert, O'Grady & Rodrigues, 2020)

While 70% of Australian students achieved proficiency in TIMSS 2015 Year 4, only 10% achieved at the *Advanced* international benchmark in mathematics compared to 54% of students in Singapore (Thomson, Wernert, O'Grady & Rodrigues, 2020). Australia's average achievement in TIMSS 2019 Year 8 showed six countries outperformed Australian students and improved from TIMSS 2015, moving ahead of England and the United States. The TIMSS 2019 score (517) was an improvement from TIMSS 2015 (505) TIMSS 2011 (505), TIMSS 1995 (509), TIMSS 2003 (506) and TIMSS 2007 (496). Proficiency was awarded to 68% of the Australian Year 8 sample, and 11% received the *Advanced* international benchmark in mathematics. In comparison, more than 32% of students in the top five countries were awarded this advanced benchmark.

Commentators argue that the lack of students in higher bands is a precursor for students not attempting advanced mathematics at school (AMSI, 2017). While this appears a reasonable assumption, it is unclear whether the lack of proficiency at higher levels results from a lack of ability or motivation to engage in them.

Figure 1.3 charts the mean scores for NAPLAN numeracy from 2008 to 2018 for all NSW students compared with all Australian students who sat the test. There is a similarity in how the NSW and Australian students perform in the Numeracy strand of NAPLAN, although NSW students typically have a higher mean than the Australian average. (ACARA, 2015b).

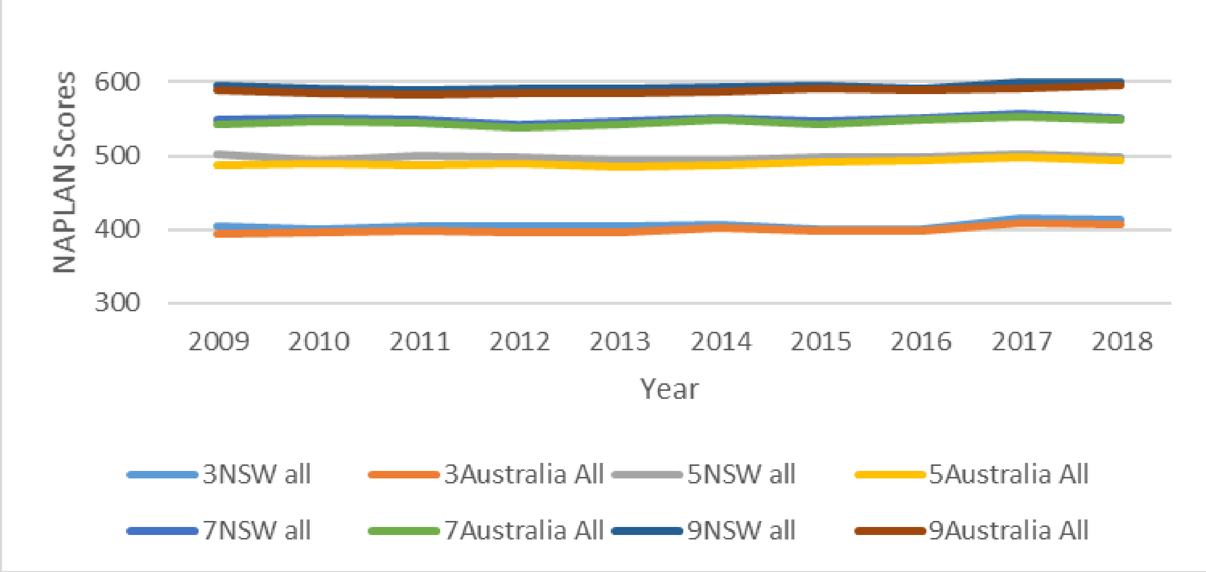

Figure 1.3 NAPLAN mean scores in Numeracy 2008 to 2018

(Source: Analysis from NAPLAN National Reports 2008 to 2018 (NAP, 2018)

1.3.1.1 Performance across different geolocations

The PISA, TIMSS and NAPLAN tests also indicate, in Australia, there is a difference in performance between metropolitan, provincial, remote and very remote students (see Figure 1.2). In 2016, the geolocations were further defined from this list to include major cities, inner regional, outer regional, remote and very remote. Inner and outer regional are grouped as provincial (see Figure 1.3). Whether there are four or five groupings, metropolitan-based students perform better than rural-based students, with the gap generally getting more prominent as the remoteness increases. The gap occurs in all five NAPLAN domains of Reading, Writing, Spelling, Grammar and Punctuation and Numeracy, and the NAPLAN National Report 2017 below typifies the description of this pattern the years and across the grades.

> Across all five achievement domains, there is a consistent pattern in the results for Australia overall. Students attending schools in major cities geolocations have the highest mean scale score, followed by students attending schools in inner regional geolocations, then students attending schools in outer regional geolocations, then students attending schools in remote geolocations, and then students attending schools in very remote geolocations. This pattern holds for both mean scale scores and the percentage of students who achieved at or above the national minimum standard. (NAP, 2018)

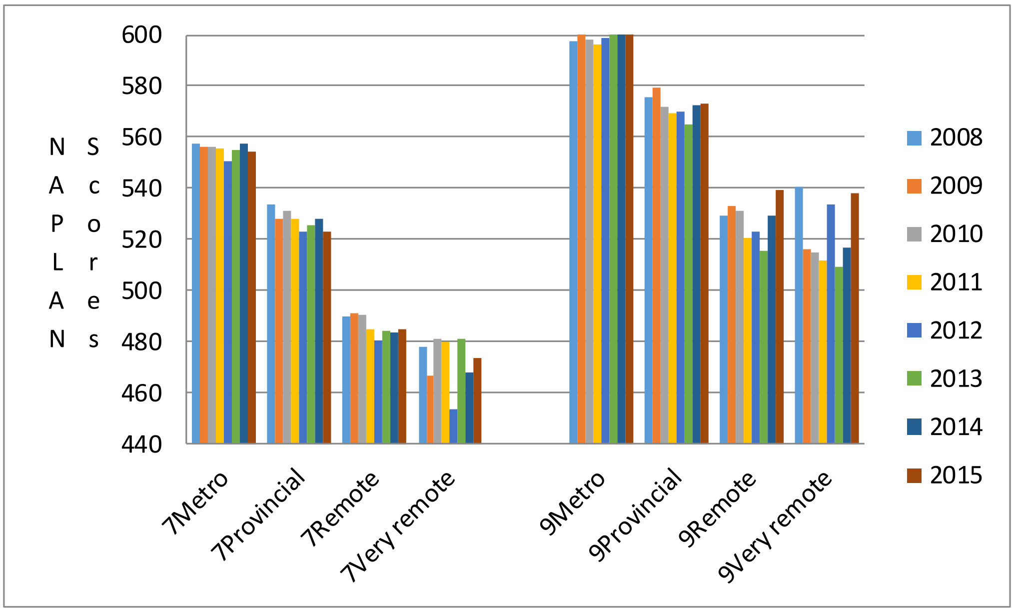

Figure 1.4 NAPLAN Numeracy Means for Metropolitan, Provincial, Remote and Very Remote locations 2008 to 2017.

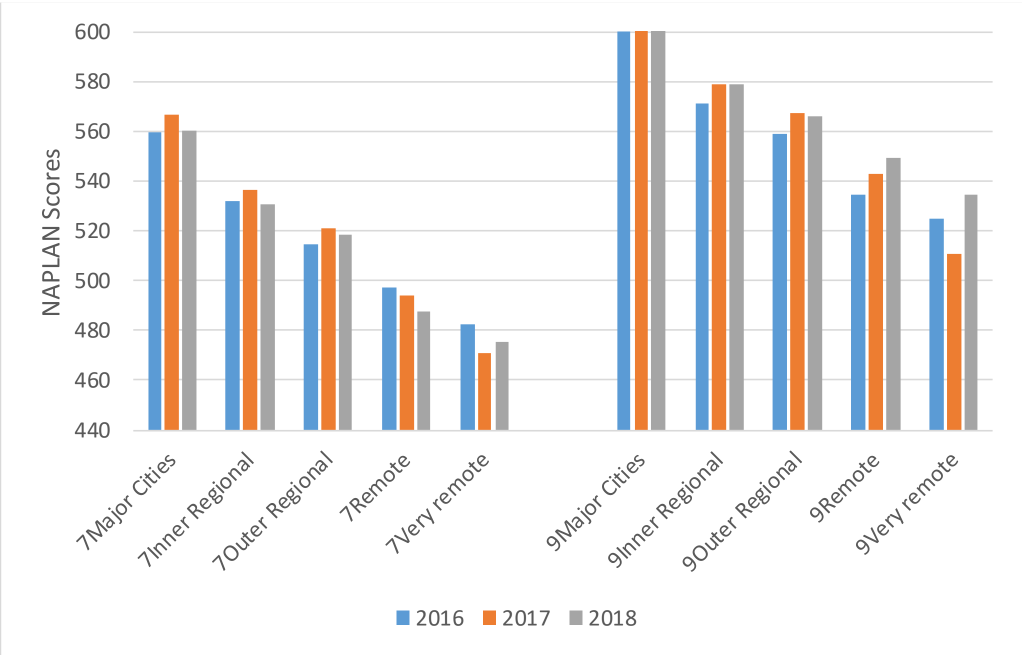

Figure 1.5 NAPLAN Numeracy Means for Metropolitan, Provincial, Remote and Very Remote locations 2016 - *2018*

(Source: Analysis from NAPLAN National Reports 2008 to 2017 (NAP 2018)

PISA and TIMSS mathematics results are also weaker in rural areas (Panizzon & Pegg, 2007, Thomson et al., 2017, Thomson et al., 2018). Metropolitan based students in Australia achieved a score of 502 points in PISA 2015 and 497 points in PISA 2018 compared to the Australian average of 494 and 491 and the OECD average of 490 and 489, respectively. For the same tests, Australian students based in provincial areas scored 472 (PISA 2015) and 476 (PISA 2018) or between three quarters and a full year of schooling behind the Australian metropolitan based students. Australian remote students scored on average 460 or a year and a half behind the Australian metropolitan based students in PISA 2015 and 440 or two-years difference in PISA 2018. While the Australian metropolitan based students were above the OECD average, the Australian provincial and remote students were below (Thomson et al., 2017; Thomson et al., 2019).

The *TIMSS 2015: Reporting Australia's results* noted that "(p)ast cycles of TIMSS have found that students attending schools in remote or regional areas of Australia are often at an educational disadvantage compared to students attending metropolitan schools" (Thomson et al., 2017, p. 72). The proficiency of metropolitan based students was 66% compared to the 60% provincially-based students. Eight per cent of metropolitan based students achieved at the advanced benchmark compared to five per cent of provincially-based students.

NAPLAN reports in six bands. A comparison of the percentage of students awarded the top two proficiency bands in NAPLAN Numeracy in NSW shows that metropolitan based students achieve higher competency levels. Figures 1.4 and 1.5 show the percentage of students in NSW who were awarded grades in the bottom two bands (described as just meeting and below the minimum standards), the middle two bands and the top two bands. The trend since 2008 has been for more metropolitan based students to achieve in the top two performance bands in both Year 7 and 9 and decreases for the Provincial, Remote and Very Remote geolocations. The proportion of students in the middle and bottom bands increases similarly. The addition of a fifth geolocation definition in 2016 and 2017 (Figure 1.6) shows that Major Cities and Inner Regional cities with an analysis showing there more students in the higher bands and fewer in the lower bands than students from Outer Regional, Remote and Very Remote (NAP, 2018).

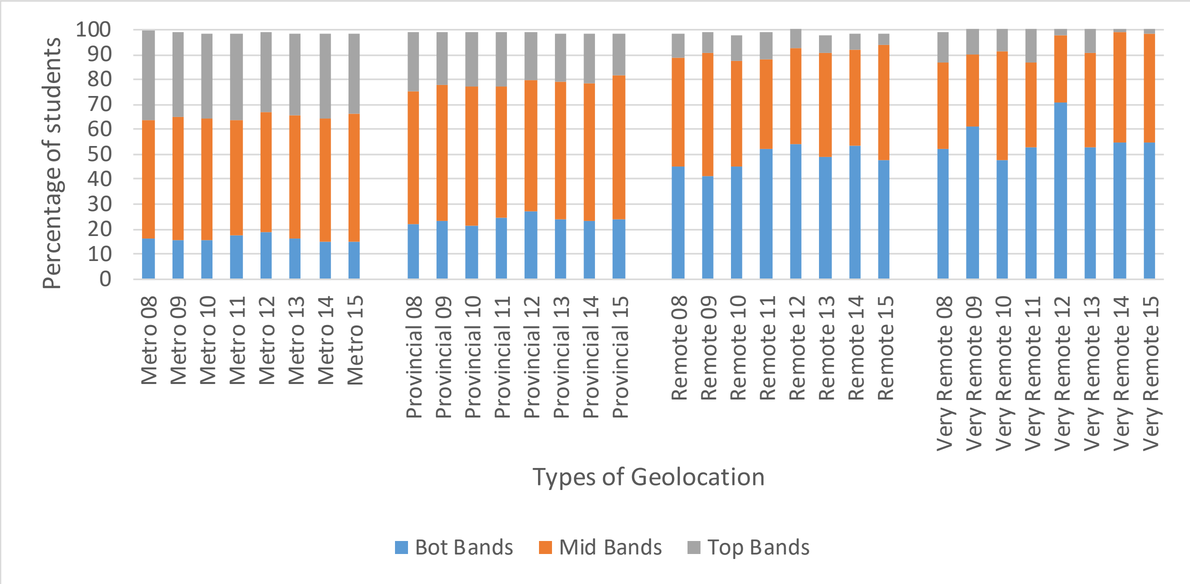

Figure 1.6 Year 7 NAPLAN Numeracy Percentage of students in performance bands for Metropolitan, Provincial, Remote and Very Remote geolocations

(Source: Analysis from NAPLAN National Report 2008 to 2015)

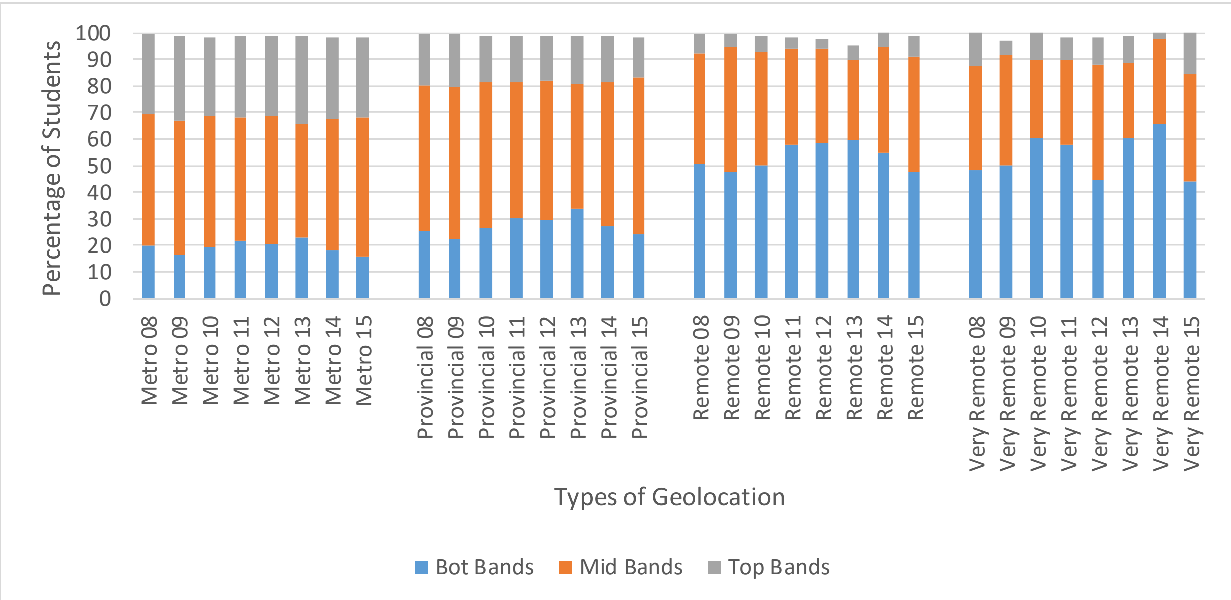

Figure 1.7 Year 9 NAPLAN Numeracy Percentage of students in performance bands for Metropolitan, Provincial, Remote and Very Remote geolocations

(Source: Analysis from NAPLAN National Report 2008 to 2015)

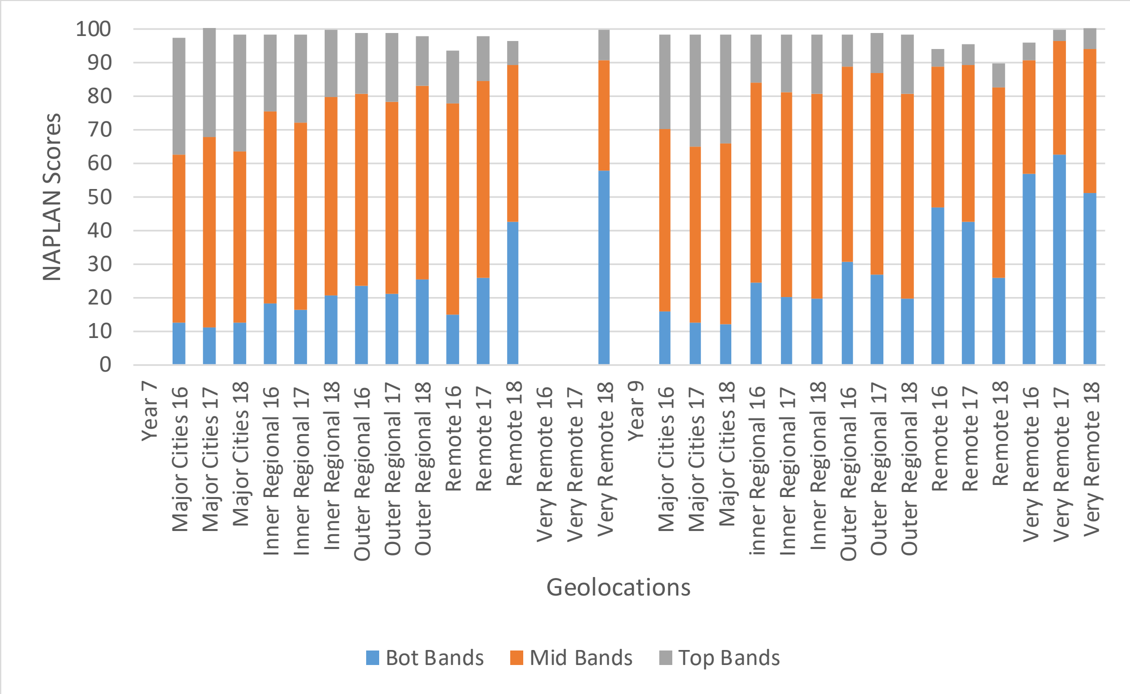

Figure 1.8 Year 7 & 9 NAPLAN Numeracy Percentage of students in performance bands for Major cities, Inner regional, Outer regional, Remote and Very Remote geolocations

(Source: Analysis from NAPLAN National Report 2008 to 2018)

The difference in achievement between rural and metropolitan based students is not unique to Australia, but it is "larger in Australia than the average of other OECD nations" (New South Wales Department of Education and Communities [NSWDEC], 2013, p. 3). Similarly, in comparing the top performance bands for the HSC, the New South Wales Government identified a similar gap in achievement between rural and metropolitan regions. HSC results are also lower for rural and remote students, and metropolitan students are more likely to be in the top two performance bands and less likely to be in the bottom two performance bands than provincial students. Provincial students, in turn, outperform their remote peers. This performance gap has widened since 2008 (Centre for Education Statistics and Evaluation [CESE], 2013).

There is a well-recognised difference in students' performance in NAPLAN, PISA, TIMSS and the HSC based on the geolocation of their school in New South Wales.

1.3.2 **Influences on Achievement**

The individual's attributes and perceptions of their capability are important, but their experiences inside and outside of school also have a marked effect on their outcome from schooling (Habibis & Walter, 2015). The environmental systems that influence a student's perceptions (Bandura, 1997) arguably occur at the individual, dyadic, triadic and larger groups levels (Bronfenbrenner, 1981). There is an interplay between the student, the home, their peers and the broader community and how the teacher approaches the curriculum, but the inter-relationship is complex, and the paths that connect them are blurred (Dinham, 2016). Investigations into specific influences on rural based students' participation in mathematics have found that self-perception of ability, previous achievement in mathematics, interest/liking of mathematics, perception of the difficulty of mathematics courses, the usefulness of mathematics in future careers, the advice of the teachers, and parental expectations and aspirations are key contributors (McPhan, Morony, Pegg, Cooksey & Lynch, 2008).

Bandura's *Social Cognitive Theory* (see Chapter 3 of this study) provides further insight into the personal dimensions that influence the students. He argues that humans contribute to their behaviours and actions through their beliefs about their capabilities to effectively complete a task and the judgments they make about the expected value of the completed task (Bandura, 1997). This concept is referred to as *human agency* and is considered to impact student achievement substantially. Self-efficacy (perceived confidence to complete a given action in a given situation) is the most critical mechanism in determining a person's human agency (Bandura, 2006). Researchers have established that student confidence in their capability has a reciprocal causality with achievement (Bandura, 1997; Deci & Ryan, 2002; Dweck, 2006; Ma & Xu, 2004; Martin, 2009). Students tend to achieve in an activity if they think they can and tend not to achieve if they think they cannot. Self-constructs such as self-concept (past experience), self-regulation (control of actions), and self-esteem (feelings) are related, but they provide alternate focusses. The self-construct mechanism that has most impact on raising or lowering of achievement is self-efficacy and vice versa (Bandura, 2010). Hence, the focus of this study is the perceived predictive confidence of students in mathematics (as described in self-efficacy) and the identified decline in achievement.

Social Cognitive Theory argues that students learn enactively and vicariously, so while mastery is a significant source in determining a person's perceived capability to complete an activity, other sources build or detract from this perceived confidence to achieve. Students are influenced by the collective agency in which they live, study and work and the proxy agency of those within the collective environment (e.g. parents, teachers and mentors). These agents operate in environments imposed on them or in environments they select and create to influence their personal attributes and competencies (Bandura, 1997).

Society and family impact an individual's view of human agency (Caprara, Regalia, Scabini, Barabranelli & Bandura, 2004; Goncu & Gauvain, 2012), but the home environment does not necessarily dominate student achievement (Holmes-Smith, 2006). Analysis of students results against socio-economic status (Thomson et al., 2019), indigeneity (NAP, 2018), gender (Rowe and Rowe, 2002; Thomson et al., 2017) and parent education (Thomson et al., 2017) show differences between students when they are grouped on these aspects. It is important to note that, although general trends exist, individual students and cohorts can achieve against general societal inclinations (Dinham, 2008). The level of influence of the socio-economic environment, ethnic and gender-based values, and home expectations are often indistinct, resulting in research having responses to the analysis. The inter-relationships between the groups of the environment are discerning elements, and an analysis of them through Bronfenbrenner's systems (1981) approach assists in understanding the role of family, peers and school within society, specifically for rural and regional societies.

Key themes for rural students in their perceptions of mathematical study are their aspirations and expectations, obstacles to aspirations and expectations, and strategies to ameliorate their aspirations and expectations for their future (Alloway, Gilbert, Gilbert, R. & Muspratt, 2004). Students knowing and understanding the relevance, importance and usefulness of mathematics and having the underlying concepts well taught are pivotal (Murray, 2011). Having a strong self-perception of their mathematical ability, the value and usefulness of studying advanced level mathematics leading to desirable careers that align with parental expectations and aspirations are essential for students in deciding whether to study Mathematics to advanced levels in senior school (McPhan et al., 2008). Teachers and parents acknowledge that the lack of occupational models in rural communities means that students have fewer images to draw when they envision what they might become (Alloway et al., 2004). Rural based parents'/carers' also believed their children have lesser opportunities to understand the application of advanced levels of mathematics (Lyons, Cooksley, Panizzon, Parnell, & Pegg, 2006).

It is clear that "what" is taught (the curriculum) matters (Brown, 2000, Marzano, 2017). For this reason, there is a common Mathematics syllabus that is compulsory in all schools in NSW. It is designed to go deeper than minimum standards and develop students' capacity for deep mathematical thinking. However, just having the same curriculum does not automatically mean that it is taught the same way to all students (Cavanagh 2006).

As a proxy agent, the teacher is a critical vehicle in delivering the curriculum (NESA, 2018a) and affects learning outcomes for students (Hattie, 2009). A regularly reported problem for rural based schools is in the employment of non-mathematics trained teachers (AMSI, 2017). The lack of in-depth subject knowledge and effective teaching strategies potentially leads to a drop in a student's confidence, especially for the more complex concepts required in advanced levels of mathematics (McPhan et al., 2008). Nevertheless, it is difficult for a teacher to perform as a competent proxy agent if they lack confidence in their capacity to respond to the learning needs of the students in their class (Schwab, 2019).

Having a positive collective efficacy as a staff to collaboratively build student capacity in learning has a strong effect (Donohoo, Hattie & Eelis, 2018). Having a collaborative faculty with strong expectations is an essential component of this shared purpose (Fullan & Quinn, 2016). The most effective mathematics faculties have mechanisms to induct new staff into the collective beliefs on building students' capacity in learning (Pegg, Lynch & Panizzon, 2007). When teachers focus on student learning and support them to construct a deep understanding, they make the most significant contributions to student achievement (Quaglia & Corso, 2014).

To overcome environmental barriers, teachers, as proxy agents, can and do influence the individual agency of the students and the collective agency of the school (Donohoo et al., 2018).

1.4 Statement of the Problem

The issue of rural based students not achieving high levels in mathematics and not choosing to participate in advanced level courses compared to their metropolitan counterparts has been a documented and ongoing issue. Research asserts a difference between rural and metropolitan based students in their performance (NAP 2017; Thomson et al., 2019) and their participation in advanced levels of mathematics (BOSTES, 2016; CESE, 2013; McPhan et al., 2008).

Commentators argue that if students are not achieving at high levels in the junior secondary years, it is unlikely they will choose to participate in a high-level mathematics course when given the opportunity (BOSTES, 2016; McPhan et al., 2008). Influences such as student perceptions of their capability, the value they place on the outcomes of studying advanced mathematics and the influences by their parents and community affect students perceived value of higher levels of mathematics courses in rural schools (Bandura, 1997; Bronfenbrenner, 1981; Habibis & Walter, 2015; McPhan et al., 2008). Attitude and motivation play a significant role in overcoming any adverse social impacts. The student’s "personal experiences, interpersonal interactions, and their views of their strengths and weaknesses" (Alloway et al., 2004, p. 248) shape their visions of their possible and probable future careers and the actions they take to form these. The perceived knowledge of their capability is particularly influential, and "students may only perform to whatever expectations they already have of their ability" (Hattie, 2009, p. 44). Those with low expectations of their capability tend to lack the effort and persistence often needed to study higher levels of mathematics (Bandura, 1997). As rural based students are not performing or participating in advanced mathematics levels compared to their metropolitan counterparts, then we must seek to understand the barriers in order to provide solutions.

Many researchers have found a connection between students' perceptions of their capability in the form of student self-efficacy and their achievement within the academic domain of mathematics (Bandura, 1997). McPhan et al. (2008) identified self-efficacy, and its sources, as an area to investigate further for rural based students in order to determine whether it is an intervening factor. In seeking to understand the potential impact on rural based students, a literature scan has found little is currently known about perceived self-efficacy and the sources for rural environments.

1.5 Aims and Research Questions

The purpose of this study is to investigate and understand the influence of the students' perceived self-efficacy in mathematics and the sources that lead to these perceptions for rural based secondary school students. Using the lens of Social Cognitive Theory (Badura, 1997), this study investigates self-efficacy and the influence of collective, proxy and individual agency on rural based students' levels of achievement and their participation in higher level secondary school mathematics. The primary research question asks whether rural geolocation characteristics significantly influence self-efficacy across mathematics in the secondary school years in developing their agency to achieve and participate in the study of advanced levels of mathematics.

In seeking to unpack and understand this broad question, this research intends to investigate rural based perceived self-efficacy in mathematics by comparing metropolitan based students. The comparison provides an opportunity to ascertain the similarities and differences between rural and metropolitan based students and the personal, environmental and behavioural determinants that build or diminish their self-efficacy. In Social Cognitive Theory (Bandura, 1997), self-efficacy is developed through the interplay of enactive and vicarious sources within the environment's collective, proxy and individual agencies. Four sources are identified as influential: enactive mastery, vicarious experience, social persuasion and affective states. Hence the following two questions are asked.

Research Question 1: Do rural and metropolitan secondary students differ significantly in their perceived self-efficacy in secondary school mathematics?

Research Question 2: What are the major influences on the perceived self-efficacy in secondary school mathematics for rural students?

1.6 Purpose and significance of the study

The data will paint a picture of the perceived student self-efficacy, their sources and the environmental influences on rural based secondary students in mathematics. In doing so, this study will add to the currently limited body of knowledge in understanding the individual, proxy and collective modes of agency for the rurally-based student.

The findings of this study provide advice for system and school leaders and teachers on how to develop best and support students' self-efficacy and agency to achieve in advanced levels of mathematics through the imposed operations and by selecting and creating school and classroom environments that facilitate high-quality learning. The guided development of mastery, the provision of explicit opportunities for vicarious experience, the use of targeted and specific forms of feedback and the reduction of negative emotions are within the bounds of school leaders and teachers. The findings will assist teachers to understand further their students as agents of their learning. So while this study does not produce a "magic fix" for this complex problem in the form of pedagogy, it does provide an understanding of the barriers and makes suggestions on actions to address them. The intention is to further teachers' understanding of how to engage students with the mathematical complexities to fill the 75% of jobs (PWC Report, 2015) requiring higher mathematics levels.

1.7 Outline of the thesis

There is a perceived need for mathematical capacity within many careers in our contemporary world. The decline in achievement and student participation in choosing advanced levels of mathematics at school has been linked to a decrease in those entering careers with a mathematical orientation. Establishing mechanisms to have more Australian students achieve and participate in higher levels of mathematics at school, while desirable, has proved perplexing, especially for rural based students.

The current literature on learning mathematics in Australian secondary schools, the influence of context on the school and the impact of collective school environments on students learning mathematics are analysed in Chapter 2. This chapter uses Bronfenbrenner's systems approach (1981) to analyse the literature. The *micro-system*, *meso-system*, *exo-system*, *macro-system* and *chrono-system* emanate from the societal value placed on mathematics and the impact this has on the more immediate settings for the student. The literature analysis hence considers how various relational systems affect the environment of a rural based student.

Based on the conditions of learning discussed in Chapter 2, Chapter 3 considers the literature on the process of learning identified through Social Cognitive Theory (Bandura, 1997). With relevance to self-efficacy, student motivation and the impact of the environment on the students, this chapter summarises the theoretical perspectives of the construct. It explores the self-regulatory processes adolescent students use to influence their motivation to participate and achieve in mathematics. The chapter concludes by synthesising the processes of learning within the conditions of learning in diagrammatic form.

Chapter 4 outlines the explanatory-sequential mixed methods research design (Creswell & Plano Clark, 2011) to gather and analyse the data gained in this study. During the journey to understand this complex and so far unresolved issue, the researcher used a pragmatic approach to unpack the story being told by the students, schools and communities.

Chapter 5 outlines the results from the *Student Self-Belief in Mathematics* questionnaire for 869 students from four rural and two metropolitan based schools. The results present student perceptions of their mathematics self-efficacy for basic, intermediate and advanced level questions for the six content topics of the NSW syllabus and the Working Mathematically process strand according to a Likert style scale that measures students' perceptions between "cannot do" and "certain can do" (Bandura, 2006). In addition, the student responses to the four sources of self-efficacy and their perceptions of their parents'/carers' and teachers' attitudes to mathematics (using symmetrical Likert scale from "strongly disagree" to "strongly agree") are analysed and presented in this chapter. The analysis notes that responses from the students followed the same pattern for the three sections of the questionnaire, and there were more similarities than differences regardless of being rural or metropolitan based.

Chapter 6 describes collective environments of the schools gained from the descriptions from the *Myschool* and the schools' websites, field notes from discussions with the principal, data gathered from the profile section of the student questionnaire (for each of the schools) and the commentary from the teachers through the semi-structured interviews. This chapter describes the influences of the school and community environment on the students' self-efficacy. The sequential-explanatory method uses the profile data provided by the students in the sample, their comparative results from NAPLAN, the school descriptions from their website and the *Myschool* website, field notes from discussions with the school principal and teachers' semi-structured interviews to form a commentary of the environmental system the school exists within as they impact the student's self-efficacy. The analysis articulates the influence of the operational environments on students' self-efficacy with assertions deriving from these descriptions. The assertions respond to the explicit and implicit actions of teachers as proxy agents who work between the individual and the collective.

Chapter 7 discusses the two research questions using the quantitative data from phase 1 of the study, mixed with the qualitative data from phase 2. This chapter discusses the influence of environmental conditions that build mathematical self-efficacy beyond the proficiency of mathematical concepts. The imposed elements of the environment have an effect, through the macro-system and the system and school influence the exo- and meso-systems they can select and create. Unfortunately, the family and community influences mean a perceived lack of value is placed on advanced mathematics across rural and metropolitan geolocations. However, in their role as proxy agent, teachers have a part to play in breaking open beliefs about education and the relevance of higher learning. students

The concluding Chapter 8 summarises and interprets the study's findings and considers the similarities and differences in metropolitan and rural students' mathematical self-efficacy and its influences based on geolocation. This chapter highlights and theorises the influences of collective, proxy and individual agency and the importance of outcome expectancy in student motivation.

The study's primary finding is that there are many more similarities than differences between the rural and metropolitan-based students considering age, gender, Indigeneity, and parental background and knowledge of adult models. The outcome of this analysis indicates the drivers of the school are not based on the geolocation but the culture of the school's system, the school's organisation and the quality of the teaching and teachers. Geolocation does not pre-destine good structure, teaching or learning.

Chapter 2: Conditions for school learning in a rural setting

2.1 Introduction

Chapter 2 presents a literature review that describes, analyses and critiques the current thinking on a) students learning mathematics in secondary schools, b) the influence of context in which the schools sits, and c) the impact of the collective school environment has on this learning. This chapter argues that students are "natural learners" (Gardner, 2004) and that the conditions of their context impact their aspirations (Lyons et al., 2006) and achievement (NAP, 2018). Individuals and collectives are both products and producers of the systems that operate in their context (Bandura, 2008; Bronfenbrenner, 1891; Pajares, 2006). The literature on rural based contexts is analysed through the five systems postulated by Bronfenbrenner (1981) in his ecological systems of human development, as seen in Figure 2.1. The ability of rural based teachers and students to influence their environment is crucial in this study. Operational environments are influential on student motivation as explained through Social Cognitive Theory (Bandura, 1997) in Chapter 3. The interplay between Bronfenbrenner's ecological systems and Bandura's Social Cognitive Theory is depicted in Figure 3.1.

The chapter describes that while some students have innate attributes and capabilities, all are capable of learning competencies given the appropriate structures for their learning (Section 2.2). Given this proposition, the influence of structures and the environment to support students learning is explored through the lens of Bronfenbrenner's (1981) ecological systems model (Section 2.3). The *micro-system*, *meso-system*, *exo-system*, *macro-system* and *chrono-system* framework used by Bronfenbrenner considers the general influences on school students, and this analysis focuses on rural based students. This systems model stresses the reciprocal influence of all components of the relationships involved in student learning, where the parts, and the processes that link the components, all interact.

The purpose of the school is to enable their students to learn to high levels, regardless of their socio-economic status, location or ethnic base (DuFour, DuFour, Eaker & Karhanek, 2010). Robinson (2017) emphasises that effective schools have a high impact when they respond to the specific needs of the students. Hattie (2009) uses a meta-analysis of over 50 000 studies finding that student learning was most affected by teacher qualities and attributes, curricula and teaching processes, student characteristics, home traits, and school components. The school operates as a bridge between the students with their prior knowledge, values and aspirations, and the desired outcomes of high levels of achievement and understanding (Hattie & Zierer, 2018). Hence, school leaders and teachers need to stimulate student capability and desire to operate in high levels of learning (Fullan & Quinn, 2016).

For contemporary schooling to be successful, the school needs to have strategies to engage students with the world in which they live (Fullan, Quinn & McEachen, 2018; Zhao, 2012). The World Innovation Summit for Education investigated successful solutions in various contexts for deep and creative learning. Their case studies showed that when individual students saw a purpose for their learning within their world, they became agents of their learning regardless of gender, social class, location or ethnic group (Hannon, Gillinson &Shanks, 2013).

NAPLAN (NAP, 2018) verify that, in Australia, rural based student achievement is generally below that of students from metropolitan based schools. Dinham (2008) notes that students can perform outside of this trend even though it is a general trend.

The issue is how the teachers and school operations invigorate enactive and vicarious learning to enhance students' learning and motivation, regardless of the contextual factors, such as a rural location. Chapter 3 describes, analyses and deliberates on the processes of learning from the learner's perspective. The chapter contemplates explicitly the processes that build students to be agents of their world and, particularly, the influence of Social Cognitive Theory through self-efficacy (Bandura, 1997). This study investigates how learning processes are influenced by contextual conditions, specifically for rural students, and ties together social cognitive theory with Bronfenbrenner's ecological systems (1981).

2.2 Student learning

There has long been conjecture around whether intelligence is innate or learned. However, contemporary learning theories assert that learning is natural and education is a process that can and does develop student knowledge, skills, concepts and values (Fullan, 2016). Deep knowledge can occur regardless of gender, social class, location or ethnic group (DuFour, DuFour, Eaker & Karhanek, 2010). Dweck (2006), in her views on student learning mindsets, argues that that self-belief in their capability to learn to complex levels is a crucial factor. Bandura (1997) refers to this notion as a student's *conception of ability* that is built or reduced through the students' interactions within their collective, proxy, and personal environments (Caprara et al., 2004; Wood & Bandura, 1989).

Educational psychologists base their theories on processes that enhance thinking and the individual's development of knowledge (Bandura, 1997; Bransford et al., 2000; Bruner 1966; Dweck, 2006; Gage & Berliner, 1975; Gardner, 2004; McTighe & Wiggins, 2013; Pajares, 2002b; Wiggins & McTighe, 2007). Alexander, Murphy and Greene (2012) reaffirm that current educational theory is based on the seminal work of Dewey (1897) and James (1890) but argue that educational psychology theories are still evolving. The process of learning for humans is a complex combination of psychobiological and experiential conditions (Pajares, 2003).

Alexander et al. (2012, p.19) argue that education is <u>not</u> linear, where

Education = Someone + Something + Someone else + Some context

Hence, a person (someone) learns something from someone else within a suitable environment. However, the problem is that this statement is too simple as it implies a linear causal relationship based on adding or subtracting from the quantity of the variables. Bandura (1997) argues that the learning process is both enactive and vicarious, so the relationship between these variables is more complex than merely adding or subtracting a variable. Alexander et al. (2012) describe this complexity through a proportionate relationship, as noted below

Education = Someone x Something x Someone else x Some context (p. 19)

Considering the context, for example, Harris, Spina, Ehrich and Smeed (2013), through a review of literature, found that student learning is most effective when students' prior experiences are valued and expanded. In keeping with the notion that knowledge and concepts are built through educative processes is the belief that children "can learn practically anything by sheer will and effort" (Bransford et al., 2000, p. 112). Learning can be optimised through a combination of prior knowledge learning, openness to new experiences, beliefs about their (the students) learning, expectations, engagement and the ability to build a sense of self from the engagement (Hattie, 2009). Good schools provide the context that encapsulates these elements (Waters, Marzano & McNulty, 2003)

An essential factor in the learning process is the student (someone) and whether they believe their learning ability is set or can be enhanced (Dweck, 2006). When students believe that intelligence is a set entity, then they either feel they are not proficient in the tasks or, if they are proficient, can consider attempting an unseen challenging task can lead to failure (Carroll et al., 2009). When the risk of making a mistake is high, the potential to lose in face among their peers is socially dangerous and becomes a disincentive to experiment and challenge (Schunk & Meece, 2006).

The concept of a *growth mindset* or the "belief that your basic qualities are things you can cultivate through your efforts" (Dweck, 2006, p. 7) facilitates challenge and seeking higher knowledge and concepts. Those who view their ability as an incremental enhancement of skill are more likely to adopt a learning goal, seek challenging tasks to provide opportunities to expand their knowledge and competencies and consider errors as a natural, instructive part of an acquisition process. Hence, students' self-belief, self-concept and self-report of their grades are strong predictors of their achievement (Hattie, 2009). In summary, students must consider themselves capable of enhancing their learning to achieve as a natural learner.

2.3 **Influence of context**

While students are capable of learning, external environmental factors correlate strongly with student academic results. For example, the socio-economic status (SES) that measures resources available to the home and parent background (such as the occupation, education and wealth/income) often shows a divide with the achievement from higher SES students and schools outperforming those from lower SES communities (Rothman & McMillan, 2003). Achievement in PISA 2018 (Thomson et al., 2019) showed that generally, Australian students in the highest SES quartile performed well above their counterparts from the lower SES quartiles.

Geolocation of the home and school (i.e., rural and metropolitan) is another general dimension used to describe different levels of achievement (NAP, 2017; Thomson et al., 2017). Other contextual factors include cultural influences on gender, indigeneity (Aboriginal and Torres Strait Islander [ATSI)], ethnic language background (Non English Speaking Background [NESB]) (Thomson et al., 2019).

An insightful framework to analyse the interplay of context, culture and the individual is Bronfenbrenner’s (1981) ecological environment theory. This theory is a nested structure where the innermost level is the immediate setting of the individual. This "inner" environment is referred to as the *micro-system* and refers to interactions involving personal relationships such as family members, peers and classmates, and influential adults, such as teachers, coaches, and mentors.

Extending from the micro-system is the alignment of two persons (or dyad) with third parties, forming triads, tetrads and larger groups. Development is most effective when this occurs, and the process is hindered and can break down if the third parties are absent or disruptive. The *meso-system* describes the impact of the third parties on the human development of the individual. For students studying in secondary school, this system captures the collaboration between the classroom, the home, the school and the people and processes aligned to their perceived career and education pathways. The teacher's direct influence in this system also means that their professional knowledge, practice, and engagement can impact the students’ learning (NESA, 2018a). The perceived efficacy of the teacher, the students and the parents is crucial within this system. Learning is achieved through the influences of the complementary and competing microsystems of the individual.

The *exo-system* describes the entities that may not directly impact the individual but indirectly impact micro- and meso- systems. Holmes-Smith (2006) used student-level regression analysis with the explanatory variables of gender, indigeneity (Aboriginal and Torres Strait Islander [ATSI)], ethnic language background (Non English Speaking Background [NESB]) and Socio-Economic Status (SES), modelled against the response variable of individual test attainment in literacy and numeracy to investigate the relationship between SES and achievement. The multi-level regression considered school effects above and beyond that related to the individual student. A school-level means-on-means regression analysis considered proportions of girls, the proportion of ATSI students, the proportion of NESB students and average SES modelled against the response variable of average test attainment for the school. The analysis factors found that SES explained little of the variation between the performances of individuals. While the external environment is influential, the school can provide vehicles to diminish negative influences such as weak aspirations and expectations reflected in the meso-system and exo-systems.

In this study, the school's structure, procedures and culture, community aspirations and expectations, the available school curriculum, and the opportunity of the student to experience pathway options are likely discriminating factors between rural and metropolitan schools and students (Alloway et al., 2004). The priority and value placed on teacher allocations and class organisation and policies on curriculum, assessment, reporting, and resourcing influence the students' learning (Hattie, 2009). The *macro-system* is influenced by Government policy and school sector ideology, which impacts the exo-system through mandatory requirements and the priorities placed on school learning.

Critiquing the impact of schools on student performance has changed over time which exemplifies the chrono-system (the relationship between the other systems and the impact of the changes on these systems through time). For example, in the mid-1960s, schools were considered inconsequential as student capability was a fixed entity related to heredity, geolocation, socio-economic background and family circumstances (Dinham, 2008). Whereas a current view is that schools make a difference and are valuable when they "achieve greater student learning than might have been predicted" (McGaw, Banks & Piper, 1991, p. 2). The chrono-system traces the different views on the impact of the school's leadership, professional community (i.e., the teachers), school environment (expectations, harmony, resources), the quality of the instruction (what is taught and how it is taught) and how they relate to the local community (Barley & Beesley, 2007). Further, the longitudinal comparisons of PISA, TIMSS and NAPLAN have impacted the emphasis systems, schools, teachers, and students place on learning in schools.

Figure 2.1 diagrammatically displays the nested construct of Bronfenbrenner's ecological system and how the student is the focal point within the various dyads and third party influences.

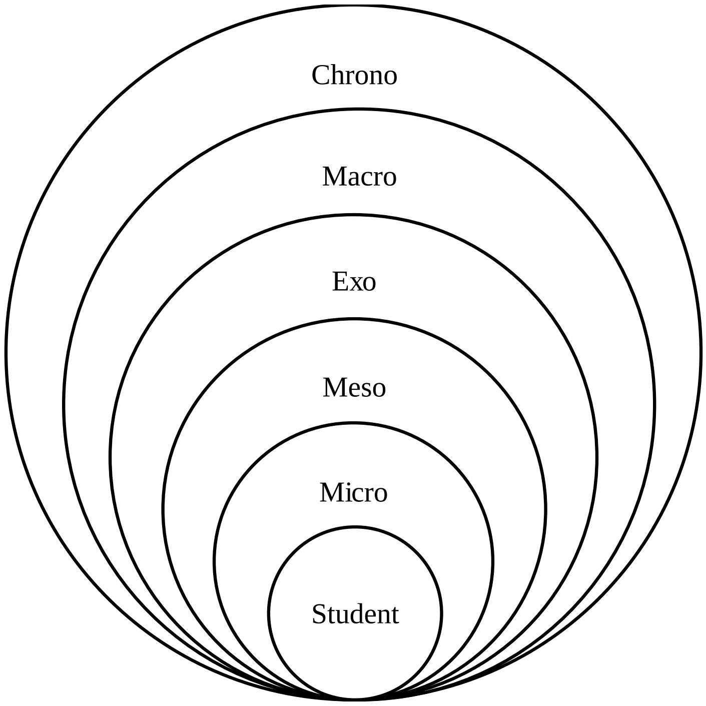

Figure 2.1 Bronfenbrenner's Ecological System

2.3.1 **Learning in the immediate environment (the Micro-system)**

Students are considered natural learners, but the contributions of their immediate environments vary. The experiences that build their conception of ability are developed through the student's relationships within their micro-systems at home, in the classroom, and through the teachers and peers (Bronfenbrenner, 1981; Pajares, 2006). The aspirations and value placed on learning are amplified within the dyads of the micro-system (Bandura, 1997). High self-efficacy and a growth mindset are enhanced when enactive, and vicarious learning receives specific feedback from those significant to the student within their micro-system (Dweck, 2006). Through this lens, McPhan et al. (2008) found that rural students' self-perception of their ability was influential in studying advanced mathematics.

2.3.1.1 The Home

Parental involvement is a critical ingredient for children's academic success as they form a dyad with their child (NSW DoE, 2019; Graves & Brown Wright, 2011). The home is considered the "nurturing place for achievement of students" (Hattie, 2009, p. 33), where parental expectations/aspirations are provided to the student and parents know how to interact with the school environment. Hattie argues that these socio-psychological measures influence responsiveness, restrictions, discipline, play, and the involvement of the parent/carers in all settings.

Parental involvement in elementary schools has a strong positive impact on students' achievement in literacy and numeracy, as shown through a longitudinal study over seven years in Chicago (Bryk et al., 2010). Similarly, these findings are supported through several meta-analyses of studies across the school years (Castro et al., 2015; Houtenville & Conway, 2008). Parent involvement has two bases, home (such as reading and assistance with schoolwork at home and setting aspirations) and school (communication, facilitation of parent involvement in school activities). Both are influential on student achievement, but each base's activities change accordingly with the students' age as the students seek more independence (Boonk, Gijselaersa, Ritzen & Brand-Gruwel, 2018). The development of internal control beliefs is optimised when there is a stimulating family environment, parents respond consistently and contingently to the child’s behaviour, provision of early independence training through granting autonomy, use of less hostile disciplinary techniques, and warm and emotionally supportive relationship with the child (Schneewind, 1995). As expected, when children grow, there are changes in management and guidance practices resulting in adolescents experiencing relational changes, uncertainty and challenge in the handover of control from parent to child within their dyadic relationships (Oettingen & Zosuls, 2006). Research supports the view that as "direct parental control declines, parental guidance takes the form of advice mutual confidence and trust" (Caprara, Scabini & Regalia, 2006, p. 99).

OECD data shows that urban students generally outperform rural students once SES factors have been adjusted except for Belgium, the United Kingdom and the USA, where rural based students do better on average than their counterparts in larger towns and cities (OECD, 2017). The impact of the rural and metropolitan environments can be distracted by other elements. For example, metropolitan areas often have higher parent income, education and wealth than rural areas (Habibis & Walter, 2015).

An Australian government report, *Maths? Why Not?* (McPhan et al., 2008) used online surveys and focus group interviews with teachers and students to investigate why rural based students are not participating and achieving advanced levels of mathematics in senior secondary grades. The report found that students’ self-perception of ability, perceptions of usefulness of the course, understanding of career paths associated with higher-level mathematics, advice from mathematics teachers and parental expectations and aspirations were significant in their decision to study or not to study advanced levels of mathematics.

Another Australian government report, *Factors impacting on students’ aspirations and expectations in regional Australia* (Alloway et al., 2004), used interviews, focus groups and parent surveys from 15 different communities (13 regional and remote, two metropolitan) across Australia. The study found that personal factors, social dimensions, obstacles to aspirations and expectations, and strategies to build student aspirations and expectations for their future were central themes. Student perceptions of their parents’ expectations and views on the usefulness of higher education are strong influences.

Both reports argue that rural based students are capable of higher levels of learning. However, their decision to engage in the higher levels of learning was related to their perceptions of the value rural based parents place on studying advanced mathematics (Alloway et al., 2004).

Further indigenous Australian families and their households are more concerned about their child’s wellbeing than learning outcomes at school (Schieicher, 2018). Ethnicity of the home was reported not to affect the number of interactions between parents and the school, but the perceived efficacy of parents in minority groups (such as low SES and indigeneity) was weaker and affected interactions with the school (Hill, Witherspoon & Bartz, 2018).

Effective schools establish positive connections with the parents and provide clear feedback on their children's learning (DuFour, DuFour, Eaker & Karhanek, 2010). A school’s positive collective efficacy can support or supplement the family unit and the student's well-being through the meso- and exo-systems they provide (Bandura, 1997).

2.3.1.2 The Teachers

Good teachers' behaviours and practices include using various interaction styles, creativity, flexibility, adaptability, and response to student learning styles (DuFour & Marzano, 2011). In Australia, these concepts are articulated as standards of professional knowledge (know students, how they learn, the content and how to teach it), professional practice (plan for and implement effective teaching and learning, create and maintain supportive and safe learning environments, and assess, provide feedback and report on student learning) and professional engagement (with colleagues, parents’/carers’ and the community) (NESA, 2018a). These standards are expected in all schools in NSW regardless of geolocation. The intended result of these standards is to build a relationship with the students that focuses on learning to feel safe to take risks. The relationship between teacher and student and the learning activities employed provide more effective learning than the resources such as curriculum and textbooks (Slavin, Lake & Groff, 2009).

An expert teacher tailors the learning activities to the context and selects or creates the instructional strategies, classroom management processes and classroom curriculum design to suit the students' learning (Waters, Marzano & McNulty, 2003). A scaffolding approach is expected in the development of concepts for each student, and in doing so, the teacher considers the individual physical’ social and intellectual characteristics of the students (Fischer et al., 2018). Teachers are expected to decide on the best strategies to develop the knowledge and understanding of their students. Students ultimately need to establish goals and expectations for themselves and evaluate and refine them as they develop high quality learning (Marzano, 2017; Robinson, 2011).

Studies in Australian schools validate that the teacher influences students’ mathematical understanding and that student concept development can be improved through good teaching (Sullivan, 2000; 2002; Sullivan, Clarke & Clarke, 2013). The ability to connect with the students to understand the content and concepts, develop a classroom that provides a safe and supportive learning environment, and use mathematics in a relevant way is a description of a "good" mathematics teacher (Murray 2011). It is not surprising that a teachers' confidence in teaching mathematics correlates with students' confidence in attempting mathematics (Arnold, 1996). When teachers have a strong sense of efficacy in their subject matter, teaching strategies, classroom management and relationships, they provide for their students' diverse needs (Schwab, 2019). The provision builds self-efficacy, persistence, resilience, self-regulation and achievement (Bandura, 1997; Schwazer & Warner, 2014). Teachers with higher efficacy judgements are more likely to be "open to new ideas, more willing to experiment with new methods to better meet the needs of their students, more likely to use powerful but potentially difficult to manage methods such as inquiry and small group work and less likely to use easy-to-adopt but weaker methods such as lecture" (Woolfolk Hoy & Davis, 2006, p. 120). The efficacy of a teacher is more than their enthusiasm within lessons and relates to the management of students and the use of pedagogy, questioning, and individualised feedback that builds towards deep learning (Wiggins & McTighe, 2007; 2013). In a study of 803 Grade 9 mathematics students, teacher enthusiasm was found to relate to teacher efficacy and lead to satisfaction from teachers. However, it did not necessarily lead to improved mastery levels of students or understanding of the utility value of mathematics (Lazarides, Buchholz & Rubach, 2018).

2.3.1.3 Non-mathematics trained teachers

The importance of teacher instructional expertise to facilitate higher learning levels for students is well researched (Dinham, 2016; Hattie, 2009; Robinson, 2011). The employment of non-mathematics trained teachers is a concern regularly expressed as a reason for the declining capability of students, especially in rural based schools. For example, AMSI (2014) found that 40% of Years 7-10 mathematics classes in Australia (junior and middle secondary) were taught by a teacher not qualified in mathematics, and this was three times the international average. The National Centre for Science, ICT and Mathematics Education in Rural and Regional Australia (SiMERR) report conducted a large scale study involving 2940 teacher surveys and 928 parent surveys with follow up interviews of 550 teachers, students and parents'/carers in 2005 (Lyons et al., 2006). The SiMERR report identified that teachers in rural based schools were twice as likely to teach outside of their subject area as teachers from metropolitan based schools and twice as likely to report it was challenging to replace science, mathematics and ICT teachers. Further, across Australia, 9% of Year 11 and 12 Mathematics classes were taught by a teacher with less than one year's tertiary study in Mathematics and 14.9% were taught by a teacher who had not completed methods in their training (AMSI, 2017).

The proportion of rural based students who experience non-mathematics trained teachers is notable in considering the gap in rural based students performance. The implication is that non-Mathematics trained teachers lack in-depth subject knowledge and effective teaching strategies, and, even if they are enthusiastic in the classroom, this has a negative impact on student learning in these formative years. Hobbs (2013) used qualitative methods to investigate the impact on 18 teachers teaching out of their field in rural schools in Victoria, Australia. She found that the context, support mechanisms and personal resources had the most effect. Support for newly graduated teachers or teaching out of their subject is enhanced if they are part of a collaborative team that provides professional learning and builds their capability and efficacy (Ayers, Dinham, & Sawyer, 2000; Pegg et al., 2007). Tytler, Symington, Darby, Malcolm and Kirkwood (2011) used interviews with 50 teachers (from 2 secondary schools, one P-12 school and three primary schools), principals and regional support officers in rural Victoria to find that professional learning of rural based teachers of mathematics was enhanced when they established discourse communities that allowed for collaborative, subject informed discussion.

2.3.1.4 Peers

As adolescents mature, they move away from their parents' influence, and they seek other social support to evolve their social systems in the form of friends within their peers (Zimmerman & Cleary, 2006). They observe and receive feedback, both verbally and non-verbally, from their peers regarding how they behave within their environment. This process tends to be bi-directional, with peers influencing each other, and is valuable as adolescents tend to choose friends with similar values and behavioural norms (Bandura, 1997).

The progression through secondary school means adolescents experience crossroads in their academic motivation and engagement. Not unexpectedly, adolescents' self-concept is affected by their peers, with students gravitating to those with similar motivational beliefs (Schunk & Meece, 2006). Adolescence is a time when peers influence attitudes, beliefs, values, and behaviours, but their influence can be positive and distracting (Wang, Kiuru, Degol, & Salmela-Aro, 2018). Hamm, Farmer, Lambert & Gravelle (2014), through observation and survey data of 188 teachers and 2543 sixth graders in rural schools across the USA, found that peer influence on effort and achievement was amenable to change can be enhanced through teacher professional development and intervention. Peers can be tutors and positive role models as long as the student considers the peer is competent (Attard, 2014). For example, an adolescent is unlikely to accept modelling from a younger person or someone they consider with less capability until they prove their competence (Schunk 2012). Schools can influence peer learning through in-class and out-of-class assistance and tutoring, making the classroom a place that students want to attend, and social facilitation through friendship, emotional support and feedback (Schunk & Meece). Alternatively, peers can impose a pressure that ridicules those who strive to achieve (Carroll et al., 2009; Schunk 2012), and there can be a strong cultural influence for students to adhere to the values of the collective environment (Habibis & Walters, 2015).

A robust collective efficacy influences the group through the meso- and exo-systems, and the peer influence can be enhanced, or the undesirable components of "peer pressur"' can be minimised through the actions of others in the collective (Bandura, 1997). An over-emphasis by the school on performance can lead students to give up because they fear failures compared to their peers (Dweck, 2006). The collective environment reflects the values and aspirations of that context and influences those within the environment. There is a tension between the desired aspirations of the schooling system and the sustainability of each community, particularly for rural based students (Alloway et al., 2004; Ceurvo, 2014; Lyons et al., 2006).

2.3.2 The classroom and school (The meso-system)

Parents look to the schools to assist in developing their children and in determining their future paths (McPhan et al., 2008). The prominent school-based figure in this development is the student's classroom teacher and the environment created within the classroom that builds a positive relationship with the student (Marzano, 2007). The classroom climate strongly affects student achievement when it heightens engagement, establishes cohesive groups, diminishes distractions, praises appropriate behaviour and actions, provides tangible recognition, and implements timely interventions for both behaviour and learning (Bryk et al., 2010). The impact on both behaviour and learning is maximised in the classroom through teachers providing formative feedback, clarity, positive teacher-student relationships, giving feedback, teaching student verbalisation, direct instruction and mastery learning (Hattie, 2009). Having strategies that maximised student engagement, on-task time, clarity of understanding, student-teacher relationship, student self-esteem and shared expectations characterise an effective classroom setting regardless of being rural or metropolitan (Pegg et al., 2007).

2.3.2.1 Moving from surface to deep learning

The shift to a pedagogy that builds creativity, critical reflection, communication and collaboration, within the micro-, meso- and exo-systems is essential in facilitating the mathematical skills considered essential for the twenty-first century (Jefferson & Anderson, 2017). However, in Australia, an increasing number of students consider attaining basic levels of mathematical competence at high school graduation rather than pursuing more advanced levels of study (AMSI, 2017). Hence, students' view of the utility value of mathematics is more about the "basics" rather than the deeper concepts. The teacher's task is to shift learning from surface to deep and then transference (Hattie, Fisher & Frey, 2017). It is arguable that if students find understanding and applying deeper knowledge accessible as their own agents, they will achieve better results and be motivated to participate in advanced mathematics courses.

Unfortunately, the pressure on teachers, from the other exo- and macro-systems (Bronfenbrenner, 1981), to focus on benchmark tests such as NAPLAN, TIMSS and PISA, may have the good intention of improving educational outcomes, but in reality is a distraction to realising the desired improvement (Hattie, 2015a). The consequences include "teaching to the test, narrowing the curriculum focus, increasing student and teacher anxiety, promoting direct teaching methods, decrease in student motivation and the creation of classroom environments that are less, not more, inclusive" (Thomson, De Bortoli & Buckley, 2013a, p. 64). Arguably, countries that place extreme value on the "Test", for example, NAPLAN, do not tend to develop confident and creative learners. Referred to as the "Prescription Trap", the external requirements that are prescribed and imposed by the government on schools can drive results that are low level and "ultimately on the wrong track" (Fullan, Hill & Crevola, 2006, p. 9). In addition, educationalists and futurists have noted concern that the move to national curriculums and the benchmark testing do not develop learners for an entrepreneurial, contemporary world (Zhao, 2012; Hannon et al., 2013). The fear is that prescriptive programmes reward and drive simplistic, measurable learning rather than facilitating deeper learning.

This discussion is not arguing about diluting students' knowledge of the "basics", but the expert teacher must establish strategies to deepen them with each of the students regardless of geolocation. Mathematics is a subject where students need mastery of essential facts before understanding the more complex ideas (Graham, Pegg, Bellert & Thomas 2004, Wiggins & McTighe, 2007). Having important facts available for automatic use frees up working memory, allowing analytical thinking and generalisations to develop (Green, 2005). There are three processes aligned with the *automatisation* of complex skills: *mergisation, contextual linkages* and *locus of attention. Mergisation* is where essential elements of the activity are merged into progressively more complex groups. *Contextual linkages* are the process where the action is predictive within a context, and the *locus of attention* is where the action produces observable effects (Bandura, 2008). Conceptualising teaching and learning as actions or goal-orientated processes and operations (psychic functions) builds the *automatisation* of fundamental ideas (Ho, 2006). The teacher then guides individualised student mastery that builds fluency, logic and sequence that continually deepens mathematical concepts (Hattie et al., 2017).

Teachers and school leaders articulate that good teaching mean that the students learn mathematics sequentially with a reduced fear of failure (OPC, 2009b). In their *Desktop Review of Mathematics School Education Pedagogical Approaches and Learning (ADGET, 2015a),* the Australian Association of Mathematics Teachers was commissioned by the Australian government to undertake an expert desktop review of the gaps in current pedagogical approaches and learning resources for the teaching of mathematics. A similar desktop review of pedagogy was concurrently undertaken by the Australian Academy of Science, who noted:

> We must aim to develop mathematical capabilities that are perceived by learners as powerful and genuinely useful in the present and future, through learning experiences students generally find engaging and that offer opportunities for exploration, explanation and creativity (ADGET, 2015b, p. 4)

Both reviews found a need to increase problems solving and inquiry-based learning into "normal lessons, calling on students to communicate their reasoning through collective argumentation. Such changes are essential to shift from a traditional' skills-competency based approach to learning for understanding, relevance and applicability (OPC, 2009a), as seen in Table 2.1 below. This thinking reflects the essence of the *AESOP* report (Pegg et al., 2007) and the suggestions from Dweck (2006) for teachers to focus on effort, process, challenge, and intrinsic reward for solving the problem rather than on performance with extrinsic rewards.

Table 2.1

Summary of changes suggested by the OPC to improve mathematics

Traditional beliefs linked with teachers who were less confident in teaching mathematics	Reform based beliefs linked to teachers being more confident about teaching mathematics
1. Mathematics is a set of operations to be learned.	1. Mathematics is a tool for thought.
2. Student's goal is to get correct solutions.	2. Student's goal is to understand.
3. The teacher needs to exercise complete control over mathematics activities.	3. Students should have some autonomy.
4. Mathematics ability is fixed and stable.	4. Mathematics ability is amenable to change.
5. Extrinsic rewards and grades are effective strategies for motivating students to engage in mathematics.	5. Students will want to engage in mathematics tasks if the tasks are interesting and challenging (not extrinsic rewards).

Source: OPC, 2009a, p. 13

Teachers' focus to develop students towards advanced levels of mathematics must surpass the performance of the competency of algorithms and content, and move to transference by the students to problem solving and application into the other school subjects (NESA, 2018b). Therefore, an essential task for the teacher in the micro and meso-systems is to scaffold mathematics relevant to understanding and living within the real world to gain students' interest. In doing so, these teachers avoid the terms often used to describe mathematics as "boring", "unenjoyable", "irrelevant", "not practical" or "cannot be used in real life" (Murray, 2011).

Undoubtedly, an unmotivated student is hard to engage in learning at any level. Longitudinal data from 2005–2009 of a stratified-cluster longitudinal sample of 6908 Korean seventh graders (starting in 2005) mapped their changes in intrinsic motivation to study mathematics. The study found that intrinsic motivation to study mathematics decreased for males and females across the middle and senior years in rural and urban areas (Lee & Kim, 2014). The teacher's role is to establish strategies and expectations that allow each student to consider that high levels of learning are accessible as complexity increases (Dohn, 2019).

Levels of *Australian students' motivation to learn and succeed in mathematics* were measured in PISA 2012 (Thomson et al., 2013b) through a four-point Likert scale (strongly agree; agree; disagree, and strongly disagree) for "I enjoy reading about mathematics", "I look forward to my mathematics lessons", "I do mathematics because I enjoy it" and "I am interested in the things I learn in mathematics". Australian students were slightly above the OECD average and were similar to United States, New

Zealand and Canada, but below the high-performing countries of Shanghai–China and Singapore. The Australian results indicated a bias by males, with 61% showing positive motivation to their mathematics learning than 46% of females. Similar results were also measured in PISA 2015 for student motivation levels in science, where once again Australia was above the OECD average but lower than countries such as New Zealand, Canada, United Kingdom and the United States (Thomson, De Bortoli & Underwood, 2017).

Changes to the motivation for students to study mathematics require development in teaching strategies that flow onto the students regardless of geolocation. Brandenberer, Hagenauer and Hascher (2018) sampled 22 mathematics teachers and their 348 seventh grade students from 17 secondary schools in the German-speaking part of Bern, Switzerland. The study evaluated the maintenance of self-determined motivation and self-concept in mathematics through a classroom-based, multicomponent intervention. Self-determination was considered by using controlled forms of motivation (e.g. students seeking to obtain rewards or to avoid negative consequences such as low grades, guilt or shame), identified regulation (e.g. students do extra work because they believe it to be needed for their prospects) and intrinsic motivation (e.g. students engaging freely in an activity simply for the enjoyment and satisfaction it brings) with the finding that both teacher and student intervention was needed to keep motivation at a high level.

2.3.3 **The collective environment of the School (The exo-system)**

The influence and importance of schools and their culture on student learning have been well researched over the years. For example, Gardner (2004) identified three assignments of modern schooling: national sophistication, deepening concepts within the discipline and production of forms of exposition and reasoning within the discipline. Assuming children are natural learners, schools should facilitate deep understanding that might not have occurred otherwise (Fullan et al., 2018; Marzano, 2017). School success should be defined by how they grow students' capacity by the time they graduate, not by the raw capability of their students, the quality of resources or structures set in place (Dinham 2017; Robinson, 2018).

To provide effective learning and outcomes for the students, schools need to establish a conducive environment that provides a challenge, supports setting high expectations, identifies targeted performance measures, develops self-regulation, self-evaluation of performance, and reduces errors (Hattie, 2009). Effective schools must provide a safe and orderly environment in their simplest form, have a well-articulated curriculum, and have teachers with pedagogical competence (Mazarno, 2017). The school's focus should be to provide high quality learning, with high levels of achievement, for all students (DuFour, DuFour, Eaker & Karhanek, 2010). Fullan (2016) reaffirms that education must have a well-articulated purpose that will evolve and adapt to those within the school. Marzano et al. (2016) cite mutual support and trust among teachers, having shared vision and values, focussing on improving student learning, focussing on teacher growth and professional development, intentional and systematic support of the collaborative model and inquiry-based approaches with the use of evidence as to the characteristics of a school learning community that produces optimal outcomes for their students.

Regardless of being rural or metropolitan, the overall achievement for students is more potent when they experience an expert team of teachers across their schooling who produce a school-wide learning environment, rather than having expert teachers working in isolation (Pegg et al., 2007). A strong and collaborative team of teachers has a more significant impact on the school environment as they build a culture of collegiality that builds their professional capital, which has a positive effect on achievement. Collegiality is not left to chance but is explicitly contrived to facilitate collaboration (Hargreaves & Fullan, 2012). The positive effect of teacher collaboration on student achievement is noted both in urban schools (Ronfeldt, Farmer, McQueen & Grissom, 2015) and in rural schools (Pegg & Panizzon, 2011). For rural schools, professional collaboration may involve forming teams from neighbouring schools (Tytler et al., 2011). DuFour, DuFour, Eaker & Many (2010) argue that an effective whole team approach with high professional capital and collective efficacy has more effect on improving student achievement than a solitary teacher even though the individual might be a highly effective expert.

2.3.3.1 School structures

The school environmental structures, such as timetable, courses, and students' experience of junior secondary mathematics, have some impact (McPhan et al., 2008). However, it is the action within the classroom where teachers adjust their teaching to deal with student needs to build a positive learning climate (Hattie, 2009).

The collective environment of the school reacts to the community in which it sits (Habibis & Walter, 2015) and establishes operational strategies to enable its learning focus. The school leaders and teachers establish the processes that have an instructional focus and are actively engaged in understanding and monitoring the teaching and learning of students from the local community (Hattie, 2015b; Robinson, 2011). They do this through developing a united moral purpose that understands the aspirations, expectations and values of the local community that form the appropriate actions to develop high quality student learning (Crowther, Kaagan, Ferguson & Hann 2002; Sharratt & Fullan, 2012). This moral purpose defines the collective environment of the school with a focus on student learning.

Having the strategic vision and establishing the procedures and actions to enliven this vision needs the hands-on support of the teachers and the middle leaders in establishing high-quality learning environments (Stoll, Brown, Spence-Thomas & Taylor, 2018). The practices, structures, expectations and rewards must support this vision (Fullan et al., 2006). Collaboration, co-ownership, reflection and sustainability of learning environments are enhanced when middle leaders create a culture of learning and openness, where experimentation and acceptable risk are supported, where teachers can speak their mind in a safe environment and where issues are explored with high relational trust (Robinson, 2017).

Schools that perform at high levels in mathematics have faculties that set high achievement expectations and implement strategies to realise these expectations. Policies and programs, the leadership from inside and outside of the mathematics faculty with a focus on learning, and harmony between parents and school leadership on facilitating high levels of learning must reflect the focus on high expectations (Robinson, 2017). Such schools have Mathematics faculties that value collegiality, support their faculty members and purposefully enculturate new faculty members into the beliefs and practices of the school (Pegg et al., 2007). Data are collected and analysed to focus on lifting the achievement of individual students to the next level of learning (Sharratt & Fullan, 2012). By analysing a set of case studies, DuFour, DuFour, Eaker and Karhanek (2010) describe the strategies and success of several elementary, middle and high schools from the USA that explicitly focused on student learning understood that resources and time were enabling variables. Collegiality can be observed through professional discussions, shared practice, collegial meetings, valuable homework, considered testing regimes, equitable grouping procedures, resources, technology, and classroom spaces. Engaging lessons, strong classroom management, support for student self-esteem and communication with parents are characteristics of high functioning Mathematics faculties (Pegg et al., 2007).

Waters et al. (2003) provide a well-accepted summary of the criteria of the collective school environment that improves student outcomes taking them from the level they enter the school and improve their outcomes regardless of their background and home environment (See Table 2.2).

Table 2.2

School and teacher practices and student factors influencing student achievement.

Component	Conditioning factor
School	1. Guaranteed and viable curriculum
	2. Challenging goals and effective feedback
	3. Parent and community involvement
	4. A safe and orderly environment
	5. Collegiality and professionalism
Teacher	6. Instruction strategies
	7. Classroom management
	8. Classroom curriculum design
Student	9. Home environment
	10. Learned intelligence/background knowledge
	11. Motivation

Source: Waters, Marzano and McNulty (2003, p. 6)

While Lyons et al. (2006) found that rural based teachers, students and parents perceived that their students did not have the same resources as metropolitan based schools, the list of school attributes in Table 2.2 does not include architecture, teaching resources and timetabling. The finances, the school size, the class size and the buildings have some influence, but the most effect on achievement relies on the teachers, leaders, students and families (Hattie, 2009). The various policies and procedures of a school are established to deliver the curriculum and reflect the collective school environment in which the students operate. The organisational policies and procedures of the teachers and students provide complementary or competing systems to their beliefs and aspirations in delivering high quality learning in mathematics.

Table 2.3 below addresses the attributes often schools touted as contextual operations of schools that affect the meso- and exo-systems of the school, regardless of external factors such as SES and geolocation.

Table 2.3

The impact of operational school attributes on student achievement

School Attribute	Effect size	Effect	Number of studies
Class Size	0.21	Small	96
School Size	0.43	Medium	21
Ability Grouping	0.12	Small	500

Source Hattie (2009)

Secondary schools with between 600 and 800 students have the best student achievement in mathematics and reading (Hattie, 2009). In contrast, larger schools can provide more curriculum offerings and opportunities for intervention, but they have a greater risk of decreased teacher-student interactions. Smaller schools reported more positive personal social interactions among students and between students, teachers and school leadership (Gouwens, 2009). Accordingly, smaller schools also reported that the teachers are more interested in the students and have more leadership opportunities.

The size of the classes also has a small effect. Discussion on the benefits of reducing class sizes is based on increasing individualised attention, student-centred teaching, minor student misbehaviour, more innovation, increased student engagement and teacher morale (Biddle & Berliner, 2002). Within-class contextual features, such as the size and number of within-class groups, can impact student characteristics, classroom management decisions, and teaching that affects the pupils (Blatchford & Russell, 2018). Generally, the effect based on smaller class sizes is small, and the greatest effect in the younger years of schooling (Biddle & Berliner). The use of appropriate teaching strategies dedicated towards the group of students, regardless of the number of students in the class, is considered to have a superior impact (Hattie et al., 2017). It is not the class size that counts, but the teaching strategies used to ensure each learner achieves. Smaller classes in rural based schools are a reality due to smaller school sizes. However, the lack of peers can restrict the educational experience (McPhan et al., 2008). This concern can be overcome by adjustments to the teaching style, as Hattie et al. (2017) argued.

Ability groupings or streaming is a school operational construct aimed at establishing homogenous groups that allow for targeted pacing and aligned concept development. Streaming is often popular amongst Mathematics teachers for the implied opportunity to focus on ability grouping and for teachers to respond appropriately. Forgasz (2010) used an online survey of 19 Government, 14 Catholic and 10 Independent post-primary schools in Australia to investigate teachers' views on school policies on streaming. Teachers identified the effects and errors of placement and selection, recognition there are alternate ways of catering for high and low achievers within mixed-ability classes, classroom management in "lower" classes, the use of under-qualified teachers in the middle to lower streams resulting in perceived disadvantage for these groups were limitations of streaming. The study also noted that the pedagogical practices in the classes of low achieving students were inconsistent.

In summary, there is little effect on student achievement. Chmielewski (2014) compared results for PISA mathematics results across OECD countries with tracked classes in the USA, reaffirming the findings of Hattie's (2009) meta-analysis that streaming (tracking) has inconclusive differences for achievement but reaffirmed the disadvantages of a low SES.

The length of lessons is a school attribute with disputed benefits. Commentators argue that longer lessons provide an opportunity for better teacher-student interaction and experimentation towards deepening thought. However, there is contradictory evidence of whether teachers change their practice to accommodate the extended time and elicit more in-depth concept development (Hipkins, 2008). The AESOP study that looked at high performing rural and metropolitan schools in NSW (Pegg et al., 2007) found that mathematics teachers preferred the length of 40 to 50-minute lessons, but this was the same structure that had operated in the school for many years. Those who had experienced 80-minute lessons likened them to *double lessons* in adjusting their pedagogy. It is the amount of time students spend on a task that is more important than lesson length.

These attributes are not specific to a particular location, and examples of streaming/non-streaming, shorter or longer lessons, smaller or larger class sizes can be found in rural and metropolitan areas. The structures of the school then represent the vision and underlying philosophies of the school. The attributes of the exo-system are across both rural and metropolitan locations (Pegg et al., 2007), although some attributes typical of rural schools are due to other factors such as their size.

Hattie argues that it is a collaboration of teachers, leaders, and systems that produces the best results in two provocative articles: *What works best in Education: The Politics of Collaborative EXPERTISE*. (2015a), and *What doesn't work in Education: The Politics of Distraction* (2015b). Schools can influence students' progress in learning by "having highly expert, inspired and passionate teachers and school leaders working together to maximise the effect of their teaching on all students in their care" (2015b, p. 2). The school system's role is to provide the support, time and resources to allow teachers and leaders to work optimally, thus forming collaborative expertise. Alternatively, he argues that political solutions can be thin if they try to address issues by appeasing the parents, adjusting the pedagogy, curriculum and learning spaces, explaining student deficits, creating new forms of schools, and changing teacher training, pay and student/teacher ratios (Hattie, 2015a). The collective school environment can be influential if they focus on improving student learning at the classroom, school and system levels (Robinson, 2017). This collaboration brings together the micro-, macro- and exo-systems with the aim of improved student learning.

2.3.4 **Goals of schooling for 21st Century Australia (the Macro-system)**

Contemporary educationalists argue that graduates from schools, regardless of being rural or metropolitan, need to have the capacity for deeper thinking (Zhao, 2012). Price Waterhouse Coopers (PWC, 2015) identified jobs that are most at risk (more than 80% chance of being automated in the next 20 years) as those with low levels of cognitive skill such as: accounting clerks (97.5% chance), checkout operators (96.9% chance), sales assistants and salespersons (85.2% chance), factory process workers (84.6% chance) and automobile bus and rail drivers (80.5% chance). There is growing attention in the contemporary literature to beckon schools to respond to these "new realities" and prepare young people to be creative, resilient and entrepreneurial, despite contextual influences (Hannon et al., 2013). Watters, Pillay and Flynn (2016) investigated Industry-School Partnerships through a longitudinal case study approach for one hundred and thirty secondary schools across both rural and metropolitan Queensland, Australia, within six industry sectors; Agribusiness, Aerospace, Building and Construction, Manufacturing and Engineering, Minerals and Energy, and Wine Tourism. Overall, the study found significant benefits to student outcomes and implications for government policy and school operational procedures when schools and industry worked together, regardless of their geolocation.

Governments consider education a national driver for prosperity and have established regimes of mandating curriculum and monitoring student achievement (Zhao, 2012). The emphasis on the HSC, NAPLAN, PISA and TIMSS and the commentary around the results exemplifies the importance governments place on this sort of testing (AMSI, 2017). The Australian government since 1989 has collaborated with the Ministers for Education (those who have political responsibility for school education from the states and territory governments of Australia) to produce four national public declarations on how to prepare school education for the "new realities" of a contemporary global world. The four declarations identify the various governments' long-term goals shaping the ensuing decade's policies and targets in all educational settings, regardless of rural or metropolitan. The goals include providing high standards and equity in developing knowledge, understanding, and skills for contemporary Australia's economic and social needs. The *Melbourne Declaration* (SCEEC, 2008) has two goals: promoting equity and excellence in schooling and a desire for Australian students to be successful learners, confident and creative individuals, and *active and informed citizens.* The emphasis is on equitably driving excellence regardless of location, ethnicity, Indigeneity, gender or SES and has been continued with the latest national statement from the Commonwealth's Education Council, the Alice Springs (Mparntwe) Declaration (AGDoE, 2019).

During this last decade, the drive for improving a mathematical underpinning of these goals is suggested by implementing STEM in schools across the nation (Education Council, 2015). AMSI (2014) also identifies the importance of well-prepared mathematical education programmes to ensure recipients are mathematically confident and creative, informed members of Australian society.

> The mathematical sciences play a pivotal role in today's knowledge economy. The discipline has a significant presence at all levels of the education system with the flow-on effects to many parts of Australian life, employment, research, business and government. (AMSI, 2014, p. 1)

Not surprisingly, the New South Wales Education and Standards Authority (NESA and formerly the BOSTES) supports the importance of success, confidence, creativity and ongoing, active learning in mathematics through its rationale in the mathematics syllabus:

> The study of mathematics provides opportunities for students to appreciate the elegance and power of mathematical reasoning and to apply mathematical understanding creatively and efficiently. The study of the subject enables students to develop a positive self-concept as learners of mathematics, obtain enjoyment from mathematics, and become self-motivated learners through inquiry and active participation in challenging and engaging experiences. (NESA, 2018b)

NESA envisions that the study of Mathematics has an educational depth that is more than computation and fluency to provide a vehicle for students to learn reasoning, understanding and creativity that engage them in challenging experiences. Schools in NSW must teach mathematics within the Australian curriculum until completing Year 10 (age 16) through mandatory mathematics syllabuses. The level of mathematics study is not prescribed, and students can choose in Year 9 and 10 from a standard, intermediate or advanced course. The compulsory nature of Mathematics reflects the importance government places on the subject. Equally clear is the desire for students to have a depth in conceptual understanding and application, not merely a mastery of essential numerical competencies. It is through the mandatory requirements that NESA drives the expectations in the school environment. Such requirements exist in rural and metropolitan schools.

2.3.5 **Learning over time (the Chrono-system)**

Governments are well aware that:

> Life in societies of today is undergoing accelerated social and technological change as well as growing global interdependence. These challenging new realities place heavy pressure on peoples' capabilities to exercise some control over the course their lives take. (Bandura 1995, p. ix)

The notions suggested by Bandura are reflected in the high level and noble goals set by the Australian Government. However, the accountability measures they use to assess the success of these goals has been primarily linked with benchmark testing in literacy and numeracy and results in the externally set HSC (in New South Wales). As with similar jurisdictions, the NSW government oversees educational and teaching standards through a government authority (NESA). NESA's curriculum rationale (NESA, 2018b) suggests a broader role for mathematical studies. Government accountability does not articulate how they measure these outcomes. Instead, the accountability measures are often based around NAPLAN, PISA and TIMSS as expressed through the AMSI discipline review 2014:

> Despite the introduction of programs to improve mathematical ability, NAPLAN national reports show that student performance in numeracy in Years 3, 5, 7 and 9 has not lifted at all over the past 6 years. (AMSI, 2014, p. 4)

The concern around the decline in student results in PISA and TIMSS has had the attention of several reports that suggest strategies to address this concern through policy, training and pedagogy (as noted in Section 1.2). Nevertheless, it is not possible to identify whether the plateauing of NAPLAN and decline in PISA AND TIMSS provides a valid critique of the higher-order criteria of *successful learners, confident and creative individuals* and *active and informed citizens (Melbourne Declaration: Goal 2,* SCEEC, 2008) without measures in place related to these higher goals. Success needs to be considered more than mastery of the "basics" of literacy and numeracy. Developing relevance and purpose for learning to required levels is vital to strengthen links between school and industry. Policies and strategies within the macro- and exo- systems are evolving to build stronger links between school and industry (Shipley, & Walker, 2020). The future of Australia within a 21st Century requires more than basic mathematical competency if the expectation of the rationale of the NSW syllabus, and the issues identified within Chapter 1, are to be realised.

This chapter began by citing a report from 2004 (Alloway et al.) that investigated the aspirations and expectations of secondary school students from regional Australia. In 2005 a substantial investigation was undertaken into understanding the perceived deficit of rural based students that led to the writing of the SiMERR report (Lyons et al., 2006), which was followed by a specific report into why students were not choosing advanced levels of mathematics (McPhan et al., 2008). In 2018 the Australian Government commissioned an *Independent Review into Regional, Rural and Remote Education* that reported on Curriculum and assessment, Teachers and teaching, Leaders and leadership, School and community, Information and Communication Technology, Entrepreneurship and schools, Improving access enrolments, clusters, distance education, boarding, Diversity and Transitioning beyond school (Halsey, 2018).

Similar to this thinking, NESA (BOSTES, 2016) has identified several concerns for the current HSC identifying eight principles based on improving standards, adjusting curriculum offerings and making assessment relevant to the needs of our contemporary world. Specifically, concern exists in students' perceptions of the value of courses that optimise their university entrance ranking (Australian Tertiary Admissions Rank [ATAR]). A high mark in standard mathematics currently leads to a higher ATAR than a medium mark in an intermediate/advanced course. Students see that being successful in a course with basic knowledge provides them with entry into prestigious tertiary courses without participating in the more challenging course. Students do not feel there is a benefit for the amount of work they need to apply to the more challenging course. NESA recommends using a common test between the mathematics courses to provide a weighting towards the advanced courses in calculating the ATAR.

2.4 **Conclusion**

The discussion in Chapter 1 established that both government and industry in Australia are concerned that students are not embracing the sophisticated mathematical principles, understanding and skills of the curriculum that they will need to carry Australia forward in the ever-changing global society. There is a belief by Australian authorities that schools should be able to produce excellence for all of their students regardless of where they live and attend school. This premise is agreed within current educational thinking where all students are considered natural learners regardless of their gender, ethnic background, social class or residential location (Bransford et al., 2000, Hannon et al., 2013). There is a complex weaving of contextual factors represented in this thesis in Bronfenbrenner's micro-system, meso-system, exo-system, macro-system and chrono-system.

These systems represent the interactions by the students, teachers, school leadership and educational policy as they attempt to facilitate improved educational outcomes for Australian students, and in particular Australian rural based students (Dinham, 2016). The context in which the school sits carries with it the beliefs, aspirations and expectations of the families within the environment and these influence the students and their motivation to study advanced mathematics (Habibis & Walters, 2015). A characteristic of a high achieving school and its ability to use the students' ecological systems (Brofenbrenner, 1981) to grow their capacity by the time they graduate. Hence, it is the role of school leaders and teachers to establish processes within the classrooms of a school, and the school as a collective, to support and challenge students to be agents of their futures.

Generally, the rural based schools' physical and operational structures are not different from the metropolitan based schools as they have resources, teachers, timetables, subject offerings, policies and leadership (Panizzon & Pegg, 2007). Alloway et al. (2004) assert that rural students' imagined futures are formed by, and in turn form, their learning conditions. It is the work of the leaders and teachers in their direct interface with students and their parent/carers that makes a difference in building student capacity and confidence to be agents. Building student self-belief in their ability and desire to study advanced levels of mathematics is complex and not solvable by broad-stroke mandates such as national curricula or benchmark testing from the macro- and chrono-systems (Hattie, 2015b; Zhao, 2012).

The ensuing chapters review the current thinking on how these conditions influence learning from the learner's perspective, explicitly considering students being agents in a complex world and the contribution self-efficacy can make in meeting these challenges. From then, this research project investigates how students are reacting, especially rural students, to the encounters of this world through an understanding of their self-efficacy. The study examines how learning processes are influenced by the contextual conditions of rural based schools.

Chapter 3: The processes of learning in mathematics

3.1 Introduction

The previous chapter provided a window into the contextual conditions that impact learning mathematics for rural based students through Bronfenbrenner's ecological systems model (1981). It also noted that some of these conditions existed regardless of geolocation. The literature review described, analysed and critiqued secondary school students learning mathematics to conclude that Australian students are capable of learning. However, how the students' sit within and the impact of the collective school environment influence their motivation, resilience, and application(Hattie 2009). It noted there is a link between the dyads, triads, and larger groups and the development of high self-efficacy and a growth mindset (Bandura, 1997).

This chapter describes and critiques the research on the processes of learning from the learner's perspective, specifically through the theoretical construct of *Social Cognitive Theory* (Bandura, 1989; Frey, 2018). Social cognitive theory is based on a triadic reciprocal determinism between the students' perceptions of their internal personal characteristics, behaviour, and environment (Bandura, 2008). It puts forward the view that learning occurs through observing the actions of others (vicariously) and the processes of internalisation (enactively) that then influence forethought and future actions (Phan, 2014; Schunk, 2012). Observations from the student's environment influence the cognition of their world that then drives their behaviour within their world through their micro-, meso- and exo- systems. Not only do the individual's perceptions of their environment impact their behaviours that build their personal attributes in mathematics, but their attributes govern the perceptions of their capability to perform these behaviours reciprocally, although not necessarily symmetrically.

Social cognitive theory contends that beliefs in capability are crucial in the processes of learning, as "it is not simply a matter of how capable you are: it is also a matter of how capable you think you are" (Pajares, 2006, p. 343). Vicarious and enactive experiences require regulation, reflection and evaluation for them to predict future actions and behaviours. The belief in a person's capacity to act successfully or not is referred to as self-efficacy (Bandura, 1997). This study contends that students' belief in their capability significantly influences whether they study advanced levels of mathematics.

Self-efficacy is domain-specific, meaning self-efficacy in mathematics is not necessarily the same as self-efficacy in other academic or non-academic areas (Bandura, 1997; Bong, 2006). High or low self-efficacy in English does not naturally lead to high or low self-efficacy in mathematics and vice versa. Hence, this chapter describes and critiques the literature that links self-efficacy and mathematics. The student's beliefs in their capability in mathematics are influenced by and influence their thought patterns, affective arousal, and choice behaviour in mathematics (Hackett & Betz, 1989). This study compares the environmental experiences of rural and metropolitan school students on their beliefs in their mathematical capability.

However, not all vicarious experiences within the ecological systems are cognised and then repeated. Hence this chapter investigates the literature surrounding the self-regulation actions that influence student motivation to engage in an activity such as advanced mathematics. While perceived mastery of advanced mathematics significantly influences student motivation to engage in it, the chapter argues that *Outcome Expectancy* is also a substantial influence (Bandura, 1997).

This chapter thus critiques the literature on the influence of parents, peers and the local culture on adolescent students, as models, evaluation, and self-regulation are enhanced or weakened when they operate within the values and social comparisons of the students' ecological systems. The chapter provides an alignment between Bronfenbrenner (1981) and Bandura (1997) in laying the platform for the resulting study.

The implications of the environment on self-efficacy and self-regulation in the learning process are used in Chapter 4 to inform the research design. The rationale for a comparative study between rural and metropolitan based schools provides scrutiny into the environmental impact on students' views of their efficacy, the sources, and regulation processes that increase or decrease their self-confidence in mathematics based on geolocation.

3.2 **Social Cognitive Theory**

Understanding the multi-dimensional aspect of human behaviour is perplexing, and psychologists differ in their views on how to explain best this complex nature (Alexander et al., 2012). Humans grow and develop through a combination of psychobiological and experiential conditions (Bandura, 1997). The ability to be your own agent is considered desirable in the changing societies of contemporary times where confidence, capability, innovation, and experimentation are highly prized (Bandura, 1997; Frey, 2018; Flammer, 1995; Hannon et al., 2013; Leroy, Bressoux, Sarrazin & Trouilloud, 2013; Schunk and Meece, 2006; Zhao, 2012; Zimmerman & Cleary, 2006).

Social cognitive theory explains the humans' control events that affect their lives through three nominated forms of agency: *autonomous* (free to act independently), *mechanical* (external forces that operate mechanistically to influence internal actions) and *emergent interactive* (a causal contribution to the individual's actions, cognitions and affects from autonomous and mechanical responses) (Bandura, 1997). Human agency is particularly relevant to adolescents where they determine when and how to assert control over their destiny, specifically in their decisions to study advanced mathematics courses (Pajares, 2006; Parker, Marsh, Ciarrochi, Marshall & Salah Abduljabbar, 2014). Being their own agent influences students' decision-making, especially when considering engaging in a more challenging study (Zhao, 2012).

Espelage, Merrin, Hong and Resko (2018) investigated within-person and between-person psychological and peer-related predictors of rates of relational aggression with 1,655 students in fifth–eighth grade from four public middle schools in the Midwest of the United States of America. Four waves of data were collected over two years and found no significant growth in relational aggression over time, consistent with social cognitive theory. These findings are important because school-based programs can affect student views on their human agency and their choices, for example, in areas such as anger management, control of impulsivity, empathy, and understanding victimization. Hence, school programs can impact students' sense of agency in the school curriculum.

There is an inter-relationship between external and internal factors that impact an individual's learning through the concepts of observational learning, vicarious reinforcement, self-reflection, self-regulation and prediction (Bandura, 1995). There is reciprocity between personal, behavioural, and environmental determinants when the individual's initial behaviour is regulated and evaluated (Bonincontro, 2012). The influence of social cognitive theory in educational settings notes that pedagogical approaches, feedback about performance, grading practices, the amount and type of attention from teachers and school transitions have the potential to impact self-efficacy (Schunk & Meece (2006). The social comparisons made by students within their environment reinforces their inability or ability to complete a task. Schink and Meece (2006) found that students who are unfamiliar with a task observe and evaluate their peers' behaviour to gauge their self-efficacy and motivation in an activity.

Schunk and Meece (2006) further note that the research on self-efficacy growth or decline using age development for teenagers as a variable has been inconsistent, thus insinuating that other dimensions with a school are also influential. Steinmayer, Weidinger and Wigfield (2018), through a study on grit (perseverance) in mathematics for two cohorts of German students, Grade 11 (n = 227) and Grade 8 and 9 (n = 586), found that persistence of effort contributed to student's prediction of their success. They also found that desire for perseverance on the task had a more substantial predictive power than openness, expectancies for success, self-efficacy, values, behavioural engagement and disaffection. Bédard-Thom and Guay (2018) used a correlational cross-sectional design with 515 high school students in Quebec, Canada, described the elements of mental toughness as a combination of tenacity, importance, positivity, task focus, self-efficacy, stress minimization, and task familiarity. Ernest (2010) further argues that perseverance is a product of self-efficacy in the learning domain of mathematics. Regardless of age or gender, self-efficacy is considered influential in academic achievement in mathematics (Putwain, Sander & Larkin, 2013; Suryadi & Santoso, 2017). If students do not see they are capable, or there is little value in the outcome, they will not pursue a study when it becomes difficult (Attard, 2014; Frey, 2018; Hoffman, 2010; Hoffman & Schraw. 2009). The research found that while self-efficacy is influential, it is one of several mechanisms that influence agency and achievement.

Schunk (2012) identifies that five mechanisms form the cycle that transfers vicarious experiences into human agency *(i) Self-efficacy, (ii) Goals and Self-evaluation of Progress, (iii) Outcomes and Expectations, (iv) Values and (v) Social Comparisons.* The mechanisms link with each other to improve motivation, learning and achievement. Evaluation and cognition of the behaviour are symbolised and reproduced through self-regulation (Ryan, Schunk & Usher, 2019). The actions are organic so that just as an individual observes, learns and acts from the influence of others, others observe, learn and act from the actions of the individual within the social setting. When humans gather together, they are affected by and affect the others in the collective. Schools are fertile environments for the alignment of proxy and collective agencies to produce students with high belief and desire to achieve within the domains of the school's curriculum (Bandura, 1997; Hattie, 2009).

The individual's agency development aligns with self-beliefs that lead to intentional, forward-thinking actions where a judgement of success is against goals and values (Schunk, 2012; Frey 2018). Self-belief that develops forethought is key to this causal structure (Bandura, 2006a). *Individual agency* occurs when people influence their behaviour and environment, especially in their micro- and meso- systems. They are both products and producers of their environment (Bandura, 1997; Bronfenbrenner, 1981). *Proxy agency* is social mediation where people within the environment rely on others to support their behaviour (Bandura, 2006a; Caprara et al., 2004). Such reliance is evident when children depend on parents, peers, and teachers to act on their behalf to benefit in the micro-, meso- and exo-systems (Karwowski, Gralewski, & Szumski, 2015; Ludwig, 2014). Within social environments, people pool their knowledge, skills, and resources for their mutual environment (Caprara et al., 2006). Goncu and Garvain (2012) reflected on a range of previous experimental research in conjunction with observational and ethnographic methods to describe and critique sociocultural approaches. They argue that children get socialised into the traditions of their cultures through their direct and indirect observations and involvement in daily events.

This perception to act together for the benefit of the group in collective events is called *Collective Agency* and aligns with socio-cultural activity. Collective groups determine what they value and establish activity to respond appropriately (Burawoy, 2015). Schools, for example, rural based schools, reflect their cultural setting (Alloway et al., 2004; Habibis & Walter, 2015).

Ahn, Usher, Butz and Bong (2014) investigated the impact of culture in building self-efficacy in mathematics. The sample of 2,893 middle school students in Korea (n = 416), the Philippines (n = 522), and the United States (n = 1,955) were surveyed to determine the influence of modelling by their teacher, family and peers. Through confirmatory factor analysis, the students were tested against power distance (based on status, authority, and legitimacy) and the collective/individualistic nature of vicarious learning and social persuasion of teachers, family, and peers. The vicarious experience from teachers and social persuasion by family members and peers proved to be significantly positive predictors of mathematics self-efficacy. Both acted as vehicles for values and social comparisons of the students' ecological systems.

Spicer (2011) used discourse analysis of one 39-minute sequence that was considered pivotal in rolling out a teacher reform by using everyday language in a large high school on the fringe of an urban area in the Midwest of the United States of America. The findings identified conditions and patterns of interaction that supported teachers' adaptation of institutionally derived reforms and actions mediated between the teachers and the school leaders. Hence the collective agency of the schools is considered influential in developing the agency of students (Donohoo, Hattie & Eells, 2018).

Bandura (1997) argues that a student's agency is a product of the collective agency and the proxy agents they encounter within their dyads, triads and larger groups. For secondary students, their social environment is a response to their self-efficacy in consideration of the task and the perceived value of the task, the models they experience and remember as being successful in the task, and the value placed on the task within the broader environment in which they exist (Bandura, 1997). Hence the personal agency in mathematics of rural based students is influenced by the collective environment of the proxy agency of those within this environment (Habibis & Walter, 2015). It is contended that rural environments' aspirations and expectations affect the collective agency and proxy agency of rural based schools and teachers. Australian based research acknowledges that the rural environment can impose values and aspirations that diverge from an academic focus in such pursuits as the study of advanced mathematics (Alloway et al., 2004; Lyons et al., 2006; Lyons & Quinn, 2010; McPhan et al., 2008).

This study seeks to identify whether the culture of rurality impacts self-efficacy and sources for rural based students compared to metropolitan based students.

3.2.1 Vicarious experiences

Observational or vicarious learning came to prominence with the *Bobo Doll* experiment of Bandura, Ross and Ross (1961). The Bobo doll was a toy with a rounded bottom and low centre of mass that rocks back to an upright position after being knocked down. The experiment, conducted at Stanford University, involved 36 boys and 36 girls aged between 37 and 69 months. Twenty-four children were exposed to an aggressive mode with the Bobo doll, 24 to a non-aggressive model and 24 as a control. The experiment showed that people learn by observation, not just through reward and punishment. This concept explains that members of the collective observe values and aspirations through actions and respond to this modelling (Bandura, 1997).

Observational Learning occurs when learners observe and adopt an action or value they had not known before. This learning's four components or sequences are *Selective Attention, Cognitive Representation,* *Symbolic Transformation, Anticipatory Motivation* (Bandura, 1989). However, "people cannot be much influenced by observed events if they do not remember them" (p. 24). Hence a significant function of the learning must be in transforming and restructuring the information within memory. The function is then matched with events within the observer's context through an internal comprehension of the activity. This crucial element distinguishes between the acquisition and the performance of the activity. People do not perform everything they see modelled. They must be motivated to further engage as "(m)odelling is not merely a process of behavioural mimicry" (Bandura, 1989, p. 24). Bransford et al. (2000) argue that the information students notice, organise, represent and interpret depends on their level of expertise. Hence in this study, the observations students make and remember are relevant to their competence in mathematics in their motivation to study advanced levels of mathematics. However, just observing a fellow student studying advanced mathematics does not necessarily motivate the student to mimic this activity.

The students must value the observation. They must then evaluate and regulate their learning before developing forethought, predicting likely outcomes, and evaluating the effort required for the possible result. If students observe explicit or implicit learning, they then consider if they have the capabilities and desire to complete the activity successfully (Bansford et al., 2000; Farkouta, 2003).

Adolescents are unlikely to accept mastery or coping mechanisms from a peer they consider to be inferior to them (Schunk, 2012). Similarly, students respond to teachers if they respect the teacher’s instructive and relational competence (Attard, 2014; Bryk et al., 2010; McPhan et al., 2008; Pegg et al., 2007; Woolfolk Hoy & Davis, 2006). In deepening how the students react, three modelling functions within vicarious processes are identified: *response facilitation; inhibition and disinhibition; and observational learning* (Ryan, Schunk & Usher 2019). *Response facilitation* refers to behaviours already known, including social prompts. *Inhibition and disinhibition* refer to the strengthening or weakening of the modelled actions by the observer. For example, classroom behaviour where students observe other students engaging in a culture of misbehaviour can be inhibited or disinhibited by those in authority. Teachers are influential figures and crucial within the social system of an adolescent facilitating positive behaviours and promoting a proactive environment (McGee & Wang, 2014; Woolfolk Hoy & Davis, 2006).

Through the modelling from respected peers and mentors, observational learning is also used to determine personal learning and performance goals within this predictive action. Carroll et al. (2009) investigated 935 students aged between 11 and 18 from 10 high schools in Australian cities regarding self-efficacy, academic aspiration and delinquency. They found that social self-efficacy had a strong influence amongst the peers and that schools had a significant responsibility to foster self-beliefs and involvement in appropriate academic and school-related activities. For adolescents, models and mentors need to be available to them as they form their views of possible post-school options and careers (Brown

& Lent, 2006). As adolescents move away from their parents, they seek other social support, which is often in the form of friends/peers. They observe and receive feedback, both verbally and non-verbally, from their peers regarding how they behave within their environment. Pajares (2006) notes the importance of effective modelling practices, selecting appropriate peer models and establishing appropriate grouping within classroom organisation to enhance the uptake of activity from model to observer.

This process tends to be bi-directional, with peers influencing each other. Adolescents tend to choose friends with "similar value systems and behavioural norms" (Bandura, 1997, p. 177). Hence, peer modelling is more likely to re-affirm the values they know (Pajares, 2006). Unfortunately, in the rural context, studying advanced mathematics is not considered relevant or valuable by many students (Alloway et al., 2004; McPhan et al., 2008; Pegg, 2009).

During adolescence, individuals use comparisons to manage and evolve their social systems (Schunk & Meece, 2006; Zimmerman & Cleary, 2006). Usher (2009) used qualitative methods to investigate the sources of self-efficacy for eight middle school students (Grades 6 – 8) selected from four subgroups of interest: African American girls and boys and White American girls and boys. Usher found that positive self-talk was an essential element of vicarious learning and self-regulation. Similarly, students' self-reporting of grades (Hattie, 2009) and their views on the school's collective efficacy (Donohoo, Hattie & Eells, 2018) strongly influence students' learning outcomes. Academically, Dweck (2006) warns that only valuing performance can lead students to believe they are not as capable as their classmates.

3.2.2 **Self-efficacy**

Self-efficacy is considered pivotal for "the origins of efficacy beliefs, their structure and function, the processes through which they produce diverse effects, and their modifiability" are consistently shown to have an impact on achievement (Bandura, 1997, p. 10).

Self-efficacy is considered the central mechanism in developing human agency, and human agency is considered the foundation of motivation, well-being, and achievement (Bandura, 2006). This personal causation includes intentionality, forethought, self-regulation and self-evaluation. Vicarious experience is considered only one of the sources of self-efficacy, with the others being enactive mastery, social persuasion, and physiological and affective states (Bandura, 1997; Lopez, Lent, Brown & Gore, 1997; Mulhern & Rae, 1998; Usher & Pajares, 2009). As an important mechanism of human agency, self-efficacy is assisted by goals, self-evaluation of progress, outcomes and expectations, values, and social comparisons (Schunk, 2012).

Using this as a base, Parker et al. (2014) used confirmatory factor analysis with data from 10,370 15-year-old Australians surveyed over seven years from a longitudinal instrument (LSAY) to identify if mathematics self-concept and mathematical self-efficacy made a difference in students gaining university ranks or entrance into STEM-related careers. The study discerned that both self-concept and self-efficacy were related to these endeavours, although the study did not consider the measures of parental aspirations, the value and importance that participants held for different post-school destinations and goal commitment.

Of the four theoretical sources of self-efficacy (Bandura, 1997), research has shown mastery experiences are the most influential and demonstrate to the student that previous success can predict future success (Arslan, 2012; Bandura, 1997; Carroll, 2009; Forgarz, 2010; Joet, Usher, & Bressoux, 2011). Farkouta (2003) used 15-minute explicit mastery teaching in 54 Year classrooms and 967 students in metropolitan government schools in Victoria, Australia, to develop self-efficacy. In concert with Bruner's scaffolded learning (1966) and conceptual transference (Wiggins & McTighe, 2006; McTighe and Wiggins, 2013), guided mastery is an enactive process that develops cognition. Bandura (1997) notes that mastery is more than a one-off action.

With mastery, students also combine their vicarious experiences to develop their perceptions of capability in future tasks. Pertinent feedback from peers as respected models (Attard, 2014) is positive. However, it can be damaging if the respected peers ridicule those who strive to achieve (Carroll et al., 2009; Sullivan, Tobias, & McDonough, 2006). Proxy agents influence observations and perceived mastery within the micro-, meso- and exo-systems through verbal and social persuasion (Usher, 2009). For adolescent students, the teacher is a crucial proxy agent in moving student's perceived self-efficacy through feedback and encouragement (Bandura, 1997; Pajares, 2006). Butz and Usher (2015) used mixed methods to analyse 2511 upper-elementary and middle school students, finding that social persuasion was an essential source of self-efficacy with mastery. They also found that teacher practices were influential, especially in praising effort, skill development and persistence rather than performance (Deci & Ryan, 2002).

Edelman (2006, p. 7) makes the point that "cognitions affect our feelings and our behaviours, so too our behaviours can affect the way we think and feel". Hence, if students' feel elation after mastering a particular mathematics problem, this affective reaction and any consequent physiological reaction will be cognised by the student about the activity. Perceived anxiety by students can negatively influence self-efficacy (Mulhern & Rae, 1998). However, anxiety can be energising when it implies a sense of importance in achieving a goal (Schunk, 2012). A substantial volume of research exists on mathematics anxiety and its relationship with perceived self-efficacy (for example, Galla & Wood, 2012; Hoffman, 2010; Jansen, Louwerse, Straatemeier, Van der Ven Klinkenberg & Van der Maas, 2013; Maloney & Beilock, 2012). The research acknowledges a high correlation between high self-efficacy and low mathematics anxiety.

When students exceed their perceived competence, mathematics anxiety acutely affects problem-solving efficiency (Hoffman, 2010; Hoffman &Schraw, 2009). Sherman and Wither (2003) found that the higher the mathematics anxiety, the lower the mathematics achievement. There is a belief that the students impact their cognitive processes if they have negative feelings about low competence (Bouffard-Bouchard, Parent & Larivee, 1991). The negative impact of anxiety can be limited to sections of the curriculum, such as counting but not subitising (visualising numbers) (Maloney, Risko, Ansari & Fugelsang, 2010). Similarly, higher mathematics self-efficacy is reported by students in the classroom context than the testing environment, suggesting negative anxiety testing (Neilson & Moore, 2003).

Seligman (1990) argues that optimism or pessimism associated with anxiety matters as much as a student's talent or desire. Authenticity in a relationship (Pajares, 2002b) and invitational theory (Zeldin & Pajares, 2000) are elements of positive psychology, but there is little literature available on the effects of positive psychology on academic self-efficacy (Bandura, 2008a). Perceptions of emotional and affective states are noted as sources that build or detract self-efficacy (Bandura, 1997).

3.2.3 **Mathematics Self-efficacy and Achievement**

Many studies investigate students' perceptions of their mathematical self-efficacy and the associated academic performance. Enactive mastery, often the major source of self-efficacy, is particularly relevant to mathematics as it is clear when students display mathematical mastery (Miller, Greene, Montaly, Ravindran & Nichols, 1994). Self-efficacy has a strong facilitative role in contributing to mathematics achievement (Nielson & Moore, 2003). Most studies into mathematics self-efficacy use a positivist approach and capture data through surveys that use a Likert style response scale that measure the belief in completing an activity. A small number of examples have used a qualitative methodology and have found this approach reveals information not apparent through a quantitative survey, especially for the vicarious experience, social persuasion sources and affective states (Usher, 2009; Zeldin & Pajares, 2000). For example, Usher (2009) found that students can use their parents' negative view of mathematics to motivate them to seek a better life (Usher, 2009).

The correlation between self-efficacy and achievement in mathematics is higher than in English, reading and science (Williams, 1994). The link between achievement and self-efficacy is bi-directional so that high self-efficacy leads to high achievement and vice versa (Williams & Williams, 2010). Several mathematics self-efficacy scales exist such as, the Mathematics Self-Efficacy Scale [MSES] (Betz & Hackett, 1993) that provides a measure of self-efficacy for 18 mathematics tasks, 18 mathematics problems and 16 mathematics courses related to general mathematics self-efficacy. As self-efficacy is specific to skills and tasks, different mathematics syllabuses need tailored scales to reflect the knowledge and skills of that programme (Bong, 2006).

The link between self-efficacy and achievement is regardless of gender (Williams, 1994), culture (Ahn et al., 2015; Joet et al., 2011), and student age. Middle school students (Arslan, 2012; Usher, 2009) and high school students (Liu & Koirala, 2009; Lopez et al., 1997; Williams, 1994), and university students (Cordova, Sinatra, Jones, Taasoobshirazi, & Lombardi, 2014; Hackett & Betz, 1989; González, Conde, Díaz, García, & Ricoy, 2018) displayed a positive correlation between mathematics self-efficacy and achievement. Investigating innate abilities also showed the vital link between mathematics self-efficacy and achievement Bandura, 2010). Mathematics self-efficacy is also evident in mathematics achievement in STEM subjects (Rittmayer, Beier, & Robbins, 2008) and problem-solving (Hoffman 2010).

This study seeks to understand whether the sources within their ecological systems (Bronfenbrenner, 1981) influence rural and metropolitan based students' perceptions of their self-efficacy. This study also considers the impact of the proxy and collective efficacy of the teachers and the school through the influence of students' perceptions of vicarious experience, guided mastery, social persuasion and affective states in response to their achievement. The individual, proxy, and collective efficacy are facilitated through the self-efficacy sources, but they need to be symbolised and cognised to influence the self-regulation that determines judgment and prediction.

3.2.4 **Self-regulation**

Self-regulation provides an understanding of the information of self-reinforcement such as standard setting, delay in gratification, goal setting, self-instruction, self-evaluation and self-reported grades (Hattie, 2009). Through self-regulation, people solve problems, create new courses of action and foster communication through self-belief in their actions that alter their social system (Schunk, 2012). Processes such as self-regulation are particularly relevant to secondary students as they develop and understand their capabilities and agency (Zimmerman & Cleary, 2006; Zimmerman & Labaun, 2010). Adolescent students expect to take on the responsibility for fostering and symbolising their learning as a stepping stone into the various contexts of post-school education, their work-life and their social life (Bandura, 1997)

Self-regulation is based on three phases: *forethought*, *performance* and *self-reflection* (Schunk 2012; Zimmerman & Labuhn, 2012). Forethought involves task analysis and self-motivation beliefs based on future events through self-efficacy and goal setting. The performance then involves self-control (strategy use) and self-observation (monitoring during the performance). Finally, self-reflection engages self-judgement and self-reaction as an evaluative function.

Self-regulation is a mechanism within the *Expectancy-Value Theory* (Wigfield & Eccles, 2000). The modernised *Expectancy-Value Theory* asserts that motivation is based on the prediction (forethought) of goal attainment (performance) and how much the goal is desired or valued (self-reflection) (Graham & Weiner, 2012).

Values develop through mastery, the intrinsic nature of enjoying mastery, the utility of future goals and the cost measured by the things given away to achieve this goal (Bandura, 1997). Outcome expectancy fits within the mediating process of motivation as students' perceptions of the worth of the expected outcomes compared to the amount of effort required to produce the outcome are strong influences on their preparedness to participate in the activity. For example, an advanced mathematics student would judge the expected value of learning a concept (such as logarithms) against the cost needed to be operationally proficient.

Learning through enactive or vicarious influences cannot be contextualised for the individual without self-reflection and not acted upon without self-regulation (Bandura, 2006a; Schunk 2012). The setting of goals embodies values and is "influenced by self-appraisal of capabilities" (Bandura 1995, p. 6). Such goals use analytical thinking, both deductive and inductive, with self-reflection and self-regulation to reinforce and deepen conceptual understanding. Cognitive constructions that influence perceived efficacy are a visualisation of the execution of the activities that are then considered against their actual and predicted success. The success leads to inferential thinking that self-regulates the decision of a person to engage in future actions (Bandura, 1997; Flammer, 1995; Locke & Latham, 2013). The accomplishment of the goal is measured against the collective environment's value of the goal. The value of the expected outcome of studying advanced levels of mathematics must out way the perceived detriments conceived by the student. The value placed on the effort needed to study advanced levels of mathematics in rural environments is considered pivotal (McPhn et al., 2008)

The empirical overlap between Expectancy-Value and Self-efficacy has been debated to consider the mutual causality (Williams, 2010). Self-efficacy is defined as the perceived ability to enact a specific behaviour, and outcome expectancies are described as "judgments about the likelihood of outcomes that flow from behaviour" (Williams, p. 418). The issue arises from a complexity where causality occurs between outcomes expectancy and self-efficacy, but one cannot have outcomes that flow from actions if the expectancy **precedes** the actions. A link exists between Expectancy-value and Self-efficacy, but the directionality and causality are still being determined (Williams, 2010).

3.2.4.1 Outcome Expectancy

Three different forms articulate processes to develop high levels of human agency: *causal attribution (attribution theory), outcome expectancies (expectancy-value theory) and cognised goals (goal theory)* (Bandura, 1997; Elliot, Dweck, & Yeager, 2017).

Outcome expectancy is "regulated by the expectation that a given course of behaviour will produce certain outcomes" (Bandura, 1995, p. 7). Humans act on expectancy determined by perceived capability, the likely outcomes of the actions and the value of the effort required. Hence, students wanting to attempt more advanced mathematics would expect to comprehend the mathematical concepts and value the effort required to gain the final results. However, if a capable person does not value the effort required for the result, they are unmotivated by the outcome and do not participate in the activity (Dweck, 2006). Hence students tend to predict the expected outcome and ascertain the value of the efforts and benefits before determining whether they will engage in the activity or not.

Explicit and challenging goals are considered crucial for enhancing and sustaining motivation, especially self-motivation (Deci & Ryan, 2002). Their levels of self-satisfaction influence such goals, perceived efficacy in goal attainment and the ability to adjust goals during the activity (Zimmerman, & Labuhn, 2012). There is an implication that goals need to be attainable and measurable (Schunk, 2012). Feedback on the goals allows the students to track their performance and adjust effort and strategy (Dweck, 2006). The timeliness and regularity of the feedback within the student's mico- meso- and exo-systems promotes goal adjustment (Hattie, 2009). The use of goals provides an impetus for self-actualisation and for students to feel they are part of something more than themselves (Marzano, 2017).

Dickson and Moberly (2013) investigated *Goal Internalization and Outcome Expectancy in Adolescent Anxiety* by surveying 70 adolescents (34 boys, 36 girls; aged 16– 18 years) about the importance and expectancies of intrinsic, identified, introjected and external reasons for anxiety. The study found that anxiety was significantly associated with heightened expectancies of undesirable goal outcomes so that anxiety extends to introjected reasons underlying approach goal pursuit.

Bandura (1997) argues a causal link between efficacy beliefs and positive and negative outcome expectancy. If participants have positive efficacy beliefs in their ability to deliver a positive outcome, but an adverse result is anticipated, there is a sense that protest, grievance and social activism can build the desired change. If there are negative efficacy beliefs for the same outcome, then resignation for the outcome and apathy are the likely results. If the efficacy beliefs are low, the individual does not believe they can affect the change to achieve the desired outcome, and they are likely to feel devalued and despondent. However, if the outcome is considered achievable and the participants have positive efficacy beliefs, productive engagement, aspiration, and personal satisfaction occur.

From the perspective of the school-aged adolescent being confronted with a changing world, they are troubled by their decisions to forge a path into their future world (The Social Research Centre, 2015). For some, the social environment has already established the aspirations for the students resulting in an intergenerational disadvantage (Habibis & Walter, 2015). For others, there is a direction forward where they are setting the path to the future through deep learning and engagement and can see a different end (Fullan, Quinn & McEachen, 2018).

There is reciprocity between personal, behavioural and environmental determinant when the behaviour is initiated, regulated and evaluated by the individual within the environment where the behaviours are actioned (Bonincontro, 2012). This study seeks to investigate the learning processes for rural based students and identify whether the rural environment affects their perceptions of their behaviours and personal attributes. The research reported in this thesis is based on the understanding that rural based students are capable but are not performing to their potential. In other words, the purpose of the research is to understand the motivation behind students' decisions to participate and resiliently engage with the study of advanced levels of mathematics.

3.3 Adolescence: shifting control

Adolescence is when individuals are managing significant biological, educational and social changes (Bandura, 2006). Given the mandatory role of schooling during this time, teachers, significant peers, parents and family members are vital social members of the student's micro-, meso- and exo-systems (Schunk & Meece, 2006). Adolescents must deal with the changing boundaries of their control, the proxy control exerted by their parents, teachers and the imposed control of the broader social system. There are changes physically and socially through puberty. This adaption period can result in a loss of personal control, where the individual becomes less confident in themselves and more conscious of social evaluation (Bandura, 1997).

In New South Wales, the context of this study, the students reach adolescence in a secondary school environment with multiple distinct lesson times with different teachers for each class. There is an expectation that secondary school students will have or rapidly develop "diverse self-regulatory skills, such as goal-setting, self-monitoring, time management and self-evaluation" (Zimmerman & Cleary, 2006, p. 46). The development of agency requires a drive from the individual. The preference, then, is for the proxy agents to use rational and firm control instead of authoritarian, directive, or unengaged methods (Pajares, 2006; Sorkhabi & Middaugh, 2014). The desired behaviours that build students' agency can be taught through dedicated prosocial behaviour programs. For example, Caprara et al. (2014) studied 151 middle school students in an intervention group and 173 students in a control group in a small city outside of Rome, Italy. Both groups were assessed three times, six months apart, with a Latent Growth Curve analysis showing an increase in helping behaviour and decreased physical and verbal aggression for the intervention group. Similarly, in their desktop audit of pedagogical approaches, the Australian Association of Mathematics Teachers found that teaching students to make and critique mathematical arguments lead to an enhanced agency in senior students (ADGET, 2015a)

The NSW curriculum rationale calls for the syllabus to "prepare students for life in the 21st century" and "to develop the capacity to critically evaluate ideas and arguments that involve mathematical concepts or that are presented in mathematical form (NESA, 2018b). Fullan et al. (2018) describes this as "deep learning" and argues that students need to possess character, citizenship, collaboration, communication, creativity and critical thinking. As such, students are nurtured to be entrepreneurial with high levels of agency (Zhao, 2012). The shift in control relies on developing independent and self-regulatory students (Zimmerman & Cleary, 2006). The evolution from dependence and interdependence to independence is a facilitated journey towards building agency (Bandura, 1997).

Astute proxy agents at the school ensure that students' interpretations are adaptive. They engage in effective modelling practices, select appropriate peer mentors and groupings, tailor instruction to the student's current capability, provide authentic praise, address self-handicapping strategies, praise effort and persistence (not ability), foster optimism, competence and confidence, challenge under-confidence and make self-regulatory practices automatic and habitual (Pajares, 2006). Good teaching builds students' agency.

3.3.1 **Influences of the teacher in developing self-efficacy of students.**

Teaching is more than delivering the prescribed curriculum (Ritchart, Church & Morrison, 2011). The Australian Professional Standards for Teaching (NESA, 2018a), under which the teachers of this study operate, states a teacher should be a "source of inspiration", "dependable", and "consistent". The school leaders and teachers need to respond context of the school through ecological systems in which the students exist (Bronfenbrenner, 1981). It is the role of the school, as a collective, to establish processes around and within the classrooms, and it is the role of the leaders and teachers to support and challenge students to re-imagine and predict their futures (Dinham, 2016). These are critical to building high levels of self-efficacy in complex areas of learning, such as advanced mathematics (Mc Phan et al., 2008).

As a critical proxy agent, the teacher has direct, indirect and relational consequences on students' perceived self-efficacy for success in mathematics and predicting the effort required to succeed. Woolfolk and Hoy (2006) describe the direct consequences from teachers on students' agency include the time student spends on the task, building student motivation through higher goal-setting, expectation, persistence, interest and creativity and willingness by the teacher to give and receive feedback that may lead to re-teaching, providing options in learning, innovation and adopting new methods of teaching. They then describe the indirect consequences of teachers on students' agency as co-regulating with students, building student autonomy, regulating against high and achievable expectations, placing value on "advanced" tasks, encouraging confidence, and providing timely and constructive feedback. Social persuasion is a crucial source of realising indirect consequences. Relational consequences establish personal responsibility for learning by the students, display care and warmth and deal appropriately with conflict and resolution.

High self-efficacy in their subject matter, the teaching process, classroom management, relationships with the individual students and their ability to influence the collective is essential (Woolfolk Hoy & Davis, 2006). Secondary school teachers, especially, are expected to have the specialist subject knowledge to build self-efficacy, primarily through the enactive mastery source (Forgasz, 2010; Woolfolk Hoy & Davis). Teachers need to select the curriculum's relevant knowledge, values, and skills, appropriate pedagogical tools, and proper formative feedback strategies for their class (Butz & Usher, 2014; Pegg & Pannizon, 2007). A favourable climate enhances the classroom environment with positive teacher-student and student-student relationships, which provides collective academic self-efficacy (Hughes & Chen, 2011). Similarly, a disruptive classroom environment harms student learning (Hattie, 2009)

Teachers also have a proxy influence on the collective environment. They are responsible for establishing the collective environment by influencing decision making at school, enlisting parent engagement, enlisting community involvement and creating a positive school climate (Bandura, 2006; Robinson, 2011; 2017). Using the sources of self-efficacy, cognitive processes, analysis of teaching tasks, and responsive feedback, teachers operate in an interactive relationship between the school's collective environment and that of each student within their class (Woolfolk Hoy & Davis, 2006). Ultimately, the school's collaborative environment and the teachers' proxy agency are geared to graduating students with high levels of self-efficacy both generally and in specific domains such as mathematics (NSEA, 2018b).

Students perceive mathematics as a challenging discipline. For example, the research articulates the student perceptions (Boaler, 2009), lack of engagement by students (Attard, 2014), misunderstanding of career directions (McPhan et al., 2008), mathematics anxiety (Bestwick and Browning, 2007) and a fixed mindset of mathematical ability (Dweck, 2006). Research also notes that the belief that learning and understanding mathematics is difficult carries through to adulthood, which can recirculate the view that learning mathematics is complicated from parent to child (e.g. AMSI 2014b; Bobis, 2009; Greiffenhagen & Sharrock, 2008). Teachers play a significant role in turning around the negative influences of anxiety and building students' views of mathematics self-efficacy.

3.3.2 Influence of collective environment on the perceived self-efficacy of students

The local environment reflects the local culture constructed from "all forms of human creation both material and immaterial" (Habibis & Walter, 2015, p. 114). The material creations of the environment mainly comprise economic resources, while the non-material creations include knowledge, beliefs, values, language and symbols. Each local environment has a particular culture, with parent variables (occupation, school education and non-school education), language background, Aboriginal and Torres Strait Island, accessibility/remoteness and Language Background Other Than English (LBOTE) used to ascertain the level of educational advantage of the area (ACARA, 2013). These variables reflect the local "environmental systems" and affect individuals through their families, communities, organisations, and social institutions, including schools (Bandura 1997).

The physical and socio-structural environments can empower and restrict status, power, and resources in the material, social, and political spheres (Habibis & Walter, 2015). Financial costs, family relationships, images of a good life and personal safety are obstacles facing students from rural locations when considering post-school education and careers (McPhan et al., 2008). For many regional and rural students, opportunities for study, training or work often result in students moving to a distant place, alone and with unknown relationships. The thought of moving can be emotionally challenging for both students and parents (Alloway et al., 2004).

The three agentic environments that schools operate within are described as imposed, selected or created (Bandura, 1997). While imposed influences are generally not controlled by the individual, people have the power over how they view the influences and how they react to them. A potential environment only becomes an actual environment when selected or created through action (Bandura 1997). Literature supports the suggestion that humans can and do influence their environment, and their environment can and does influence their behavioural factors and personal factors (Pajares, 2006).

For example, while low socioeconomic (SES) status is correlated with low achievement, students in low SES schools can achieve well, just as students in high SES schools may not achieve well (Dinham, 2008). While environments and social systems influence human behaviour, *Social Cognitive Theory* would argue that self-beliefs and self-regulation have a more substantial effect. Hence, while SES does not directly influence human behaviour, the aspirations, personal standards, emotional states, and self-efficacy beliefs within that social system may affect self-regulation and impact behaviour (Pajares 2002b). Unfortunately, there is a gap in the research on student self-efficacy in mathematics based on geolocation. This study investigates whether being in a rural based school impacts students' efficacy in mathematics.

3.4 Aligning social cognitive theory within the ecological systems

Social cognitive theory describes the impact of student perceptions of their personal attributes, behaviours and environment in developing their agency in advanced levels of mathematics. These perceptions are developed through vicarious and enactive learning and drive the students' beliefs in their capability. The actions to build or inhibit these perceptions occur within the system's framework of the conditions of learning described in Chapter 2 by Bronfenbrenner (1981). Ultimately agency must be owned by the individual, but the proxy influences within the micro-, meso- and exo-systems are crucial in its development and sustainment. The influences are not one–way, and the students can and do become products and producers of the elements of these systems. Whether through policy, perceived reality, or cultural value, the imposed operations from the macro-system impact the selection and creation of actions that influence student agency. Over time, the constructs of the macro-system can change and evolve.

The figure below articulates the impact of others on the individual through the mico-, meso, and exo-systems through vicarious learning and social persuasion. The influence of self is articulated through enactive learning (seen as mastery), self-regulation and outcome-expectancy.

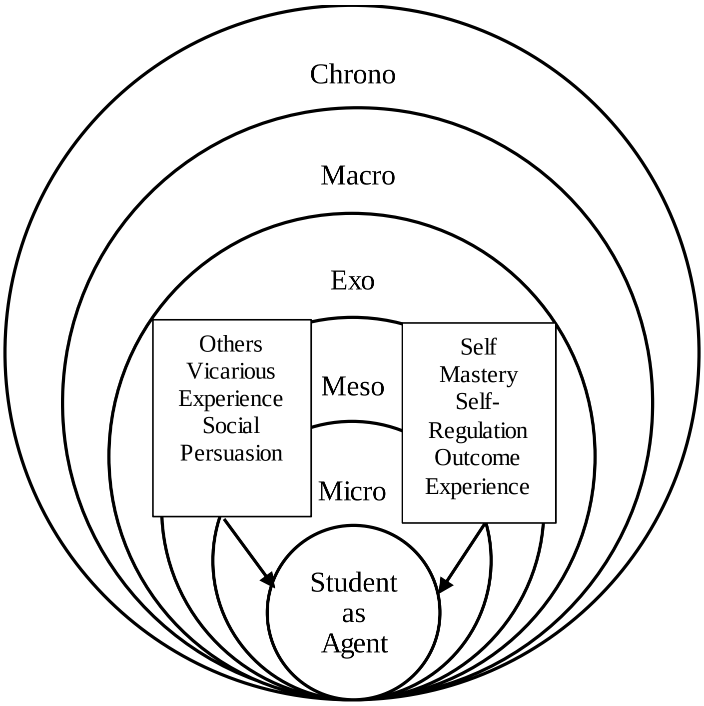

Figure 3.1 Aligning social cognitive theory within Bronfenbrenner's ecological systems

3.5 **Conclusion**

The issue being investigated in this study is whether self-efficacy in secondary school mathematics influences rural-based students in developing their agency to achieve and participate in higher mathematics levels. The review in Chapter 3 focuses on Bandura's Social Cognitive Theory (1997) as a learning process. At the heart of Social Cognitive Theory, human learning has enactive learning and vicarious learning. However, there is still much discussion on the best lens to view educational psychology to cater for the complexities of human behaviour. Unfortunately, motivational approaches often assume students value an expected, successful outcome, but "the most chronic and pervasive motivation problems are evident in children neither wanting to learn nor try (to learn)" (Graham & Weiner, 2012, p. 392).

Bandura (1997) takes the broader social environment into account and argues that student perception of personal, behavioural and environmental determinants acts bi-directionally on each other to form triadic reciprocity. The review of Chapter 2 provides a basis for understanding the impact of the various ecological systems on the individual through the lens of Bronfenbrenner (1981). The applications by the actors of the systems are intentional, act through forethought and are cognised through self-regulation and self-reflection for them to develop agency.

Social Cognitive Theory (Bandura, 1997) describes that human beings strive to work within, select and create an environment to suit their needs. Human agency and is seen in three layers: individual, proxy and collective. There is strong evidence to link school-based achievement with students' perceived self-efficacy and vice versa for specific academic domains, particularly mathematics. The research also indicates strong validation of the four major sources of self-efficacy: enactive mastery, vicarious experience, social persuasion, affective states (Butz & Usher, 2015; Usher and Pajares, 2009). While mastery is considered the most influential source in developing self-efficacy, the influence of the proxy and collective agents are also critical. The key proxy agents are parent/carers, teachers, and peers, who all operate within their social systems. These personalities influence the sources to develop and maintain students' perceived self-efficacy in high school mathematics.

After considering the available literature regarding students being capable of advanced levels of mathematics and the processes for personal causation that is described through self-efficacy, it is proposed that an investigation into perceived self-efficacy in mathematics will provide advice on why students are not choosing to participate in advanced levels of mathematics. Such a study will make a significant contribution to the field of education. After completing the literature review, it is clear there is a gap in research that considers the specific context and domain of self-efficacy in mathematics in rural based school. This gap prompts the research questions:

> Do rural and metropolitan secondary students differ significantly in their perceived self-efficacy in secondary school mathematics?
>
> What are the major influences on the perceived self-efficacy in secondary school mathematics for rural students?

The next chapter identifies the methodology and research methods designed to address these two research questions and includes the description of participants, the sources and analysis of the data, and ethical considerations.

Chapter 4: Methodology and Methods

4.1 Introduction

> "Treating people as thinking organisms enables researchers to gain a fuller understanding of why people behave the way they do." (Bandura, 1996, p. 329)

This study explores government and commentators' concerns on why rural students are not achieving or participating in advanced levels of secondary school mathematics courses by considering the student's perceived self-efficacy of mathematics and its sources. Measures of personal causation are seen through Social Cognitive Theory (Bandura, 1997) and aligned within the students' ecological systems (Bronfenbrenner, 1981).

As such, the following research questions are asked:

Research Question 1: Do rural and metropolitan secondary students differ significantly in their perceived self-efficacy in secondary school mathematics?

Research Question 2: What are the major influences on the perceived self-efficacy in secondary school mathematics for rural students?

However, efficacious reactions are complex and, according to Pajares (2003), "must be understood as having both situational and universal properties and within each of these properties evolutionary, biological, historical, social, cultural, economic, political, and interactive components" (p. 178). The perceptions held by the students, teachers and leaders involved in this study reflect constructed knowledge. The knowledge gained in this research reflects a complex combination of these properties and seeks to construct a new understanding as "an invitation to interpretation (Crotty, 1998, p.51) towards solving this baffling problem. The pragmatic desire of the researcher to analyse and interpret the situational and universal properties of the data gained from these questions constructed the research path described in this chapter.

4.2 Methodology

This section outlines a mixed methods research model (Creswell & Plano Clark, 2011). Mertens (2015) argues that mixed methods are particularly relevant for researchers trying to solve a problem "that is present in a complex educational or social context" (p. 304). The researcher believed this was evident in this study. Mertens then states that mixed methods have an intuitive characteristic and provide more depth to draw conclusions.

Creswell (2009) defined mixed methods as:

> … an inquiry that combines or associates both qualitative and quantitative forms. It involves philosophical assumptions, the use of qualitative and quantitative approaches and the mixing of both approaches in a study. Thus, it is more than just collecting and analysing both kinds of data: it also involves the use of both approaches in tandem so that the overall strength of a study is greater than either qualitative or quantitative research. (p. 4)

Hunter and Brewer (2015) argue that the social construction of knowledge needs to understand the conundrums around the knowledge. Particular to this study is the view described by Ernest (1998) that mathematics is a constructed knowledge based on six elements: mathematical knowledge, mathematical theories, objects of mathematics (character, origins and relationship with language), applications of mathematics (including relating mathematics with the knowledge of other disciplines), mathematical practice and the learning of mathematics (involving the transition of the other five elements). Mathematics is thus considered a constructed knowledge through *production* (i.e. mathematical knowledge is created), *re-contextualisation*, *reproduction* and *operationalisation* so that mathematical knowledge is elaborated with social knowledge through the "dialectical knowledge between them" (Ernest, p. 241). The perceptions of students, teachers, and leaders express this dialectical knowledge.

Creswell and Plano Clark (2011) note that the research design needs to consider (a) the research objective (such as exploration, prediction, explanation, evaluation); (b) the type of data and how it operates; (c) type of analysis to make sense of the data; and (d) type of inference that results from the study (Leech & Onwuegbuzie, 2008). The epistemology of the study and the strategies used to uncover the knowledge, analysis and inferences rely on where it fits on the subjective to the objective axis of inquiry (Pearce, 2015). This study acknowledges that teachers and leaders sit on this axis because of the students' perceptions within the micro-, meso- and exo-systems.

Leech and Onwuegbuzie (2008) suggest that concerns about a mixed-methods approach lie in the variety of designs or typologies that researchers use under the banner of multi or mixed methods studies. Alise and Teddlie (2010) investigated prevalence rates of methodology across social/behavioural sciences and established a term called "quasi-Mixed in nature". Studies with both quantitative and qualitative methods can be criticised for collecting two different types of data with little to no integration occurring in drawing inferences. This study gathers different data sets from within the school's ecological systems (Bronfenbrenner, 1981) and mixes the data through the lens of the perceived operational environments of Social Cognitive Theory (Bandura, 1997). Pano Clark and Ivankova (2016) bring together the considered opinion of several theorists to emphasise that integrating the data is essential in mixed methods. Issues of data quality based on the research question need scrutinising during the "mixing" of the data.

The knowledge drawn from quantitative and qualitative data of this study is intertwined, and a deeper and broader understanding can be discerned through the corroboration of the different data streams (Creswell & Plano Clark, 2011). Mertens (2015) argues that combining quantitative and qualitative methods reflects a pragmatic approach to finding the most practical and effective method of developing inferences from the study. The mixing of methods also balances the strengths and weaknesses of the data gathered (Plano Clark & Ivankova, 2016). The mixed-methods designs should be dynamic (Maxwell& Loomis, 2003) and have a synergistic effect (Hall & Howard, 2008) in the relationship between mixed design elements. Creswell and Plano Clark (2011) note that the design of mixed methods can be predetermined before the research begins or emergent, with the design taking on additional methods to gain a fuller understanding.

The typologies in mixed methods are either sequential or concurrent (or parallel), with the purpose of the research being explanatory, exploratory or transformative. Tashakkori and Teddlie (2010) note that "everyday problem solvers use multiple approaches concurrently or closely in sequence and examine a variety of sources of evidence in decision making" (p. 273). Mertens (2016) hence suggests that mixed methods have two overriding philosophical paradigms (pragmatic and transformative) with two temporal relations (parallel and sequential).

For this study, the researcher decided that the explanatory sequential methods design would best answer the research questions by mixing the student data with commentary from the teacher, leaders and school website c. The methods do not gather two separate sets of data but use the qualitative investigation to deepen the quantitative data set collected in the student questionnaires. Creswell and Plano Clark (2011) refer to this design as the explanatory-sequential design, where the initial phase collects and analyses quantitative data to collect information on the study’s questions. A qualitative phase follows this to explain the quantitative results (see Figure 4.1). The timing allowed the researcher to meet with the teachers of the students involved in the questionnaire. The researcher identified inadequacies from the teacher interviews during this phase and introduced an additional interview.

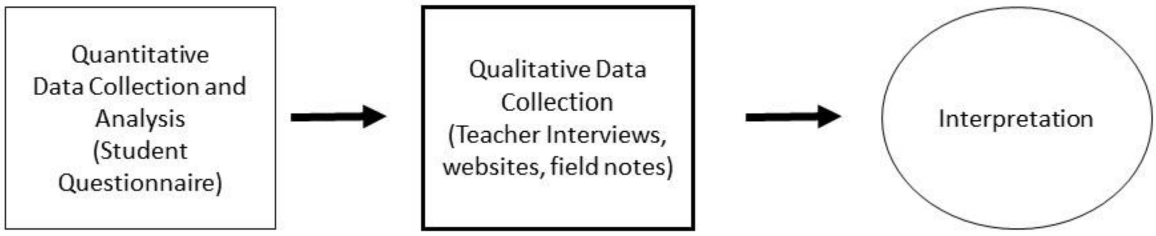

Figure 4.1 Explanatory-sequential Mixed Methods Research Design

(Adapted from Creswell & Plano Clark 2011, p. 69)

4.3 Methods Phase 1

This sequential mixed-methods study used two phases. The first phase gathered quantitative data in keeping with social cognitive theory from the students about their perceived self-efficacy and sources for the various subtopics of the NSW Mathematics syllabus. The student questionnaire also gathered students' information about their age, gender, indigeneity, language background of their parents, and perceptions of the education levels of their parents, the number of people they know who use advanced mathematics in their work and on their parents and teacher's attitudes to mathematics. The later information identified elements of the students' meso- and exo- systems (Bronfenbrenner, 1981). It also investigated the conditions of learning for the particular school regarding the students' vicarious learning and aspirations that indirectly impact the micro-system of the student (see Section 4.3.)1. The second phase gathered data from teachers, leaders, and school websites to understand and enrich the students' questionnaire results.

4.3.1 Participants – Phase 1

The study participants' first phase was 869 secondary students studying mathematics in rural (n = 540) and metropolitan (n = 329) secondary schools in NSW. The rural based sample of students surveyed represents 22.1% of the possible student population from the four schools. The metropolitan based sample of students surveyed represents 22.8% of the possible student population of the two metropolitan schools. The number of students involved in the questionnaire is listed in Table 4.1. The table identifies the school (*non de plume*), being rural or metropolitan, the school's student enrolment and the size of the sample involved in the questionnaire and the breakdown of ATSI and LBOTE students.

As gender has been a suggested influence on student achievement (Thomson et al., 2012), the researcher chose coeducational schools to provide a gender mix. Single-gender schools were not involved in this study.

Socio-economic status has been a suggested influence (Rothman & Mc Millan, 2003) and is reflected in the ICSEA scores provided by ACARA as part of the measure of educational advantage. ICSEA is a scale determined from fourteen variables that include parent occupation, parent-school education and non-school education, parent language background, the school's percentage of Aboriginal and Torres Strait Island enrolments, accessibility/remoteness, the percentage of Language Background Other Than English (LBOTE) and a NAPLAN weighted likelihood estimate score (ACARA, 2018). It has a mean of 1000 and a standard deviation of 100. The purpose of limiting the selection of schools to this band of ICSEA values was to avoid other influences, including socio-economic status, given the implied impact it has on student achievement (Dinham, 2016; Habibis & Walter, 2015). The chosen Schools had ICSEA scores between 1000 and 1070, putting them above average (1000) but within one standard deviation (100) of the mean inferring they experienced middle levels of advantage. Government sources provided the ICSEA for each school on the public website *Myschool* and are provided in Section 4.3.2

Three sectors of schools exist in Australia: Government, Independent and Catholic system. The latter two school systems require parents to contribute financially to the school through a designated fee. The schools of these systems are a choice from the local government school. As Hattie (2009) identified, attendance at fee-paying schools (e.g. Charter schools) has some influence on the learning outcomes. Hence schools from the Catholic sector schools were chosen for their similarity in the moral purpose provided on their public websites, although three separate governance entities (dioceses) were involved.

New South Wales provides its mathematics syllabuses in three stages, each with two-year stage groups. Years 7 (12-13years old), 9 (14-15 years old), and 11 (16-17 years old). The students studying in the same grade are approximately the same age, and they are engaged in the same curriculum provided by the state authority, although the sequence of topics varied from school to school. Given that years 7 and 9 are also years in which NAPLAN tests are conducted, the researcher considered these groups to be familiar with the style of questions used in the questionnaire based on NAPLAN wording and phraseology. Year 11 was added to the student participant group to provide a cohort of students who had already selected courses at the advanced, intermediate and general levels. Students from these grades also provided a snapshot of junior, intermediate, and senior school adolescents.

Participation in the research was voluntary, so permission was needed from the Directors of Education of the Catholic diocesan system to whom the schools belonged (see Appendix I) and then from the individual school Principals and parents'/carers' of the students (see Appendix J). The researcher made personal contact with several Principals from coeducational Catholic sector schools within the range of ICSEA during the selection period. Four rural based schools and two metropolitan based schools accepted the invitation to form the sample. The Principals who decided to be part of the study indicated their motivation was based on a desire to improve student self-confidence in mathematics and increase participation in higher levels of mathematics. In particular, the metropolitan based schools' Principals specifically nominated that improvement of mathematics mastery was part of the school's improvement plans and were motivated to participate in the research. The rural based schools were all from one diocesan system with a designated plan to improve student agency across the school, not just mathematics (DuFour, DuFour, Eaker & Many, 2010).

The sample included 477 female (rural n = 290, metropolitan n = 187) and 329 male (rural n = 250, metropolitan n = 142) students. The students of the sample were from Year 7 (rural n = 244, metropolitan n = 182), Year 9 (rural n = 189, metropolitan n = 121) and Year 11 (rural n = 101, metropolitan n = 22). The surveys were administered to the students by their normal classroom teacher in normal mathematics periods. While students could withdraw from the sample up until the time they sat the questionnaire, no schools reported students refusing to complete the survey. One non-serious attempt at the questionnaire was withdrawn from the analysis during data cleansing and not counted in the final total. During data cleansing, questions with double entries were discounted, as were questions where students had not responded to the question. Hence not all questions had 869 responses. The analysis only used the responses received. The mixed methodology used commentary from principals, teachers and information on school Websites to consider the data provided through the quantitative questionnaire.

Table 4.1

Number of students who participated in the Mathematics Self-Belief questionnaire.

School Name	Rural or Metro	Survey sample	School enrol	ATSI * (% of sample)	ATSI* (% Enrol of the school)	LBOTE** (% of sample)	LBOTE** (% Enrol of the school)
St Christopher's College	Rural	344	1040	3.5	3	9.5	3
St Benjamin's College	Rural	29	129+	20.7	6	7	3
St Catherine's College	Rural	114	207+	5.2	3	8	3
St Kathleen's College	Rural	53	1065	3.8	9	9.5	8
St Paul's College	Metro	77	919	1.2	1	61	35
St Sarah's College	Metro	252	522++	2.7	3	19	11
Total		869					

*Aboriginal and Torres Strait Islander; ** Language Background Other Than English; + K-12 school secondary enrolments; ++ 7-11 school with approximately 180 students to be added once Year 12

This research seeks to compare the mathematical self-efficacy, sources of mathematical self-efficacy and the perceived parent and teacher attitudes towards mathematics between rural and metropolitan based students. Hence, in phase 1, the student's responses were compared unweighted based on location given they represented 22.1% (rural based) and 22.8% (metropolitan based) of the relevant possible student populations. The proportion of students from each school who participated in the questionnaire was inconsistent. While this is partially due to the total individual enrolment of each school, it was apparent that when the Principal and the faculty leaders were supportive of the study, the number of students increased, which is considered in the analysis of Phase 2 of the study. The commentary from teachers and principals in phase 2 reflected the conditions and processes for learning found in the meso- and exo-systems of the school, that support the building of student self-belief in their mathematical ability. The student data was aggregated by initially by location, and then considered by grade, gender, language background, indigeneity, and the number of people students knew who used advanced mathematics in their jobs (see Section 5.2) for analysis. The proportions of each criterion based on location are recorded in Chapter 5.2. There is similarity in the student profile for both rural and metropolitan samples, except in the grade proportions. As such unweighted analysis was conducted. The implications for the analysis within the grades is noted in the limitations of this study.

4.3.2 **Index of Community Socio-Educational Advantage (ICSEA) for the selected schools**

ICSEA is the measure used by the ACARA to establish comparability between schools with similar students (ACARA, 2018). The sample's ICSEA values varied from 1011 to 1070 when questionnaire and teacher interviews occurred (2015 and 2016). The scores were within one standard deviation of the mean, indicating they represent above middle levels of advantage. The limiting of ICSEA values assisted in reducing outside influences.

Table 4.2

Index of Community Socio-Educational Advantage (ICSEA)

School	School Name (fictional)	2013	2014	2015	2016	2017	2018
Rural School 1	St Christopher's College	1011	1009	1011	1014	1016	1014
Rural School 2	St Benjamin's College	1023	1017	1020	1011	1015	1000
Rural School 3	St Catherine's College	1045	1040	1046	1042	1043	1036
Rural School 4	St Kathleen's College	1024	1024	1022	1025	1028	1025
Metro. School 1	St Paul's College	1070	1074	1065	1070	1070	1074
Metro. School 2	St Sarah's College	1024	1021	1030	1029	1037	1034

Source: Myschool website (www.myschool.edu.au) 2013-2018

Additionally, the Myschool website reports that the mix of students across the four quadrants of SEA is where Q1 is the lowest quartile and Q4 is the highest quartile. Table 4.3 below shows that all six schools of the sample had between 56% and 71% of students in the middle two quartiles (i.e., middle 50%) of the SEA, indicating they were middle to upper-middle socio-educational contexts. Social-educational advantage, parent education levels and students' knowledge of people who use advanced mathematics in their jobs were considered evidence of third parties (exo-system) who influence student aspirations towards participation in advanced levels of mathematics (Habibis & Walter, 2015). The implication that higher levels of social-educational advantage were linked with parent education at tertiary levels (Thomson et al., 2017) was analysed through the teacher and principal comments, especially where SEA quartiles seem to match this suggestion. A crucial point from this discussion is that success in some communities is not perceived by the tertiary education or trade-based training of parents, which negatively impacts students' value on studying advanced mathematics levels.

Table 4.3

Socio-Educational Advantage (SEA) national quartiles of student background for the sample schools 2015-2018

School Name	Year	Q1 (%)	Q2 (%)	Q3 (%)	Q4 (%)
St Christopher's College	2015	21	36	31	13
	2016	20	35	33	13
	2017	19	34	33	14
	2018	20	35	36	10
St Benjamin's College	2015	21	30	27	21
	2016	25	29	27	18
	2017	24	31	27	19
	2018	28	35	25	16
St Catherine's College	2015	11	30	33	26
	2016	12	32	32	25
	2017	14	29	32	25
	2018	15	30	33	21
St Kathleen's College	2015	16	31	30	22
	2016	16	31	31	25
	2017	16	29	32	24
	2018	17	29	32	22
St Paul's College	2015	10	24	35	31
	2016	10	21	35	34
	2017	10	23	35	32
	2018	8	22	38	32
St Sarah's College	2015	17	33	33	18
	2016	16	35	32	16
	2017	16	32	33	19
	2018	18	32	34	17

Note: Q1 is the bottom quarter, Q2 and Q3 are the middle quarters, and Q4 is the upper quarter.

4.3.3 **Data Sources**

The data gathered by the student questionnaire had four sections. Section 1 gathered student profile data. Section 2 gathered data on the perceived sources of mathematical self-efficacy nominated by Bandura (1997) using a six-point Likert scale. Section 3 used the method suggested by Bandura (2006) and Bong (2006) to collect student perceptions of their mathematical self-efficacy and use an 11-point scale. Section 4 assembled student perceptions of their parent and teacher attitudes to mathematics using a six-point Likert scale.

4.3.3.1 Developing Phase 1: Quantitative Questionnaire

The first phase of this explanatory-sequential mixed-method design measured students' perceived self-efficacy in mathematics, their perceived sources of mathematics self-efficacy and their perceptions of parent/carer and teacher attitudes to mathematics. Bong (2006) nominates three criteria to ensure the measures gathered self-efficacy rather than self-esteem (feelings) and self-concept (past experience). Firstly, self-efficacy is a predictive function that reflects confidence to "successfully execute the required behaviour under the specified circumstances" (Bong, 2006, p. 293). Secondly, while acknowledging that the affective outcomes are part of the moderation of self-efficacy, items do not seek emotional responses that may arise from the prediction, such as joy. Thirdly, asking relevant questions about competence compared to others or similar past experiences is not a robust predictive measure of perceptions against the designated criteria. Hence questions are not relative to other students or experiences.

Bandura (1997), Bong (2006), and others (such as González et al., 2018; Williams & Williams, 2010) describe self-efficacy as domain-specific and skill/task-specific. As this research investigates self-efficacy in mathematics, questions are geared towards mathematics self-efficacy, not general self-efficacy or self-efficacy for other subjects. The questions are designed to collect information on *Mathematics Self-Efficacy* for the relevant skills of the sub-strands of the curriculum.

The student questionnaire contained a section to build the student profile (e.g., gender, indigeneity) and three sections that asked for student perceptions self-efficacy sources and proxy agent attitudes. It was developed by the researcher using survey questions adopted from existing instruments for Section 1 (Student Profile), Section 2 (Sources of Self-efficacy), and Section 4 (Parent/Carer and Teacher Attitudes to Mathematics). These sections were standard across the grades, with space for the students to answer each question on the questionnaire.

The responses to Section 1 provided measures against established important profiling criteria with students identifying their gender, indigeneity, perceptions of their mothers'/fathers' education, language spoken at home and the number of people the student know who use advanced mathematics. Sections 2 and 4 use a six-step Likert scale with 1-Strongly Disagree, 2-Disagree, 3-Disagree More than Agree, 4-Agree More than Disagree, 5-Agree, and 6-Definitely Agree. The six-point scale provided a sufficient number of steps to ascertain the "variations in student's judgements" (Bong, 2006, p. 299) and the clear distinction between student agreement or disagreement with the statement through its symmetrical design.

The student questionnaires were designed and printed to be scanned using Opscan8 optical mark recognition that was then uploaded as a Microsoft Excel spreadsheet for cleansing before analysis through IBM SPSS version 26.

4.3.3.2 Section 1: Student profile

Student confidentiality was ensured, and names were not collected from those participating in the questionnaire. It was considered that anonymity encouraged the students to respond honestly and provided them with privacy as part of the ethics of the study (Mertens, 2015). A number system distinguished students by geolocation, school and grade to compare during the analysis stage. There was no linking of the number system with student names or their results to ensure anonymity. Pseudonyms represented school names involved in this study for privacy reasons, and references or descriptions to their websites were reported in standard phraseological terms to avoid detection through search engines.

Student profiles were gathered to analyse their responses against elements of the profile. First, students were asked to identify their gender ("Male", "Female"), allowing the study to evaluate whether gender was a determinant in the student responses (Hattie, 2009; Zeldin & Pajares, 2000). Students identified if they were Aboriginal or Torres Strait Islander [ATSI] ("Yes", "No") to appraise the impact of indigeneity given the well-documented gap between ATSI and non-ATSI students in NSW (NAP, 2018).

In developing an understanding of the students' collective environment (meso- and exo-systems), information was gathered regarding student perceptions of their parent and family background. Students' declarations of Mother's Education and Father's Education ("Left school before Year 12", "Year 12", "Trade Certificate or Diploma", "Degree" and "Don't Know") was in keeping with the PISA 2003 Student Questionnaire (OECD, 2019) and the TIMSS surveys (Thomson et al., 2017). While parent education was an element of social-economic status, this study was more concerned with the possible vicarious experiences from parents as models, and the social persuasion students received to participate in higher mathematics levels. In keeping with Bourdieu's concept of field (Habibis & Walter, 2015), it was theorised that parents with higher levels of education acted as positive models and provided support and reward for students studying advanced levels of mathematics and the contrary for parents with lower levels of education (Caprara et al., 2006; McPhan et al., 2008). Student perceptions of their parents' background provided insight into their view of their homelife's collective and proxy agency within their ecological systems.

Similarly, the nomination of the language spoken at home ("English", "Mostly English", "Mostly my parent's native language", and "My parent's native language") described student ethnicity. Ethnicity is an area reported by TIMSS, PISA and NAPLAN and non-English language backgrounds and is considered a possible area of disadvantage (Australian Government, 2011). However, others see cultural influences as positive and drive students to achieve high levels, especially in mathematics (Ahn et al., 2015; Kim & Park, 2006; Oettingen & Zosuls, 2006). This element was designed to identify effects due to aspirations or issues related to new migrants within the school population.

The students were asked to nominate "How many people, other than your Maths teacher, do you know who use advanced maths for their job? E.g. engineer, accountant, scientist". The response options: *0, 1, 2, 3, 4, 5, 5+* provided for nil, low, medium and large responses as Brown and Lent (2006) and Betz (2006) argue that a link exists between student self-efficacy and the decisions they make about careers, including those that use advanced mathematics.

4.3.3.3 Section 2: Sources of self-efficacy

The questions in this section used the validated work of Usher and Pajares (2009) from a three-phase process that included a focus group, made up of students, teachers and parents, trialling and checking for consistency through confirmatory analysis and seeking opinion from experts (Bandura, Zimmerman and Schunk) to select 24 items that were based on Social Cognitive Theory. Usher and Pajares identified six questions for each of the four sources with good internal consistency as measured by Cronbach's alpha coefficients (mastery $\alpha = 0.88$, vicarious experience $\alpha = 0.84$, Social persuasion $\alpha = 0.88$, and physiological states $\alpha = 0.87$). The internal consistency provided confidence in the reliability of the questionnaire. The commonly used indices for the confirmatory factor analysis were employed with Satorra-Bentler (S-B χ^2 (246) = 601.21, $p < .0001$), Comparative Fit Index (CFI = .96), Root Mean Square Error of Approximation (RMSEA = 0.4) and the Standardised Root Mean Square Residual (SRMSR = 0.4) meaning that the questions measured the theorised source. All standardised factor loadings were at the $\alpha = 0.5$ level ranging between 0.61 and 0.83.

Seventeen of the twenty-four items from Usher and Pajares (2009) were worded as a positive statement (e.g. "I make excellent grades on maths tests"). The exceptions were one question in mastery ("Even when I study very hard, I do poorly in maths") and the six questions for physiological states that depicted negative emotions (e.g. "I get depressed when I think about learning maths"). The analysis of the negatively worded questions would use a reversing of the scale.

In order to localise the phraseology, the researcher included an added phase in a minor number of cases to bring them in line with similar terms that school students in Australia use. For example, "math" was altered to "maths", "on math" was altered to "in maths" or "at maths". Three senior and expert high school mathematics teachers assisted in developing this phase of the questionnaire development. Each of these teachers also had responsibilities for the supervision of teachers, teaching programmes and written assessments within their schools. The teachers were considered knowledgeable in understanding the learning processes and the language needed to provide clarity to the students. The teachers raised concern that the six physiological questions were all negatively worded and promoted negative emotions about mathematics. In discussion with them, the researcher determined that "Doing math work takes all of my energy" would be altered to "Doing maths give me energy" to provide positive wording but to keep the same intent. This question, however, during the analysis proved problematic and an outlier from trends in student responses and was later removed from the discussion. When common factor analysis was conducted, the question failed to load with others from affective states. Hence the number of questions used in the analysis of the sources of self-efficacy was reduced to 23.

The items were further verified for validity with the self-efficacy construct by submitting them to an expert in the field (R. Schwarzer, personal communication 10 November 2014). The self-efficacy expert advised that placing the mathematics-self-efficacy questions before the source questions may negatively influence their responses, especially if the questions were perceived as difficult and could lower their mathematical self-efficacy. In response, the questionnaire section related to the sources of efficacy was placed in the questionnaire prior to the section based on mathematics strand self-efficacy. This reduced the potential for the mathematics self-efficacy section to influence the perceived sources of self-efficacy following the cautions of the self-efficacy expert (R. Schwarzer).

The questions in the sources of self-efficacy section used a six-point scale that asked students to identify whether they agreed or disagreed with the statement (1 = definitely disagree, 6 = definitely agree). Having three points describing disagreement and three points describing agreement meant that students' responses would indicate if they agreed or disagreed with the statement and the intensity of their perception.

In summary, the questions used to measure the sources of self-efficacy were based on the work of Usher and Pajares (2009), with changes in phraseology identified by three expert Australian secondary mathematics teachers. In addition, the questionnaire was checked with an expert in the field of self-efficacy (R. Schwarzer, personal communication 10 November 2014). The changes suggested by the expert teachers and the self-efficacy expert were implemented.

The survey questionnaire is listed in Appendices B and C

4.3.3.4 Section 3: Mathematics Self-efficacy

Section 3 of the student questionnaire was designed to collect student perceptions of their mathematical self-efficacy by subtopic in the Australian mathematics syllabus and by the degree of difficulty. Self-efficacy must be task-specific and based on the content and concepts of the individual year 7, 9 and 11 mathematics syllabuses, so a set of mathematical tasks were used to express their level of confidence or sense of self-efficacy in solving. The questions were designed to ask students to predict their confidence to answer the question successfully rather than provide an answer in accordance with the suggestions of Schwazer (personal communication 10 November 2014) and Bong (2006). Hence the stimulus questions were targeted for each year group. Some overlap was planned between the years as the syllabuses build on each other, and a difficult question in Year 7 could appear as a basic question for Year 9 and so. The scale for the student responses for all three-year groups was in concert with the suggestions of Bong (2006) and Bandura (2006) and, extended from 0 to 10 with "Cannot do at all", "Maybe can do" and

"Highly certain can do" as the descriptors at the beginning, middle and end of the continuum. The 11-point scale was in keeping with Bandura's (2006) recommendations to enable the questionnaire to capture variations in student perceptions. The scale began with zero as self-efficacy scales are "unipolar ranging from 0 to a maximum strength" (Bandura, p. 212). The lowest indication of incapability to "do" an activity or skill was "0". The content of the questions was from the relevant, mandatory NSW syllabuses. The wording and degree of difficulty were based on the questions used in NAPLAN in Year 7 and Year 9 and checked by three expert teachers in Australian secondary school mathematics.

A space for the answers to Section 3 (Self-efficacy of Mathematics topics) was provided on common pro-forma, but separate question sheets were provided for the different grades as these questions were grade specific. In addition, student measures were provided against the specific skills and tasks of the mathematics curriculum relevant to their age (Bong, 2006).

The New South Wales mathematics curriculum must be taught in all NSW (NESA, 2019). Secondary schooling in NSW begins in Stage 4, consisting of Year 7 and Year 8. Students are typically 12 to 13 years of age and follow on from seven years of primary schooling. A common mathematics course is taught to all students in Stage 4 with the expectation that teachers will differentiate the course to suit the needs of the students. Stage 5 consists of Year 9 and Year 10 (typically 14 or 15 years old), and while mathematics is compulsory, students are allowed to select to study from one of three courses: the elementary course (5.1), the intermediate course (5.2) and the advanced course (5.3). Most students in Year 10 progress into Year 11 (typically 16 years old) as students in NSW must be at school or involved in training or employment until the age of 17 years. Mathematics is not a compulsory subject in Year 11, which is the first year of Stage 6. However, most students select one of the five courses offered: General/Standard (2 x standard level courses that are non-calculus based), Mathematics/Advanced (an intermediate level course that includes calculus-related topics), Extension I and Extension II (both courses that extend the Mathematics/Advanced course). The 'Advanced' and 'Extension' mathematics courses are considered prerequisites for mathematics-based university courses such as engineering or finance.

To design a valuable measure of subject-specific self-efficacy, the researcher needed to consider the levels of specificity at which self-efficacy is assessed; ensure the questions are those that the students can answer rather than guess; make questions relative to a mastery experience rather than a comparison to other students; and use a rating scale that allows students to predict their confidence (Bong, 2006). As noted previously, to ensure the questions were accessible to students, the researcher established separate question banks for Year 7, Year 9 and Year 11. Year 7 and 9 questions were based on the content covered in the respective NAPLAN tests and were cross-checked for alignment with the syllabus. As Year 11 students have completed Stage 5, the questions were sourced from content common across the three courses of the Stage 5 mathematics syllabus.

Cross-checking the questions' scope and degree of difficulty was done by analysing NAPLAN and comments from three previously mentioned expert teachers in the NSW Mathematics syllabus. NAPLAN provided a benchmarked difficulty level of questions aligned to bands. The low bands reflected less difficult questions, and the higher bands used more complex questions. The 2014 and 2013 NAPLAN tests were used as guides to determine basic, intermediate and advanced items for Number, Algebra, Measurement, Geometry, Statistics and Probability. Three items (one basic, one intermediate and one advanced) per sub-strand were selected, totalling 18 content-based questions. For each year group, the "basic questions" were obtained from questions from the lower performance band levels of NAPLAN, questions from the middle-performance bands were used for the intermediate level items, and the top performance bands were used to set the advanced level items in year 7 and 9. For example, in Year 7, the achievement was reported in Bands from 4 to 10, so a basic question, such as telling the time on an analogue clock, was aligned to a capability related to Band 4. In a further example, Year 7 Section 3 Question 9, "Calculate the area of a rectangle if its length is given and you know the perimeter", was ranked at a Band 9 capability and thus an advanced level question. For Year 7, basic questions were gained from questions aligned to Bands 4 and 5 capabilities, intermediate questions for Bands 6 and 7 and advanced questions for Bands 8, 9 and 10. Year 9 had Bands ranging from 5 to 10, so a basic question was considered at Bands 5 and 6, the intermediate questions at Bands 7 and 8 and the advanced at Bands 9 and 10. Some items selected for Year 11 were carried forward from the Year 9 question bank, for example, Question 11 (intermediate geometry), "Using Pythagoras' Theorem find the length of the side of a triangle", was used as Question 10 (basic geometry) in Year 11 as this is a commonly expected skill in all Stage 5 courses. Other questions were selected from the syllabus content by the researcher, and the previously mentioned three expert teachers validated the level of difficulty. A gradation of difficulty was determined using more complex concepts from the common content areas across the Stage 6 courses.

The questions asked the students to predict their confidence to answer the question successfully rather than provide an answer, and diagrams or graphs were generic without values. This was explained to students before the completion of the questionnaire. Schwarzer (personal communication, 10 November 2014) indicated it was essential to have students identify their perceived confidence, not try to solve the question.

The wording and presentation of the questions were designed to be similar to the style used in NAPLAN. For example, technical terms (e.g., "simplify the algebraic expression") and colloquial terms (e.g., "get the answer") were used similarly to those that appear in the NAPLAN questions. In addition, the language was checked for student accessibility by three experienced mathematics teachers. Teachers who administered the questionnaire did not report language or terminology difficulty by students.

Items were added to cover the Working Mathematically process strand. These questions were universal for all syllabuses regardless of the student's grade. The four Working Mathematically questions were based on developing understanding and fluency in mathematics through inquiry, exploring and connecting mathematical concepts, choosing and applying problem-solving skills and mathematical techniques, communication and reasoning as indicated within the mathematics syllabuses. Confidence that the students can remember learned strategies is a key to developing transference of problem-solving knowledge and skills and their prediction in their ability to solve future questions (Hattie & Zierer, 2018). Similarly, confidence in their ability to articulate questions and solutions is a prized skill within collective argumentation that enhances students' confidence in problem-solving (AGDET, 2015b). Applying mathematical learning in other contexts, including other school subjects, identified student confidence to transfer mathematical knowledge (Pegg et al., 2007). The students' questions were checked for accessibility by the three expert mathematics teachers described earlier.

The questions were:

1. I can remember ways of solving questions. (develop understanding and fluency, problem solving skills)
2. I can put maths questions into my own words. (communication, develop understanding and fluency)
3. I can use maths techniques in other subjects. (connecting mathematical concepts, choosing and applying problem-solving skills)
4. I can tell others how to solve a question. (mathematical techniques, communication and reasoning).

Bandura (2006b) suggested a standard way for measuring self-efficacy beliefs by using a scale from zero to 100 (0 "Cannot do"; 50 "Moderately certain"; 100 "Highly certain can do"). Bong (2006) made a similar observation regarding the use of this scale, providing descriptors at 0 (not sure), 40 (maybe), 70 (pretty sure) and 100 (real sure). However, a 10-point scale with similar descriptors for single digits for "0", "5", and "10" was considered to be acceptable (Bandura, 2006; Betz & Hackett, 1993). Bong (2006) provided further examples of using a 5 point, a 6 point and a 7-point scale (Likert style) but warned that response scales with too few steps did not always capture the subtle distinctions in student response scales.

The researcher decided that a scale, beginning at 0 (Cannot do at all) with a continuum indicated via an arrow to 10 (Highly certain can do), would provide the scope for students to select an appropriate response. A midpoint of "maybe can do" was placed over the 4, 5 and 6 scales.

4.3.3.5 Section 4: Parent/Carer and Teacher Attitudes to Mathematics

Many researchers (Bandura, 2006; Bryk et al., 2010; Habibis & Walter, 2015) support the concept that teachers and parents influence teenagers through vicarious experiences and social persuasion sources. Schneewind (1995) suggests using an integrated model for studying the control beliefs of culture, family and parent systems. The Fennema-Sherman Mathematics Attitude Scales (Fennema & Sherman, 1976) measure student perceptions of nine scales with 12 items. The scales are identified under the headings *Attitude Toward Success in Mathematics scale; Mathematics as a Male Domain scale; Mother, Father and Teacher scale; Confidence in Learning Mathematics scale; Mathematics Anxiety scale, Effectance Motivation in Mathematics scale; and Usefulness of Mathematics scale* and can be used separately (Mulhern & Rae, 1998). Given the influence parents'/carers' and teachers provide through their proxy agency (Caprara et al., 2006; Boinincontro, 2010; Woolfolk Hoy & Davis, 2006), the researcher identified there was a gap in the questionnaire to investigate the student's perceptions of these key figures and the impact they have on the development of the individual efficacy on the students.

The Fennema-Sherman scales have been used extensively and were validated by analysing 1600 high school participants using Likert style measures (Fennema & Sherman, 1976). Mulhern and Rae (1998) verified using a shortened version of the Fennema-Sherman Mathematics Attitudes Scale that consisted of 51 items through the principal component method with varimax rotation. The selected elements showed internal consistency with Cronbach's alpha between the Mulhern and Rae study (0.79 to 0.96) and the original Fennema-Sherman study (0.87 to 0.91). Mulhern and Rae (1998) reduced the number of questions from 12 to 9 for the three scales that measured *Mother, Father and Teacher Attitudes.* The wording of each of the parents' scales' questions was the same except for the stem "My mother" or "My father".

The researcher believed using the collective term parents'/carers' as the stem to the questions would provide the students' synthesised view of the attitudes towards the mathematics of their parents or carers and hence describe the vicarious experience and social persuasion that was influencing them. This also provided an option for students who were not living with or in regular contact with both parents.

Of the nine questions suggested by Mulhern and Rae (1998), six were chosen with only minor adjustments to fit in with the colloquialisms of the students (for example, "maths" for "math"). Of the remaining questions, "My father/mother thinks I could be good at maths" was considered to be already measured in Section 1 Question 15 with "Adults in my family have told me I am a good maths student". Two questions of the residual parent questions were aimed at a post-school intent ("My father/mother thinks I'll need mathematics for what I want to do after I graduate" and "My father/mother wouldn't encourage me to plan a career which involves math"). In keeping with the suggestions by McPhan et al. (2008), Alloway et al. (2004) and Lent, Lopez and Bieschke (1991), the researcher believed a question with a specific reference to career destination was needed. Hence the question "My parents/carers think I will need harder maths to get a good job when I leave school" was included instead of the questions from Fennema-Sherman/ Mulhern-Rae.

Of the questions suggested by Mulhern and Rae (1998) for the *Teacher Attitudes to Mathematics* scale, the researcher chose three for their similarity to the questions asked of parents/carers to reflect the socially persuasive influence of the teacher ("My teacher thinks I am the kind of person who could do well at maths", "My Maths teachers have made me feel I have the ability to do the harder maths courses at school" and "My maths teachers have been interested in my progress in maths"). A further question ("I have found it hard to win the respect of my maths teachers") was selected to reflect the relational trust that is significant in the proxy influence by teachers (Woolfolk Hoy &Davies, 2006). The final question chosen was to provide a measure of the social persuasion of teachers regarding careers ("I would talk to my maths teacher about careers that use maths"). Cronbach alphas of the instrument are reported in Section 4.3.3.2.

4.3.4 **Data Analysis**

Student questionnaires were collected and scanned through an OpScan 8 optical mark recognition (OMR) process. The student responses for the four sections had been marked by the students using a number code for each of the questions within each section. The number code varied depending on the response field (e.g. for gender, male = 1, female = 2). Sections 2 and 4 used a six-point Likert scale, and Section 3 used an eleven-point scale from 0 to 10. The results were placed in a Microsoft Excel 2013, and responses that the students had crossed out were manually adjusted from their original scripts.

Factor analysis was conducted through IBM SPSS 26 and calculated the loadings by maximising the retention of the common variation. The factor analysis revealed four latent factors in Section 2 (enactive mastery, vicarious experience, social persuasion and affective and emotional states), two latent factors in Section 3 (perceived most difficult and perceived least difficult) and two latent factors in Section 4 (perceived parent attitudes to mathematics and perceived teacher attitudes to mathematics). The factor scores identified the latent variables that linked the relationships between the variables with new variables (factors). Given the multivariate relationships identified by the factors, a Multivariate Analysis of Variance (MANOVA) was then used to determine differences between the independent variables and multiple dependent variables at a level of significance $p < .05$ as suggested by Field (2009). The multiple dependent variables meant that MANOVA was the preferred analysis. A factor score is a numerical value that indicates a person’s relative position on a latent factor. The multivariate approach provides maximal discrimination between the variables such as location, gender, parent education, language used at home and knowing people who use advanced mathematics in a career (Grice & Iwasaki, 2007). Group statistics identified means and standard deviations for the student factor scores for Sections 2, 3 and 4. To compare factor scores by indigeneity, the Mann-Whitney U Test was used due to the small number of students who identified as indigenous. The findings of this section of the study generated the mixing and the consequent discussion from the commentary of the qualitative data

4.3.4.1 Section 1

The profile of the students provided a comparison of Sections 2, 3 and 4 by rural and metropolitan across each of the three grades and the total of the three grades by mean and factor scores for the identified latent variables within each section for significant difference ($p < .05$) using MANOVA as there were multiple dependent variables. The comparison between rural and metropolitan for the three sections was also compared by gender using MANOVA. The number of students identified as indigenous was small, and a Mann-Whitney U Test was used to compare the factor scores for the latent variables.

For parent education levels, a distinction was established between those parents who had not studied after leaving school ("Left school before Year 12" and "Year 12") and those who had studied at certificate, diploma or degree level. This division is related to the aspirational discussions parents have with their children about their career-based study. The section "Don't Know" was also analysed as it was a significant proportion of the student responses, and the researcher reasoned that not if students do not know their parents' education levels implied it was not an important discussion topic in the family home.

The nomination of the language spoken at home ("English", "Mostly English", "Mostly my parent's native language" and "My parent's native language") was used to describe student ethnicity, where non-English language backgrounds and is considered a possible area of disadvantage (Australian Government, 2011). The student results were compared between only English spoken at home and other than English.

The students were asked to identify persons who used advanced maths in their job by nominating nominate: *0, 1, 2, 3, 4, 5, 6+,* noting *You can use "0" if you don't know anyone.* Despite being prompted to use "0" if they did not know of any people in these jobs, many students, particularly rural students, did not answer the question. The quantitative analysis only considered those who responded to the question and compared those who knew zero people to more than one person. The phase 2 discussions with teachers identified that students regularly do not relate school-based mathematics with the real world.

4.3.4.2 Section 2

Principal Component Analysis was conducted through IBM SPSS 24 to maximise the retention of the variation in the input variables. Following, the factor analysis of the 869 questionnaires used in this study reported the item loadings aligned to the theorised sources of self-efficacy, as seen in Table 4.2. In this table, the first six questions measured perceived enactive mastery, the following six questions (Question 7 to Question 12) measured perceived vicarious experience, the following six questions (Question 13 to Question 18) measured perceived social persuasion and the final six questions (Question 19 to Question 24) measured the perceived affective states source. Questions 19 and 20 were designed to provide a source ranking for *Affective and Emotional States* but did not load with the other items from this source. Item 5, "I do well on maths classwork", loaded with vicarious experience suggesting that students compare their capability against their classmates rather than against the curriculum. Item 19 "Just being in maths class makes me feel nervous" loaded with the vicarious experience source suggesting that nervousness was related to their observed experiences of their peers or others in their social system such as parents or siblings. Item 20 proved to be an outlier in the study loaded with the social persuasion source, inferring that energy, or lack of it, in the mathematics class comes from the feedback the students receive and their social interaction with respected peers. Item 20 was ultimately removed from the study.

A Cronbach's Alpha of the 24 items in this section produced an internal validity of $\alpha = 0.931$, indicating strong internal reliability. The internal consistency of all sections was adequate with mastery $\alpha = 0.861$, vicarious experience $\alpha = 0.797$, social persuasion $\alpha = 0.870$ and affective and physiological states $\alpha = 0.846$.

Table 4.4

Factor loadings of the four sources that influence mathematical self-efficacy

Student Questionnaire: Section 2 Sources of Self-efficacy	Mastery	Vicarious Experience	Social Persuasion	Affective and Emotional States
1. I get good marks in maths tests.	.71	.26	.402	.18
2. I have always been successful with maths.	.57	.11	.495	.22
3. Even when I study hard I do poorly in maths.	.62	.10	.098	.37
4. I got good grades in maths on my last school report.	.65	.22	.32	.19
5. I do well on maths classwork.	.38	.45	.33	.23
6. I do well even on the most difficult maths questions.	.53	.30	.47	.27
7. Seeing adults do well in maths motivates me to do better.	-.22	.64	.35	.07
8. When I see how my maths teacher solves a problem I can picture myself solving the problem the same way.	.26	.71	.09	.13
9. Seeing my classmates do better than me in maths motivates me to do better.	.14	.70	.18	.03
10. When I see how another student solves a maths problem, I can see myself solving the problem the same way.	.26	.73	.06	.03
11. I imagine myself working through challenging maths problems successfully.	.36	.50	.42	.23
12. I compete with myself at maths.	.10	.49	.45	.07
13. My maths teacher told me I am good at learning maths.	.27	.35	.52	.11
14. People have told me I have a talent for maths.	.35	.07	.77	.17
15. Adults in my family have told me I am a good maths student.	.34	.13	.74	.19
16. I have been praised for my ability in maths.	.25	.15	.77	.15
17. Other students have told me I am good at learning maths.	.31	.20	.73	.12

18. My classmates like to work with me in maths.	.06	.34	.42	.13
19. Just being in maths class makes me feel nervous.	.18	.07	.07	.78
20. Doing maths give me energy.	-.1	.34	.56	.10
21. I start to feel stressed-out as soon as I begin my maths work.	.08	.04	.15	.83
22. My mind goes blank and I am unable to think clearly when doing maths work.	.19	.14	.24	.75
23. I get anxious when I think about learning maths.	.18	.10	.16	.86
24. My whole body gets tense when I have to do maths.	.16	.09	.11	.83

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 8 iterations.
b. The factors provided for 41.23%, 10.23%, 6.75% and 4.57% to total 62.84% of the variance.

The items for Section 2 were analysed as a whole and for the four sources (enactive mastery, vicarious experience, social persuasion and affective states) against rural and metropolitan students, and by grade, gender, indigeneity, parent education levels, language spoken at home and the people the students knew in careers that used advanced mathematics. The factor scores for these four latent variables were checked for significant difference ($p < .05$) via a MANOVA, given the multiple dependent variables, with Independent Variables Test (*t*-test), used to identify significant difference for single dependent variables, such as gender across the whole cohort or within the rural or metropolitan cohort. A Mann-Whitney U test was used for the indigenous versus non-indigenous comparison of this dependent variable due to the small number of students who identified as indigenous.

4.3.4.3 Section 3

Section 3 used an 11-point scale to rank student perceived self-efficacy on 18 content items and four process (Working Mathematically) items. The questionnaire ranked the questions by subtopics from the NSW mathematics syllabuses (Number, Algebra, Measurement, Geometry, Statistics & Probability). The analysis re-arranged the questions so that the basic questions from the subtopics were grouped (Number, Algebra, Measurement, Geometry, Statistics & Probability), followed by the intermediate questions and the advanced questions using the same grouping. The researcher reasoned that the self-efficacy would decrease as the questions got more challenging, so differences in topic self-efficacy would be more easily identified.

A Cronbach's Alpha of the 22 items in this section produced an internal validity of 0.943, indicating strong internal reliability. Similarly, the three subsections based on degrees of difficulty also indicated strong internal validity with the basic questions registering $\alpha = 0.786$, intermediate questions $\alpha = 0.814$, advanced questions $\alpha = 0.832$ and the working mathematically questions measuring $\alpha = 0.888$

It was theorised that the questions of similar levels of difficulty would load together. However, as can be seen from the Common Factor Analysis, the loadings in Table 4.5 below all Number, Algebra, Advanced Geometry, Advanced probability and the four Working Mathematically questions aligned. The "Perceived Most Difficult" factor was determined after considering four of the six "Advanced" questions, all four of the Working Mathematically questions, and all algebra questions loaded together. As noted in phase 2, discussion with teachers through interviews verified that students believed algebra difficult. The basic and intermediate number questions also loaded with the advanced questions suggest that students find mental computation of the number questions in the questionnaire (decimals and proportionate division of money) also difficult. The remaining basic and intermediate questions from the remaining content areas and advanced measurement and statistics questions aligned. The term "Perceived Least Difficult" was determined after considering teacher comments regarding their perceptions of the interviews that students perceived measurement, geometry, statistics and probability as easier topics.

Table 4.5 specifies the questions by strand, theorised levels of difficulty based on NAPLAN and the factor alignment of "Perceived Most Difficult" and "Perceived Least Difficult" based on the highest factor loading.

Table 4.5

Factor loadings for mathematical self-efficacy for the strands of the NSW Mathematics syllabus

Strand	Difficulty	Perceived Most Difficult	Perceived Least Difficult
S3_Q1 Number	Basic	.46	.45
S3_Q4 Patterns & Algebra	Basic	.65	.25
S3_Q7 Measurement	Basic	.23	.62
S3_Q10 Geometry	Basic	.17	.68
S3_Q13 Statistics	Basic	.27	.72
S3_Q16 Probability	Basic	.21	.69
S3_Q2 Number	Intermediate	.64	.33
S3_Q5 Patterns & Algebra	Intermediate	.56	.42
S3_Q8 Measurement	Intermediate	.49	.52
S3_Q11 Geometry	Intermediate	.42	.52
S3_Q14 Statistics	Intermediate	.36	.54
S3_Q17 Probability	Intermediate	.28	.67
S3_Q3 Number	Advanced	.68	.24
S3_Q6 Patterns & Algebra	Advanced	.65	.36
S3_Q9 Measurement	Advanced	.37	.65
S3_Q12 Geometry	Advanced	.53	.48
S3_Q15 Statistics	Advanced	.44	.54
S3_Q18 Probability	Advanced	.54	.35
S3_Q19 Working Mathematically		.79	.32
S3_Q20 Working Mathematically		.76	.28
S3_Q21 Working Mathematically		.75	.23
S3_Q22 Working Mathematically		.70	.25

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 3 iterations.
b. Factors provided 45.95% and 5.84% to total 51.821% of the variance

The factor scores for the students were generated using these two latent variables. The initial construct of basic, intermediate and advanced across the six sub-strands did not load. Based on the perceived least and perceived most difficult loadings, the students' questionnaire responses were then analysed against location, gender, parent education, language spoken at home, and the number of people the students declared they knew used advanced mathematics in their jobs. As with Section 2, the number of students identified as indigenous was small, and a Mann-Whitney U test was used to test for significance ($p < .05$) for this profile dimension.

4.3.4.4 Section 4

Students' responses to these questions had a strong internal consistency of $\alpha = 0.789$ (Cronbach's alpha) for the 12 questions used in the questionnaire, with the seven parents'/carers' questions having an internal consistency of $\alpha = 0.736$ and the five teacher questions registering $\alpha = 0.704$. Table 4.6 outlines the 12 questions from the fourth section of the student questionnaire. The questions used in Section 4 of the *Student Self-Belief in Mathematics* questionnaire loaded to the predicted parents/carers and teacher dimensions. For example, item 4, "My parents/carers think I am the kind of person who could do well at maths", while loading with parent/carers, suggests that students and parents rely on the teachers' opinions to determine perceived mastery.

The factor scores for the students were generated for the student perceptions of the two latent variables parents'/carers' attitude to mathematics and teachers' attitudes to mathematics. A MANOVA and *t*-test were used to check whether the student responses were significantly different ($p < .05$). As with Section 2 and 3, the number of students identifying as indigenous was small, and a Mann-Whitney U test was used to test for significance ($p < .05$) for this dimension of the profile.

Table 4.6

Factor loadings for the student parent/carer and teacher attitudes to Mathematics.

Student's Self-Belief in Mathematics Questionnaire Section 4: Perceived parents/carers and teacher attitudes to mathematics	Perceived Parent/carer attitudes	Perceived Teacher attitudes
1. My parents/carers think maths is one of the most important subjects I study.	.74	.18
2. My parents/carers strongly encourage me to do well in maths.	.80	.23
3. My parents/carers have always been interested in my progress in maths.	.73	.26
4. My parents/carers think I am the kind of person who could do well at maths.	.56	.47

5. As long as I have passed my parents/carers don't care how I go at maths.	.46	-.06
6. My parents/carers think I will need harder maths to get a good job when I leave school.	.51	.10
7. My parents/carers show no interest in whether I do harder maths courses.	.50	.02
8. My teacher thinks I am the kind of person who could do well at maths.	.26	.77
9. Maths teachers have made me feel I have the ability to do the harder maths courses at school.	.24	.77
10. My maths teachers have been interested in my progress in maths.	.15	.77
11. I have found it hard to win the respect of my maths teachers	.05	.45
12. I would talk to my maths teacher about careers that use maths.	.06	.56

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 3 iterations.
b. Factors provided for 34.13% and 12.12% to total 46.25% of variance.

4.4 Methods Phase 2

The typology was an explanatory-sequential design (Creswell & Plano Clark, 2011). The researcher realised that more depth was required to investigate the emerging trends by analysing the student questionnaire and the first teacher interview. The axiological desire to gather the "right" information resulted in interview 2, even though this was not an expected path. Being pragmatic and in keeping with the exploratory-sequential design, the researcher designed a second interview for teachers. In particular, the researcher sought further information on how students viewed the relevance of the mathematics topics, applying mathematics within other subjects and problem solving as perceived by the teacher (McPhan et al., 2008). Teachers use assessment strategies and methods to gather feedback from students (Black & Wiliam, 1998; DuFour, DuFour, Eaker & Karhanek, 2010; Marzano, 2017) were identified as another area requiring deeper investigation. This information provided valuable descriptions of the teacher's interaction with the students as part of the proxy operative environment. Hence the typology shifted to an emergent design (Creswell & Plano Clark, 2011)

4.4.1 Participants - Phase 2

The sample was formed from Catholic systemic, coeducational schools within the ICSEA of 1000 and 1070. Schools were asked to nominate a sample of staff who had taught mathematics to the students who participated in the student questionnaire. The teachers all taught mathematics as their major subject and had a variety of teaching experience. Gender and middle management status were ultimately represented in the samples from both interviews. Interview 1 provided comment from three rural based schools and one metropolitan based school and involved eleven teachers. Interview 2 was used with the one rural based and one metropolitan based school of the sample not involved in Interview 1. Hence, teachers were involved in only one interview to restrict potential influence from interview 1 but provided a comment from both a rural and a metropolitan perspective. The researcher used the two interviews to determine themes from the teachers' commentary. One teacher, RT9, had moved schools over the school vacation and provided insight into the collective environment for both St Kathleen's and St Catherine's in their interview. In total, sixteen teachers were interviewed, as shown in Table 4.7.

Table 4.7

Teachers involved in the Teacher Interviews 1and 2

School Name	Interview 1	Interview 2
St Christopher's College	3	nil
St Benjamin's College	1	nil
St Catherine's College	3	1*
St Kathleen's College	nil	2*
St Paul's College	4	nil
St Sarah's College	nil	3

* Teacher RT9 has moved from St Kathleen's to St Catherine's after the student questionnaire had been

4.4.2 **Data Sources**

The explanatory-sequential approach (Creswell & Plano Clark, 2011) of a mixed methods research design uses the qualitative phase to explain the quantitative results. In this case, two rounds of interviews with teachers were used to explain the student perceptions gained from the questionnaires and deepen the understanding of the patterns emerging. It is understood that these teachers would likely be teaching mathematics classes not involved in the questionnaire as part of their teaching load. Hence the interview process would seek to guide the teacher comments towards the years involved in the survey rather than referring to the general cohorts of students. The first interview was designed based on the initial response to student data. However, questions remained to be answered after the first interview and the interview questions were adjusted for the second interview. Interview data and student questionnaire results were supplemented with documentary data from the School and Myschool websites and the researcher's field notes from discussions with the school principal. The latter provided descriptions of the conditions for learning, especially within the meso- and exo-systems (Bronfenbrenner, 1981).

4.4.2.1 Teacher Interview 1

A semi-structured interview was considered the best method to gather teacher comments and deepen and expand their experiences, ideas, and beliefs on student and collective efficacy in high school mathematics. Semi-structured interviews rely on a conversational dimension in order for the "respondents" concerns and interests to emerge" (Mertens, 2015, p. 384).

Hence, the interview guide was to identified key introductory elements, including a description of the interview style, specifying the target classes for their responses, the prompting process of the interviewer, the ability of the teacher to answer or decline to answer the prompt and to ask for clarification if needed, how the interview would be recorded, how their responses would be validated, and the emphasis on privacy in the study for them and their students. Given the nature of a semi-structured interview, teachers would be asked to add information if they believed it relevant. In this study, the researcher conducted all interviews to enhance the interview technique and data gathering procedures.

The interviewed teachers were asked for their perceptions of student ability in general and by syllabus strands. The interview questions were designed to investigate student confidence within their micro-, meso- and exo-systems (Bronfenbrenner, 1981). The questions investigated the various influences within these systems on students and included the perceived confidence for the mathematical strand, the influence of peers (Badura; 1997), student mindset towards their achievement (Dweck, 2006), levels of anxiety (Hoffman& Schraw, 2009),), methods of feedback (DuFour, DuFour, Eaker & Karhanek, 2010), methods of adjustment (Marzano, 2007), the availability of instructional equipment, the quality of professional learning (Hattie, 2009), the involvement of the community and the influence of parent expectation(Caprara et al., 2006).

The prompting questions are found in the Appendix F.

4.4.2.2 Teacher Interview 2

A semi-structured design was also used to elicit the teachers' commentary. The entry discussion questions ensured the focus of the interview was on the teachers' perceptions of the students, not a commentary on teaching in general. Teachers were prompted to illustrate their role as proxy agents within the students' ecological systems (Bronfenbrenner, 1981).

This interview sought to investigate the teacher views on how students perceived problem solving, the relevance of the mathematics topics, and mathematics applicability within other subjects (Zhao, 2012). The teachers were also asked to describe the techniques used to assess students' knowledge and how they then provided feedback to students, and the adjustments to the pedagogy they used in reaction to the feedback (DuFour, DuFour, Eaker & Karhanek, 2010). Interview 2 identified the support strategies for students, questions on perceptions of student confidence and collective efficacy by the teacher would be included (Bandura 2006) to provide continuity between the interviews.

Similar to Interview 1, the teacher guide can be found in Appendix F.

4.4.3 **School and Myschool Websites and Field Notes**

Each school in the sample had a publicly available website that provides an annual school report and a profile listed on the Australian Government-run *Myschool* website at the time of the questionnaire.

School vision and mission statements were supplemented by descriptions of the successes of the school. The school websites also provide a link to the mandated Annual School report that provides messages from key school personnel and bodies, contextual information about the school, student outcomes in standardised national literacy and numeracy testing, the granting of Records of School Achievement, results of the Higher School Certificate, professional learning and teacher standards, workforce composition, senior secondary outcomes, student attendance and management of non-attendance, retention of Year 10 to Year 12 (where relevant), post-school destinations, enrolment policies and characteristics of the student body, school policies, school-determined improvement targets, initiatives promoting respect and responsibility, parent, student and teacher satisfaction and summary financial information.

The *Myschool* website produces a profile for each school with information on school facts such as ICSEA, student attendance rates, a map/school location, financial information for each school, and an indication of students' literacy and numeracy achievement in NAPLAN performance over many years. The information on ICSEA compares the school financial distribution by identifying the percentage of the families who attend the school against the quartiles of the Australian national distribution. For example, St Christopher's had a distribution of 21% in Quartile 1 (the lowest quartile), 36% in Quartile 2, 30% in Quartile 3 and 13% in Quartile 4. The school finances describe both government and private sources of income.

Discussion occurred between the researcher and the principal at two key points of the study: first, seeking permission from the school to participate in the research and, secondly, during the visit by the researcher to the school site to undertake the teacher interviews. The interviewer engaged in discussions with the principal in both instances regarding their rationale for research into student self-belief in mathematics. The summary of these discussions was recorded as field notes.

This data set was also used to describe the school's profile and triangulate the information gathered from the student questionnaires and teacher interviews.

4.4.3.1 Data Analysis Phase 2

A thematic analytical approach was adopted as "Thematic analysis allows researchers using qualitative methods to incorporate operative and open-ended measures or forms of information collection into their designs" (Boyatzis, 1998, p. vii). The qualitative data from both teacher interviews were checked to ensure that the commentary, summary notes and quotations reflected the "conversation" of the semi-structured interview (Mertens, 2015). The interviewees were provided with copies of the transcripts or the summary notes and quotations from the interview for checking, and any comments they made were then included to provide their final commentary before analysis. The checking provided a sound basis for the coding and theme development needed before the mixing of the two sets of data (Hall & Howards, 2008)

The phase 1 interview questions (both interview 1 and 2) were deduced from the students' responses to the questionnaire and areas identified as conditions for learning. The teacher's comments were manually coded using phrases, sentences, and paragraphs to establish that they were aligned with a label before grouping them into themes described by Creswell and Plano Clark (2011). The themes were induced through "substantive significance" that considers the consistency across and within the commentary from the interviews. The two different interviews provided different lenses to develop the themes. The use of both interviews allowed the key themes from the teachers to emerge. Once coded, the development of categories and themes was interactive with the prime purpose to reflect the conversation of the interview (Creswell & Plano Clark, 2011). As this is a mixed-methods study, the development of the themes was deduced from the quantitative data findings and further induced throughout the mixing process (Mertens, 2015). Coding reliability was established through triangulation between the student questionnaire responses and two interviews.

The teachers' commentary and comments reflected their proxy agency within the meso- and exo-systems. The themes that emerged through the interviews in response to the student questionnaire responses were the school's collective agency, the teacher's proxy agency, the student's agency and the explicit use of strategies to shift from proxy to individual agency in mathematics teaching. As proxy agents, the teachers provided their perceptions of the school's collective agency, the students' individual agency, and their processes to move students from reliance to be confident individual agents.

The school and Myschool website and field notes used linguistic and graphical data to describe the school's narrative and profile. These descriptions provided information for the meso and exo-systems of the school and reflected key sociocultural descriptions (Habibis & Walter, 2015).

The schools' websites also described how they perceived their school to be a good school based on the curriculum provided, goals and feedback, community involvement, a safe and supportive environment, collegiality and professionalism of the staff (Dinham, 2016; Waters et al., 2003). They also referred to their moral purpose, capacity building, and learning beyond the classroom and accountability measures such as NAPLAN (Fullan & Quinn, 2016).

The profiles for the schools were gathered to describe the school's perceptions of their place within the local community (Bryk et al., 2010) and levels of parents' satisfaction with the school (NESA, 2019). Included in this section were comments from the principal in outlining the school's educational direction (OPC, 2009b). The school composition, such as size, type, education programmes and focus, grading and classroom climate, was also described for their influence on the meso-system (Hattie, 2009). The experience and leadership of the staff who formed the interviews were also identified for their direct, indirect and relational influence on the students' beliefs (Attard, 2014; Woolfolk Hoy & Davies, 2006). Details regarding the enrolment composition and proportionality of the sample (grade, gender, indigenous), and the profile data gathered from the student questionnaires (parent education language spoken at home and the number of people known to use advanced mathematics in their careers) were provided for each school to assist in describing the meso- and exo-systems.

In response to the student questionnaire responses, the themes that emerged through the interviews, school profiles and field notes supported the conjectures of Bandura's operative environments (1997). The data collected and analysed identified the collective agency, the teacher's proxy agency, the student's individual agency, and explicit strategies to shift from proxy to individual agency.

4.5 Challenges and solutions

According to Creswell & Plano-Clark (2011), the challenges of the explanatory-sequential design include the time required for the two-phased approach, selection of the quantitative results to be investigated and the identification of the participants for the second phase.

Creswell (2009) noted that the time lapse between the phases of the collection is a potential destabiliser in terms of validation mixed methods. Students completed the questionnaire as an individual school cohort on the same day, but not all schools completed the questionnaire at the same time. All schools conducted the questionnaire in the last third of the school year. As a result, it was theorised that students would have completed approximately the same amount of the syllabus.

Within six weeks after the students completed the questionnaire, teachers who participated in the initial qualitative phase were interviewed with Interview 1. Interview 2 evolved after further analysis of the student questionnaire data and the initial teacher interview responses. As a result, this interview was administered the following year, but within six months of the student questionnaire completion. In order to restrict issues of confusion between cohorts, teachers were selected from those who had taught students involved in the questionnaire the year before. The interviewees were asked to respond to the questions with the previous year's students in mind and to consider them in their responses. Some students who were taught in the previous year were also taught in the current year's classes. The teacher's comments provided general reflections and historical examples to make a point. These comments provided insight into the operative environment of the teacher's classroom and the school that influences students' perceptions (Woolfolk Hoy & Davis, 2006). Teachers did not report any significant change to the processes and policies of the school from the time of the student questionnaire to the interviews. The principals of the schools were the same for the student questionnaire and the teacher interviews.

4.5.1 Reconciling quantitative and qualitative findings

Mixed methods merge the data. The explanatory-sequential style uses qualitative results to explain the quantitative statistics through an "interactive strategy … that facilitates comparison and interpretations" (Creswell & Plano Clark, 2011, p. 67). The first of the research questions, "*Do rural and metropolitan secondary students differ significantly in their perceived self-efficacy in secondary school mathematics?*" uses quantitative methods from the data gained from the *Self-Belief in Mathematics* questionnaire Section 3 to determine the significant statistical difference ($p<0.05$). Comparing the data from the rural and metropolitan based students were then used to guide the formation of the questions asked in the semi-structured interviews. The teacher interviews investigated the perceived influences in the school that affected the students' self-efficacy in mathematics via the micro-, meso and exo-systems.

The second research question ("*What are the major sources of the perceived self-efficacy in secondary school mathematics for rural students?*"*)* considers the factors that have an impact on self-efficacy as noted in social cognitive theory and through the perceived ecological systems. The analysis interprets and merges the quantitative data gained from the student *Self-Belief in Mathematics* questionnaire and the qualitative information gained from the teacher interviews. Through the questionnaires, students specified their levels of perceived efficacy in mathematics, the four sources of efficacy and their perceptions of the attitudes of parent/carers and teachers to mathematics. The themes derived from the teachers' commentary described the collective, proxy and individual modes of agency and the movement from the proxy to the individual agency through their ecological systems. These themes were across both rural and metropolitan based teachers and the six different schools.

Table 4.6 aligns the quantitative and qualitative data within four themes as they emerged through the analysis of the teacher interviews to describe the perceptions provided from the student questionnaires. The matrix uses the lens of social cognitive theory to identify the four sources of efficacy that includes an analysis of the students' perceived mastery in their self-efficacy of mathematics and how they sit within the three operative environments for this study (imposed, selected and created as described by Bandura, 1997).

Table 4.8

Merging the data

Theme	Quantitative Student Questionnaire	Qualitative Interview 1	 Interview 2
Collective agency	Sources of Self Efficacy and Parents'/Carers' and Teachers Attitudes to Mathematics • Number of people you know who use advanced mathematics • Mothers' and Fathers' Education Levels • Language spoken at home	• Impact of NESA on student learning (Imposed Environment) ○ Syllabus ○ NAPLAN ○ HSC • Impact of school organisation on student learning (Created Environment)	• Impact of NESA on student learning (Imposed Environment) ○ Syllabus ○ NAPLAN ○ HSC • Impact of Community on school organisation (Selected Environment) • Impact of school organisation on student learning (Created Environment)

Theme	Quantitative	Qualitative	
	Student Questionnaire	Interview 1	Interview 2
	•	•	•
Proxy Agency	• Parents/Carers Attitudes to Mathematics • Teacher Attitudes to Mathematics • Mathematic Self-Efficacy by Year 7, 9 and 11	• Parent Influence • Community Influence	• Parent Influence • Community Influence
	Sources of Self Efficacy • Vicarious Experience (parents, peers) • Social Persuasion	Sources of Self Efficacy • Feedback from student to teacher • Feedback from teacher to student • Teacher activity • Professional learning for Teachers	Sources of Self Efficacy • Vicarious experience • Feedback from student to teacher • Feedback from teacher to student • Teacher confidence

Theme	Quantitative	Qualitative	
	Student Questionnaire	Interview 1	Interview 2
Individual Agency	Mathematics Self-Efficacy • Year 7, 9 and 11 • NSW syllabus content Basic, intermediate, Advanced, Sources of Self Efficacy and Parents'/Carers' and Teachers Attitudes to Mathematics • Mastery • Perceived mastery • Vicarious experience (self) • Affective States	Sources of Self Efficacy and Parents'/Carers' and Teachers Attitudes to Mathematics • Mastery Core content • Mastery Advanced content • Vicarious experience (self) • Affective States	Sources of Self Efficacy and Parents'/Carers' and Teachers Attitudes to Mathematics • Mastery Core content • Mastery advanced content • Vicarious experience (self) • Affective States
Moving from proxy to Individual agency	1. Perceived mastery Working Mathematically (selected & created environments)	2. Revision and retention (Selected & created Environments) 3. Relevance and application (selected & created environments)	

4.6 Validating the data and the results

The philosophical paradigm was pragmatic and explanatory (Creswell & Plano Clark, 2011; Mertens, 2015). As both quantitative and qualitative data were being mixed, the quality of the interpretation needed to respond so that "the inferences in the study process are accurate" (Plano Clark & Ivankova, 2016, p. 163) posits that the following terms that reflect the different elements required to ensure that the data analysis and interpretations reflect an accurate picture of the study and will withstand scrutiny as noted in the below list from Mertens.

1. Credibility, which parallels Internal Validity
2. Transferability, which parallels External Validity (or Generalisability)
3. Dependability, which parallels Reliability
4. Confirmability, which parallels Objectivity

4.6.1 Credibility and Internal Validity

Student questionnaires produced four data sets. The first data set provided information regarding student profiles and included parent background information. This data was later mixed with the teacher interviews to produce an understanding of the collective efficacy. The data from Section 2 were based on work provided by Usher and Pajares (2009) and used their validation study that tested for internal validity. Common factor analysis showed loading agreed with predictions for Mastery, Vicarious Experiences, Social Persuasions and four of the six Affective and Physiological States. One question, in particular, Section 2 Question 20, failed to load and was identified as an outlier and was withdrawn from the discussion. Internal validity for the student questionnaire results was strong, with the Cronbach's Alpha of the 24 items in this section being 0.931. The internal consistency of each of the subsections was strong, being between $\alpha = 0.797$, for vicarious experience, and $\alpha = 0.870$ for social persuasion with mastery $\alpha = 0.861$ and affective and physiological states $\alpha = 0.846$.

Section 3 questions were designed by the researcher and validated through comparison to NAPLAN and in discussion with expert teachers. A Common Factor Analysis found that loadings the Number and Algebra, Advanced Geometry, Advanced Probability and the four Working Mathematically questions loaded together and were determined as being "perceived as most difficult". Through the interviews, teachers verified that students perceived algebra to be difficult and hence the view that students perceived these questions to have "advanced" level knowledge and skills. The remaining basic and intermediate questions and advanced measurement and statistics questions also loaded together. A Cronbach's Alpha of the 22 items in this section produced an internal validity of 0.943. Similarly, the three subsections based on advanced ($\alpha = 0.832$,) intermediate ($\alpha = 0.814$) and basic (0.786) also indicated strong internal consistency.

Section 4 was based on the work of Mulhern and Rae (1998), who verified the use of a shortened version of the Fennema-Sherman Mathematics Attitudes Scale through common factor analysis. Mulhern and Rae (1998) showed an internal consistency between α= 0.79 to 0.96. with the original Fennema-Sherman study measuring between α= 0.87 to 0.91. Students in this sample indicated moderately strong internal consistency for the 12 questions used in the questionnaire registering a Cronbach's alpha of 0.789, with the seven parents'/carers' questions having $\alpha = 0.736$ and the five teacher questions registering $\alpha = 0.704$.

Mertens (2015) suggests member checks and triangulation as criteria for establishing credibility regarding the teacher interviews. All teacher interviews transcripts and interview summary notes/quotations were sent to interviewees within four weeks of the interview for member checks. Any response from the interviewees was incorporated into the teacher commentary for use in the interpretation and dissertation.

Triangulation involved the analysing of data through quantitative and qualitative methods. The data were analysed through IBM SPSS 24, and the results were checked against a broad cross-section of the peer-reviewed literature available. Teacher comments were verified through member checks and cross-linked with the results from the student questionnaire. Publicly available descriptions of the profile and academic achievement of the school gained from the *Myschool* website and the school's website were used to validate or challenge the comments made by teachers through their interviews. Field notes gathered during discussions with the school principals were also considered to validate teacher comments and student questionnaire results.

Table 4.9

Methods, Steps and Analysis used in triangulation of the student questionnaires and teacher interviews.

Method	Steps	Analysis
Student questionnaire based on self-efficacy scales, sources of self-efficacy, parent/carer and teacher attitudes to mathematics.	Design Pilot Sampling Review Large scale sample across four rural and two metropolitan schools for Years 7, 9 and 11 Data read through Opscan8 and cleansed to eliminate anomalies	Statistical testing (using IBM SPSS statistics 24) Check themes arising from the analysis against the themes in current literature
Teacher interview 1 and Teacher Interview 2 (semi-structured)	Design Pilot Sampling Participant selection Interviews (taped or summary notes with quotations) for all schools of the sample.	Text analysis (Coding of words, phrases and segments, codes tested against the text of all interviews.)
Triangulation	Data Analysis Document checks Member checks Field notes Data from the *Myschool* website	Commonalities, variance

4.6.2 **Transferability and External Validity (or Generalisability)**

Transferability is described by Mertens (2015), as a "concept that allows readers of the research to make judgements based on similarities and differences when comparing the research question to their own" (p. 271). She suggested using "thick descriptions" to provide time, place, context and culture so readers could make judgments.

The information gained from the student profile section of the questionnaire, discussions with the sample school principals, descriptions of classes through teacher interviews and school profiles determined through the school and the *Myschool* websites provide a comprehensive description of each school. The multiple sources of data infer that the "thick" descriptions are available through the corroboration of the data. Mertens (2015) also suggested using multiple cases to provide the reader with the option of bringing the story within this study to another situation. In this study, sixteen teachers were interviewed from six different schools to provide a varied and comparable sample. The restriction on the selection of schools based on their ICSEA and sector type allowed exploration of the collective, proxy, and individual agencies within the imposed, selected and created operative environments without potential distractions such as communal wealth/poverty or unique ideology that influence the sample

4.6.3 Dependability and Reliability

Mertens (2015) describes dependability and reliability as stable over time, showing that the findings could be consistently repeated. The same questionnaire was provided to all students with sections 1, 2 and 4 common across the grades sampled. Section 3 questions had content designed for each Year 7, 9 and 11 Year groups based on NAPLAN and syllabus documents and were checked for applicability for the age group. The four Working Mathematically questions were based on the common process outcomes that occur in syllabus documents for each grade were and, as such, were the same for each grade. The teachers interviewed had taught students who had been involved in the questionnaire and within six months of the sitting of the questionnaire. A second interview was considered important to clarify and enrich the student questionnaire and corroborate and deepen the themes of Interview 1. Mertens (2015) notes that any changes to a research method in qualitative processes need to be well documented within the report, as shown in the earlier sections of this chapter.

4.6.4 Confirmability and Objectivity

The collection of quantitative data provided the initial platform for objectivity. Using a standard student questionnaire and keeping the administration at the school level established a distance between this data and the researcher. The use of IBM SPSS 24 also provided a vehicle for objectivity at the analytical phase.

Ensuring objectivity through the interpretation stage is considered particularly difficult within mixed methods. Researchers always bring their background and view of the world into their interpretations, and in particular, the pragmatic process of mixing implies a need for the researcher's opinion to be involved. Hence, Mertens (2015) argues that confirmability is a parallel criterion for delivering quality within the research so that the interpretations and reporting are not biased towards the researcher's opinion.

The analysis of the teacher interviews and the process of mixing data was able to be substantiated through the "chain of evidence" (Mertens, 2015). The cross-checking of transcripts of the interviews by an external peer, the discussions related to the mixing of data with an external peer, the alignment of teacher comments back to specific sites, the use of publicly available material to describe the profile and achievement of each site in the sample mitigated against bias.

4.7 Ethical considerations

Ethical considerations are a significant element of all research. However, Mertens (2015) emphasises the importance of ethics in the pragmatic paradigm of mixed methods. The additional ethical concerns of mixed methods relate to the multiple phases of collecting the data (Plano Clark & Ivankova, 2016).

Ethics approval was sought and provided through the Australian Catholic University (2015-35H), as seen in Appendix G. Given the nature and location of the research, the ACU Human Research Ethics Committee (HREC) were concerned about the impact of collecting data from Aboriginal and Torres Strait Islander students, although it was deemed low risk. Further acknowledgement was requested and sought from the relevant Aboriginal Education authorities from the State Co-ordinator Aboriginal Education, Catholic Education Commission NSW, and the NSW Aboriginal Education Consultative Group (ECG) as noted in Appendix H.

Research ethics consent was provided to all participants. Discussions were initially held with the Director of the relevant Catholic Education Office, who provided their system's requirements for research conducted in schools of the system. A specific request form was completed following the relevant Catholic Education Office protocol. (Please Appendix I)
The research did not begin until the principal's consent and written acceptance were received from parents on behalf of the students involved following routine school procedures. Teacher consent was identified before the interview and was secured at the time of the interview. (Please see Appendix J)

The researcher made personal contact with each Principal to describe the project and outlined the safeguards, such as consent, anonymity, reasonable time length (30 minutes) and the ability to withdraw. The researcher also made contact with the Principal at the time of the teacher interviews. Care was taken to ensure teachers interviewed were satisfied that comments would be considered impartially and any changes suggested by teachers during member check were incorporated into the transcript/summary of the interview.

Establishing the research site and developing a rapport for a workable relationship with teachers meant that data was to be collected without impinging on the workings of the school. The data collection was not to create a situation that led to students missing out on instruction, nor having a detrimental effect on their self-efficacy or the teachers' self-efficacy. Students were to participate in the questionnaire in their regular lesson time with their regular classroom teacher supervising. Provisions were made at the school so that students were not disadvantaged in their learning by taking part in the questionnaire. Students' participation was voluntary, and students were allowed to withdraw at any time in the questionnaire process. The researcher received no adverse comments regarding student participation

During the interviews, the researcher ensured a time was provided to build rapport with the teacher and emphasise that their comments were received impartially. The framing of the questions was to affirm the interview as a description of the teacher's classes, not an investigation into their teaching practice, although this was often revealed through their narrative in the interview. The researcher monitored the interviews to ensure that teachers' rights were observed and care was used to choose non-judgemental phraseology in the prompting questions.

Students were referred to by their code numbers and schools by their nom-de-plume to preserve privacy through the analysis.

4.8 **Summary**

This chapter outlines the rationale for a mixed-methods approach for this study. Investigations into motivation are complex and require a method that acknowledges and works with the inter-relationship of the data (Graham & Weiner, 2012). The development of the two phases using an exploratory-sequential paradigm was considered the most appropriate mixed-methods. Validated quantitative survey questions were available for the perceived sources of self-efficacy and the parents'/carers' and teachers' attitudes to mathematics. Supporting the conjectures of Bandura 2006) and Bong (2006), the researcher realised a specific measure was needed to be designed in order to measure the perceived self-efficacy for the NSW curriculum that included the six content sub-strand and the process sub-stand against basic, intermediate and advanced benchmarks. Validation occurred through alignment with the questions and the NAPLAN tests, checking with a self-efficacy expert and three experienced mathematics teachers to ensure students could access the knowledge and skills used in the questionnaire. Through the student response to this section, it became evident that the questionnaire did not perceive each of the content topic areas as equally difficult. All of Number and Algebra, all of the Working Mathematically and the advanced Geometry and Probability questions loaded with the areas that had reduced confidence levels, suggesting that the students perceived these as the most difficult. All the Measurement and all of the Statistics questions loaded with those with higher confidence led to the view that students perceived these as least difficult along with the basic and intermediate Geometry and Probability questions.

The selection of participants was invited from schools that were coeducational, Catholic and had an ICSEA between 1000 and 1070. While this provides limits on external factors to focus on the items of the research question, it provides a limit within the transferability of the findings. The student profile data gathered in this student questionnaire provides a lens that includes the identified factors from the external environment (gender, age, indigeneity, ethnicity, parental education levels and personal knowledge of potential mentors in mathematics).

The reconciliation of the data from students was corroborated and deepened with the commentary from teachers, field notes from the discussion with the principal publicly available school and *Myschool* websites. The identified themes of Collective Agency, Proxy Agency, Individual Agency and Moving from Proxy to Individual Agency formed the framework for the results, discussion and implementation chapters of this mixed-methods study.

In conclusion, the research path of this study has undergone many twists and turns to make sense of the data as it has come in. While the initial assumptions that the rural and metropolitan geolocations would have delivered significantly different results for student perceived mathematics self-efficacy and that identifying sources to support this finding proved evasive, the resultant research path is a reminder that investigations into education and social setting are complex.

The following chapters unpack the data with the discussion providing insights into the workings of schools as they strive to prepare the citizens of the twenty-first century.

Chapter 5: Mathematics mastery and students' self-belief

5.1 Introduction

This chapter reports on the data gained from the student *Self-Belief in Mathematics* questionnaire gathered in the first phase of the explanatory-sequential mixed methods research design (Creswell & Plano Clark, 2011) used in this study. The student questionnaire was the starting point in the sequence, so the first data to be outlined are the students' responses to the Self-Belief in Mathematics questionnaire. The chapter begins by outlining the information from students on their profiles using gender, school grade, indigeneity, parents' education levels, language spoken at home and the number of people the students know who used advanced mathematics in their careers. This information begins with the descriptions of students' micro-, meso- and exo-systems (Bronfenbrenner, 1981).

The second phase of the research design, the qualitative phase, gathers the commentary from teachers through interviews, from descriptions about the school and field notes, the discussion with principals is reported in Chapter 6. The second phase investigates and reconciles the findings of the quantitative data through the themes of the collective agency of the school and its place within the local community, the proxy agency of the teachers, the individual agency of the students and the explicit strategies to move mathematical learning from proxy to individual agency. This commentary deepens the meso- and exo-system (the classroom and the school) by outlining the conditions of learning for the students in their different schools and communities.

The discussion in Chapter 7 results from the mixing of the two sets of data and responds to the two research questions this study:

> *Do rural and metropolitan secondary students differ significantly in their perceived self-efficacy in secondary school mathematics?*
>
> *What are the major influences on the perceived self-efficacy in secondary school mathematics for rural students?*

The data gained from the student questionnaire included descriptions of their profile, perceptions of their capability to solve a range of questions from the six content sub-strands of the NSW mathematics syllabus and the Working Mathematically process strand (NESA, 2018b), the sources of self-efficacy, as posited by Bandura (1997) and their parents/carers' and teachers' attitudes to mathematics (Mulhern & Rae, 1988).

Even though the content questions of Section 3 of the questionnaire were designed to represent three levels of difficulty (basic, intermediate and advanced), the questions loaded so that the Number, the Algebra and Patterns, the advanced Geometry and Probability and the Working Mathematically questions all reflected lower student confidence. The investigations found the questions loaded across the syllabus sub-strands to expose latent variables on the syllabus sub-strands that they perceived as more difficult and least difficult. Hence the descriptions of the student data in this chapter are by the factors of the student questionnaire identified through the Principal Component Analysis described in Chapter 4 rather than by the individual questions. This provides the opportunity to compare the perceptions on levels of difficulty of the questions and the sources of these perceptions for the rural and metropolitan based students.

The sources of the perceived self-efficacy were measured in Section 2 (Sources of Self-Efficacy), where the factors loaded on the theorised sources of student self-efficacy, namely enactive mastery, vicarious experience, social persuasion, and affective states (Bandura, 1997). Similarly, other influences on student confidence were related to their perceptions of parents'/carers' and teachers' attitudes to mathematics gathered in Section 4 (Parents/Carers and Teachers Attitudes to Mathematics). The factors in Section 4 loaded on the theorised sections for parents/carers and teachers.

Factor scores were calculated from the component score coefficient matrix and analysed to give an individual's placement on the factor so that the factor scores have a mean of zero and a standard deviation of 1 (Distefano, Zhu, & Mîndrila, 2009). By conducting a MANOVA on the factor scores, a significant difference ($p < 0.5$) between the factors based on multiple independent variables were identified (Field, 2009; Grice & Iwasaki, 2007). The data in the analysis of all three sections of the questionnaire for each of the elements of the student profile was clear in showing that the rural and metropolitan student of this study have more in common than they have different. In summary, the perceived self-efficacy of mathematics was statistically similar ($p < .05$) between rural and metropolitan based students. Similarly, the theoretical sources had more similarity than the difference ($p < .05$). However, the influence through perceived attitudes to mathematics from parents/carers and teachers in the students' perceptions were significantly different ($p < .05$) between the two geolocations. The specific factors were identified through an independent samples t-test.

5.2 The Students of this Study

In total, 869 students from four rural based schools and two metropolitan schools provided the sample for this study from all students who participated in the Self-Belief in Mathematics questionnaire. It is noted that not all students completed each question as noted in the variosu section of following analysis.

The proportion of students involved from rural based school 540 (62%) and the metropolitan based school 329 (38%).

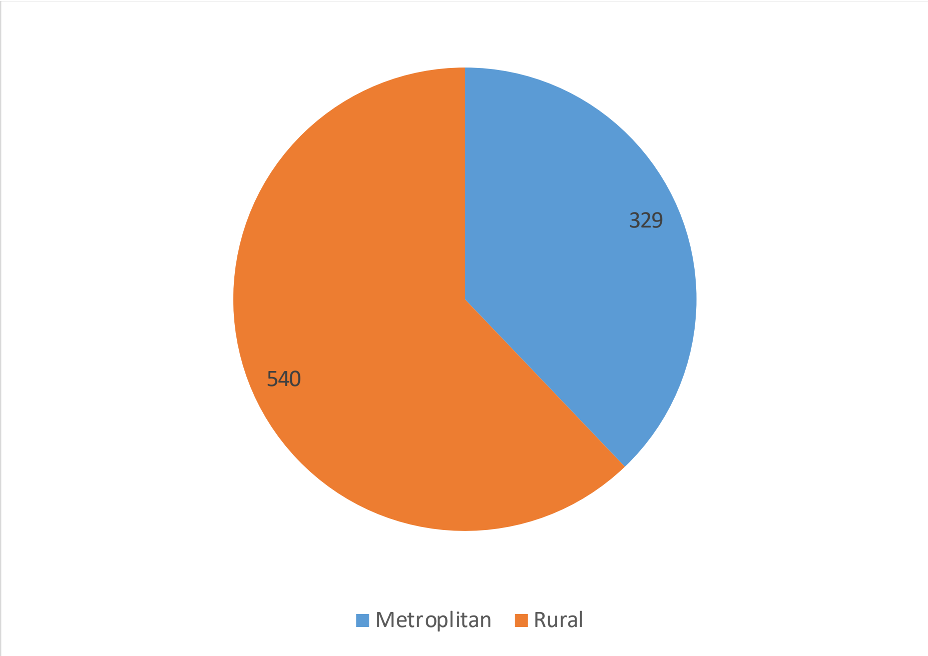

Figure 5.1 Total Rural and Metropolitan Based Students who participated in the Student Self-Belief in Mathematics questionnaire

Similar proportions of females and males participated in the questionnaire from rural based schools and metropolitan based schools. In total, 293 (54.3%) female students and 247 (45.7%) male students participated in the Student Self-Belief in Mathematics questionnaire from the rural based schools and 186 (56.5%) females and 143 (43.5%) males from the metropolitan based schools as shown in Figure 5.2 below.

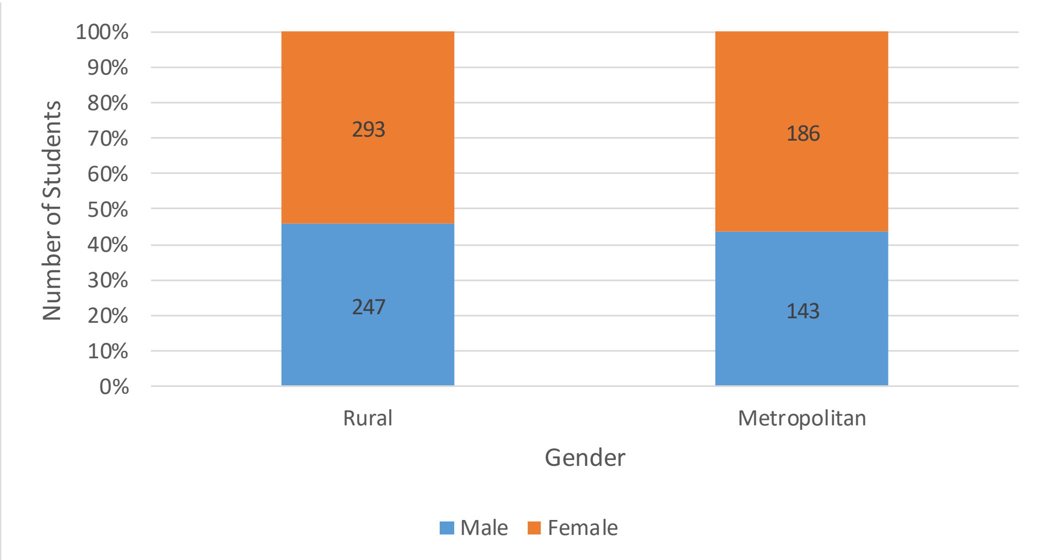

Figure 5.2 The number of male and female students who participated in the Student Self-Belief in Mathematics questionnaire for rural and metropolitan based schools

Figure 5.3 shows the number of students from Years 7, 9 and 11 who participated in the Student Self-Belief in Mathematics questionnaire. In both geolocations, there was a more significant proportion of Year 7 students in the cohort. For rural based schools, 246 (45.6%) students were in Year 7, 192 (35.6%) students were in Year 9, and 102 (18.9%) were in Year 11. In the metropolitan based schools, 184 (55.9%) students were in Year 7, 122(37%) students were in Year 9, and only 23 (7.0%) students were in Year 11. The Year 11 responses in the metropolitan based schools had less impact than that of the rural based schools. The Year 7 students most influence on the questionnaire results in both geolocations.

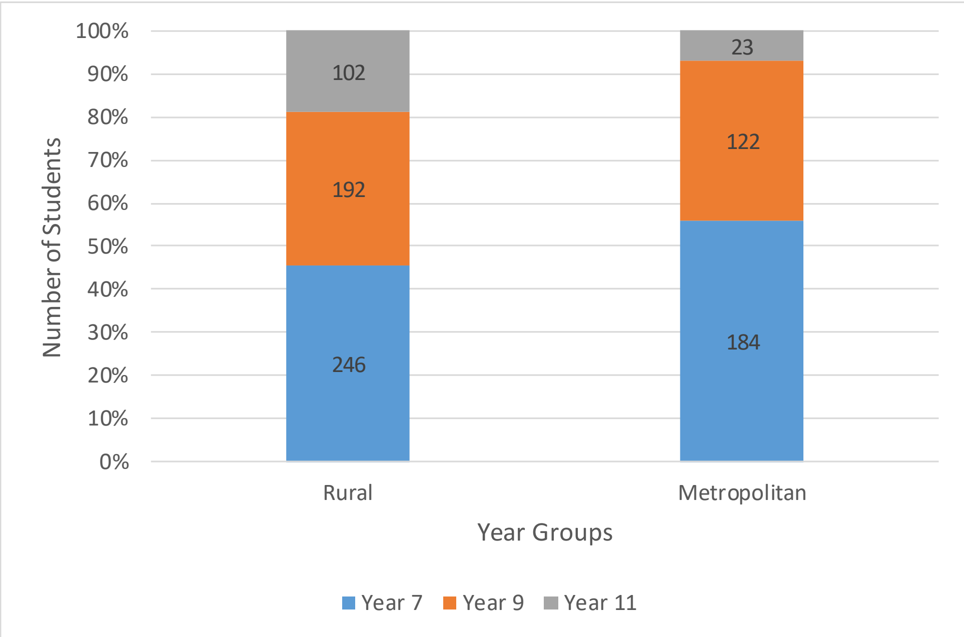

Figure 5.3 The number of students from Year 7, 9 and 11 who participated in the Student Self-Belief in Mathematics questionnaire for rural and metropolitan based schools

The students who completed the Student Self-Belief in Mathematics questionnaire were predominantly Non-Indigenous. Only 26 rural based students and eight metropolitan based students identified as Indigenous. This represents 4.7% of the rural sample and 2.5% of the metropolitan sample. These proportions can be considered compared to the indigenous percentage of the Australian population (2.8%) and 2.9% of the NSW population (Australian Bureau of Statistics, 2016). While proportionate to the broader population, the small number of students identified as Indigenous was problematic for the data analysis.

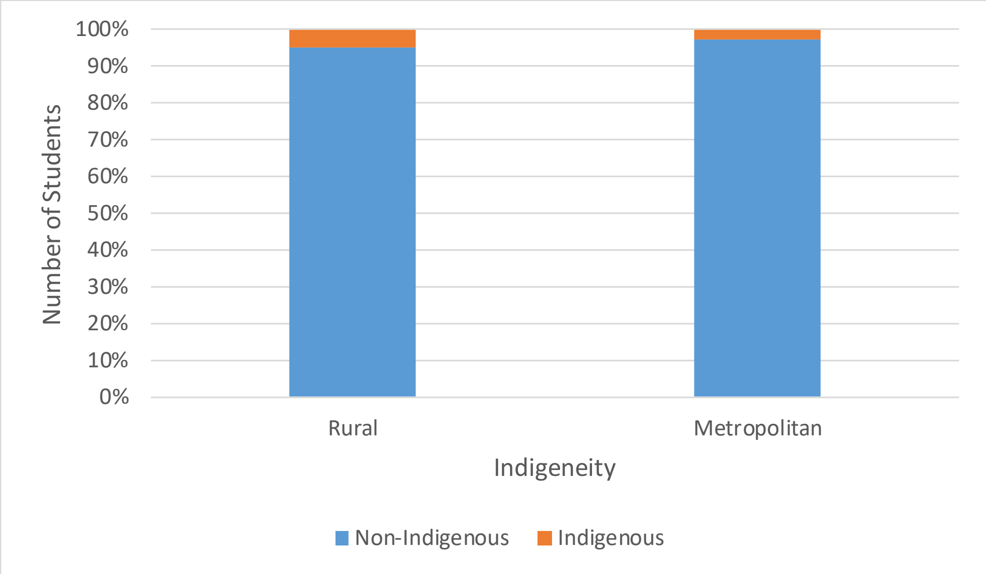

Figure 5.4 The number of students who identified as Indigenous and Non-Indigenous in the Student Self-Belief in Mathematics questionnaire

Figures 5.5 and 5.6 depict the percentage of students who knew the education levels of their mother and their father. The students were asked to indicate if their mother/father had left school before they finished Year 12, at year 12 or if they had a trade certificate or diploma or a university degree. As can be seen, the smallest proportion for both rural and metropolitan based students was mothers with trade qualifications. In both geolocations, more fathers left school before year 12 than mothers. The students were also asked to indicate if they did not know their parent's education level. This response accounted for the largest share (about one third) for rural and metropolitan based students for both father's and mother's education levels. It was implied that knowing parents' education levels meant that parents and students had discussed post-school education options and provided a modelling influence.

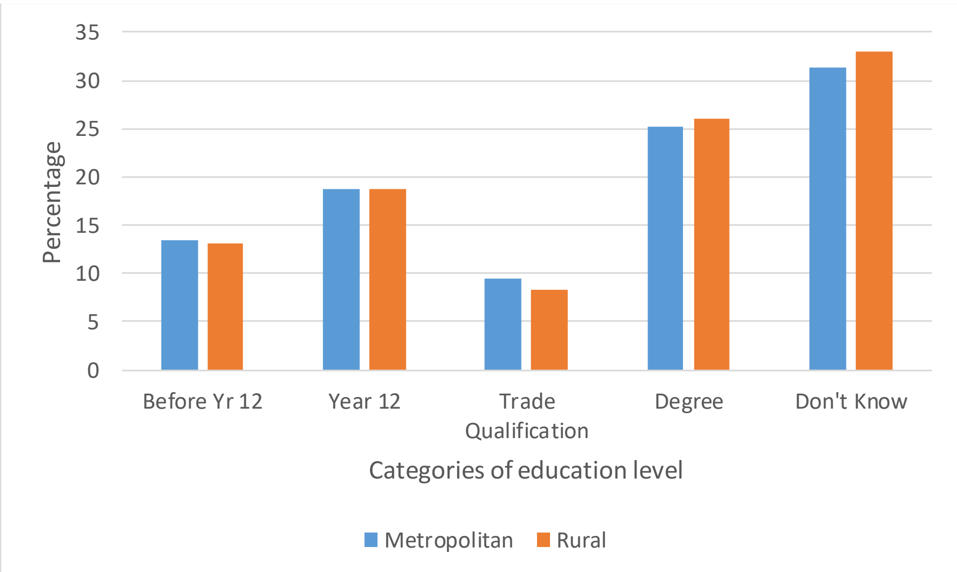

Figure 5.5 The number of students who knew their Mother's Education Level

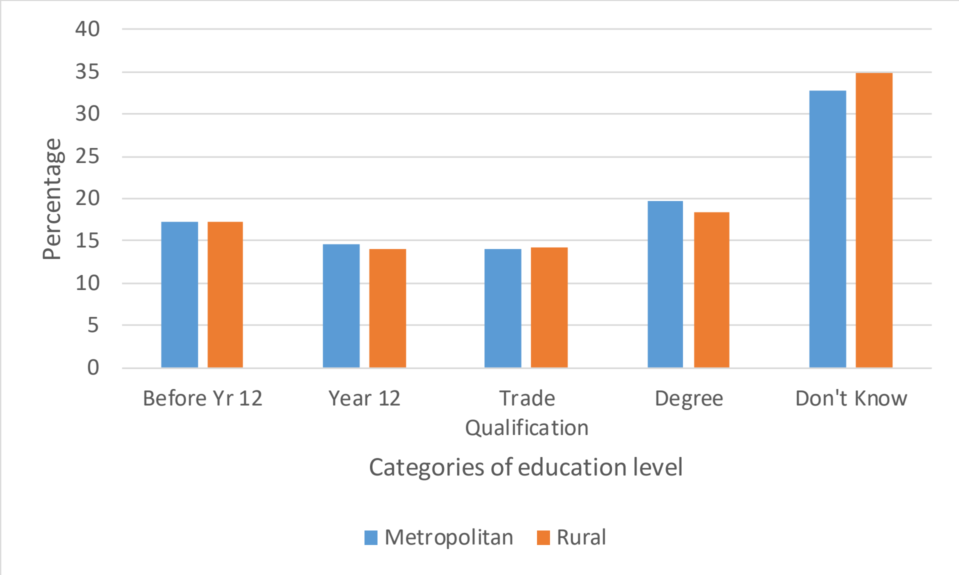

Figure 5.6 The number of students who knew their Father's Education Level

Figure 5.7 represents the number of students whose family spoke another language at home. English was the largest proportion of both rural and metropolitan groups. However, the rural based students had a smaller proportion of the cohort who spoke another language besides English at home.

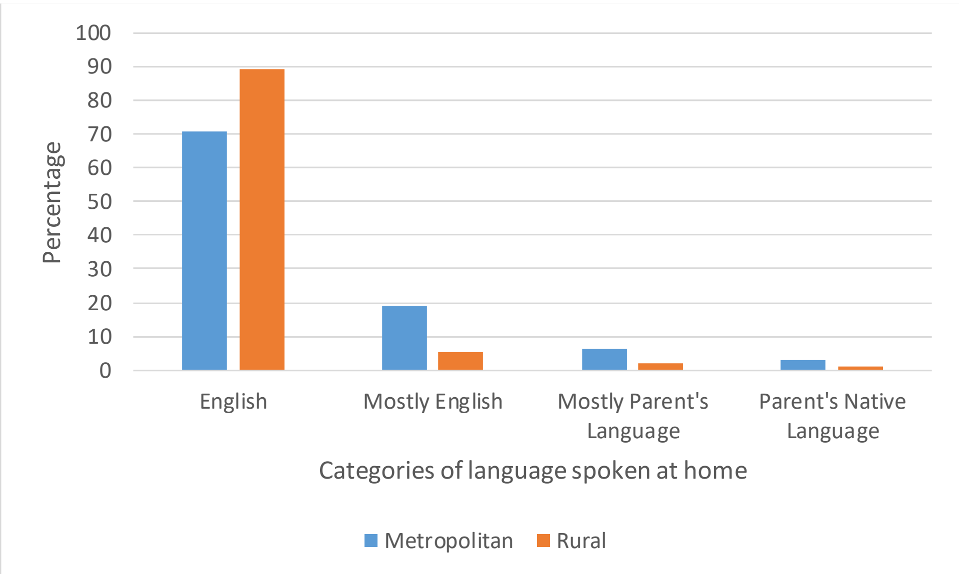

Figure 5.7 The number of students who have a language other than English spoken at home

The final descriptor of the student profile on the Student Self-Belief in Mathematics questionnaire was based on the number of people they knew people who used advanced mathematics in their job. Students were asked not to include their Mathematics teacher in this count and provide examples expected to be present in rural and metropolitan communities (such as engineers, accountants, or scientists). Knowing zero people was the most popular choice for both geo-locations, and the number of people in each subdivision declined as the number of people who used advanced mathematics increased up to them knowing five people. Both rural and metropolitan students indicated that some students knew six or more people, which was larger than some of the other selections. Even though students could have answered zero, it is noted that not answering the questions was the most common option for rural based students. This suggests that either the students did not understand the question or decided not to answer the question. Either way, this reflects poorly on the rural based students' potential vicarious experience from the people who use advanced mathematics in their job.

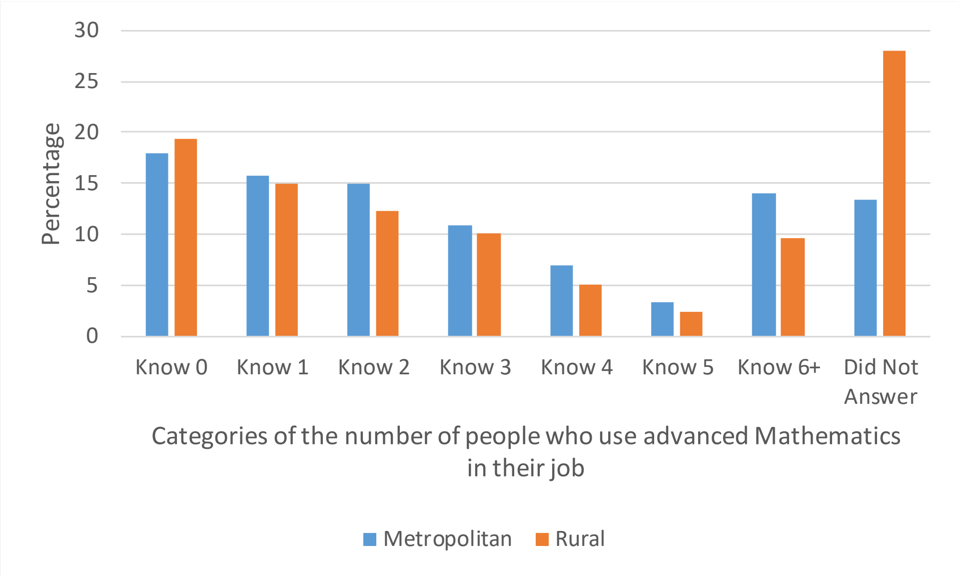

Figure 5.8 The number of students who know a person who uses advanced mathematics in their job

5.3 Trends for students of this study against the identified factors

In the Student Self-Belief in Mathematics questionnaire, students were asked for their perceptions in Section 2 (Sources of Self-Efficacy), Section 3 (Mathematics Self Efficacy based on the NSW Mathematics curriculum) and Section 4 (Parents/Carers and Teacher's attitudes in Mathematics). The order of the questionnaire was deliberately set, so the students completed the perceived sources of self-efficacy in Section 2 before completing the mathematics self-efficacy questions to ensure their responses in section 3 did not influence the students' initial perceptions. The scaling of Section 2 and Section 4 was a six-point Likert style scale used to measure student agreement with the statement. The students responded to their Mathematics self-efficacy on a scale from 0 to 10 ("cannot do at all" to "highly certain can do") to reflect their level of confidence to complete the task (Bong, 2006).

5.3.1 Student Perceptions of their Mathematical Self-Efficacy

The pattern of the responses from the student questionnaire showed there was general homogeneity between the rural and metropolitan cohorts from the sample schools. Figure 5.9 shows the mean responses by the students. In this figure, the responses have been aligned so that the six basic questions from Section 3 are displayed in the sequence of number, algebra and patterns, measurement, geometry, statistics and probability. The following six questions are the intermediate level questions in the same topic order, followed by the six advanced level questions in the same topic order. This provides a view of the students' perceptions of their ability to solve the questions according to the difficulty of the specific question. The final four questions are the Working Mathematically questions that look at the processes of developing understanding and fluency, problem solving skills, communication, connecting mathematical concepts and mathematical techniques, communication and reasoning. As shown in the figure below, the mean student response for rural based students and metropolitan based students largely follow the same pattern. It is also clear that the students from both geolocations perceived some sub-strands as more difficult than other topics, and, hence their self-efficacy scores were lower. If students perceived all of the sub-strands a similarly easy or difficult, then the basic questions would all have higher perceived levels of confidence to complete the questions leading to the advanced questions having lower levels of confidence.

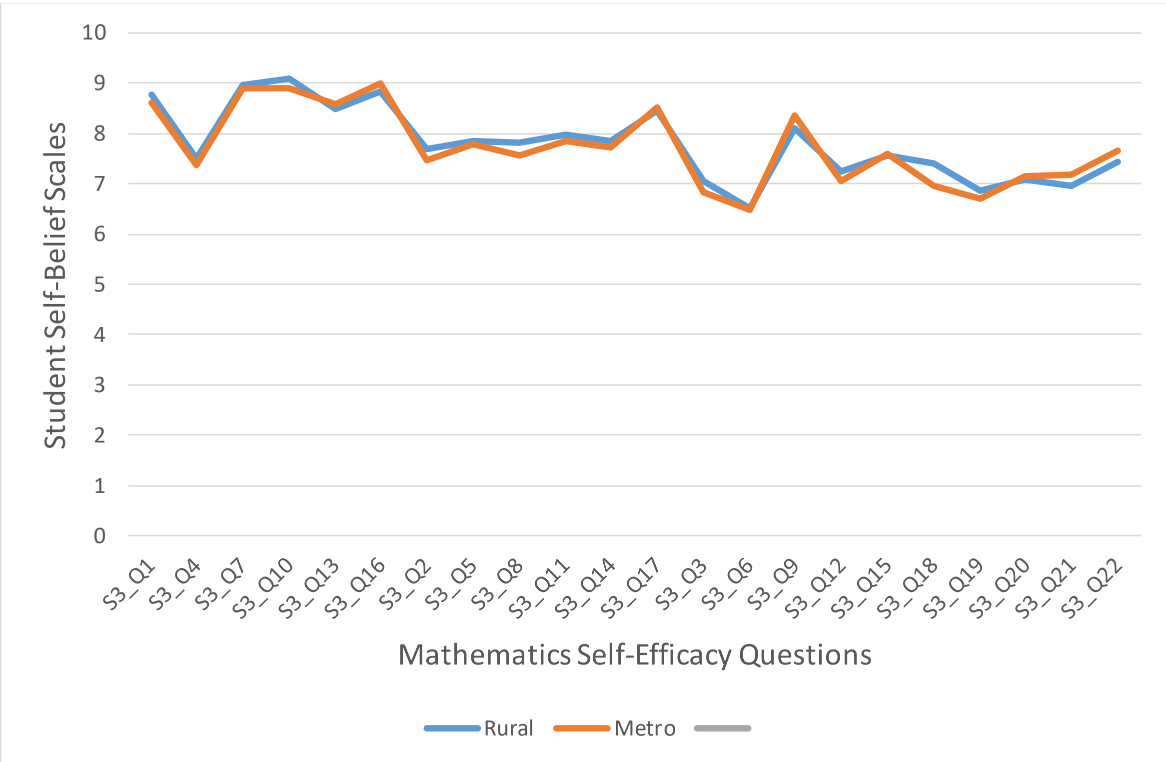

Figure 5.9 Mean Responses to Mathematics Self-Efficacy by Location

However, the irregularity between the students' levels of confidence indicates that they perceive some sub-strands as more difficult and some as less difficult. For example, Questions 3, 6, 12 and 18 have lower levels of confidence to complete the question, but Questions 9 and 12 have a higher level of confidence even though they were all considered "advanced" questions. The responses on the individual confidence scores provided factor scores for the two factors, "Perceived Most Difficult" and "Perceived Least Difficult". A MANOVA conducted for differences between rural and metropolitan based students for these two latent variables indicated no significant difference (F (2,829) = .535, p =.586; Wilk's Λ = .999). Hence, student perceptions that the questions were more or least difficult occurred regardless of the students' geolocation. The mean factor score and standard deviation for factors are listed in Table 5.1 below.

The perceived confidence in number and algebra, and patterns is important as these skills are used to perform calculations, recognise patterns, describe relationships and apply generalisation techniques (NESA, 2018b). Similarly, understanding and fluency, problem solving skills, communication, connecting mathematical concepts and mathematical techniques, communication and reasoning (as reflected in the Working Mathematically process sub-strand) are needed to explain mathematical thinking and apply it to the social systems external to the school. So, the perception by students that these, regardless of intended difficulty, were considered most difficult in both rural and metropolitan settings is notable.

Table 5.1

Mean and standard deviation of the factor scores for the rural and metropolitan students for Mathematics self-efficacy

Factor	location	*N*	*M*	*SD*
Perceived most difficult	Rural	523	0.02	1.0
	Metro	309	0.00	1.0
Perceived least difficult	Rural	523	0.0	1.02
	Metro	309	0.03	0.93

5.3.1.1 Mathematical self-efficacy Perceptions by grade

An independent *t*-test for rural based students identified the Year 11 group (*M* = .31, *SD* = .91) as significantly more confident from the Year 7 (*M* = -.10, *SD* = 1.05) in the perceived most difficult questions ($t(338) = -3.38$, $p < .001$, d = .41). Year 11 were also significantly more confident on both the questions perceived most difficult when compared to Year 9 (*M* = -.04, *SD* = .95, ($t(289) = -3.00$, $p < .001$), d = 0.37), but paradoxically less confident with the questions perceived as least difficult (Year 11: *M* = -.22, *SD* = 1.01, Year 9: *M* = .13, *SD* = .88, ($t(290) = -3.10$, $p < .001$, d = .12).

The independent samples *t*-test of the factor scores also showed that the metropolitan based Year 7 (*M* = .12, *SD* = .93) who were significantly more confident from the Year 9 (*M* = -.17, *SD* = 1.05) in the perceived least difficult questions ($t(285) = 2.491$, $p = .01$, d = .29). There was no significant difference between Year 7 and Year11 and Year 9 and Year 11 for metropolitan based students.

5.3.1.2 Gender views of Mathematics Self-Efficacy for Rural and Metropolitan locations.

In order to compare the male and females of the groups, two sets of data are described in this section. The first compared males and females within the geolocation to test whether there is a gender bias for the latent variables. Using the factor scores from the student questionnaires, a MANOVA showed there was no significant difference between rural males and rural females ($F(2,518) = .743$, $p = .476$; Wilk’s

Λ = .997), nor between metropolitan males and females (F (2,302) = .643, *p* =.527; Wilk's Λ = .996) in their perceptions of being able to solve the most or least difficult questions.

The second analysis compared rural based males to metropolitan based males and rural based females against metropolitan based females to see if gender centred perceptions of confidence in mathematics were affected by geolocation. Rural and metropolitan based male students (F (2,371) = .669, *p* =.513; Wilk's Λ = .996) and, the rural and metropolitan based female students (F (2,455) = 1.797, *p* =.167; Wilk's Λ = .992) had statically similar responses for their self-efficacy for both of the identified levels of difficulty. Hence, regardless of being male or female for either rural or metropolitan based students in the sample, their responses were similar.

5.3.1.3 Indigenous students and Mathematics Self-Efficacy.

The proportion of the student population who identified as Indigenous was small (rural 4.7% and metropolitan 2.5%). It is clear from Figure 5.10 that there is a gap between the confidence of the rural based Indigenous and Non-Indigenous students. A Mann-Whitney U test showed that there was a significant difference ($p < .05$) for the questions that were perceived least difficult (*U* = 4826, *Z* = -2.08, *p* = 0.04) but no significant difference for the questions perceived as most difficult *U* = 5479, *Z* = -.951, *p* = 0.34). The small cohort of Indigenous students from the metropolitan sample had varied perceptions in comparison to the Non-Indigenous students although neither latent variable was significantly different (Perceived least difficult *U* = 2280, *Z* = -.856, *p* = 0.39 and Perceived most difficult *U* = 2412, *Z* = -.717, *p* = 0.47)

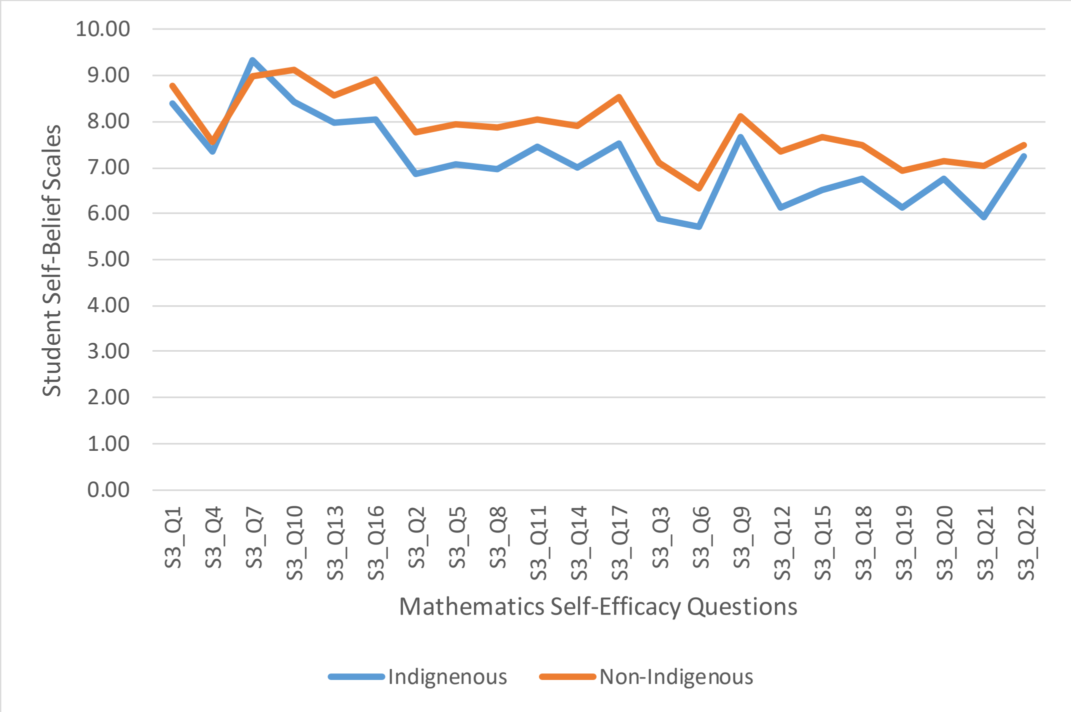

Figure 5.10 Mean Responses to Mathematics Self-Efficacy for Indigenous students by rural location.

5.3.1.4 Parent Education Levels with Mathematics Self-Efficacy

Parents' education levels were described for mothers and fathers against five options: Left school before Year 12, Year 12, Trade Certificate or Diploma, Degree, Don't Know. The factor scores for rural based student's perceptions of their mother's education were not significantly different (F (8,980) = 1.292, *p* =.244; Wilk's Λ = .979) in the questions that were perceived most difficult and those perceived as least difficult through a MANOVA of the factor scores. The students found that their perceptions of most and least difficult questions were moderately significant based on their perceptions of their father's education levels (F (8,980) = 1.968, *p* = .05; Wilk's Λ = .969). An independent samples *t*-test was conducted on the factor scores and compared students whose fathers had not studied post-school (NSPS), including those who left before or at Year 12 and those who reported they had studied post-school either at trade or at trade degree level (SPS). The results showed that both the questions that were perceived most difficult (SPS *M* = 0.24, *SD* = 0.85, NSPS *M* = -0.08, *SD* = 1.04, *t*(340) = -2.23, *p* = .03, d = .34) and the questions perceived least difficult (SPS *M* = 0.24, *SD* = 0.82, NSPS *M* = -0.11, *SD* = 1.04, *t*(340) = -3.27, *p* = .01, d = .37) were significantly different. Students whose father's had studied a trade or at university after school were more confident than those who had fathers who had not studied.

There no significant difference (p < .05) for metropolitan students for their mothers' levels of education (F (8, 552) = 1.493, *p* =.157; Wilk's Λ = .958). However, the MANOVA showed significant difference in mathematics self-efficacy based on their father's education level (F (5, 550) = 4.035, *p* =.001; Wilk's Λ = .892). Similar to the rural based students an independent samples *t*-test was conducted on the factor scores that compared students whose fathers had not studied post school (NSPS), and those who reported they had studied post-school (SPS). The results showed that the questions that were perceived most difficult (NSPS *M* = -0.16, *SD* = 0.90, SPS *M* = 0.21 *SD* = 1.0, *t*(200) = -2.73, *p* = .01, d =.37) were significantly different, but the questions perceived least difficult were not (NSPS *M* = -.07, *SD* = 0.98, SPS *M* = 0.03, *SD* = 1.04, *t*(340) = -3.27, *p* = .01).

As shown in Figures 5.5 and 5.6 a larger number of students indicated they did not know their parents' education levels. Rural based students had 183 who indicated they did not know their father's education level as did 105 metropolitan based students. Given this was about one third of the students a second independent samples *t*-test was conducted on the factor scores comparing those who did and those who did not know their father's education levels. The rural based students who know their father's level of education regardless of what level were significantly more confident on the questions perceived most difficult (*M* = 0.10, *SD* = 0.95) than those who did not know (*M* = -0.16, *SD* = 1.07, *t*(335.46) = -2.652, *p* = .01, d = .27). The questions perceived as least difficult were not significantly different (Don't Know: *M* = -.06, *SD* = 1.00, Did Know: *M* = 0.06, *SD* = 0.97, *t*(520) = -1.324, *p* = .19). For metropolitan based students, the questions most difficult (Don't Know: *M* = -.96, *SD* = 1.05, Did Know: *M* = 0.03, *SD* = 0.97, *t*(305) = -.975, *p* = .33) or those perceived as least difficult Don't Know: *M* = -.01, *SD* = .97, Did Know: *M* = 0.01, *SD* = 1.02, *t*(303) = .085, *p* = .93) did not prove to be significantly different.

5.3.1.5 Language spoken at home with Mathematics Self Efficacy

The number of students whose families spoke English only as the language at home was the largest rural and metropolitan groups. For rural based there was no significant difference based on the language spoken at home (F (6, 1018) = .826, *p* =.549; Wilk's Λ = .990). A larger proportion of metropolitan based students from the sample schools were more likely to have a non-English language spoken at home, and this proved significant (F (6,600) = 2.486, *p* =.02; Wilk's Λ = .952). An independent samples *t*-test found that "English only" was not significant, but that students' whose families spoke English only and Mostly English (*M* = -.05, *SD* = .97) were moderately more confident when compared to those who spoke all or mostly their parents' native tongue at home (*M* = .33, *SD* = 1.18, *t*(304) = 1.962, *p* = .05, d = .5) for the questions the students perceived least difficult.

5.3.1.6 Known people in careers that use advanced mathematics with Mathematics Self-Efficacy

Students were asked to nominate *How many people, other than your Maths teacher, do you know who use advanced maths for their job? E.g. engineer, accountant, scientist. You can use '0' if you don't know anyone.* The options were "0", "1", "2", "3", "4", "5" and "6+". Despite being prompted to use "0" if the students did not know of any people in these jobs, many students, particularly rural students, did not answer the question. The MANOVA of the factor scores showed that there was no significant difference for rural based students (F (12,758) = 1.637 *p* =.08; Wilk's Λ = .950), nor for metropolitan based students (F (12,506) = .495, *p* =.918; Wilk's Λ = .977).

5.3.2 **The Sources of Mathematical Self-Efficacy perceived by the Students**

In Figure 5.11, the student responses to the sources of self-efficacy in Section 2 of the Self-Belief in Mathematics questionnaire show that both rural and metropolitan based students responded similarly. The student responses were gathered on a six-point Likert scale ("1" representing "definitely disagree", and "6" representing "definitely agree" with the other scales representing "disagree", "disagree more than agree", "agree more than disagree"; and "agree"). This symmetrical Likert scale provided information on whether students agreed or disagreed with the statement.

The questions are reported in their source groups of enactive mastery, vicarious experience, social persuasion and affective states. Question 20, "Doing maths gives me energy", was predicted to measure perceptions of positive affective states, but the results were out of trend for both groups of the sample and was withdrawn from the analysis as explained in Chapter 4.

These questions loaded to the predicted sources (enactive mastery, vicarious experience, social persuasion and affective states) except for Question 5, "I do well on maths classwork", and Question 19 ", Just being in maths class makes me feel nervous". Question 5 suggests that students rely on the vicarious experience of their classmates to judge their success. Question 19 suggested that comparing oneself with classmates leads to them feeling nervous. The student perceptions for this question were analysed within the vicarious experience source. Factor scores were calculated for these latent variables with a MANOVA showing no significant difference ($F(4,336) = .685$, $p = .60$; Wilk's $\Lambda = .992$) for the loaded variables based on location.

As can be observed from figure 5.11 Question 7, "Seeing adults do well in maths motivates me to do better", recorded the lowest mean results for rural based students ($M = 3.15$, $SD = 1.4$). The metropolitan based students result also identified more disagreement than agreement for this question ($M = 3.44$, SD 1.42) as the flex point between agreement and disagreement is a score of 3.5. Hence the measures from the students in this study indicated that observing adult mentors using "maths" was not a source that built their mathematics self-efficacy in both geolocations.

The questions used to measure the affective state's source were worded negatively, so the analysis was reversed to give a positive commentary. The student responses showed that studying mathematics did not carry negative emotions such as nervousness, stress, anxiety or tension.

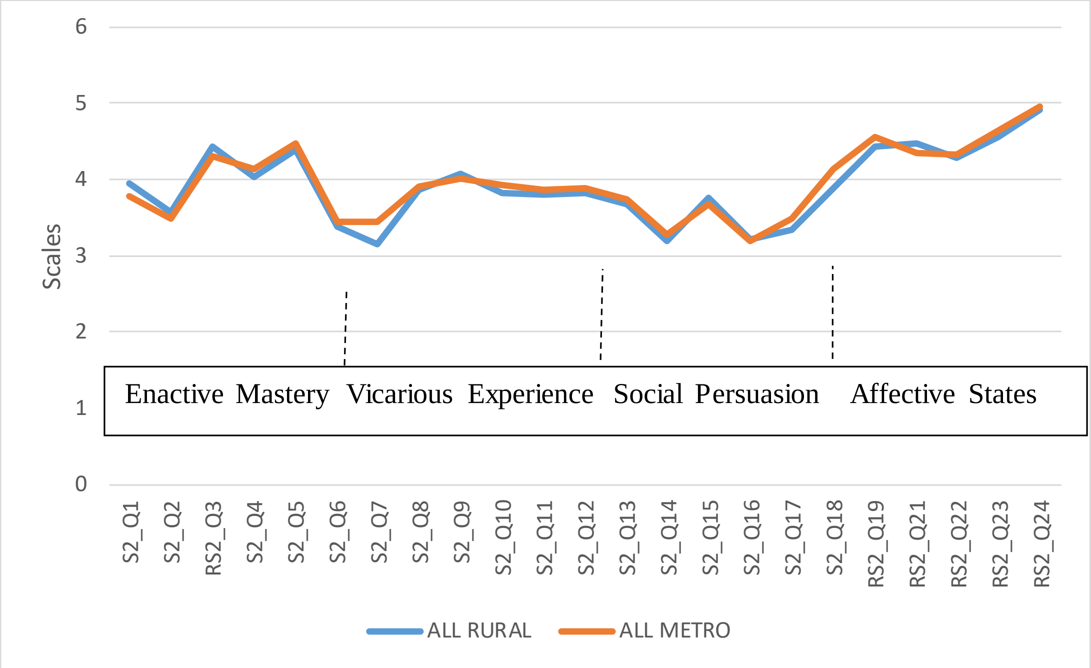

Figure 5.11 Mean student responses to Sources of Self-Efficacy

5.3.2.1 Sources of Self-Efficacy by grade

An independent *t*-test found that the rural based year 7 and 9 students were not significantly different, but the Year 7 were significantly (*M* = .08, *SD* = 1.02) more positive about their perceived mastery than Year 11 (*M* = -.35, *SD* = .90, t(337) = 3.525, p < .001, d = .43). The Year 7 (*M* = .07, *SD* = .99) were also more confident about the social persuasion they received about their mathematics self-efficacy than Year 11 (*M* = -.19, *SD* = .90, *t*(335) = 2.209, *p* = .03, d = .26). Year 9 were significantly (*M* = .09, *SD* = .99) more positive about their perceived mastery than Year 11 (*M* = -.35, *SD* = .90, *t*(335) = 3.781, *p* < .001. d = .47).

The independent *t*-test found that for metropolitan based students Year 7 were significantly more confident about the vicarious experience they perceived for their mathematics self-efficacy (*M* = .12, *SD* = .93) than Year 9 (*M* = -.17, *SD* = .90, *t*(285) = 2.491, *p* = .01, d = 0.3) and in their affective states about their mathematics (Year 7: *M* = .17, *SD* = .93, Year 9: *M* = -.27, *SD* =1.08, *t*(295) = 3.882, *p* = .00, d = .45). Year 7 and Year 11 and Year 9 and Year 11 were not significantly different.

5.3.2.2 Gender and sources of Self-Efficacy

The sources of self-efficacy for rural based students was significantly different (F (4, 483) = 5.278, *p* <.001; Wilk's Λ = .958). The rural males were significantly more confident about their mastery (*M* = .12, *SD* = .99) and affective states (*M* = .18, *SD* = .99 than the rural females in mastery (*M* = .17, *SD* = .93, t(521) = 2.436, *p* = .02, d = .21 and affective states (*M* = -.15, *SD* = 1.05, *t*(526) = 3.920, *p* < .001, d = .34).

Following a similar trend, the metropolitan based students were also significantly different (F (4, 265)

= 3.544, *p* =.01; Wilk's Λ = .949). The metropolitan males were significantly more confident about their affective states (*M* = .13, *SD* = .90 than the metropolitan females (*M* = -.10, *SD* = 1.07, *t*(315) = 2.094, *p* = .04, d = .24).

There was no significant difference comparing rural and metropolitan male students (F (4, 336) = .685, *p* =.60; Wilk's Λ = .992), nor between rural and metropolitan based female students (F (4, 417) = 1.028, *p* =.39; Wilk's Λ = .990).

5.3.2.3 Indigeneity and sources of Self-Efficacy

As previously noted, the small number of indigenous students in each cohort (rural n = 26/540 and metropolitan n = 8/328) makes the impact of the analysis of data difficult to judge. The rural based students' responses generally have the indigenous students disagreeing with the statement more than the non-indigenous students. However, a Mann-Whitney U-test of the factors scores indicated that there were no areas of significant difference (p < .05) for any of the sources of self-efficacy for either rural or metropolitan based students.

5.3.2.4 Parent Education and sources of Self-Efficacy Education levels and sources of Self-Efficacy.

The data presented in this section is based on the sources of self-efficacy when compared by the students' perceptions of their mothers and fathers levels of education. There was no significant differences (p< .05) in the factor scores for the sources of self-efficacy for rural based students knowledge of their mothers (F(16, 1393.741) = 1.249, *p* =.22; Wilk's Λ = .957) or father's (F(16, 1393.741) = 1.629, *p* =.06 Wilk's Λ = .945) level of education.

Similalry for metroplitan based students, there were no sgnificant difference in the spources of self-efficacy when compared by the students' perceptions of their mother's (F(8, 508) = .943, *p* =.48; Wilk's Λ = .971) or father's (F(8, 508) = .443, *p* =.90 Wilk's Λ = .986) level of education.

5.3.2.5 Language spoken at home and their Sources of Self-Efficacy

The results showed there was no significant difference (p < .05) in any of the sources for rural students (F(12, 1257.023 = .1.679, *p* =.07; Wilk's Λ = .959). As with the rural based students, there was statistical similarity in the perceived sources of self-efficacy with all sources (F(12, 693.478) = 1.315, *p* =.21; Wilk's Λ = .942).

5.3.2.6 Known people in advanced mathematics careers with their Sources of Self-Efficacy

A MANOVA of the factor scores of the students responses indicated that the rural based students selection of the sources of self-efficacy had some statistical difference (F(24, 1239.657) = 1.529, *p* =.05; Wilk's Λ = .903). The students who did not anyone who used advanced mathematics was a large group (102 students) and, through and independent t test, this group were significantly weaker in their perceptions of enactive mastery (*M* = -.16, *SD* = 1.06), vicarious experience (*M* = -.27, *SD* = 1.01) and social persuasion (*M* = -.14, *SD* = 1.03) than those who knew at least one person (enactive mastery: *M* = .10, *SD* = .98, *t*(388) = 2.282, *p* = .02, d = .26; vicarious experience: *M* = .17 , *SD* = 1.01, *t*(383) = 3.987, *p* = .00, d = .46; and social persuasion: *M* = .12, *SD* = .98, *t*(388) = 2.292, *p* = .02, d = .26). The large number of students who did not respond to the question was potentially problematic as it increases the pool of students who did not indicate they knew people who used advanced mathematics in their jobs. As the students did not respond they were discounted from the analysis.

For metropolitan based students, the number of people you know people who used advanced mathematics in their jobs was not significant (F(24, 779.164) = 1.076, *p* =.37; Wilk's Λ = .892)

5.3.3 Student Perceptions of Parent/Carer and Teacher Attitudes to Mathematics

Section 4 of the Student-Belief in Mathematics considered student perceptions of their parents'/carers' and teachers' attitudes to mathematics. The mean student responses showed that students responded positively to their parents'/carers' attitudes to mathematics regardless of geolocation. Students indicated their parents see mathematics as an important subject to study, encourage them to study and are interested in their progress with means between 4.91 and 5.26 for six of the seven questions. For example, the students agreed that "My parents/carers think maths is one of the most important subjects I study" (Question 1: rural *M* = 4.91, *SD* = 1.23, metropolitan *M* = 5.15, *SD* = 1.18), "My parents/carers strongly encourage me to do well in maths" (Question 2: rural *M* =5.07, *SD* = 1.04, metropolitan *M* = 5.26, *SD* = 0.96), and "My parents/carers have always been interested in my progress in maths" (Question 3: rural *M* =4.75, *SD* = 1.20, metropolitan *M* = 4.95, *SD* = 1.15). However, their agreement was weaker for "My parent/carers think that I will need harder maths to get a good job when I leave school" (Question 6: rural *M* =3.61, *SD* = 1.46, metropolitan *M* = 3.98, *SD* = 1.46).

Similarly, students' reported positive perceptions about their teachers' attitudes to mathematics in Question 8 "My teacher thinks I am the kind of person who could do well at maths" (rural *M* =4.15, *SD* = 1.81, metropolitan *M* = 4.32, *SD* = 1.24) and Question 10 "My maths teachers have been interested in my progress in maths" (rural *M* =4.08, *SD* = 1.22, metropolitan *M* = 4.3, *SD* = 1.31). However, it is noted that both rural and metropolitan students both disagreed with Question 12 "I would talk to my maths teacher about careers that use maths" (rural *M* = 3.39, *SD* = 1.55 and the metropolitan *M* = 3.38, *SD* = 1.58).

As seen in Figure 5.12, the rural based and metropolitan students' perceptions follow a similar pattern with the rural students generally weaker than the metropolitan based students. However, there was a significant difference (F(2, 816) = 5.455, *p* <.001; Wilk's Λ = .987). An independent samples *t*-test of the factor scores showed rural students were significantly weaker for both parents'/carers' (rural *M* = -0.08, *SD* = 1.02, metropolitan *M* = 0.30, *SD* = 0.95, *t*(837) = -3.126, *p* < .001 d = -.24) and teachers' attitudes to studying mathematics (rural *M* = - .37, *SD* = 0.98, metropolitan *M* = 0.06, *SD* = 1.03, *t*(834)

= -1.970, *p* = .0, d = .14).

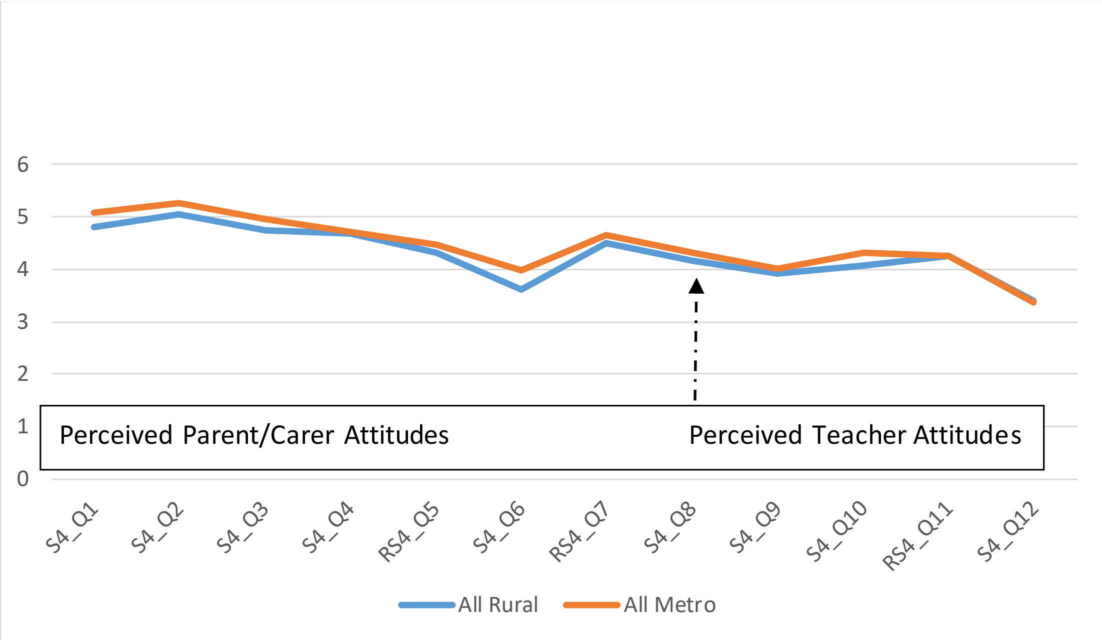

Figure 5.12 mean student responses to Parent/Carer and Teacher Attitudes to mathematics

5.3.3.1 Parent/Carer and Teacher Attitudes to Mathematics by grade

For rural based students a statistical difference was observed between grades F(4, 1024) = 6.592, *p* <.001; Wilk's Λ = .950). There was no difference between Year 7 and 9 and no difference between the impact the teacher attitudes had in comparing Year 7 and 11 and Year 9 and 11. However, student perceptions of their parents' attitudes to mathematics for Year 11 (*M* = - 0.39, *SD* = 1.15) were significantly weaker than Year 7 (*M* = 0.02, *SD* = 0.98, *t*(335) = 3.362, *p* < .001, d = .4) and Year 9 (*M* = 0.30, *SD* = 0.95, *t*(284) = 4.360, *p* < .001, d = .58).

There was no significant difference between the factor scores of metropolitan based students in the perceived parent or teacher attitudes to mathematics F(4, 598) = 1.676, *p* =.15; Wilk's Λ = .978)

5.3.3.2 Parent/Carer and Teacher Attitudes to Mathematics: A Gender view

Student perceptions of their parent/carers attitudes to Mathematics were generally cohesive when considered by gender. Within the rural F(2, 512) = 1.454, *p* =.23; Wilk's Λ = .994) and metropolitan based students (F(2, 297) = 1.506, *p* =.22; Wilk's Λ = .990) there was no significant difference between males and females for both parents'/carers' and teachers' attitudes to mathematics. There was also no significant difference between the males from rural or metropolitan based schools F(2, 363) = 1.870, *p* =.16; Wilk's Λ = .990). However, some significant difference was found in comparing the rural based females with the metropolitan based females F(2, 450) = 3.962, *p* =.02; Wilk's Λ = .983) The rural based females factor scores were significantly less (*M* = -0.11, *SD* = 1.01) than metropolitan females less (*M* = 1.17, *SD* = 0.95, *t*(463) = -2.879, *p* < .001, d = .24) for parents'/carers' attitudes to mathematics and for teacher's attitudes to mathematics (rural *M* = -0.08, *SD* = 0.98, metropolitan *M* = 0.13, *SD* = 1.01

t(459) = -2.229, *p* = .02, d = .21). As noted in Figure 5.12, student responses to the questionnaire were generally positive. The weakest of the parents'/carers' attitudes to mathematics was Question 6 "My parent/carers think that I will need harder maths to get a good job when I leave school" with rural female (*M* = 3.43, *SD* = 1.42) and metropolitan female (*M* = 3.89, *SD* = 1.47). This implies that rural female students do not perceive that their parents'/carers' believe that the study of advanced mathematics is needed for a good job.

Question 12, "I would talk to my maths teacher about careers that use maths" was the weakest of the comments from all students about their teachers' attitudes to mathematics and particularly for the rural female *M* = 3.29, *SD* = 1.55, and metropolitan female *M* = 3.39, *SD* = 1.59). There appears to be a break in the alignment between mathematics learned at school and applied to careers.

5.3.3.3 Indigeneity and Parent/Carer and Teacher Attitudes to Mathematics

Both rural based and metropolitan based Indigenous students were generally very similar to their non-Indigenous classmates in their perceptions of parents'/carers and teachers' attitudes to mathematics. Using a Mann-Whitney U test, the factor scores for the latent variables were not significantly different based on indigeneity.

5.3.3.4 Parent Education Levels with their Parents'/Carers' and Teachers' Attitudes to Mathematics

For rural students, their perceptions of their parents'/carers' and teachers' attitudes to mathematics had no significant difference based on their mother's education level (F(8,968) = 1.173, *p* =.31; Wilk's Λ = .981). However, a significant difference (F(8,968) = 2.127, *p* =.03; Wilk's Λ = .966) based on father's education levels was found. Knowing whether their father had studied for a trade or degree (parents/carers: *M* = .07, *SD* = 0.98; teacher: *M* = .07, *SD* = 0.92), or not (parents'/carers' *M* = -.80, *SD* = 1.04, *t*(335) = -1.326, *p* = .19, d = ..24; teachers' *M* = .07, *SD* = .97, *t*(339) = -.232, *p* = .82, d = .36) did not prove significantly different when investigated through and independent samples *t*-test. The difference in this group was based on the students' perceptions of their teacher's attitudes to mathematics based whether the students knew their father's education or not (Did not know Father's level of education *M* = -0.15, *SD* = 1.09, Know their Father's education level *M* = .08, *SD* = .94, *t*(315.425) = -2.423, *p* = .01, d = .24). Metropolitan based students recorded no significant difference for parent's/carer's or teacher's attitudes to mathematics based on their mother's level of education (F(4, 572) = .908, *p* =.46; Wilk's Λ = .987), or their father's level of education (4,572) = 1.577, *p* =.18; Wilk's Λ = .978).

5.3.3.5 Language spoken at home with Parents'/Carers' and Teachers' Attitudes to Mathematics

An independent samples *t*-test compared the perceptions from rural based students who spoke only English at home as the large majority of the sample (*N* = 469) with parents'/carers' attitudes: *M* = -.01, *SD* = .97; teachers' attitudes: *M* = .02, *SD* = .98 compared to those who spoke some other language at home (parents'/carers' attitudes: *M* = .26, *SD* = 1.09, *t*(514) = 1.782, *p* = .08; teachers' attitudes: *M* = -.15, *SD* = 1.16, *t*(515) = .067, *p* = .25) showing no significant difference. Further, no significant difference was found when the independent samples *t*-test compared by students who spoke only or mostly English (parents'/carers' attitudes: *M* = .00, *SD* = .99; teacher's attitudes: *M* = .01, *SD* = .99) to those who spoke mostly or all their parent's native tongue (parents'/carers' attitudes: *M* = .32, *SD* = .77, *t*(514) = 1.354, *p* = .18; teachers' attitudes: *M* = -.11, *SD* = 1.16, *t*(515) = -.492, *p* = .62)

Metropolitan based students indicated no significant difference between the responses chosen by the students based on the language spoken at home. (F (6, 590) = 2.018, *p* =.06; Wilk's Λ = .960) and the parents/carer's or teachers' attitudes to mathematics

5.3.3.6 Knowledge of the number of people who use advanced mathematics in their jobs with Parents'/Carers' and Teachers' Attitudes to Mathematics

An independent samples *t*-test identified that rrual based student not knowing anyone who used advanced mathematics (parents'/carers' attitudes: *M* = -.23, *SD* = 1.06; teachers' attitudes: *M* = -.15, *SD* = 1.11) were significantly less positive than those who knew at least one person who used advanced mathematics in their job (parents'/carers' attitudes: *M* = .11, *SD* = .96, *t*(385) = 2.984, *p* < .001, d = .34; teachers' attitudes: *M* = -.15, *SD* = 1.11, *t*(386) = 2.923, *p* < .001, d = .34
).

The metropolitan based students perceived no significant difference based on the number of people they knew who used advanced mathematics in their careers (F (12, 494) = 1.068, *p* =.39; Wilk's Λ = .950) for parents'/carers' or teachers' attitudes to mathematics.

5.4 Conclusion

This chapter has explored the student responses to the Self-Belief in Mathematics questionnaire to determine areas of similarity and difference. The analysis has explored the student responses to their mathematics self-efficacy, their sources of self-efficacy and their perceptions of their parents'/carers' and teachers' attitudes to mathematics. The major finding of these data is that there is more similarity than difference when considering the students' responses when considering whether the schools were rural or metropolitan. The responses from the students followed the same pattern for the three sections of the questionnaire.

Through factor analysis, the questions loaded to indicate which areas of the mathematics syllabus the students perceived as most difficult and which they perceived as least difficult. The trend in responses between rural and metropolitan based students showed their responses were statistically similar in their belief that number, algebra and patterns and Working Mathematically were considered more difficult than measurement and statistics.

The factor analysis of the sources of self-efficacy and the attitudes to the mathematics of the parents'/carers' and teachers' loaded to the theorised areas. The student responses followed similar patterns for each of the sources. It was clear that negative emotions such as nervousness, stress, anxiety and tension are not part of the students' experience in mathematics lessons in either geolocation. Students from both rural and metropolitan based schools both disagreed that observing adults "do well at maths" motivated them to do better. Students also indicated that regardless of geolocation, their parents'/carers' considered mathematics an important subject to study at school but did not see it as important to get a "good job". This point was compounded by the students indicating that they would not seek career advice from their mathematics teacher.

The student perceptions of their parent's/carer's and teacher's attitude to mathematics, while following a similar pattern between the rural and metropolitan based students, found that the rural based students were significantly lower ($p < .05$) than the metropolitan students. In particular, the rural females were significantly lower than the metropolitan females for both Paretns'/carerparents'/carers' and teachers' attitudes ($p < .05$), not for males.

Further, by considering the education levels of their parents, rural based students' who did not know their mother's or their father's education level had significantly lower perceptions of their teachers' attitudes as to whether they could do well at mathematics, were interested in their progress, though they had the ability to do "harder maths courses" and were respected by their "maths teacher".

When students were asked to nominate the number of people they knew who used advanced mathematics, areas of difference surfaced in all three sections. If students identified they did not know any people who used advanced mathematics in their jobs, then rural based students were significantly less confident in both the least and most difficult questions, less influenced by the enactive mastery, vicarious experience and social persuasion sources and had lower perceptions of both parents'/carers' and teachers' attitudes to mathematics. Metropolitan based students were largely unaffected by this distinction, with students who indicated they did not know anyone who used advanced mathematics in their job being affected by the social persuasion source out of the eight latent variables analysed.

The other elements from the student profiles test age (grade at school) had little difference within the rural and metropolitan cohorts. While reflective of the Australian and New South Wales proportions, the small number of indigenous students also provided little in differentiating the student responses. The language background of families was dominated by those who speak English as their main or only language at home and showed a similarity in the responses to that of the whole cohort.

These data indicate that the student's perceptions and knowledge of their school and community environment impact their mathematical self-efficacy, sources, and influences. In developing an understanding of this environment and the drivers on students' perceptions, this study uses a qualitative exploration to consider the school and the environment in which the students reside. The collective environment is important (Bronfenbrenner, 1981). However, it is how the school and its teachers deal with the external environment that makes the difference (Hattie, 2018). School-based operative environments designed and implemented by the principal and the teachers influence their ability to build and hone productive learning environments (Dinham, 2016). Chapter 6 now explores the student survey findings through teacher interviews, field notes from discussions with the school's principal, the published profile and descriptions of the school on the school's own website, and the Government rum Myschool website.

Chapter 6: Teachers' and principals' perspectives

6.1 Introduction

The qualitative phase of this study seeks to understand the students' learning conditions by considering the systems they are operating within for each of their contexts (Bronfenbrenner, 1981) and the impact they have on the processes identified in Chapter 5. This chapter addresses research question two:

What are the major sources of the perceived self-efficacy in secondary school mathematics for rural students?

The explanatory-sequential method uses the commentary from the school descriptions from their website and the *Myschool* website, field notes from discussions with the school principal, and teacher's interview responses to understand the implications of the ecological systems on the students. The analysis of the responses by the students through the Self-Belief in Mathematics questionnaire compared the students by geolocation and against elements of micro-, meso- and exo-systems gained from their perceived profiles. This chapter considers the Bronfenbrenner systems within each school before summaries are formed for the rural and metropolitan based schools.

The second phase of this study begins by describing the collective environment of the communities of the school that is encompassed within the ICSEA. The ICSEA is a federally determined index used to reflect the levels of advantage and disadvantage of the school, that in turn respond to and drive the educational policies of the exo- systems, that in turn influence the meso- and micro-systems. The implication is that schools with higher levels of educational advantage, as measured by ICSEA, should be higher performance on NAPLAN tests across the school (ACARA, 2018). By sampling schools with similar educational advantages in this study, the researcher reasoned that the influences through the micro-, meso- and exo-systems would also be comparable.

The results in NAPLAN for the schools in this sample are used to build their descriptions relative to their achievement against Australian and "like schools" (referred to as "Statistically Similar School Group") (ACARA, 2018) as it gives a snapshot of the literacy and numeracy standards. As described in The original implication of this study was that rural based schools would perform below similar metropolitan based schools, although ultimately, this was not the case for the schools selected. The commentary provided in this chapter provides some insight into why this occurred and the subsequent impact on student self-efficacy.

This commentary describes the micro, meso- and exo-systems of each school. The qualitative data articulate the teacher and principal perceptions of the sources of student self-efficacy (micro-system) in mastery and confidence, vicarious experience, social persuasion and affective states. Included in the descriptions are the data on students' knowledge of their education levels and the number of people who use advanced mathematics in their job, given the implied connection 'third parties' have within the meso-system. The experience of teachers and their views on differentiation of pedagogy, assessment and applicability (problem solving) of the curriculum is also articulated as they reflect the collective efficacy of the mathematics faculty on the student's meso-system (Pegg et al., 2007). Similarly, the teachers' perceived influence on school policy and their faithfulness to applying the school's direction help describe the exo-system operating within the school. Finally, the teachers' understanding of state and system policy, procedures and ideologies (macro-system) are described as the imposed operative environment of the school.

The perceptions and comments by teachers build on the profile descriptions and establish a platform for the discussion provided in Chapter 7 that mixes the student questionnaire quantitative data and the descriptions of the collective efficacy of the school, the proxy efficacy of the teachers, the students' individual efficacy, and the strategies teachers use to move students from proxy to individual efficacy.

6.2 NAPLAN results for the sample schools

NAPLAN is a benchmark test undertaken by almost all students in Years 3, 5, 7 and 9 in all Australian schools. It provides longitudinal comparisons for literacy (reading, writing, spelling and, grammar and punctuation) and numeracy. Comparisons can be made against the national and state means and against schools with similar levels of advantage (as defined by ICSEA).

The first reflection of the data for the six schools of this study considers the school means for Year 7 and Year 9 Numeracy compared to the *All Australian Schools*' average. The data are from 2010 to 2018 and describe the general levels and trends of mastery within the schools. The Australian school's average is annualised and determined by the cohort. Comparing the school's mean with the Australian schools' mean identifies whether the school is above or below the average for Year 7 or Year 9.

NAPLAN data are designed to allow the school to be compared with "like schools" with similar socio-educational advantages or disadvantages (ACARA, 2018). Bronfenbrenner (1981) articulates that the ecological systems influence student education. It is with this sentiment that a comparison of the NAPLAN Numeracy means and "like school" Numeracy means is undertaken below to glean which schools are growing student capability relative to their levels of advantage.

6.2.1 Comparing NAPLAN Numeracy Means from the sample schools with the Australian schools' mean

The Australian schools' mean has varied over the years between 538 (2012) and 554 (2017 and 2018) for Year 7 and between 583 (2011) and 596 (2018) for Year 9. The difference between the sample school NAPLAN Numeracy Mean and the Australian Numeracy Mean is displayed for Year 7 in Figure 6.1 and Year 9 in Figure 6.2. The graph is positive if the school's mean is greater than the Australian mean. If it is less than the Australian mean, the graph is negative. The Year 7 NAPLAN test was based on content from Stage 3 (the last two years of Primary schools), and the Year 9 NAPLAN TEST was based on Stage 4 (years 7 and 8). The Year 7 cohorts generally came from local feeder schools, and, as the tests were done after one school term, their results tended to reflect the learning from the student's primary school. Being in the same geographical locale, the primary and secondary schools often have similar environmental influences and levels of advantage. The Year 9 cohorts reflect the learning the students have gained from their Year 7 and 8, and hence these data can generally be attributed to the processes, learning and teaching of the high school.

While there is inconsistency in some years, the graphs show the four rural schools of the sample generally gained higher results than the Australian schools' mean, which is in keeping with their ICSEA scores being greater than the mean of 1000. The metropolitan schools have a mean for NAPLAN numeracy that began being less than the Australian mean but were improving. In particular, St Sarah's College was a growing school that began Year 7 in 2011 with the first Year 9 cohort in 2013 and hence resulted for Year 7 in 2010 and Year 9 in 2011 and 2012 were not available. Their mean results are improving but remain below the mean of Australian schools.

The similarity between rural and metropolitan based students in their self-efficacy and sources seems contradictory to this dataset given the strong alignment between self-efficacy and achievement (Ahn et al., 2015; Liu & Koirala, 2009). It would be expected that the rural based schools with the higher levels of mastery represented in NAPLAN would have higher levels of self-efficacy and sources. The evidence provided in the qualitative data analysis provides an insight into the reasons for this occurring. Particularly the influence of the various environmental systems on the students' self-efficacy beliefs and the value they give to the study of advanced mathematics.

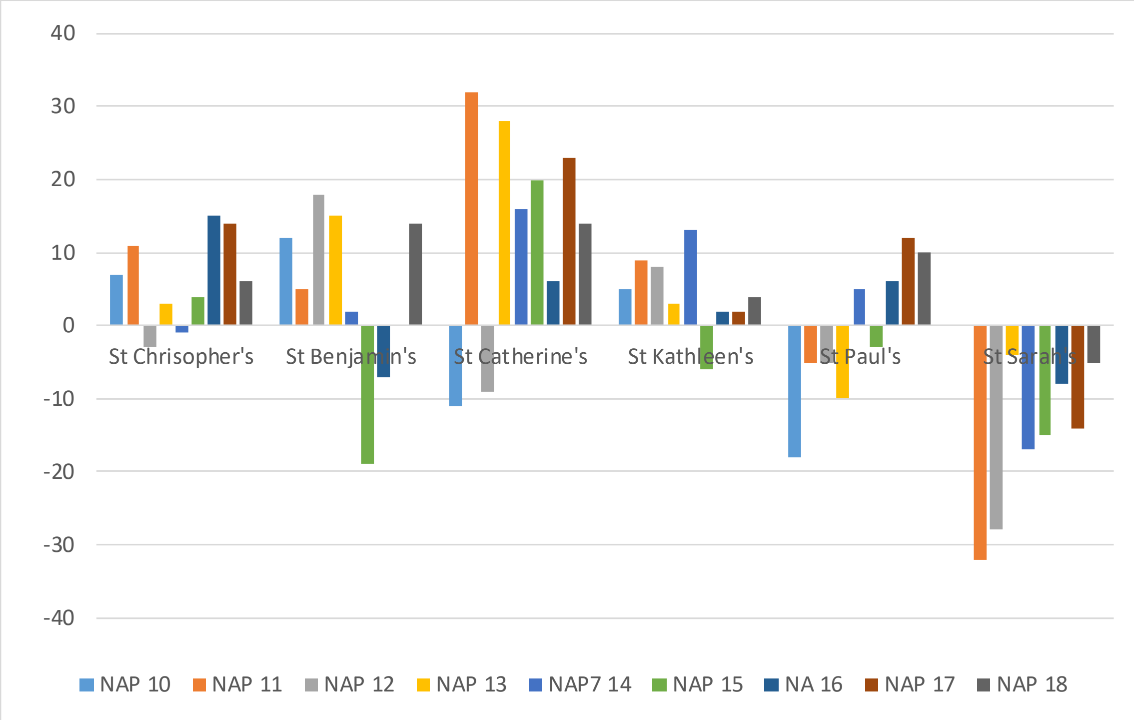

Figure 6.1 Difference between the NAPLAN Year 7 Numeracy mean of the individual sample schools and the Australian schools average

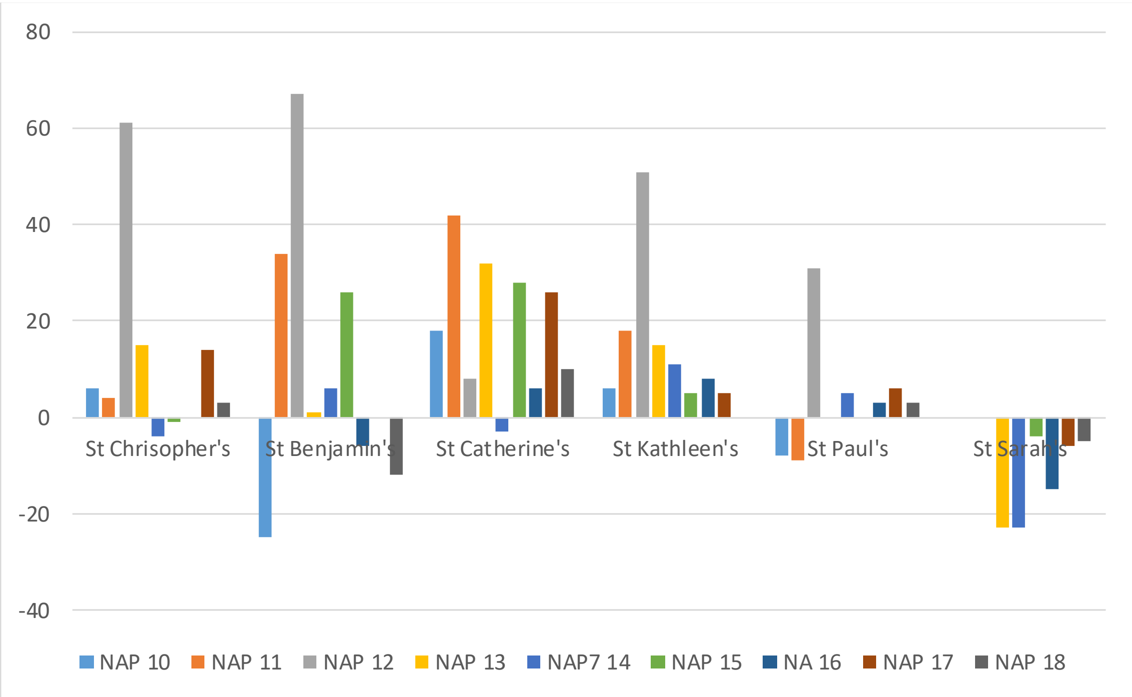

Figure 6.2 Difference between the NAPLAN Year 9 Numeracy Mean of the individual sample schools and the Australian schools' average.

6.2.2 **Comparing NAPLAN Numeracy Means to "Like schools"**

The comparison of results against "like schools" for Year 7 NAPLAN in Figure 6.3 below indicates the students' response to the curriculum provided from the feeder schools in the final years of primary school referred to as Stage 3 (NAP, 2018). The results are variable for the rural based schools of the sample, with some positive and others negative. St Catherine's and St Benjamin's are K-12 schools, and the majority of their feeder schools are from their existing students in Year 6. These results suggest that numeracy levels are strong in the primary section of St Catherine's. The positive results in Year 9 (please see Figure 6.4) indicate that the strong focus on learning in numeracy goes across both primary and secondary sections of the school. Comments in the descriptions of St Catherine's support the notion that the principal and school leadership of St Catherine's have high expectations on instruction and understanding and explicitly target guided mastery to increase student self-efficacy. The varied results from St Benjamin's in comparison between Figures 6.3 and 6.4 indicated a possible gap between the quality of instruction used in the school's primary section compared to the secondary section. The highly positive scores for Year 9 insinuate that students' capability in numeracy increased through Year 7 and 8 so that they outscored students from "like schools". This was a response to the dedicated focus on guided mastery and feedback (social persuasion) by the teacher involved.

However, the Year 7 results for the metropolitan based schools suggest that the primary feeder schools for St Sarah's underprepared their students, which is supported by comments from the teachers and resulted in establishing a two-speed curriculum entitled "Common" and "Support" (see Section 6.5.2). Some success was noted with the gap in numeracy knowledge and skills with "like schools" (as measured through NAPLAN) being reduced for the students in Year 9. The teachers and principal from St Sarah's describe intervention processes aimed at improving students' self-efficacy. This was not the case for St Paul's, which the principal described as underperforming academically. The students entering St Pauls appear, in the main, capable of the numeracy outcomes expected of stage 3. The gap between St Paul's and their "like schools" in Year 9 alludes to a failure to build on the knowledge and skills the students brought into the school. The principal and the teachers of St Paul's indicated that the students were generally disinterested in learning mathematics, and a lot of work was being done to re-engage them in learning, which was yet to be realised.

The teachers interviewed stated they realised the proxy role they play in students' learning, although strategies to explicitly shift students from reliance on the teachers' proxy efficacy to self-efficacy were reliant on them as individuals, not a faculty strategy. Therefore, a collaborative faculty approach to building self-efficacy through enactive mastery, vicarious experience, social persuasion and affective states is considered rather than relying on individuals (DuFour, DuFour, Eaker & Karhanek, 2010; Pegg et al., 2007).

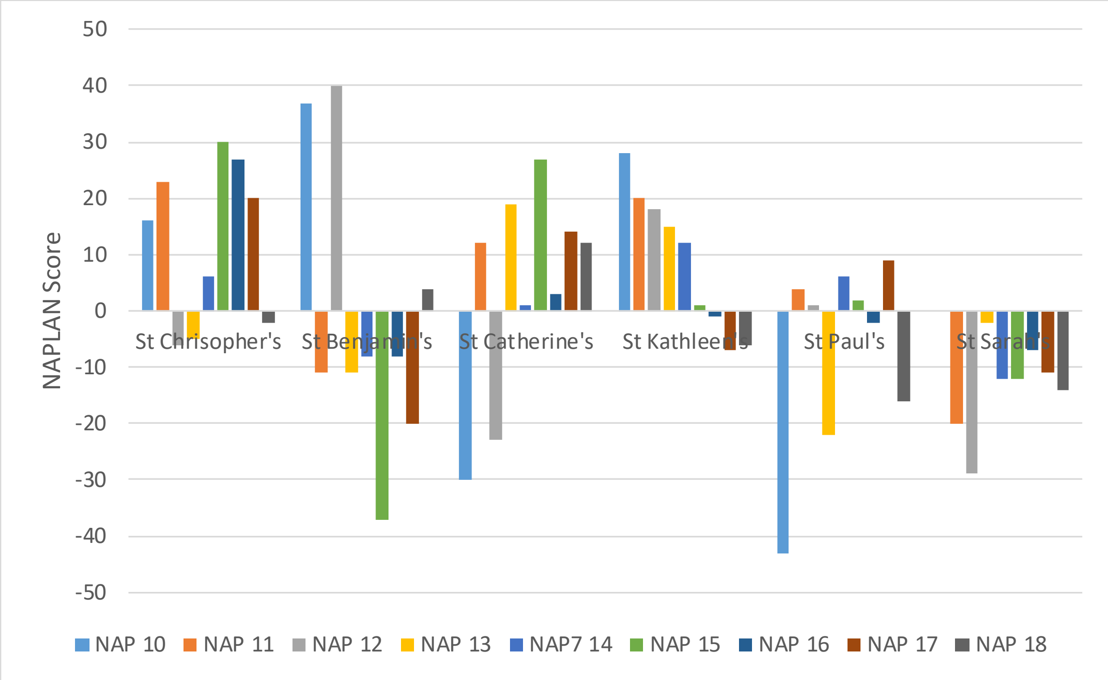

Figure 6.3 Difference in NAPLAN Year 7 Numeracy means for sample schools and "Like Schools" Numeracy mean

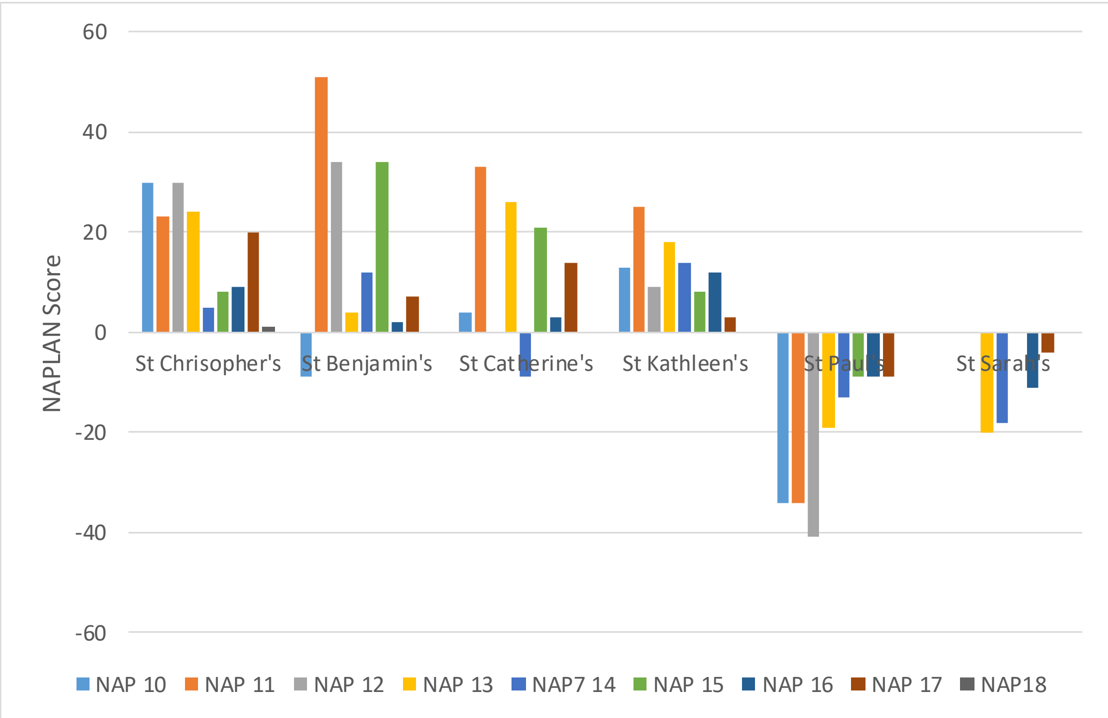

Figure 6.4 Difference in NAPLAN Year 9 Numeracy Means for sample schools and "Like Schools" Numeracy Mean

6.3 Descriptions of the Rural based schools

The following section draws together the student responses from Section 1 (student profile descriptors) of the Self-belief in Mathematics questionnaire, descriptions from their website and the *Myschool* website, field notes from discussions with the school principal and a summary of key themes from the teacher interviews regarding the environmental system of the school and community. The descriptions for each school begin with a general outline from the views of the teachers, principals and websites, followed by the micro-, meso-, exo- and macro-systems identified by Bronfenbrenner (1981), namely: teacher perceptions of the students' sources of self-efficacy within their major focus; the influence of third parties (parents and community); and the whole school direction and initiatives. The outline of the context of the community through the perceptions of students, teachers, and principal provides a background from which the meso- and exo-systems emanate.

6.3.1 **St Christopher's College**

An outline of the community through the perceptions of the students, teachers and principal

St Christopher's was a Year 7-12 comprehensive, co-educational school. It had been operating within the provincial town for more than 40 years. The ICSEA of the school was moderately over the mean of 1000 with measures between 1009 and 1016. The families who attended St Christopher's had 67% to 71% within the middle two quadrants of ICSEA, and only 10% to 14 % of the families were in the top quarter. The school community was predominantly English speaking (87.8%), with only 1.5% speaking their parents' native language and 2.6% mostly their parents' native language, which was reflective of the broader school population. Twelve of the respondents identified as ATSI, making up 3.5% of the students in the sample. St Christopher's had 344 (63.7%) students of the 540 rural based students who completed the questionnaire. The sample was made up of 141 (41%) students from Year 7, 131 (38.7%) from Year 9 and 72 (20.9%) from Year 11. There were 152 (44.2%) males and 189 (54.9%) females.

Three teachers were interviewed from St Christopher's College using Teacher Interview 1 and are referred to as RT 1, RT2 and RT3. The teachers were experienced and long-term staff members at St Christopher's, with one teacher being the assistant coordinator. All classes from Year 7 to 12, including advanced classes in Stage 5 and 6, were represented in the classes taught by these teachers. The three teachers expressed that they could make a difference and placed a high value on having strong relational trust between student and teacher and between student and student.

> Year 7 feel the need to fully understand. If they get a question right, they will ask me to please check their work. Year 9 also like their work checked (RT 2).

RT 3 noted that the students were motivated by each other, but this was part of a common approach that compared student results to describe success.

> Year 11 students want to keep up and so are striving to be on the same level as their classmates. They are motivated by others (RT 3).

The teachers believed that they held a key proxy role in facilitating learning with the students (Bandura, 1997). The number of comments proffering competitive learning between students and the lack of comments regarding cooperative or individualistic environments implied this was the preferred motivational strategy. The Principal, however, supported the notion of collaborative learning and saw it as a mechanism to achieve the goal stated on St Christopher's webpage to "achieve high levels of learning for all students".

Teacher perceptions of the students' sources of self-efficacy within their major focus

The teachers stated that the students were capable of the expected level of work and that streaming catered for the student's learning by scaffolding mastery. They indicated that the students generally preferred work they knew how to complete, even if it was repetitious, and this led to high levels of confidence and low levels of anxiety. The general response from teachers interviewed was to aim the content at the "basic level" of the class and then to build mastery once they were confident.

> I start easy and will try to get harder through the lesson. I feel the students will choose easier questions as they want to succeed. They think they can prove to themselves they can do it easily, even kids with high ability. It's nice to do something easy (RT 3)

> Give them the strategies and change the numbers, and they are happy. They're not happy with things they haven't seen before. They feel comfortable with repetition (RT 2)

Feedback was gained through interaction between the teacher and students during lessons, quizzes and topic tests. Formative comments from the teacher to the students were provided through lessons, and lessons were differentiated to suit the needs of the students. Challenge was provided in a measured capacity because the students "like to know the starting point" as "(t)he starting point is the struggle" (RT 1).

The three teachers shared the view that performance in assessment tasks was used to determine success and geared their lesson strategies to support this belief. RT 3 referred to Year 7 and Year 10 to exemplify the importance of classwork preparing the students for the examinations because the exams provided evidence of improvement.

> Year 7 are happy with their progress, and they say thanks and seem happy. Results showed progress, and the mark improved from the half-yearly… Year 10 need to use problem solving and Working Mathematically. This needs to occur not just in the yearly exam (RT 3)

Ranking the students against their peers occurred regularly, and they believed students gauged success by comparing their results against other students. Relegation and promotion between the classes were considered an incentive for students in their achievement. Similarly, they believed that the success of other students built confidence as a class and acted as a motivator for the individual to attempt challenging work. They felt that students seeing their peers succeed built their confidence.

> Early success is important. 9MX topped the level in the tests, and they feel they can do the work. The kids ask for harder work. (RT 1)

> The students want to keep up and so are motivated to be on the same level as their classmates. They are motivated by others. (RT 3)

However, the strategy of using motivation based on the competition can backfire, as explained by RT 2

> Year 11, some see me at lunchtime, and like the success, they get out of these extra lessons, others bitch at the others in the class who might beat them. "They must have cheated" is a comment. (RT 2)

There appeared little adjustment outside of providing "extra work" through textbooks or homework. Any extension was left to student choice, and extra work was provided on sheets or through homework. Similarly, the teachers did not mention problem solving and applications to the real world as an element of their lessons, and this was largely left up to students to take this "extra step". There were no explicit strategies articulated to promote the transference from proxy to individual agency in learning, and this was left up to the students to make this connection.

A student's conception of their ability and confidence to take on the challenge at the risk of failure was considered desirable but not a priority and the responsibility of the student. Given that success in mathematics at St Christopher's was measured by comparative results, it was not surprising that teachers reported students preferred the surety of gaining a "good mark" rather than attempting a challenging activity without the guarantee of success.

> Lessons are mainly the basic work. Extension worksheets are available for the more able students. I encourage others to do more. (RT 3)

Student's felt anxiety with tests and the level of their performance in them as identified by RT 2 that "often the more capable get anxious". This possibly reflects the concern that the focus on performance rather than incremental learning can act as a de-motivator for capable students who prefer avoidance to possible failure. Even though the teachers wanted the best for their students and believed they could achieve "high levels of learning", the reliance on performance as a measure of success seemed to work against encouraging them to challenge their learning and be risk-takers.

The influence of third parties

This section focuses on the influence of parents and the community. The education level of parents was considered an influence on student aspirations as part of the exo-system. Students indicated that the largest parent education level option was for parents having a degree (mothers: 27.6% and fathers: 21.5%). Parents with a trade certificate or diploma were the smallest group (mothers = 8.3% and fathers = 13.4%), reflecting the skill shortages in "Technicians and Trades", "Electro-technology and Telecommunications", "Community and Personal Service" (AGDESE, 2019). The 10% to 14% of the school population in the top quarter of ICSEA identified that many families who attend St Christopher's were not in the highest quartile of educational advantage. Almost all (98.3%) of the students completed this section of the survey, but more than one third (33.4%), did not know their parent's education level.

Approximately half the sample (52.3%) knew more than one person who used advanced mathematics in their job, but 34% of students did not answer the question. As with the other schools in this study, there was a lack of adult mentors available for students to model the application and value of studying advanced post-school mathematics. The three teachers indicated that parents' aspirations were for students to "pass" mathematics without expecting more. They felt that "Some kids do more than pass, but most accept this a good thing" (RT3) and that the streaming meant that parents had already accepted that a "pass" was acceptable. The soft resources identified by Halsey's review into remote and rural education (p. 22, 2018) of "aspirations, relationships, networks, values, and reasons for hope" were not there to encourage students into post-school advanced mathematics. There was an acceptance of the inevitability of a fixed mindset on the ability that led to low aspirations consistent with the findings of Dweck (2006)

Table 6.1

St Christopher's College students' knowledge of their parents' education levels and the number of people they knew who used maths in their jobs

	Education level				People known who use advanced maths for their job.		
	Mother		Father				
	(n)	%	(n)	%		(n)	%
Before Yr 12	45	13.1	56	16.3	0	47	13.7
Yr 12	63	18.3	47	13.7	1	51	14.8
Trade Cert/Dip.	29	8.4	46	13.4	2	42	12.2
Degree	95	27.6	74	21.5	3	35	10.2
Don't Know	109	31.7	115	33.4	4	12	3.5
					5	7	2.0
					6+	33	9.6
Total	341	99.1	338	98.3	Total	227	66.0

Whole of school direction and initiatives

The St Christopher's website stated the school provided formation, learning, direction, growth and wellbeing within a full curriculum including vocational subjects. The school, it said, believed in a broad and balanced education that builds students' confidence and the skills to develop their talents as emotionally intelligent young people. The principal stated St Christopher's had a strong and caring reputation for the students within the local community.

The principal noted that St Christopher's had recently reorganised their structures to un-streamed classes, although the Mathematics faculty fought this move. The three Mathematics teachers interviewed identified the faculty's reluctance to move away from streaming as they felt they were less able to deal with the needs of their students in un-streamed classes. These teachers felt some victory in this argument by keeping the graded classes in Stage 5 that were aligned to the three courses (5.1 Standard, 5.2 Intermediate and 5.3 Advanced). While some cross-curriculum teaching was implied between the courses by referring to class groups as a "5.2/5.1 class", the students were graded into these groups on ability. The teachers referred to their classes as the "top", "middle" or "bottom" within the courses. The teachers indicated that collaboration between the teachers in teaching and learning was not a regular action, with RT2 noting that the mathematics faculty "would like to see KLA based meetings and external PD".

In summary, St Christopher's had an above-average ICSEA with NAPLAN numeracy results better than the Australian average and their "like schools". The principal and public website articulated a school that cared and strove for high-quality learning supported by contemporary pedagogies. The teachers interviewed operated out of a teacher-centred, direct instruction approach to learning and teaching with a strong belief in their role as a proxy agent. They stated that streaming of classes assisted them in this role. Parent aspirations for their student's learning appeared to be influenced by the school's approach. Students appeared to be aware of the use of mathematics in careers, even though approximately three quarters did not have parents with degrees. In general, there appeared to be a disconnect between the principal's vision and the operations of the mathematic faculty.

St Christopher's College Assertion 1: The belief in a focus on performance appeared to have a negative effect on students' motivation to seek and engage in challenging mathematics. The teacher's preferred to ensure mastery of the "basics" with low anxiety levels within the current class structure, rather than providing a student-centred approach to deep learning. Within the collective environment of the school, the teacher's beliefs were at odds with the policy direction articulated by the principal.

6.3.2 **St Benjamin's College**

An outline of the community through the perceptions of the students, teachers and principal

St Benjamin's College was a rural Catholic school and at the time of the questionnaire was a Kindergarten to Year 10 school in the process of extending to Year 11 and 12 the next year. As a result, there were no Year 11 students to survey. It had been operating within the provincial town on this site through various organisational structures for more than 140 years. Originally run by a religious order, it became fully staffed by lay teachers many years ago. The ICSEA of the school was moderately above average, with measures between 1000 and 1023. The trend shows an increase in the percentage in Q1 (lowest quartile) and a decrease in Q4 (highest quartile), resulting in an overall decline in the ICSEA, and St Benjamin's had 56% to 60% within the middle two quadrants of ICSEA. The 20% (6/29) of the sample identifying as ATSI was reflective of the strong indigenous population who attend St Benjamin's. The school community was predominantly English speaking (93.1%), with nil students who answered the questionnaire from homes that speak their parents' native language.

St Benjamin's had only 29 (5.4%) students of the 540 rural based students who completed the questionnaire. The sample of students represented more than half of the students in Year 7 (20/35) and slightly less than half of Year 9 (9/23). Year 7 dominated the total student responses to St Benjamin's questionnaire, with 20 (61%) students from Year 7 and 9 (39%) from Year 9. In total, there were 17 (58.6%) males and 12 (41.4%) females.

St Benjamin's had a relatively small secondary school population and only offered classes to Year 10 (Stage 5) at the time of the questionnaire. Only one of the two mathematics teachers was interviewed (RT4). This teacher was long-standing, highly regarded within the school as a passionate leader in mathematics teaching but did not hold a formal coordinator's role. Both Year 7 and 9 were taught by RT4 and were described as the "top" group of the two groups per year. RT4 was animated by the idea of understanding more about the motivating factors of the students at St Benjamin's.

The principal expressed strong confidence in RT4 as an innovative and highly professional teacher. Given the school's direction towards Stage 6, the principal articulated a need to "get it right". The principal articulated the need to develop the teachers, but this was left up to the teacher to initiate and drive.

Even though the size of the secondary section mitigated against a subject-specific Mathematics faculty, all Mathematics classes were taught by Mathematics trained teachers. RT4 believed both the mathematics teachers made a difference to student learning, and they took their classroom role seriously, believing strong relational trust existed between student and teacher and between student to student, stating that "they enjoy pleasing the teacher". NAPLAN results were greater than their like schools in Year 9 but were quite varied in Year 7. This is surprising as almost all of Year 7 had attended Year 6 at St Benjamin's.

Teacher perceptions of the students' sources of self-efficacy within their major focus

The teacher perceived the students were capable of the expected level of work, but they lacked confidence. RT4 considered that the role of the teacher was to provide the required scaffolding and stimulus to guide the student's learning. Constructing learning opportunities, assessment and adjustment to lessons were a natural part of the teaching process described by RT4. The scaffolding of lesson material was designed to provide guided mastery and was the general approach used. Attempts were made to link learning with the real world, and RT4 felt the students responded better when given visual clues rather than written textbook-style questions (ADGET, 2015b). Texts and worksheets were used more often than hands-on activities, and RT4 pondered if there was "a difference between how students react to textbooks, worksheets, practical activities and investigation related to the task"?

RT4 indicated the difficulty many students had with visualisation of the question and noted:

> Students are not confident to work out harder questions on their own … they prefer guided mastery.
>
> Students find questions where they need to comprehend and then solve the question more difficult than when they are given a visual representation. Students prefer questions where the visual prompt is given.

Recognition of the struggle with "new ideas in Algebra and the transference between topics" was used by RT4 to paint a picture of students more keenly engaged in practical activities rather than academia.

> Comprehension of the questions in problem-solving can be an issue, depending on the questions

and whether they are given a visual or not (RT4)

According to RT4, they generally preferred work they knew how to complete, even if it was repetitious, which was key to building high levels of confidence and low levels of anxiety. The students preferred questions they could quickly work out rather than problems that caused them to ponder and solve.

Student feedback was received through the verbal comments, workbooks responses and classroom discussion Confidence was supported through social persuasion by the teacher and expressed by student engagement in their learning. Success measures were more than mastery with RT4 noting the importance of the relationship with the students:

> They are comfortable, and there is a security of success. Year 7 like to please the teacher, not just themselves and not just to be there and form their own knowledge. (RT 4)

Formative comments from the teacher to the students were provided within the lessons, and scope and sequence were differentiated to suit the needs of the students. RT4 focussed on building confidence with Year 7 through mastery and social persuasion, which supports the previous point suggesting a lack of rigour in the upper primary classes regarding mathematics. Year 9 would approach the challenge but needed to understand where the challenge was heading and did "not like long-winded discussions and evaluations" (RT4). Students were biased towards finding an answer rather than exploring their "capacity to critically evaluate ideas and arguments that involve mathematical concepts or that are presented in mathematical form" (NESA, 2018b).

The influence of third parties

The school was situated in a medium-sized town with farming, light industry and tourism the main economic activity. The principal noted that a number of the wealthier families and more academically able students chose to enrol in boarding school from Year 8 onwards, indicating they wanted a larger school with more "opportunity". The principal also indicated that a number of parents had themselves attended boarding school, and it was "family tradition" going back through the generations.

Contrasting with 21% of the school population being in the top quarter of ISCEA at the time of the questionnaire, only 10.3% and 13.8% indicated their mothers’ or fathers’ have a degree. The percentages were similar for those students who knew their mothers (13.8%) and fathers (10.3%) had a trade certificate or diploma. The percentage of students who did not know their parents’ educational background was a concern, with approximately half (51.7% for mothers and 44.8% for fathers) not knowing this about their parents. It is possible that many of those in the higher SEA band did not have degrees, or do not talk of their formal education, perhaps being small business owners in areas such as light engineering, retail or farmers. One fifth (20.7%) of the sample indicated they did not know a person who used advanced Mathematics in their job. However, more than a third (34.5%) knew one person, and 62.4% of the students knew at least one person who used advanced mathematics in their job. This suggests that this group of rural students understood there was a knowledge of the practical use of advanced mathematics.

Table 6.2

St Benjamin's College students' knowledge of their parents' education levels and the number of people they knew who used maths in their jobs

	Education level				People known who use advanced maths for their job.		
	Mother		Father				
	(n)	%	(n)	%		(n)	%
Before Yr 12	2	6.9	5	17.2	0	6	20.7
Yr 12	5	17.2	4	13.8	1	10	34.5
Trade Cert/Dip.	4	13.8	3	10.3	2	1	3.4
Degree	3	10.3	4	13.8	3	3	10.3
Don't Know	15	51.7	13	44.8	4	2	6.9
					5	1	3.4
					6+	4	13.8
Total	29	100	29	100	Total	27	93.1

Whole of school direction and initiatives

The school website recorded that St Benjamin's wished to provide a relevant curriculum for a changing world. St Benjamin's was actively engaged in activities to give the students an experience past the town boundaries, and Year 9 participated with the local government high school in "Outward Bound" (a leadership and teamwork program for school students). A number of their teaching programs expressed a desire to build their capacity as learners by establishing the system focus on the PLC model similar to that advocated by DuFour, DuFour, Eaker and Karhanek (2010). St Benjamin's had recently engaged with a university partner to focus on optimising primary school mathematics learning and teaching, although RT4 did not discuss this initiative. RT4 expressed appreciation for the professional development undertaken in preparation for the impending introduction of Year 11 and "loved the programming workshops".

In summary, RT4 felt both Mathematics teachers at St Benjamin's were able to impact the school's collective efficacy and rated their influence as "10/10". The proxy agency of this teacher was high in both the impact on student learning and the influence on school organisational structure. RT4 was keen to extend their knowledge by adjusting the pedagogy to suit the student contextual needs of St Benjamin's.

St Benjamin's College Assertion 2: The teacher at St Benjamin's realised the significance of explicitly implementing strategies to transfer from proxy agency to individual agency through guided mastery, vicarious experience, targeted social persuasion and monitoring the affective states. The students at St Benjamin's, according to the teacher, relied on support from the teacher to comprehend and then solve practical problems. The beliefs of the senior teacher interviewed dominated the policies and procedures that influenced mathematics learning at the school.

6.3.3 **St Catherine's College**

An outline of the community through the perceptions of the students, teachers and principal

St Catherine's College was a Kindergarten to Year 12 Catholic school that had recently expanded to a full Kindergarten to Year 12 school. The principal stated that the strong results in NAPLAN and other externally based measures had meant that St Catherine's was held in high regard by the local community for its educational provision. The township was a rural, mining and tourist service centre that was undergoing growth in prosperity and population. St Catherine's had almost doubled its whole school population over the five years prior to the questionnaire and interviews. The school has had continued to grow, and the principal anticipated it ultimately would be a K-12 school of more than 1000 students. The ICSEA of the school had the highest measures for the rural based schools and lay between 1036 and 1046 and had the highest proportion in Q4 (highest quartile) between 21% and 26%. The school community was predominantly English speaking (92.1%), with only 1 (0.9%) students who said they spoke their parents' native language at home. The proportion of indigenous students was similar to that of the whole school at 5.3%.

St Catherine's had 114 (21.1%) students of the 540 rural based students who completed the questionnaire. The sample of students represented had 47 from Year 7 (41.2%) and 40 from Year 9 (35.1%), and 27 from Year 11(23.7%). The sample from St Catherine's was almost all of each year cohort of about fifty students in the junior grades and less than 40 in Year 11. In total, there were 60 (52.6%) males and 54 (47.4%) females.

The school had recently developed faculty heads in the secondary to cater to the school's growth, one of which was for Mathematics. Three teachers, including a longstanding staff member, a teacher who was about to move town after three years of teaching at St Catherine's and the faculty head, were interviewed as part of Teacher Interview 1 (referred to as RT5, RT6 and RT7). The school's inaugural mathematics faculty coordinator had been at the school for almost 12 months. Interview 1 was conducted during one school visit in the last quarter of 2015. Given the strong results of St Catherine's and in seeking to understand the reasons for the school's academic success, one teacher was interviewed with Teacher Interview 2 (RT8) to further understand the proxy and collective agency of the school.

Additionally, this teacher had recently taught at St Kathleen's College and provided a contrast between a traditional school and a growing school. This interview was within six months of the first round of interviews. All classes from year 7 to 12, including advanced level class groups in Stage 5 and 6, were represented in the classes taught by these teachers.

Teacher perceptions of the students' sources of self-efficacy within their major focus

During the data-gathering period, comments from the principal and teachers articulated the school's focus on high expectations of students and their learning. The teachers believed their students were capable of the expected level of work but felt they lacked depth in their understanding of the content and skills. The students were procedural in their approach to their work, as exemplified by their comments regarding algebra, where students were considered technically proficient in operating with algebraic terms, but their desire to explore the complexities of generalisation was insufficient. Individually, the teachers interviewed addressed this shortfall, although no comment was made regarding a faculty approach.

> (They) tend to see algebra as a process rather than as a concept for generalisation. I went back to basics with year 9 on defining variables as they needed the basic concepts. They needed a purpose for studying the rules of algebra and where it comes from (RT5).

> Year 7 tend to find algebra is a stumbling block at the high-end ability to transfer from concrete to theoretical. (RT7)

The students did not always recognise the gaps in their understanding and logic of the mathematical concepts. The teachers commented that students' understanding was shallow, and while they seemed to cope during class time, they were unable to translate their knowledge to the assessment tasks.

> When I was watching them (Year 7) do the survey I noticed some were indicating they could do work that I thought … 'Well no!' … Their ability in classwork is different to testing. I think they have it in class, but they don't seem to retain or apply it. (RT6)

> I thought they had got it, but when they were assessed they did worse than I thought they should. (RT7)

> (Year 9 are a) middle group, a wide range, at the beginning of the year their ability was below normal but hey have come a long way. (RT5)

The teachers felt that students needed further development in understanding the underlying concepts of the mathematics content and skills to address the disconnect between knowing the mathematical concepts and applying them. Building student understanding through relevance and application was described as pivotal to developing mastery.

> I think in year 8, there is a whole lot of concepts like ratio and rates, Pythagoras' theorem, the heart of equations of algebra, and percentages and that understanding you have to encourage them with percentages, you know how to do it but now relate to the world (RT8)

The teachers were highly supportive of the principal's desire to promote high expectations for the students and felt that the students were shifting in the depth of their understanding. There was a genuine concern for the students to reach their academic potential and that confidence and mastery levels were interwoven to build the concept of their ability. As described by RT7, "Is it the horse or cart that leads them to take risks? Confidence helps in them wanting to take risks". Remediation received formalised support, although some students "have decided they (were) failures at Maths" (RT7), and teachers were seeking strategies to build student self-efficacy in their mathematics.

During the process of gaining mastery in the topics, the teachers believed the students preferred being challenged to build their "mathematical conversations" (RT7). The students received sound support and feedback during these activities, and this was provided through a combination of informal feedback during classes, explicit formative assessment strategies and analysis of summative assessment items. Adjustments were made to student learning based on feedback, such as pre-tests and short quizzes. The teachers reported that they encouraged students to attempt difficult questions, although the provision of extension material was informal with loose structures. This area was identified by the faculty head as an area for professional discussion amongst staff to increase students' achievement and self-efficacy.

> I walk around the class and peak over their shoulders, and respond to any questions. I like to read their faces as to whether they have got it or not. I sometimes ask them 5 questions on a piece of paper, and I do pre-tests at the start of a unit. (RT5)

> We have a system to identify the lower end, but we don't push the high order kids. The system data show this. I give them challenging questions. You need questioning to build the mathematical conversation (RT7)

> High-end kids are self-motivated and easy to cater for… set and forget … extra work and then let go. For the slower kids I focus on the knowing the basic concepts well (RT6)

Teachers expressed a strong perception of their ability to encounter student learning needs in mathematics and provide positive outcomes for the students, thus shifting the agency from them to the individual student.

Peer teaching was encouraged amongst students, and both teachers and students gave verbal praise.

> Peer interaction (happens) when they can help another student. Group discussion. I get the kids to demonstrate on the board to volunteer for parts of the solution (RT7)

Teachers commented that, generally, students were not anxious about their mathematics study. However, some teachers commented that levels of anxiety were experienced by some Year 7 students about their mathematics as they entered high school and were concerned that the jump to a more formalised approach was new to them and an area they needed to address.

> When we first started, they (Year 7) were pretty worried about maths. As the year has gone on, they have has settled down (RT6)

The influence of third parties

Students indicated that 22.8% of their mothers had a degree, while only 13.2% of fathers had the same tertiary level of study. While the number of mothers with trade qualifications was small (7.0%), the proportion of fathers with a trade certificate or diploma was higher than the number who had a degree (18.4%). Approximately, one third mothers (16.7% + 18.4%) and fathers (15.8% + 13.2%) had not studied post-school. The proportion of students who did not know their parent's education levels was more than one third (mothers: 35.1% & fathers: 39.5%).

Teachers stated that some parents considered mathematics a hard subject and found it difficult when they were students. The concern was that parents' expectations negatively impacted the student's belief about the subject.

> Parents often say 'I hated maths', 'I was no good at Maths at school', 'it was my weakest subject, right in front of the students' (RT6)

> Parents will say 'maths is hard', 'I could never do it as a kid'. But they're happy that their kids are trying. If they pass and their parents found maths hard, then they are happy (RT5)

In keeping with this belief, more than a quarter of this sample (28.9%) indicated they did not know a person who used advanced Mathematics in their job. In developing their understanding of the relevance and accessibility of mathematics, St Catherine's had embarked on a STEM initiative where "One of the science teachers wants to do science and technology as a STEM day and invite people in to talk about their jobs" (RT5). According to the principal, the day was set up to present STEM to students through professionals working in the field, and St Catherine's had also entered into a partnership with a university to support STEM initiatives. This proactive stance helps explains the 56.1% of students who knew at least one person who used advanced mathematics in their job.

Table 6.3

St Catherine's College students' knowledge of their parents' education levels and the number of people they knew who used maths in their jobs

	Education level				People known who use advanced maths for their job.		
	Mother		Father				
	(n)	%	(n)	%		(n)	%
Before Yr 12	19	16.7	18	15.8	0	33	28.9
Yr 12	21	18.4	15	13.2	1	13	11.4
Trade Cert/Dip.	8	7.0	21	18.4	2	15	13.2
Degree	26	22.8	15	13.2	3	9	7.9
Don't Know	40	35.1	45	39.5	4	10	8.8
					5	4	3.5
					6+	13	11.4
Total	114	100	114	100	Total	97	85.1

Whole of school direction and initiatives

The teachers reflected the development of a faculty as a collective to drive and support student learning. The faculty, including RT8 as an incoming teacher, shared the view that student confidence required constant reinforcement despite the school's historically strong NAPLAN results. The principal gave credit to the teachers' hard work in producing strong results and believed that planned and well-directed strategies produce desirable results. As such, the principal was willing to act on well-considered suggestions from the staff. The principal provided the impetus for many of the collaborative strategies used at St Catherine's, but the staff fully supported this initiative and felt that the achievement and self-efficacy of the students increased.

St Catherine's had also adopted the concept of a PLC as part of a system imitative and had implemented a number of strategies to enhance the mechanisms as suggested by DuFour and colleagues (DuFour, DuFour, Eaker & Many, 2010). The teachers of this emerging faculty had a strong belief in their role as proxy agents for their students and felt they could, and do, influence the school's collective efficacy. As a result, the discussion was underway to address a perceived structural needs in the Year 8 timetable "to get the extra lesson" (RT8) to improve mastery and confidence levels for the students.

In summary, St Catherine's had an above-average social-educational index with NAPLAN numeracy results better than the Australian average and their "like schools". The principal and public website articulated a school that encouraged students to think "flexibly and with creativity", to take "responsible risks", and to ask "effective questions" in their learning. The teachers interviewed provided a number of contemporary pedagogical approaches that were focused on student-centred learning. The principal and teachers pointed out that St Catherine's actively put in place strategies to ensure students were aware of the use of mathematics in careers. In general, there appeared to be a strong connection between the principal's vision and the operations of the mathematic faculty that resulted in students with a high belief in their capability in mathematics and the value of putting effort into its study.

St Catherine's College Assertion 3: The belief in building confidence through targeted mastery, vicarious experiences, social persuasions and monitoring of affective states was well understood by the principal and the teachers interviewed. The resultant positively affected students' motivation to seek and resiliently engage in challenging mathematical content. The teachers considered they had the opportunity to play a special role, as a proxy agent, in helping students be their own agents with deep learning. The teachers and the principal believed the school's policies to support a moral purpose focused on student-centred, deep learning.

6.3.4 **St Kathleen's College**

An outline of the community through the perceptions of the students, teachers and principal

St Kathleen's College is a Catholic co-educational comprehensive high school with a student population of more than 1050 students and teaching and support staff of over 140 at the time of the questionnaire and interviews. It resided in a prosperous township that was a rural, mining and tourist service centre with a number of engineering, manufacturing and construction industries. The school website stated that St Kathleen's offered a wide variety of electives across the KLAs, and 50 different courses and subjects were offered in the senior years. The principal noted that the school had a strong academic tradition with about 75% of Year 12 students usually gaining entry to various universities and the Dux regularly scored an ATAR of 98 or 99 out of 100, placing them amongst the top students in the state. The principal also noted that St Kathleen's students had achieved HSC results scores at the highest levels over the years and that the isolation of gifted students into "enrichment classes" in Years 9 and 10 was considered a crucial preparation. The school's website also boasted an extremely well-resourced vocational education curriculum and several other co-curricular areas of success at the state and regional levels. However, over recent years, the principal felt St Kathleen's had some disappointment in NAPLAN results, even though they were better than their like schools. This was the principal's rationale for engaging in this study.

The ICSEA of the school was between 1022 and 1028, with between 22% and 25% in the highest quartile (Q4) and 16% to 17% in the lowest quartile (Q1). The school community was predominantly English speaking (90.4%), with only 1 (1.9%) students said they spoke their parents' native language at home.

The Principal supported the questionnaire, but the Mathematics faculty appeared disinterested as the administration of the consent forms and the student questionnaire were undertaken by a leadership team member, stepping in at the last minute. Disappointingly, the sample from St Kathleen's was a particularly small proportion of the school population with approximately 20% of Year 7, less than 10% of Year 9 and an insignificant number (n = 3) of Year 11 participating in the questionnaire. The cohort was only 52 (9.2%) students of the 540 rural based students who completed the questionnaire. The sample of students represented had 38 from Year 7 (73.1%) and 12 from Year 9 (23.1%), and three from Year 11(3.8%). Of this sample, 17 (32.7%) were male and 35 (67.3%) female. St Kathleen's only had 2 (3.8%) ATSI students of the 52 students in the sample, which was well below the 10% of the school population.

The principal of St Kathleen's had implemented a model of PLC as part of a system initiative that focussed on teacher collaboration and planning within Year 7 and 8 Mathematics. By being involved in this research, the principal wanted to understand if student confidence and motivation were part of the reason why students were not performing as well as anticipated. The researcher interviewed two teachers with Teacher Interview 2 (RT8 and RT9). One teacher was an experienced, long-term staff member and held an informal facilitators role for the Year 7 Professional Learning Teams (PLTs) and taught Year 9 and Year 11 within the teaching allocation. The other teacher had recently moved to St Catherine's but had been a significant teacher in implementing the PLC process into Year 8 at St Kathleen's immediately before the relocation and had taught Year 9 and Year 11. This teacher provided a comparison between St Kathleen's as a traditional, highly regarded school and a newly positioned growing school. While this was a small proportion of the Mathematics staff at St Kathleen's, it was in keeping with the small number of students involved in the questionnaire. Both teachers also covered most of the courses from Years 7 to 12.

Teacher perceptions of the students' sources of self-efficacy within their major focus

Teachers in their interviews described a strong focus on mastery that was results-driven. For example, student course selection into Year 9 was "based on their overall results at the end Year 8" (RT8). Similarly, when students asked for the rationale for studying a mathematics topic, RT9 responded, "in three weeks when I give you a test in it". The school system at St Kathleen' imposed restrictions on course selection which meant that some missed out on their desired course "and some of those kids just gave up" (RT8). Both teachers also indicated that this approach had led to an underlying belief that some students were naturally more capable and motivated than others.

> They are a normal Year 9. Two naughty boys. That's normal isn't it, and a couple of clever girls who have no tolerance for the naughty boys. It's a normal Year 9 (RT 9)

While the Stage 5 classes were based on courses, stage 4 were mixed ability and considered un-streamed. However, before entering Year 7, the students sat for diagnostic literacy and numeracy tests at the end of Year 6. Information was also gathered about "emotional and health issues … from the application forms and the primary school feeders" (RT9). The principal indicated that the mixed ability classes were based on roll call groups and provided a transition into high school. The Year 7 and 8 classes were taught by teachers who formed PLTs and provided a timetabled lesson "to sit together and discuss what was important, what they needed to know and share ideas on how we taught it" (RT8). However, RT9 questioned how the "entry tests" were used to allocate students to the classes and felt that there was bias in how some students were distributed based on their capacity to work independently.

> Well, the year 7 are un-streamed. For whatever reason, one of the classes seems to have all the learning issues and health issues all in the one room. And the other class is okay it only has one student with literacy problems, two at most. So they are very different classes. Very different dynamics. I don't know how they turned out that way or whether it was meant to be. Because you have teacher aid support, and the teacher aid I have in this class is the most experienced for Year 7. So perhaps they did want those kids under a stronger regime or a stronger teacher aid. I'm not sure! They (Year 7) do an entry test. They are trying to keep an academic balance across the classes. They don't want a clever class, and that is not the idea in Year 7 (R 9).

The teachers interviewed, and the principal spoke positively of the PLC approach articulated by DuFour and associates (DuFour, DuFour, Eaker & Many, 2010). Theoretically, the PLTs identified a guaranteed curriculum, teaching strategies, assessment strategies and intervention processes for those who required assistance. The planning and discussion allowed teachers to collaborate about the Year 7 and 8 classes, but the school's focus on results limited staff evaluation and adjustment to the student's needs.

> Some teachers don't like reflecting back on their results when we do little assessments of things like that as they feel it reflects on their results (RT8).

Further, the emphasis on results rather than understanding tended to limit the curriculum provided. The teachers of the un-streamed classes focussed "on the basics but (the students) might have missed out on extension" (RT8). The teachers noted that St Kathleen's provided targeted support for the students who were identified but felt more focus was placed on "bring(ing) up kids who were struggling to the essential, but the upper end may miss out" (RT8).

> After we do the formative assessment, we do a small tutorial session in (timetabled response to intervention) time. (RT9)

Extension and problem solving were provided in class through textbook and worksheet activities with enrichment provided "when (the students have) the time and the place (RT9). Practical and hands-on activities were not considered appropriate as the school as "the behaviour problems made it difficult" (RT8). The reliance on textbooks and worksheets was an issue as the student's literacy levels were considered an impediment.

> To me, some don't have a lot of literacy, and it is a literacy issue, not a maths issue. If you are doing something that is visual and diagram some students have no problem whatsoever, but as soon as you vary it in a bit of sentence structure, they have the skills, they can't unlock it (RT9).

Year 9 and Year 10 classes were identified by the courses (5.3 Advanced, 5.2 Intermediate, 5.1 General). The whole grade cohort was divided into two blocks of students, with roughly even numbers, across the timetable with one advanced (5.3) class in each block. In one block, the 5.3 course was taught to an extension class made up of the thirty most capable all-around students of the entire cohort based on the previous year's formal testing. Aggregating marks determined placement in the extension class from across all KLAs in Year 8 and again in Year 9 for progression into the next year. Being a member of the "extension class" was considered prestigious and strong preparation for the HSC.

However, the "extension class" was not necessarily the 'top 30 mathematics' students from Year 8 or Year 9. The number of students in the 5.3 classes was capped for organisational purposes, and teachers reported that some students, who were capable and wanted to study the advanced course, were not allowed due to a timetable constraint. The disappointment by students who missed the cut off resulted in a decrease in their motivation as they would be studying a lower-level course. Teachers indicated that the students and the teachers felt low efficacy in addressing this concern and articulated a sense of resignation and apathy towards this imposition.

> Well, at St Kathleen's, we had 8 classes in year 8, and only two were going to extension, and some kids missed out, and I think they might have had the ability if they worked a bit harder. They seemed to know the basics, but they might have missed out on extension. Where some went into extension, who didn't want to be there… And they were the only ones who could do 5.3. A few should have been in 5.3, and some of those kids just gave up, and we would encourage them to work hard, work hard because if someone comes out of 5.3, another student would go back up. But there is a point where they've missed too much and can't go up, especially in Year 10. (RT8)

Feedback to the students on their learning was gained through homework, end of topic quizzes (in the textbook), online quizzes and observations through class time. This information was part of the discussion of the teachers within their PLT. The principal had hoped that the PLT process would flow from Year 7 and 8 into Year 9 and the other grades without a timetabled meeting period because teachers saw the benefits of the process. Unfortunately, there was no evidence from either interviews or field notes to support this was happening.

The fact that students' allocation into Year 9 and 10 courses and classes were exclusively based on their marks limited the options for summative assessment. This led to the faculty's focus on "consistency" to ensure that students did not get an unfair advantage from the assessment. As a result, the mathematics faculty "predominantly (used) pen and paper tests" so that "the 140 something kids do the same test on the same day in Year 9 across the school" and "setting and marking rotate through the teachers who have them" (RT9). Attempts to vary this approach had been tried unsuccessfully as the teachers "could never tell if the kid did it (the assessment task) or someone else did it .... So there is no accountability" (RT 9).

This rigid view of assessment reduced flexibility as the students' marks was eventually used to stream them and place them in courses. The process was reported to be successful for students with an academic focus, but for many students, this approach led them to conclude that mathematics was over-academic and irrelevant to their needs.

> Anything they don't like. (The students say) "When am I going to use this? (RT9)

The influence of third parties

Students indicated that 32.7% of their mothers had a degree, while only 11.5% of fathers had the same level of tertiary study. The small number of participants in the questionnaire suggests that aspirational parents who wanted their children to be self-confident in mathematics were the parents who were motivated to have their children involved in the study. The stronger representation of mothers suggests this sample were influenced by their mothers' views on careers and post-school training. One parent (a mother) from St Kathleen's contacted the researcher expressing interest in the idea of student self-belief in mathematics as it was an issue she was addressing with her Year 7 child. The number of mothers with trade qualifications was small (7.7%), and the proportion of fathers with a trade certificate or diploma was approximately the same proportion as those who had a degree (13.5%). While it appeared that only highly motivated parents were engaged in the survey, more than 25% of students (mothers: 25.0% & fathers: 26.9%) did not know the educational background of their parents.

Further, more than one third (34.6%) of students did not know a person who used advanced mathematics in their job, although 53.9% knew more than one person. St Kathleen's had no contact with the external community through the parents, ex-students, businesses or the local university. RT8 contrasted this with the attitude at St Catherine's, where the school had strong community links with university groups, local engineering and science-based local industry and parents who talk about their experiences and "the relevance of Maths in life".

Table 6.4

St Kathleen's College students' knowledge of their parents' education levels and the number of people they knew who used maths in their jobs

	Education level				People known who use advanced maths for their job.		
	Mother		Father				
	(n)	%	(n)	%		(n)	%
Before Yr 12	5	9.6	14	26.9	0	18	34.6
Yr 12	12	23.1	10	19.2	1	7	13.5
Trade Cert/Dip.	4	7.7	7	13.5	2	8	15.4
Degree	17	32.7	6	11.5	3	7	13.5
Don't Know	13	25.0	14	26.9	4	3	5.8
					5	1	1.9
					6+	2	3.8
Total	51	98.1	51	98.1	Total	46	88.5

Whole of school direction and initiatives

The St Kathleen's website stated they "encouraged" the students to reach their "potential". The website provided a list of successes in curricular and co-curricular areas. The principal reaffirmed the reputation the school had in the community for graduating students who gained high-quality HSC results and was motivated to establish procedures that would enhance their academic reputation. There was agreement by the principal and the teachers interviewed that student confidence and self-efficacy was a crucial element of students' success. Both teachers indicated that self-efficacy was built through guided mastery, vicarious experience, social persuasion and affective states, but there was a difference in their predominance. RT8 felt that social persuasion was critical, while RT9 felt mastery was dominant

> Give praise. Give them a question they know. Prompt – help (RT8)

> They'll have a go, and soon as they taste success, then you're on the way (RT9)

Both teachers felt their role was to encourage students to reach their potential in keeping with the school's mantra. However, in doing this RT8, was focussed on "giv(ing) them everyday life experience" with all of the classes, thus providing transference of knowledge as a proxy agent (Hattie et al., 2017). RT9 had a more academic focus that was aimed at the HSC and spoke that Year 10 need to be "academically focussed", "serious about succeeding", and they need "to know they won't get into engineering if they have General Maths". In the same way, RT9 felt that "With Year 9, it is not much point trying to relate to the rest of their life. They haven't thought of that yet!"

Through these different lenses, both teachers were also critical of the school process to limit the option for students in Year 9 through the "enrichment class model", suggesting that this process harmed student motivation and their conception of ability (Bandura, 1997).

> I am disappointed with what happened with Year 9 and that accelerated class. I know what happened with those maths students who didn't make it through because there were others who were better at English and history … Well, there is only one accelerated class. But it did affect the students (RT9)

The strong focus on the HSC and university entrance also raised the concern of the scaling process where the standard course proved more attractive for able students. RT9 had a sense of resignation and that the students did not value the outcome of studying advanced mathematics at school if the ultimate aim is to achieve a high ATAR.

> Oh no, I don't need mathematics, I get more ATAR points doing General. We all that is true, but it's wrong, and it's the university's problem, and there is nothing we can do about that.

In summary, St Kathleen's has an above-average social-educational index with NAPLAN numeracy results better than the Australian average and their "like schools". The principal and public website spoke of the importance of realising the student's potential for success in the HSC. This resulted in a strong focus on academic results and opportunities through the years to provide maximum support for the academically able. The principal and the teachers understood the importance of self-efficacy in building student capability, but there was a divergence in achieving this. The reliance on marks, rather than challenge, seemed to disengage those who were likely to get the "kids who are likely to be in a building construction course" (RT9). For these students, there seemed little value and use in the topics being taught.

St Kathleen's College Assertion 4: The Teachers stated the school built an academic focus based predominantly on marks and performance, which was the school's policy position. This approach, the teachers noted, was successful for some students but appeared to have a negative effect on the motivation to fulfil their mathematical potential for a large number of students. Being in the top mathematics group in Year 9 and 10 was considered prestigious for those in the junior years who were hoping to make the cut. The students' perceived they added value to their ATAR (to gain university entrance) by studying the Standard (General) course, which was less work. Hence this line of thinking negatively influenced their perceived value in studying advanced mathematics in the senior years.

6.4 **Descriptions of metropolitan based schools**

6.4.1 **St Paul's College**

An outline of the community through the perceptions of the students, teachers and principal

St Paul's College was a large coeducational, comprehensive school in a developing area of metropolitan Sydney. The ICSEA of the school was between 1065 and 1074 and the highest from the sample of both the rural and metropolitan based schools. The families who attended St Paul's had between 31% and 34%% in the top quartile and less than 10% in the bottom quartile. The school website noted that St Paul's provided many extra-curricular opportunities, including public speaking, chess and creative and performing arts. A majority spoke only or mostly English (39% + 33.8%, totalling 72.8%), with 26% of the sample coming from homes with no English or a limited amount of English.

St Paul's had 77 (23.4%) students of the 329 metropolitan based students who completed the questionnaire. Of the 77 student participants, 19 (24.7%) were from Year 7, 46 (59.7%) were from Year 9, and 12 (15.6%) were from Year 11. The sample from St Paul's was only about 10% of the Year 7 and 11 and about 25% of the Year 9 cohort. In total, there were 27 (35.1%) males and 49 (63.6%) females. Only 1 (1.3%) of the respondents identified themselves as ATSI.

St Paul's Principal was new and referred to the NAPLAN evidence when noting that St Paul's had been underperforming. Their NAPLAN results were regularly below that of their like schools. In conjunction with the new Principal, a number of key staff were also new, including the Mathematics Faculty head and assistant faculty head. The assistant faculty head was leaving St Paul's at the end of the year, and the incoming assistant faculty head was from the staff. Both assistant faculty heads were young, highly regarded teachers, but with less than two years at St Paul's. At the time of the interviews, St Pauls' was undergoing renovations to the Mathematics classrooms to accommodate contemporary learning and to provide open, comfortable and flexible learning spaces.

Four teachers were involved in Teacher Interview 1, including the faculty head, an experienced teacher and new to the school, the outgoing assistant faculty head and the incoming assistant faculty head. Between the teachers interviewed, all stages and courses offered within St Paul's were covered. The teachers stated that the students did not feel successful at mathematic and preferred the basic concepts. While the longstanding staff member felt the students were working at their study, the newer staff did not support this view.

> The majority don't feel successful, although, from the reports, they are happy with their grades. In class, they have made improvements and have the right attitude and work hard (MT1)

> Students prefer if it comes easy… The students do not like harder work. The culture of the school

> is not a work culture. There is generally a lack of drive. Some of the top ends, yes, but as a general rule, not a work culture. The work culture is on the improve, but kicking butts and support of the parents is not there (MT2)

> Year 9 would just not do the work. They are mainly boys, and there are behaviour management issues and learning support. Sometimes they don't bring their pens (MT4)

The desire by students for easier work and their lack of motivation for the challenging topics resulted in the students not having the capacity for the course concepts needed for advanced mathematics. MT3 noted that "out of the two 5.3 (year 10 Advanced) classes, you could not make one accelerated class". This was based on the experience of the teacher from an independent school.

> They feel success when they can understand the content. When they can do it…
> Compared to work I have done in the independent sector, what we consider a high level here is not strong (MT3)

Teacher perceptions of the students' sources of self-efficacy within their major focus

The teachers of the sample believed that they held a key proxy role to improve resilience and deepen learning with the students. While they did not use the specific term "self-efficacy", they referred to the four sources (guided mastery, vicarious experience, social persuasion and affective states) to develop high achieving and confident students.

> In year 11 students, we are paired with other teachers so that if the instructional/explicit cycle doesn't work, the explicit is done again (MT1)

> Touch base with them (the students), and check for understanding and whether they need help (MT2)

> I know this through (with the students) talking grades and maths for next year and their anxiety (MT4)

> Year 11 enjoyed the harder work and work in groups. They feed off each other and work on the board. Relationships are strong in the class, and sometimes I don't need to teach (them), they do it (MT4)

Adjustments were made in response to the feedback the teachers received from the students through the formative assessment. The teachers worked with an instruction partner and provided intervention or extension after discussion with them. The structured intervention included "master classes", "withdrawal and re-teach", as well as individual assistance in their normal classes. The teachers understood that the school was building a focus on learning engagement but felt the parents were driven by their children's performance, with many students using outside of school tutoring to boost the student's marks.

There was growing relational trust within the class groups. The teachers (MT3 and MT4) felt that the strategies they had in place were making a difference and felt confident that motivating the students to be engaged in their learning was occurring.

> Year 9, we scaffold a lot. Rich tasks majority of them can do this. They may need prompts and the lead-in (MT4)

> PBL (Project Based Learning) made a difference. First, the kids hated it, then they realised they liked it. I ran PBL in an independent school (MT3)

The principal, in keeping with Bandura's views (1997), articulated that the secondary curriculum was being developed on the belief that learning should build the confidence and capacity of each student, and this supported the notion of St Paul's mission statement that the school was nurturing the students to be hope-filled, courageous leaders, and this would be achieved through a focus personalised. However, the students generally preferred work they knew how to complete, even if it was repetitious, and that learning led to results.

> I talk with the class about the average (mean) and ranks and motivate them to beat the others. The teacher can influence this. Also, this is influencing parents through the kids' class average and grade average comparison (MT1)

> The top-end needs extension… The students do not like harder work… There is generally a lack of drive. (MT2)

Reference was made by MT1 and MT2 to the use of formative assessment strategies such as observation, pretesting, homework, verbal feedback and student self-reflection both in class and through an online blogging arrangement. In addition, MT3 was using self-reflection, goal setting and targets to build student confidence and self-efficacy (Schunk & Meece, 2006).

> Pre-test, post-test. I discuss the post-test with them. We use (a commercial resource) topic tests and lessons, and the data is analysed. I use the (same commercial resource) results to help with estimates (MT1)

> Face to face, by walking around the classroom and touching base. I go around all the classes and

> keep an eye on the strugglers. I touch base with them and check for understanding and whether they need help (MT2)

The influence of third parties

Parents' education level was considered an influence on student aspirations, so 26% of mothers and 35.1% of fathers had a degree that indicated an educated workforce and the highest proportion. However, 37.7% of students did not know their mother's or their father's levels of education. The teachers indicated little contact with the community for learning activities, and excursions were considered too expensive. The desire for community involvement in "project-based learning" was suggested by MT3, who saw the opportunity for involving parents and community members who use advanced mathematics in their jobs, but "there was no funding for maths" (MT4).

Teachers indicated communication occurred with parents using telephone calls and emails. MT1 expressed some concern that some parents had lost confidence in the school's ability to gain the expected results and were using tutors to teach the curriculum knowledge and skills before the class teacher. An unfortunate repercussion was that the classwork at school became a revision and the students became disengaged.

> They have some natural talent, and some have an outside tutor in Math, so the lesson is a recap of the work done with their tutor (MT1)

The students knew the value of mathematics for work, with 63.6% knowing at least one person, 14.3% knowing six or more people, and only 16.6 % did not know anyone who used advanced mathematics in their job. Comments by parents about their own difficulty with mathematics at school worried the teachers, especially when these comments were made in front of the students. Teachers believed that parents were happy with their child if they passed but were concerned that the students' work ethic was weak, and the parents did not support efforts by the school to address disengagement. For example, MT2 highlighted his concerns with lack of parental support:

> The students do not like harder work… The work culture is on the improve, but kicking butts and support of the parents is not there. Some kids just don't do detentions (MT2).

Table 6.5

St Paul's College students' knowledge of their parents' education levels and the number of people they knew who used maths in their jobs

	Education level				People known who use advanced maths for their job.		
	Mother		Father				
	(n)	%	(n)	%		(n)	%
Before Yr 12	9	11.7	4	5.2	0	13	16.9
Yr 12	11	14.3	7	9.1	1	9	11.7
Trade Cert/Dip.	7	9.1	9	11.7	2	13	16.9
Degree	20	26.0	27	35.1	3	3	3.9
Don't Know	29	37.7	29	37.7	4	6	7.8
					5	7	9.1
					6+	11	14.3
Total	76	98.7	76	98.7	Total	62	80.5

Whole of school direction and initiatives

The principal noted that part of the renewed direction of the school was a new organisational structure had been established mid-year. The teachers were paired in the instructional cycle that included master classes and intervention groups with a direct focus on guided mastery to develop their confidence. This support was formalised into withdrawal groups as well as the informal tuition during class by MT2.

> Yr 9 has two classes of 5.3 (Advanced) all in together, and they get support as needed. Groups withdrawn, Master classes, normal classwork (MT2)

A one-to-one laptop program was in place, which was considered fundamental to the individualised approach to learning and the teachers listed many web-based resources to assist student learning. The use of a "flipped classroom" technique (McLaughlin et al., 2014), where content-rich homework was given to allow for discussion and extension of thought during class time, was considered a valuable approach. However, not all Mathematics teachers interviewed fully understood this process and concern existed for those students who would not complete the homework. There was also the uncertainty of the benefits of the organisational structure where teachers worked in pairs.

A system set of professional learning was highly regarded by the teachers and put in place to support this learning focus. However, according to the teachers of St Pauls, as proxy agents, they were had limited capacity to influence the collective efficacy of the school. Only one teacher (MT3) spoke of using an integrated learning approach within their focus on learning and considered it a success with Year 9. MT4 also commented, with frustration, that attempts to build a connection between school mathematics and real-life through an excursion had been rejected by the school leadership due to cost.

> The community should be here for the PBL as part of the presentation. We could use draftsmen or architects for measurement, for example (MT3)

> I tried to do some excursions, but there was no funding for maths (MT4)

In summary, St Paul's above-average social-educational index was not represented in their NAPLAN numeracy results which were below the results of their "like schools". The principal and public website articulated a school preparing students to be leaders in a contemporary world. The teachers interviewed were seeking to improve student motivation to engage with challenge and reliance. Direct instruction and a focus on mastery were considered the best way to give students a feeling of success and build their self-efficacy. Some parents did not feel St Paul's was not facilitating the aspirations they had for their children and had engaged tutors. Students appeared to be aware of the use of mathematics in careers. In general, teachers felt that the students felt that studying easier work was socially safer than attempting the challenging work.

St Paul's College Assertion 5: Parents' perceived performance focus appeared to negatively affect students' motivation to seek and engage in challenging mathematical concepts. Parental expectations influenced the strong emphasis teachers placed on improving performance. The teachers were attempting to use guided mastery to deepen students learning past the "basics" without providing a link to real-life learning. As described by the principal and the school publications, the school's policies focused on deepening learning, but the teachers' practices at the time of the study were not aligned to these principles.

6.4.2 **St Sarah's College**

An outline of the students and the teachers

St. Sarah's College was a systemic co-educational Catholic high school operating in a new and growing residential area in the outer metropolitan suburbs of Sydney. Opened with a small initial cohort in Year 7, it was entering its first HSC and was quickly becoming a six stream comprehensive high school. The ICSEA of the school was moderately over the average, with measures between 1021 and 1037. The families who attended St Sarah's had 65% to 67% within the middle two quadrants of ICSEA with only 16% to 19 % of the families in the top quarter and a similar proportion of 16% to 18% in the bottom quarter. The school community was predominantly English speaking (80.2%), with only 1 (0.4%) speaking their parents' native language and 9 (3.6%) mostly their parents' native language. Seven (7) of the respondents identified as ATSI, making up 2.8% of the students.

St Sarah's had 252 (76.6%) students of the 329 metropolitan based students who completed the questionnaire. There were 165 (65.5%) students from Year 7, 76 (30.2%) from Year 9 and 11 (4.4%) from Year 11. The sample from St Sarah's was an active school representation with three-quarters of the Year 7, about half of Year 9 and approximately one-quarter of the Year 11 cohort. In total, there were 115 (45.6%) males and 134(53.2%) females.

St Sarah's was developing its culture, and the Principal of St Sarah's was interested in identifying and building student self-belief in their learning and reflected the school's website by referring to perseverance and self-discipline. Three teachers were interviewed using Teacher Interview 2. One experienced teacher had been at the school from its start and held the position of Mathematics coordinator. The other two teachers were younger and in the first few years of their careers. All teachers showed a great passion for the school and their students' learning and stated that some students were capable for the expected level of work, but they lacked background knowledge and understanding and had low confidence in their capability.

> There are some strong kids, but there are some real issues. Confidence issues, anxiety issues. We've had to teach them not to be afraid to make a mistake. They have low confidence (MT5)

The principal was similarly passionate about the idea of growing the students' mindset (Dweck, 2006) and stated that the vision was for the students from St Sarah's to be confident and high performing in twenty-first-century skills. These ideals were repeated by the teachers interviewed.

Teacher perceptions of the students' sources of self-efficacy within their major focus

The proxy agency of the teachers was geared to create and select appropriate strategies in their classroom to establish mastery in the mathematics syllabus and build self-efficacy. They acknowledged their role in targeting and adjusting the learning to build the student's capacity and the need for belief in their own agency in teaching mathematics. There was a focus on developing mastery of the basic knowledge and skills, and teachers felt they were successful. They indicated that the students generally preferred work they knew how to complete, which built their confidence. The emphasis was on their learning rather than the results, and many creative activities and assessment tasks were being employed.

> We have experienced teachers, and they were able to build a great teacher-student relationship. They were able to build confidence. We started with Number. To build confidence, we used some games. They were fun and not threatened by the games. Games such as counter games, grids, competitions. They were engaged and involved … We've had to teach them not to be afraid to make a mistake. There was a lack of confidence in the Primary teachers. One kid was even given maths as a punishment! We needed to do something different. They weren't behaviour issues, they're nice kids. (MT6)

> We have really been focussing on student learning rather than just knowledge. This is a school push and our programmes use big ideas. A focus on learning is important. (MT5)

> Students do not feel good at maths when they come to us from the primary. Feeling good is important, and they need self-belief. It is not about whether Mum or Dad are good at maths or not. We need to bring Year 7 up to standard in skill and confidence (MT7)

The teachers of St Sarah's stated that streaming at their schools was used to provide a learning program targeted at the perceived capability of students. Hence, St Sarah's provided two scopes (programs) for each year group to support this view: Common and Support. As noted by MT5, "I like it (the filtered streamed classes) because it helps me pace the courses". The two scope approach was established initially to address the learning needs and lack of confidence of the first cohorts. Each program incorporated "Learning intentions" that identified success criteria, and goal setting was included in the strategies of the lesson. An unintended consequence of streaming is the impact on students' self-efficacy through stereotyping by themselves and others.

> But the kids say, "I know I'm in the bottom class" … The trouble with 5.1 is that gives a limit to the grade you can give a student. The best you can give is a D (MT5)

To limit the social impact of streaming, students were moved between the classes as they settled into the school year. Unfortunately, not all placement changes for students were able to be accommodated. MT5 spoke of four students capable of promotion from the "bottom class" to the "middle class", but only two students could be moved due to class size restrictions.

Teachers were in charge of the sequence and depth of learning within their classes and used formative assessment to determine learning concepts and teaching strategies to build mastery and self-efficacy. The formative assessment was simple, regular, influential on teaching, and assessed through various non-traditional strategies. Some strategies identified in the interviews included quizzes, assignments, open-book tests and hands-on activities. The teachers were committed to understanding the students' levels of mastery and adjusting their teaching to suit the needs of the students. Similarly, flexible strategies were used to gain summative information on student learning, and these methods were considered to document the levels of mastery for each student, build confidence and resilience, and reduce anxiety.

> I do a lot of scaffolding in my lessons. I use the mini-whiteboards a lot. They tell me whether the kids have got it or not. It depends a lot on what they write down. The kids like to rub out their answer. It is a real visual, and they feel if they get it wrong, it doesn't last (MT5)

> I also use end of topic task. It may be problem solving, research, topic test. This gives me an idea of how the kids have gone. I sometimes use a quick quiz… The students know that failure is not bad, so we use it like revision to show if they are doing well or not doing well. It tells me that it might need reteaching (MT7)

> Our informal assessment has really worked. I can now assess you on what you write in class. Beforehand you might find that you know the kids understand it from the classwork, but they would not get the question right in the test. But the kids know the work. You know some students are a wreck in exams (MT6)

Problem-solving and creative thinking was seen as a step that follows once the basics are understood. Two teachers felt that exposing the students to problem-solving too early would negatively influence their self-efficacy. However, one of the teachers (MT7) saw problem solving as a way of helping the student understand the mathematical concepts.

> We don't do much problem solving. The kids don't have the suite of skills to really do problem solving. We mainly try to engage them and build their basic skills. We are still developing this and have just started doing the AMT (Australian Mathematics Teachers) challenge. These questions are a real challenge. (MT6)

> I'm only in my third year of teaching Maths. I would like to do problem-solving, but I'm still getting to know the work myself. I'm still getting to know how things fit together (MT5)

> I try to break down the questions using a flow chart. They look for keywords and work out the content in the question. I use this for Year 11 too. Year 9, I experiment with some of the parts of the content. We pick out the content and have a look at it. The kids like the hands-on parts. Last year I played roulette with them. They like not using pen and paper but prefer to think about it. Sometimes they bring in their own methods from outside, like in probability. But it is more their perspective on where they would like to start. They look at the questions, and we sometimes discuss the direction of the question and their perspective on how to work it out (MT7)

There was a strong sense among the teachers and principal that students learn and are influenced by their peers. While many schools achieve this through relationship building and informal opportunities for students to work together in class, MT7 had an explicit strategy of creating working teams of students. This approach assisted with mastery as well as providing relevance and application.

> For Year 9, I have a seating plan, and I picked the students to have some outgoing and some

> quieter persons. I align have one stronger and a slightly weaker ability student together. They are a good group, and there is no bullying. They don't pick on someone if they don't know and answer. One or two in the group are the leaders, but I didn't know it works out that way. It works well (MT7)

The influence of third parties

The influence and aspirations of parents and the community impact students' aspirations (Habibis & Walter, 2015). Teachers indicated that academic study was not part of the parents' culture and in particular, some parents considered mathematics a hard subject and difficult. Family expectations are often reflected in the students' self-efficacy (Caprara et al., 2006). The levels of parent education of the sample indicated that 25% of mothers and 15.1% of fathers had a degree suggesting tertiary level education was not usual. The number of mothers with trade qualifications was small (9.5%), of fathers with 14.7%. Approximately one-third of mothers (13.1% + 20.2%) and fathers (21% + 16.3%) had not studied post-school, and this was a concern for teachers in building a culture of learning. The proportion of students who did not know their parent's education levels was slightly less than one third (mothers: 29.4% & fathers: 31.3%). Many parents commute for work in other suburbs of the city.

> Many of the parents here have not gone past Year 10 or Year 12. There aren't many people who have been to university. The cultural capital is an issue (MT6)

In contradiction with this belief, only 18.3% indicated they did not know a person who used advanced Mathematics in their job, with 66.7% stating they knew at least one person. Students, however, queried the relevance and applicability of mathematics.

> The kids ask, "When will I use this" all the time. I just tell them that it is the thinking that counts. Problem-solving is really valued by employers, and I am teaching them how to think and use problem-solving skills. I try to bring in real life (MT5)

Table 6.6

St Sarah's College students' knowledge of their parents' education levels and the number of people they knew who used maths in their jobs

	Education level				People known who use advanced maths for their job.		
	Mother		Father				
	(n)	%	(n)	%		(n)	%
Before Yr 12	35	13.9	53	21.0	0	46	18.3
Yr 12	51	20.2	41	16.3	1	43	17.1
Trade Cert/Dip.	24	9.5	37	14.7	2	36	14.3
Degree	63	25.0	38	15.1	3	33	13.1
Don't Know	74	29.4	79	31.3	4	17	6.7
					5	4	1.6
					6+	35	13.9
Total	247	98.0	248	98.4	Total	214	84.9

Whole of school direction and initiatives

The St Sarah's website stated the school sought to develop a love of learning, and persistence and commitment were crucial. To deliver this aim, the principal and the teachers agreed that explicit strategies "to do something different" to build their confidence (MT6). While streamed classes potentially placed much value on performance, the teachers interviewed advocated that St Sarah's promoted a learning focus.

> We have really been focussing on student learning rather than just knowledge (MT5)

The teachers said the school directive restricted the number of formal assessments to two per year group embedded formative assessment into their teaching and learning and lessened the number of written tests. Faculty collaboration was in place for the writing of the teaching scope, and this project dominated the limited number of faculty meeting opportunities. The teachers exhibited high self-efficacy in their role. Collaboration in discussing common learning goals within the faculty appeared non-existent. Hence the ability of teachers to influence the way learning occurred at the faculty and school levels were limited to informal discussion and still required further development for them to be influential in the collective environment.

> The school has made a decision to have two formal assessments each year, and the rest are informal. I do one informal after each topic. I try and get away from testing and use open-ended activities. I sometimes use a quiz to check to see if they know their words. I keep the quiz small, say five questions (MT5)

> In year 7 and 8, the formalised is minimised. For example, I use cards to test fractions. The kids have cards and a set of questions, such as make up the largest fraction or what is the largest addition you can make from the cards. We do it in class, not a sit-down exam. It's hands-on, and the kids look at it like a game (MT6)

The school's organisational structure included a daily "academic care" group where teachers provided mentoring goals and student discussions. "Academic care" was an imposed activity supported by the teachers, although MT6 lamented that the change from using this time for numeracy skill development to general student attitude ("mindset").

A project aimed at introducing a school-wide numeracy program was being discussed but not implemented, and teachers expressed interest in a timetable with longer periods. However, the teachers reported they had little influence on the school collective efficacy at this stage of its development, except for determining teaching resources.

> We want a whole-school approach to numeracy. Go across all the KLAs. Look at a Problem-solving paradigm K-6 then to St Sarah's start in the Primary so we can really build on what they do. We are doing the same things. I have been talking with the local primary about a common numeracy approach. There's variable influence on the school. Certainly, things you ask for you tend to get, especially resources. (MT6)

> The maths faculty is not really influential (MT5)

The teachers expressed concerns around the current method used by government authorities to calculate an ATAR, where the standard course "scales well and (is) easier" so that students "get a better mark for one-third of the effort" (MT6). The implication being, that policy and processes at the NESA level needed to change to provide a value for the extra work needed for intermediate and advanced mathematics courses in Stage 6. It was a cause for great concern for MT6, who stated, "After all, I can't lie to the kids … (you) can get a better mark with a third of the effort".

In summary, St Sarah's has an above-average ICSEA, but with NAPLAN less than their "like schools". The principal and teachers believed self-efficacy was crucial to building student mastery and confidence in learning. While focused on improving the basics, the teachers used a variety of strategies, including direct instruction, gaming, and investigation. They had a strong belief in their role as a proxy agent and in transferring knowledge into application. The streaming of classes was designed to boost the self-efficacy of students, although students perceived some stereotypes existed. Parent aspirations for their student's learning appeared to be influenced by their own experience of school. Students appeared to be aware of mathematics in careers, even though only a minority had a degree or trade qualification. In general, there appeared to be a strong connection between the principal's vision and the operations of the mathematic faculty.

St Sarah's College Assertion 6: The teachers and principal stated that achievement, learning and self-efficacy were strongly linked and put in place explicit strategies to focus on the four sources of self-efficacy: mastery, vicarious experience, social persuasion and affective states. The teacher's focus on mastery was aimed at decreasing anxiety levels and increasing motivation to engage in deep learning. The practices of the mathematics faculty were based on the belief that students entered year 7 with low mathematics self-efficacy and parents had low expectations for their children. The teachers articulated that the ATAR system did not support students studying advanced mathematics, which caused them conflict as they wanted to reduce anxiety and stress for the students even if it meant recommending a less challenging course.

6.5 Conclusion

This chapter describes the influences of the school and community environment on the students' self-efficacy. The sequential-explanatory method uses the profile data provided by the students in the sample, their comparative results from NAPLAN, the school descriptions from their website and the *Myschool* website, field notes from discussions with the school principal and teachers' semi-structured interviews to form a commentary of the environmental system the school exists within as they impact the student's self-efficacy. While Chapter 5 noted no significant difference between the students' self-efficacy and their sources, the NAPLAN results were more favourable for the rural based schools compared to the metropolitan based schools, which is not reflective of NAPLAN data reports (NAP, 2018). While mastery is an important mechanism in self-efficacy (Bandura, 2006), this result suggests that other sources are influential for this sample. Social persuasion, vicarious experience and affective states sit within the micro-, meso- and exo-systems. The commentary articulates the influence of the operational environments on students' self-efficacy with assertions deriving from these descriptions. An element of these environments is the value placed on mathematical knowledge as an entity, or one that can be enhanced (Dweck, 2006), providing the students with a conception of their ability that is either static or able to be grown (Bandura, 1997). The assertions also respond to the explicit and implicit actions of the teachers as proxy agents who work between the individual and the collective.

St Christopher's College Assertion 1: The belief in a focus on performance appeared to have a negative effect on students' motivation to seek and engage in challenging mathematical concepts. The teacher's preferred to ensure mastery of the "basics" with low anxiety levels within the current class structure, rather than providing a student-centred approach to deep learning. The teacher's beliefs were at odds with the policy direction articulated by the principal.

St Benjamin's College Assertion 2: The teacher at St Benjamin's realised the significance of explicitly implementing strategies to transfer from proxy agency to individual agency through guided mastery, vicarious experience, targeted social persuasion and monitoring the affective states. The students at St Benjamin's, according to the teacher, relied on support from the teacher to comprehend and then solve practical problems. The beliefs of the senior teacher interviewed dominated the policies and procedures that influenced mathematics learning at the school.

St Catherine's College Assertion 3: The belief in building confidence through targeted mastery, vicarious experiences, social persuasions and monitoring of affective states was well understood by the principal and the teachers interviewed. The resultant was a positive effect on students' motivation to seek and resiliently engage in challenging mathematical concepts. The teachers considered they had the opportunity to play a special role, as a proxy agent, in helping students be their own agents with deep learning. The teachers and the principal believed the school's policies to support a moral purpose focussed on student-centred, deep learning.

St Kathleen's College Assertion 4: The Teachers stated the school built an academic focus based predominantly on marks and performance, which was the school's policy position. This approach, the teachers noted, was successful for some students but appeared to have a negative effect on the motivation to fulfil their mathematical potential for a large number of students. Being in the top mathematics group in Year 9 and 10 was considered prestigious for those in the junior years who were hoping to make the cut. The perceived added value to the ATAR (to gain university entrance) by studying the Standard (General) course was less work and negatively influenced studying advanced mathematics in the senior years, which took more work.

St Paul's College Assertion 5: Parents' perceived focus on performance appeared to have a negative effect on students' motivation to seek and engage in challenging mathematical concepts. Parental expectations influenced the strong emphasis teachers placed on improving performance. The teachers were attempting to use guided mastery to deepen students learning past the "basics" without linking to real-life learning. As described by the principal and the school publications, the school's policies focused on deepening learning, but the teachers' practices at the time of the study were not aligned to these principles.

St Sarah's College Assertion 6: The teachers and principal stated that achievement, learning and self-efficacy were strongly linked and put in place explicit strategies to focus on the four sources of self-efficacy: mastery, vicarious experience, social persuasion and affective states. The teacher's focus on mastery was aimed at decreasing anxiety levels and increasing motivation to engage in deep learning. The practices of the mathematics faculty were based on the belief that students entered year 7 with low mathematics self-efficacy and parents had low expectations for their children. The teachers articulated that the ATAR system did not support students studying advanced mathematics, which caused them conflict as they wanted to reduce anxiety and stress for the students even if it meant recommending a less challenging course.

The rural and metropolitan based schools have many things in common, and the school, regardless of their geolocation, understood the importance of good education and the major role teacher play in supporting students in their learning. All schools of the sample supported the need to develop mastery and understanding in students, and this was provided through guided mastery, vicarious experiences, social persuasion and addressing debilitating affective states. Much focus was placed on ensuring students felt confident in their capability and considered mistakes were a natural part of learning. There was a tension between ensuring fluency and competence and over-emphasis on procedural responses. It was clear that while results were important, the teachers realised that depth in learning was needed. If the focus is only on performance, students and teachers risk developing an entity mindset where engaging in challenging mathematical concepts is not encouraged (Dweck, 2006).

Teachers play a significant part as proxy agents operating between the imposed, selected and created operational environments of the school (Bandura, 1997). The perceptions and comments by teachers reflected their own efficacy in being change agents for the students (Woolfolk Hoy & Davis, 2006) with the ultimate desire to have students with high levels of agency. Not all teachers had explicit strategies to connect problems solving and application into the students' learning, and a number of students questioned the relevance of the topics. Many of the rural and metropolitan based schools had processes and procedures in place to provide teachers with the opportunity to influence the operative environments of the school. Unfortunately, they also felt that some crucial processes from NESA (for example, the ATAR calculation), school policy (such as classes organisation), and parental support were out of their control.

The influence on student aspirations from parents and adults who use advanced mathematics in their jobs indicated that many students know careers exist that use mathematics. The student’s perceptions of their parents’ levels of education were significant as many students did not know. Teachers understand the importance of parents’ comments, especially if they articulate the difficulty they experienced in learning mathematics.

Based on the assertions gathered from the six schools and sixteen teachers interviewed, Chapter 7 links and reconciles the student questionnaire quantitative data with commentary of the ecological systems of the schools to discuss the research questions:

> Do rural and metropolitan secondary students differ significantly in their perceived self-efficacy in secondary school mathematics?

What are the major influences on the perceived self-efficacy in secondary school mathematics for rural students?

Chapter 7: Discussing the results

7.1 Introduction

Researchers, governments and businesses are concerned that Australian school students are not performing to the desired levels of participation and achievement in advanced levels of mathematics (AMSI, 2014; NAP, 2017). Further, students' achievement in NAPLAN, PISA, TIMSS and the HSC is generally weaker for rural based students in New South Wales (AMSI, 2017; CESE, 2013; NAP 2017). Unfortunately, given the continuance of these trends, responses used to date have not provided a solution.

Human behaviour is multi-dimensional (Alexander et al., 2012), and the social cognitive theory explains that humans grow and develop through a variety of vicarious and enactive learning experiences that inform and motivate them (Bandura, 1997). The development of human thought, belief, and problem-solving through vicarious, symbolic, and self-regulatory processes and self-efficacy influences students' achievement behaviours. Self-efficacy influences task choice, persistence and learning strategies (Schunk, 2012). A weight of evidence argues that student achievement has a reciprocal causality with their perceived confidence in achieving the task (Bandura, 1997; Deci & Ryan, 2002; Dweck, 2006; Ma & Xu, 2004; Martin, 2009). The perceived confidence to complete a mathematical task is described as mathematical self-efficacy, and that raising or lowering a student's mathematical self-efficacy affects achievement and vice versa. Self-efficacy is more than a belief in mastery of knowledge and skills from the past. Self-efficacy is the conception of agentic capacity to successfully complete future activities and is a key mechanism in social cognitive theory. Hence, mathematical self-efficacy is the belief that one can successfully conduct the learned mathematical knowledge and skills in the future. Students select and create the perceived "environmental supports for what they want to become" (Bandura, p.2) to shape their future. These environmental supports are produced individually and as part of a collective through the students' ecological systems (Bronfenbrenner, 1981).

The literature review identified that there was a gap in research that investigated mathematics self-efficacy in rural based school students in seeking to understand the differences in mathematical performance between rural and metropolitan based students. The researcher reasoned that if participation and achievement were weaker for rural based students, and self-efficacy was a significant mechanism in student learning and motivation and causally linked, mathematics self-efficacy might also be weaker for rural based students. Bandura (1997) and others (Butz & Usher, 2015; Joet et al., 2011; Usher & Pajares, 2009; Schunk, 2012) identified four sources of self-efficacy, namely enactive mastery, vicarious experience, social persuasion and affective states. The researcher hypothesised that the difference in achievement would mean differences in these sources between rural and metropolitan based students. Hence the primary research question of this study asked whether self-efficacy in secondary school mathematics was a significant influence on rural based students in developing their agency to achieve and participate in the study of higher levels of mathematics.

This problem was then developed into two research questions for investigation.

Research Question 1: Do rural and metropolitan secondary students differ significantly in their perceived self-efficacy in secondary school mathematics?

Research Question 2: What are the major influences on the perceived self-efficacy in secondary school mathematics for rural students?

The researcher used an explanatory-sequential mixed methods methodology to investigate these questions. Research Question 2 proved provocative. It was initially focused on the four theoretical sources of self-efficacy identified above. However, to explain the results from the student questionnaire, this investigation was expanded to consider the environmental supports that influenced the student's self-efficacy as an exercise of agentic control. These environmental supports build the students mathematical self-efficacy through the micro-, meso-, exo- and macro systems of the student (Bronfenbrenner, 1981).

The selection of schools with similar socio-economic advantages, as measured by ICSEA values, suggested that some of the potential influences on the external environment (such as SES) would be mitigated. The central tenet of social cognitive theory is that perceptions of social/environmental factors are in a triadic reciprocal relationship with perceived personal attributes (cognitions, beliefs, skills, affects) and behaviour (Schunk, 2012). Hence the contextual systems experienced by students affected their cognitions, skills, beliefs and affective states, and their behaviours and vice-versa (Bandura, 1997). Bronfenbrenner's ecological systems (1981) is used to investigate the relationships within the schools' operational environments. The discussion in this chapter considers the influence of environmental conditions that build self-efficacy as a predictive action that goes beyond replicating mastery of mathematical concepts.

This chapter begins by analysing and interpreting the quantitative data from the *Self-Belief in Mathematics* questionnaire reported in Chapter 5. These findings answer the first research question, with the major outcomes showing more similarity than difference in the responses based on geolocation. Furthermore, the responses from the students followed the same pattern for the three sections of the questionnaire regardless of being rural or metropolitan, although some significant difference was detected in parents'/carers' and teachers' attitudes to mathematics.

If self-efficacy were only about mastery, then the NAPLAN results reported in Chapter 6 would be expected to be similar. However, the findings in Chapter 6 showed that the rural based students performed better against the Australian mean and "like schools" in Year 7 and Year 9 NAPLAN Numeracy over a number of years. Bandura (1997) described self-efficacy as a socio-cognitive construct that builds determinism and freedom for the individual and the collective in which they dwell. The multi-dimensional nature of human behaviour displayed in this study, once again, proved to be complex.

The second part of this chapter discusses the influences of the students' self-efficacy (within their micro-system) using the quantitative data from the survey, mixed with the commentary from the principal, the school and *Myschool* websites, and teachers' interviews. The qualitative data were reported in Chapter 6, with the findings described as assertions that captured the essence of the schools' findings. The explanatory-sequential mixed methods used the conditions on learning described through the Bronfenbrenner ecological systems (1981) to bring the data together within the themes of collective, proxy, individual agency and transference from proxy to individual agency. Within the discussion, themes are the micro-, meso-, exo- and macro- systems in which the agents act. Thus, this discussion combines and merges the data to assist in discerning the response to the primary research question: whether self-efficacy in secondary school mathematics influences rural based students in developing their individual agency to achieve and participate in the study of higher levels mathematics?

7.2 Mathematics self-efficacy

The *Student Self-Belief in Mathematics questionnaire* was completed by 869 students in total, with 540 (62%) rural based students from four schools and 329 (38%) metropolitan based students from two schools.

The data gained from the student questionnaire included their perceptions of their capability to solve questions that reflect a range of difficulty from the six content sub-strands of the NSW mathematics syllabus and the Working Mathematically process strand (NESA, 2018b). The content questions were based on types that students were expected to have seen before and would have already formed perceptions of their mastery skills in these areas. The measures of mathematical self-efficacy are designed to reflect student confidence to master similar knowledge and skills in future settings (Bandura, 2006).

The Working Mathematically process questions asked students to predict their capacity to solve harder questions, put "maths" in their own words, apply their "maths techniques" into other subjects, and communicate how to solve a "maths question". Mathematics is cognised through symbols that reflect mathematical knowledge, mathematical theories, objects of mathematics (character, origins and relationship with language), applications of mathematics (including relating mathematics with the knowledge of other disciplines), mathematical practice and the learning of mathematics (involving the transition of the other five elements) (Ernest, 1998). Mathematical self-efficacy represents the student's confidence in learning, practising, and applying mathematical knowledge, theories and objects in future events.

The mathematics self-efficacy questions, based on the sub-strands of the NSW syllabus, loaded into two areas labelled as Perceived Most Difficult and Perceived Least Difficult questions. The factor scores were then calculated from the component score coefficient matrix and analysed to give an individual's placement on the factor so that the factor scores have a mean of zero and a standard deviation of 1 as suggested by Distefano, Zhu, and Mîndrila (2009). The factor scores were tested for a significant difference ($p < 0.5$) between rural and metropolitan based students on their perceived mathematical self-efficacy, their perceptions of the four sources of mathematical self-efficacy and their perceptions of their parents'/carers' and teachers' attitudes to mathematics (Field, 2009; Grice & Iwasaki, 2007).

Even though these syllabus sub-strand questions were designed from NAPLAN to represent basic, intermediate and advanced levels of difficulty, the sample students perceived that some strands were more difficult than others. They had lower confidence in all of the Number, the Algebra and Patterns, the Working Mathematically, and the advanced Geometry and Probability, as seen in the lower mathematics self-efficacy scores than the others in the questionnaire. A major finding of this research is that the perceived mathematics self-efficacy factor scores were statistically similar, as shown in Section 5.3.1. This means that the students' predicted mastery for all questions, whether they were the least difficult or the most difficult questions, were unaffected by geolocation. Regardless of the students being rural or metropolitan based, easy questions were identified with high mathematical self-efficacy and difficult questions with less mathematical self-efficacy.

7.2.1 **Rural and metropolitan similarity with number and algebra**

In keeping with the strong similarity in the responses of rural and metropolitan based students, the lower ratings of perceived self-efficacy for the number and algebra were seen in Section 5.3.1. This meant that students from both geolocations perceived that number and algebra were more difficult than the other content sub-strands. The content and concept of number and algebra are significant elements of "(t)he symbolic nature of mathematics (that) provides a powerful, precise and concise means of communication" (NESA, 2018b). NESA also notes that number and algebra are crucial "building blocks" in developing fluency, logical reasoning, analytical thought and problem-solving skills. Mastery in these areas is a vital step in developing and communicating the predictive nature of mathematical understanding (OPC, 2009a). Fluency in surface knowledge that develops conceptual relationships and extended abstraction are key steps in promoting deep mathematics learning (Hattie et al., 2017). As noted by the Australian Association of Mathematics Teachers, "(a)lgebraic reasoning is important in junior secondary mathematics, and crucial in the higher levels of mathematics in the senior years and beyond" (ADGET, 2015a, p.10). Tools, such as number and algebra, assist students to make connections, identify patterns, solve problems and construct meaningful information that leads to deep learning (Fullan et al., 2018). The interviewed teacher's commentary also reflected the perception by both rural and metropolitan based students that all levels of number and algebra were difficult. Confidence and competence in number and algebra are crucial for conceptual understanding, procedural fluency, strategic competence, adaptive reasoning needed a disposition for studying advanced mathematics (Sullivan, 2011). The application of algebra, such as substituting into a measurement formula, loaded with those considered as least difficult. According to Bloom's Taxonomy of cognitive tasks, applying a concept is below the higher-order *analysis*, *synthesis* and *evaluation* (Gage and Berliner, 1975). The lower confidence of students to use their mathematical knowledge in number and algebra means their confidence to seek and acquire new knowledge and skills when needed is compromised (Ernest, 2010).

7.2.2 **Rural and metropolitan similarity with Working Mathematically**

The NSW syllabus emphasises that students need to be able to "respond to familiar and unfamiliar situations by employing strategies to make informed decisions and solve problems relevant to their further education and everyday lives" (NESA 2018b). Westwood (2008) argues that "problem-solving (is) not so much a subsection of mathematics curriculum but rather as a method teaching … (that) provides the most relevant way to help students engage in interesting learning" (p. 52). Problem-solving provides applicability for the study and is a mechanism for motivating and sense-making. Hence, it is pertinent in this study that students' results in the Working Mathematically components: *I can remember ways of solving hard questions [problem-solving, fluency], I can put maths into my own words [communication], I can use maths techniques in other subjects [reasoning, understanding], I can tell others how to solve a question [understanding, communication]* also loaded with the questions perceived most difficult.

The Working Mathematically process strands are designed to be woven into the content strands in application, understanding, reasoning and communication (NESA, 2018b). Regardless of whether the content is basic, intermediate or advanced, students communicating their knowledge and displaying understanding and reasoning is essential in showing their mastery (Bransford et al., 2000). Mathematical knowledge and skills shift from surface to deep and transfer learning (Hattie et al., 2017). However, rural and metropolitan based students showed their confidence in the Working Mathematically questions' capability to align with their responses to the most difficult questions in the other strands. Regardless of being rural or metropolitan based, their mathematical self-efficacy was lower for these processes, leading to weakened confidence to build their knowledge and skills when challenging scenarios to arise. There appeared to be a lower motivation to engage in mathematical content that students perceived to lack applicability and consequence to their futures (Bandura, 1997).

7.2.3 **Rural and metropolitan mathematical self-efficacy similarity by grade**

In both geolocations, there was a larger proportion of Year 7 students in the cohort with schools, 246 (45.6%) rural based students and 184 (55.9%) metropolitan based students in Year 7. These students had spent almost one year in secondary school at the time of the questionnaire, so they were familiar with the model of the school's curriculum, timetables, operations, policies and procedures. In addition, this group of students had taken part in the nationwide NAPLAN test approximately six months beforehand. Therefore it was assumed that these students' perceptions would not be distorted by the transition from primary to secondary schooling (Andrews & Bishop, 2012). Year 9 was the next most populous grade with 122 (37%) rural and 192 (35.6%) metropolitan based students with Year 11, then with 102 (18.9%) rural and 23 (7.0%) metropolitan based students.

For the students in this sample, as seen in Section 5.3.1.1, a MANOVA showed a significant difference between the mathematical self-efficacy perceptions in the grades for the rural based students and metropolitan based students, although the effect size was only medium. The rural based Year 11 group (M = .31, SD = .91) who were significantly more confident from Year 7 (M = -.10, SD = 1.05) in the perceived most difficult questions. Year 11 were also significantly more confident on the questions perceived most difficult when compared to Year 9 (M = -.04, SD = .95). The stronger mathematical self-efficacy by Year 11 in the questions perceived most difficult is a positive finding, given that they are in the process of choosing their post-school career pathway. These choices are difficult, and students consider their capabilities, interests, current and long term prospects of alternate occupations, accessibility of potential careers and the type of identity they seek to construct for themselves (Bandura, 1997).

The MANOVA also showed a significant difference between mathematical self-efficacy and metropolitan-based students' grades, as noted in Section 5.3.1.1. Year 7 (M = .12, SD = .93) who were significantly more confident from the Year 9 (M = -.17, SD = 1.05) in the perceived least difficult questions, although the effect size was small. While there was no significant difference between Year 7 and Year 11 and Year 9 and Year 11, the small group of Year 11 metropolitan based sample made it difficult to make judgements.

An unfortunate potential consequence of students in Year 7 and Year 9 students rating themselves lower in their mathematical self-efficacy for the questions perceived most difficult is the influence it has in later years. McPhan et al. (2008) identified success in mathematics in the junior grades as crucial in building students' perceptions of advanced mathematics. As was seen in Chapter 6 (for example, St Christopher's College and St Sarah's College), an over-emphasis on the "basics" to build confidence and fluency can dilute the capacity to engage in challenging mathematical concepts (Fullan et al., 2006). Mathematics is a subject where students need mastery of essential facts before understanding the more complex ideas (Graham et al. 2004, Wiggins & McTighe, 2007) and cycles through the surface, deep and transfer learning (Hattie et al., 2017). Automatic recall of "basics" is helpful as this frees up working memory to develop analytical thinking and generalisations (Green, 2005). However, the sophisticated mathematical understanding, fluency, logical reasoning, analytical thought processes, and problem-solving skills needed for advanced levels of mathematics (ACARA, 2015a) require scaffolding (McTighe & Wiggins, 2013). Guided discussion (Bransford et al., 2000), argumentation (AGDET, 2015b), targeted discussion, justification and application to real-world issues (Boaler, 2002), and facilitating mindset that embraces challenge (Dweck, 2006) are considered necessary. The importance of the teacher and parents (as proxy agents) and collective efficacy as sources that explicitly and implicitly scaffold the development of strong student self-efficacy in mathematics is discussed in Section 7.3.

7.2.4 **Rural and metropolitan mathematical self-efficacy similarity by gender**

More females participated in the questionnaire than males, with 293 (54.3%) female students and 247 (45.7%) male students from the rural based schools and 186 (56.5%) females and 143 (43.5%) males from the metropolitan based schools. In Australia, there is broad concern that female students achieve lesser results (Thomson et al., 2012) and have weaker participation in advanced mathematics (Koch, 2019). However, in this sample, when comparing the student's perceptions of their mathematics self-efficacy based on gender, there were no significant differences identified in Section 5.3.1.2. This was the case by comparing males and females within the rural and metropolitan samples. The comparison also considered rural females against metropolitan females and rural males against metropolitan males. The similarity in results meant that females perceived most difficult areas, males also perceived as most difficult, and the same for the areas they found least difficult. In keeping with the trends, both males and females perceived number, algebra and Working Mathematically more difficult than the other content areas.

7.2.5 **Rural and metropolitan mathematical self-efficacy comparison by their parent education levels**

Students' perceptions and knowledge of their school and community environment impact their mathematical self-efficacy (Caprara et al., 2009). Parental perceptions, especially mothers, are linked to children's beliefs in their mathematical ability, career choices and the endorsement of traditional gender roles (Buckley, 2016). Unfortunately, Buckley also found that children of high-achieving mothers avoid engaging in advanced mathematics for fear of not being as good as they were. Therefore, the collective environment, where the students observe and are taught what is valued as social capital (Habibis & Walter, 2015), is essential and the manner that the school-based operative environment deals with the external environment (Hattie, 2018).

Students were asked to nominate the education levels of their mother and their father according to whether they had left school before they finished Year 12, at year 12 or if they had a trade certificate or diploma or a university degree. These data are analysed in Section 5.3.1.4. Students indicated that more mothers had a degree than fathers, but they represented the smallest category with a trade certificate or diploma reflecting the skill shortages in regional and metropolitan areas (AGDESE, 2019).

Student's identification of their parents' education levels was analysed to see if this environmental element influenced students' mathematical self-efficacy. It was suggested that knowing parents' education levels meant that parents and students had discussed post-school education options and provided a modelling influence (Bandura, 1997; Caprara et al., 2006; Habibis & Walter, 2015). However, the proportion of students who did know their parents' education levels was the largest share (about one third) for both rural and metropolitan based schools, as seen in Figures 5 and 6. Not knowing parent education implied that a modelling influence was not evident to the students.

There was a feeling among the teachers interviewed that many parents, in both rural and metropolitan areas, spoke openly about their lack of competence in mathematics in front of their children (see Sections 6.4.3, 6.5.1 and 6.5.2). Such comments reflected a poor model for students regarding their mathematical capabilities and self-efficacy (Pajares, 2006).

A MANOVA was conducted to test whether rural based students had weaker mathematics self-efficacy than metropolitan based students based on mother's education levels and father's education levels with the results reported in Section 5.3.1.4. However, considering the students' perceptions of their mothers' education, the perceived least and most difficult factor scores were not significantly different. Hence, the level of the mother's education was not a discriminating factor in either rural or metropolitan based locations.

Rural-based students' views of their father's education levels were moderately significant for their perceptions of the most and least difficult questions. Further investigation through an independent samples *t*-test on the factor scores found that students whose fathers had not studied post-school (NSPS) had lower mathematical self-efficacy than those who had studied post-school either at trade or degree level (SPS), with moderate effect size, in both the questions that were perceived most difficult and the questions perceived least difficult. A similar result occurred for metropolitan based students, where the independent samples t-test showed that students whose fathers had not studied post-school (NSPS) were significantly lower in the questions perceived least difficult than those who reported their father's had studied post-school (SPS), once again with a moderate effect size. The implications of low mathematical self-efficacy in the "basics" suggest that students would replicate their father's choice that post-school study in mathematics was not for them (Habibis & Walter, 2015). The focus on building fluency in knowledge and skills in such content and concepts (as seen in Chapter 6) would reaffirm the importance of competence in low order skills rather than scaffolding the transfer to deep learning (Hattie et al., 2017). For rural based students, the implication is that students whose fathers with NSPS have lower mathematical self-efficacy in the more difficult questions, including number algebra and Working Mathematically, suggesting perceived limited value for them in this study (McPhan et al., 2008).

Although this influence may be overstated. Figures 5.5 and 5.6 indicated that a large number (around one third) of students indicated they did not know their parents' education levels. Rural based students identified 183 did not know their father's education level, as did 105 metropolitan based students. A second independent samples *t*-test investigated the factor scores of those who did and those who did not know their father's education levels, as seen in Section 5.3.1.4. The rural based students who knew their father's level of education, regardless of what level, had significantly higher self-efficacy than those who did not know, although with only a moderate effect size. For metropolitan based students, neither the questions most difficult or those perceived as least difficult proved significantly different.

While it is known that mothers have more influence on student study habits (Brown & Lent, 2006), the modelled influence of fathers had the most impact in this sample. Rural based students who knew their father's had studied after school had higher levels of mathematical self-efficacy. Metropolitan based students recorded an effect for the least difficult questions, which were designed to reflect the "basics" discussed in section 7.2.3. Those who knew their fathers had a trade certificate or a degree had higher mathematical self-efficacy with the basics, but not with the question reflecting more advanced levels of thinking, including the Working Mathematically process strand.

7.2.6 **Rural and metropolitan mathematical self-efficacy comparison by the number of people students know who use advanced mathematics in careers**

Students were asked the number of people they knew who used advanced mathematics in their job. The MANOVA of the factor scores analysed in Section 5.3.1.6 showed no significant difference for rural based or metropolitan based students for the students who responded to the question with moderate effect.

Knowing zero people was the most popular single choice for both geo-locations, although many students' indicated they knew at least one person. Both rural and metropolitan students also indicated they knew six or more people, which was larger than some of the other selections. This suggests that some rural and metropolitan based schools knew many people in careers where advanced mathematics was used. McPhan et al. (2008) suggested that knowing people who use advanced mathematics in their job is likely to influence their choice to participate in advanced mathematic courses as the students have a role model and the study has good social value (Habibis &Walter, 2015).

Even though students could have answered zero, it is noted that not answering the questions was the most common option for rural based students. This suggests that either the students did not understand the question or decided not to answer the question. Either way, these rural based students did not indicate they knew people who use advanced mathematics in their job. While having role models who use advanced mathematics in their careers acts as social persuaders (Caprara et al., 2004), not knowing such people suggests the opposite. For models to be effective, the student needs to believe social capital is balanced against their beliefs in their capability to emulate them. The relative influence of these elements was not clear from this study and implied an area requiring further study.

7.2.7 **Conclusion: Mathematical self-efficacy**

In summary, there was no general statistical difference between rural and metropolitan based students in mathematics self-efficacy considering a range of independent variables. In particular, the number, algebra and Working Mathematically questions had lower mathematical self-efficacy in both rural and metropolitan based schools of the sample. The similarity of the measures of mathematics self-efficacy was across all questions, whether perceived as difficult or not.

7.3 **The major sources of the perceived self-efficacy in secondary school mathematics**

This section discusses the data gained through both Phase 1 and 2 of the study to answer the second research question: What are the major sources of the perceived self-efficacy in secondary school mathematics for rural students? The phase 1 data are based on student responses to the Self-Belief in Mathematics questionnaire that gathered perceptions on the theoretical sources of self-efficacy and parent/carer and teacher attitudes to mathematics. The questionnaire asked students to respond to a symmetrical Likert type scale to record agreement or disagreement with the relevant statement. As well as the theoretical sources of mathematical self-efficacy, this phase also describes the students' perceptions of their parents'/carers' and teachers' attitudes to mathematics, given their major role as proxy agents (Bandura, 1997). The collective environment is important (Bronfenbrenner, 1981) however, it is how the school and its teachers deal with the external environment that makes the difference (Hattie, 2018). Hence the assertions listed below use the commentary from Phase 2 to investigate and interpret the "source" results in Phase 1. Phase 2 was based on the qualitative data gained from the field notes with principals, school websites, and teachers' commentary in the semi-structured interviews.

7.3.1 **Comparing the sources of mathematics self-efficacy**

The factor analysis of the sources of self-efficacy loaded to the theorised areas of enactive mastery, vicarious experience, social persuasion and affective states. As seen through the data analysis in Section 5.3.2, the student responses followed similar patterns for each source, with agreement levels matching the rural and metropolitan based students. Hence the levels of enactive mastery, vicarious experience, social persuasion and affective states were statistically similar.

One notable point of similarity was that both rural and metropolitan based students had a low agreement about observing adults "doing well at maths" motivated them to do better. This reflects the previous discussion in Section 7.2.6, where knowing people who use advanced mathematics in their jobs did not discriminate between students in their mathematics self-efficacy. This sentiment is contrary to the premise of many reports (for example, McPhan et al., 2008; AMSI 2019) where students did not know that models exist that use advanced mathematics in their careers is considered an impediment to them choosing to study advanced mathematics. Hence, students seeing adults as competent in studying advanced mathematics were not a motivator for this sample of rural and metropolitan students who disagree with this statement, as seen in Section 5.3.2.

Studying mathematics did not seem to cause negative emotions, with both rural and metropolitan based students reflecting that nervousness, stress, anxiety and tension were not part of their experience in mathematics lessons. The lack of negative emotions implies that the students believed the classroom environment climate was cohesive. Positive peer and proxy relationships provide a powerful effect through the "climate of the classrooms, peer influence, and the lack of disruptive students" (Hattie, 2009, p.33). Commentary from teachers in Section 6.4 also noted that they selected and applied strategies to provide an anxiety-free classroom environment deliberately. For example, many teachers sacrificed giving students challenging work that may raise their stress levels for work the students found easier to succeed. As a result, students were not usually anxious or stressed during lessons, although some responded negatively during assessments. The school's and teacher's choice and application of assessment strategies are noted in section 7.3.3.1 as influencing students' views, their conceptions of ability and their motivation to engage in challenging and new mathematical knowledge.

7.3.2 **Comparing parents'/carers' and teachers' attitudes to mathematics**

The student perceptions of their parent's/carer's and teachers' attitudes to mathematics were considered sources that impacted them through a proxy agency (Bandura, 1997). While following a similar pattern between the rural and metropolitan based students, a MANOVA of parents'/carers' and teachers attitudes to mathematics, as seen in Section 5.3.3, revealed that the rural based students had statistically less agreement than metropolitan based students. The analysis through gender found that rural and metropolitan males were statistically similar but that rural females were significantly lower than the metropolitan females for both parents'/carers' and teachers' attitudes. While students' measures of mathematical self-efficacy were similar across rural and metropolitan areas based on gender (see Section 7.3.1.3), rural based females perceived their parents'/carers' and teachers were less interested and supportive of them than metropolitan based females. Similar to the previous comments around the influence of models, it seemed the rural based females' perceptions of their parents'/carers' and teachers' attitudes to mathematics were weaker than those of the metropolitan based schools, yet their mathematical self–efficacy was statistically similar (see Section 5.3.1.2). The teachers made some limited comments from St Kathleen's and St Paul's (see Section 6.4) on the weaker motivation levels of some disinterested male students, but generally, a distinction based on gender was not apparent in the comments from the teachers around capacity and support for their students. The teachers did not report gender stereotypes in mathematical self-efficacy, mathematical self-efficacy sources, or parental attitudes to students studying mathematics.

7.3.3 **Comparing the assertions from the principal, school websites and teachers**

The assertions below were compiled from the profile data provided by the students in the sample, their comparative results from NAPLAN, the school descriptions from their website and the *Myschool* website, field notes from discussions with the school principal and teachers' semi-structured interviews to form a commentary of the environmental system the students exist within. As noted above, human behaviour has many dimensions (Alexander et al., 2012) and Bandura posed the social cognitive theory to explain the complex relationship between behaviour, environment and personal capabilities (1997). The second research question was asked to identify and compare the rural and metropolitan based students' sources of self-efficacy. Mastery is an important mechanism in self-efficacy (Bandura, 2006). However, the NAPLAN results of the sample schools (see Section 6.3) indicated that rural students outperformed metropolitan based students.

Given that the measures of mathematical self-efficacy and theoretical sources of self-efficacy were essentially the same as seen in Chapter 5, the analysis of the school's assertions seeks to unravel the other sources from the students' environmental systems that are influential. In particular, the proxy role of teachers and parents and the collective role of the school through imposed, selected, and created environments (Bandura) are identified as crucial elements within the micro-, meso- and exo- systems. The influences of mathematical self-efficacy that inform and motivate student behaviour to participate and achieve in mathematics reflect students' personal traits and socio-cultural environment. Mathematical self-efficacy exceeds replicating previous mathematical competencies and emerges as a construct to exercise personal control within the micro-system of a student.

The assertions determined through Chapter 6 are listed below.

> St Christopher's College Assertion 1: The belief in a focus on performance appeared to have a negative effect on students' motivation to seek and engage in challenging mathematical concepts. The teacher's preferred to ensure mastery of the "basics" with low anxiety levels within the current class structure, rather than providing a student-centred approach to deep learning. The teacher's beliefs were at odds with the policy direction articulated by the principal.

> St Benjamin's College Assertion 2: The teacher at St Benjamin's realised the significance of explicitly implementing strategies to transfer from proxy agency to individual agency through guided mastery, vicarious experience, targeted social persuasion and affective monitoring states.

The students at St Benjamin's, according to the teacher, relied on support from the teacher to comprehend and then solve practical problems. The beliefs of the senior teacher interviewed dominated the policies and procedures that influenced mathematics learning at the school.

St Catherine's College Assertion 3: The belief in building confidence through targeted mastery, vicarious experiences, social persuasions and monitoring of affective states was well understood by the principal and the teachers interviewed. The resultant was a positive effect on students' motivation to seek and resiliently engage in challenging mathematical concepts. The teachers considered they had the opportunity to play a special role, as a proxy agent, in helping students be their own agents with deep learning. The teachers and the principal believed the school's policies to support a moral purpose focussed on student-centred, deep learning.

St Kathleen's College Assertion 4: The Teachers stated the school built an academic focus based predominantly on marks and performance, which was the school's policy position. This approach, the teachers noted, was successful for some students but appeared to have a negative effect on the motivation to fulfil their mathematical potential for a large number of students. Being in the top mathematics group in Year 9 and 10 was considered prestigious for those in the junior years who were hoping to make the cut. The perceived added value to the ATAR (to gain university entrance) by studying the Standard (General) course was less work and negatively influenced studying advanced mathematics in the senior years, which took more work.

St Paul's College Assertion 5: Parents' perceived focus on performance appeared to have a negative effect on students' motivation to seek and engage in challenging mathematical concepts. Parental expectations influenced the strong emphasis teachers placed on improving performance. The teachers were attempting to use guided mastery to deepen students learning past the "basics" without providing a link to real-life learning. As described by the principal and the school publications, the school's policies focused on deepening learning, but the teachers' practices at the time of the study were not aligned to these principles.

St Sarah's College Assertion 6: The teachers and principal stated that achievement, learning and self-efficacy were strongly linked and put in place explicit strategies to focus on the four sources of self-efficacy: mastery, vicarious experience, social persuasion and affective states. The teacher's focus on mastery was aimed at decreasing anxiety levels and increasing motivation to engage in deep learning. The practices of the mathematics faculty were based on the belief that students entered year 7 with low mathematics self-efficacy and parents had low expectations for their children. The teachers articulated that the ATAR system did not support students studying advanced mathematics, which caused them conflict as they wanted to reduce anxiety and stress for the students even if it meant recommending a less challenging course.

7.3.3.1 The impact of school/faculty policies and practices

These assertions show that, regardless of their geolocation, the teachers interviewed and the principals and the school websites articulated the importance of delivering high levels of mastery with students' confidence and motivation to do so. Furthermore, the principal and the teachers acknowledged the teachers' major role and the importance of school policies and procedures in supporting students in their learning with the ultimate desire to have students with high levels of mathematical agency (Dinham, 2016). The principals also identified their role in providing a shared purpose, designing the organisational applications and managing the instructional program needed to produce an effective school (OPC, 2009b).

The teachers' commentary noted common strategies and practices amongst the teachers of the mathematics faculty (Pegg et al., 2007), although the faculty did not necessarily operate collaboratively. The commentary of the individual teachers was not always aligned with the shared purpose of the school. While having common views, the teachers interviewed from St Christopher's articulated that the mathematics faculty held a different view from the whole of school leadership on the best way to provide excellence in education. St Paul's teachers indicated their operations were not in line with those of the principal. In both of these cases, the lack of common direction between the vision stated by the principal and the varied teachers' views suggested the learning climate of the students was not harmonious across the school and hence not as effective and efficient as it could have been (Dinham, 2017).

However, alignment between the school's policies and the direction of the mathematics faculty did not necessarily produce positive learning outcomes. The teachers at St Kathleen's were aligned with the imposed school environment and felt too strong to oppose. Both teachers interviewed accepted the processes and procedures that relied on performance and adapted their practice to suit it (Bandura, 1997). Having the "right drivers" is critical in providing a learning climate where "*successful learners, confident and creative individuals* and *active and informed citizens*" (The Alice Springs [Mparntwe] Declaration, AGDoE, 2019) are developed following the Australian goals for school education. The assertion coming from St Kathleen's was that the reliance on performance to build the extension class model in stage 5 had a negative consequence on developing a "growth mindset" in mathematics (Dweck, 2006). Bandura (1997) recognises that a growth mindset contributes to a student's conception of their ability to form their predictive views of their self-efficacy through reflection and regulation.

The principals and the teachers of this study understood the benefits for students in having a positive mathematical self-efficacy and that mastery was a major mechanism to build student belief in their mathematical competencies (Bandura, 1997). There was a general view (as noted in the assertions in Chapter 6) that the role of the mathematics faculty was to build students confidence and competence in the mathematics syllabus. This was a reasonable approach given the mandatory nature of the mathematics curriculum in New South Wales (NESA, 2019). However, having a prescribed curriculum does not automatically mean that it is taught the same way to all students (Cavanagh 2006). The shared visions, strategic actions through policy and operations, levels of comfort and capacity of teachers and, monitoring and accountability, provide the basis for the drivers on how the school encounters and delivers the curriculum (Fullan & Quinn, 2016). As a result, most of the teachers in this sample tended to focus on ensuring fluency and proficiency of the basics and that mathematical self-efficacy was about building confidence and reliance in these areas. Instead, mathematical self-efficacy should build a belief in capability that informs and motivates students to be their own agents in their learning (Bandura, 1997; Deci & Ryan, 2002; Dweck, 2006).

The principal and teachers from St Catherine's articulated that building mathematical self-efficacy had a goal to exceed proficiency in the relevant syllabuses. They articulated through their programs that they could help and support them to realise their potential as learners (DuFour, DuFour, Eaker & Karhanek, 2010). A particular emphasis was placed on learning in context to build meaning, knowledge and critical thinking (Fullan et al., 2018).

Similarly, the approach from St Sarah's that limited the number of formal, summative assessments in Year 7 to 10 was very well accepted by the teachers. They felt that removing pressure from teachers on written tests gave them the freedom to focus on learning and feedback (Wiliam, 2011). Removing anxiety from tests meant the students reproduced their regular classroom work in assessments while still providing accurate measures of student learning.

It was apparent that when the principal beliefs, the teacher beliefs, and the school's policies were aligned with a focus on providing deep learning, high levels of engagement and desire for learning by students resulted (as expressed in the assertion from St Catherine's). The teachers from St Catherine's described their students as having positive mathematical self-efficacy that informed and motivated them to participate and challenge themselves to higher levels of learning (DuFour, DuFour, Eaker & Karhanek, 2010).

To develop mastery focused on student needs, the rural based schools were all involved in a system-based initiative to establish the DuFour Professional Learning Community [PLC] model (DuFour, DuFour, Eaker & Many, 2010). The mathematics teachers interviewed from the four rural schools were experienced mathematics-trained teachers, but they had different levels of experience with PLC principles and the associated policies and procedures. St Benjamin's and St Catherine's described pedagogical strategies proffered by the PLC model and the use of formative strategies to support the concept of student-focussed learning. While the construct of PLC was accepted and implemented by the four rural based schools by itself, it did not seem to build mathematical self-efficacy that informed and motivated students to embrace learning advanced levels of mathematics.

7.3.3.2 The impact of teachers

The principal and teachers agreed that the teachers influence students' mathematical understanding and that student concept development can be improved through good teaching (Sullivan et al., 2013). As a proxy agent, teachers are ideally placed to connect with the students, so they understand the content and concepts, develop a classroom that provides a safe and supportive learning environment, and use mathematics in a relevant way are descriptions of a "good" mathematics teacher (Murray 2011). The teachers interviewed were experienced and projected good efficacy in their subject matter, teaching strategies, classroom management and relationships, and their ability to build strong situational motivation (i.e. goals, self-efficacy), persistence, resilience, self-regulation and achievement (Bandura, 1997). While teachers with higher efficacy judgements are more likely to be open to new ideas and more willing to experiment with new methods that suit the needs of their students (Woolfolk Hoy & Davis, 2006), most of the teachers interviewed believed mastery and fluency of surface learning was their priority. The teachers indicated that ensuring confidence at this level was critical with some examples (RT4, RT5, RT8, MT3 and MT6), but not all, providing explicit opportunities for students to develop deep thinking and transference (Wiggins & McTighe, 2007; 2013). The opportunity to go past the knowledge and skills of the prescribed curriculum was seen as an opportunity to shift from interdependent to independent learning (Ritchart, Church & Morrison, 2011). Setting high expectations, teaching content within context, and providing feedback formed key elements building students desire to engage in the mathematics curriculum to advanced levels (Hattie et al., 2017; Marzano, 2017).

As noted in their responses to Section 4 of the student questionnaire in Section 5.3.3, rural based students' opinion was significantly less positive than metropolitan-based students, although the effect size was only moderate. The perceptions meant that rural based students had a less optimistic view of the levels of interest in progress, belief in capability and respect from the student mathematics teacher. Both rural and metropolitan based students disagreed with the statement that they would talk to their mathematics teacher about careers. The teachers interviewed from rural and metropolitan based schools indicated they had strategies to build student views of their capacity, although as mentioned above (Section 7.3.3.1), many teachers preferred to provide students with work they would complete rather than building wonder and challenge.

If students do not see they are capable or have little value in the outcome, they are not likely to pursue mathematics when it becomes difficult (Attard, 2014; Hoffman, 2010). Teachers who exposed their students to more demanding knowledge and skills in a guided fashion with a view to transference commented more positively on their motivation to challenge and resilience (Ernest, 2010). Anxiety in mathematics particularly affects problem-solving efficiency when students perceive they have exceeded their competence (Hoffman, 2010; Hoffman &Schraw, 2009). In many cases, the low levels of anxiety expressed by the students (see Figure 5.11) was due to avoidance of challenging thinking rather than scaffolding and monitoring challenging mathematical concepts in a guided way.

7.3.3.3 Parent and student descriptions of school based mathematics

The junction between parent and community expectations and the role of the learning school based mathematics were described by teachers in three key ways: (i) *parents expressing they couldn't do mathematics when they were at school,* (ii) *students expressing mathematics was irrelevant,* (ii) *parents and students expressing that you only need standard mathematics, not advanced mathematics.*

A concern among teachers was the parents' comments that they (the parents) found mathematics a difficult subject, and they were unable to master it when they were school students. The teachers felt these comments heightened students' view that mathematics was difficult, especially when parents openly stated this opinion in front of their children. Teachers believed this was considered a reason for students opting for success at a lower level of mathematics, which caused less anxiety for them and kept with their parental aspirations, rather than attempting a course that challenged and at times provided failure (McPhan et al., 2008).

Parental aspirations and perceptions about the importance of mathematics affect student perceptions (Alloway et al., 2004; Caprara et al., 2006). For example, the students from both rural and metropolitan based schools were both positive about the support they received from their parents in Section 4 of the student questionnaire stating they "have always been interested in my progress in maths" and "have always been interested in my progress in maths" (please see Section 5.3.3). Hence, the parents' belief that mathematics was a hard subject was influential on the student (Habibis & Walter, 2015).

Secondly, teachers believed the students did not see the relevance in their mathematical study. Comments such as those from RT8 and MT5 noted that students often asked, "When will I use this?" especially in the more theoretical topics such as algebra. The response by teachers was often based around the academic approach to mathematics rather than developing knowledge in context. Suggestions that the knowledge and skills were needed for an upcoming assessment task, as suggested by RT8, did not motivate students. Both teachers also asserted but did not appear to provide work samples on applications in navigation, construction and engineering. RT9 responded by using word stories and using problems that used the concept. Similarly, MT6 and RT5 sought to build relevance into their teaching by building knowledge in context and developing critical thinking (Fullan et al., 2018).

Thirdly, the rural and metropolitan students' response to Section 4 of questionnaires showed they perceived that their parents'/carers' thought "maths is one of the most important subjects I study", but "as long as I have passed my parents'/carers' don't care how I go at maths" and they "show no interest in whether I do harder maths courses". The teachers felt that the students considered mathematics as a study was important, but mastering advanced levels of mathematics was not necessary for all. Asked about student reaction to doing "work they already knew how to do" teachers indicated that while some might be "bored", many would "enjoy the sense of having succeeded/achieved already" (RT1) and that the "students do not like harder work" (MT2). There was a belief that students preferred mathematical work in which they had high perceived confidence rather than being challenged. The students' reported lack of negative emotions in their questionnaires was supported by the teachers, although the teachers stated that the students lowered their expectations to avoid anxiety and tension.

The effort/learning relationship, where "studying hard" is related to "success", is a critical principle in developing resilience (Deci & Ryan, 2002). The teachers interviewed indicated that students could not see that studying advanced levels of senior mathematics was worth the effort. The external pressure of the HSC was a concern to them and their students, and the ATAR calculation favoured students being successful in a standard course with less effort than the intermediate course (BOSTES, 2016). Bandura (1997) refers to this concept as expectancy-value, where students weigh up the anticipated effort against the anticipated value of the expected outcome. In this case, the students believed they were better off giving their time to the other subjects and not worrying about the extra time needed to study the advanced mathematical courses. This was a contentious issue for both rural and metropolitan based teachers who wanted to extend their students to their potential but felt they needed to support them to optimise their ATAR even though it resulted in the students participating in lower conceptual levels.

7.3.3.4 Fluency and competence versus challenge

The class organisation, curriculum provision and assessment procedures were considered powerful tools in driving the learning at the school. Schools that preferred streaming classes based on assessment results argued that this effectively provided the guided mastery that builds self-efficacy. Unfortunately, St Christopher’s, St Benjamin’s, St Pauls’ and St Sarah’s interpreted the link between guided mastery and confidence meant an over-reliance on ensuring that fluency of basics with the unfortunate consequence of under-provision of challenge and critical thinking opportunities (Fullan et al., 2018). Comments from MT6, for example, suggested that transference of mathematical knowledge (Hattie et al., 2017) only occurred once competence of the basics was assured.

All teachers spoke of developing students who were confident in their capability, although that led to tension between ensuring fluency and competence at the expense of providing challenging mathematical concepts and problems. The fear that failure by the students would lead to them dropping their confidence, which would then lead to a further failure (Ernest, 2010; Koch, 2019) was a common sentiment whether in a rural or metropolitan based school. Almost all of the teachers' response was to provide students with work they could complete with low effort and assured success, rather than challenging work that required students to ponder, but with the risk of failure.

The perceptions and comments by teachers reflected their efficacy as change agents, and there was a feeling that failure by the students would reflect poorly on them as their teacher (Woolfolk Hoy & Davis, 2006). The teachers realised they played a significant part as proxy agents operating between the school's imposed, selected, and created operational environments (Bandura, 1997). Teachers perceived that the school's summative assessment process meant that their emphasis was often on procedural responses to develop student capability (Murray, 2011). They indicated that higher levels of capability would lead to students wanting to study higher levels of mathematics because they were able. Hence they were confused that building mastery did not naturally translate into students being motivated to try higher levels of mathematics. Their view that self-efficacy was based on students' confidence to replicate previous knowledge and skills did not automatically lead to students believing they could seek and acquire new and more sophisticated knowledge and skills (Ernest 1998).

The teachers well accepted the development of the automaticity of essential knowledge and skills. However, many did not take the next step of embedding relevance and problem-solving into the learning processes (Westwood, 2008). The teachers of this sample often described the application of mathematics as a conclusion to their teaching. Therefore, many of these teachers did not include the essence of Working Mathematically within their pedagogy. The development of relevance and deeper learning linked to real-life learning (Fullan, 2018) was often described as implicit. There was a lack of explicit teaching of Working Mathematically processes within their "normal" lessons and consequently a lack of strategies to connect problems solving and application into the students' learning (McTighe & Wiggins, 2013; Marzano, 2017; Ritchhart et al., 2011). The strategies needed to focus on the deeper levels of understanding that promoted relevance and application (Boaler, 2002) appeared incidental rather than planned.

7.4 The ecological systems

7.4.1 The impact of family and teachers on the micro-system

Bronfenbrenner (1981) describes the micro-system as the interactions that involve personal relationships such as those with family members, peers and classmates and influential adults (for example, teachers, coaches and mentors). This section considers the data gained in this study about the parents/carers and teachers on the students' mathematical self-efficacy. One result within this system was the students' perceived mathematics self-efficacy, sources and parent/carer and teacher attitudes to mathematics. As noted in Section 7.2, the mathematics self-efficacy of the students was statistically similar for both rural based and metropolitan based students. This suggests that the combination of entities within the micro-system has had the same result regarding students' self-efficacy in mathematics. The four theoretical sources of mathematics self-efficacy (enactive mastery, vicarious experience, social persuasion and affective states) were predominantly the same (see Section 5.3.2).

The rural based students reported significantly weaker responses (Section 5.3.3) for their perceptions of their parents'/carers' and teachers' attitudes to mathematics. Further investigation identified that rural based females levels of agreement were significantly weaker than metropolitan based females for both parents'/carers' and teachers' attitudes to mathematics.

This meant that rural based females perceived their parent/carers had a less positive attitude about the importance of mathematics at school and in the workforce and encouragement they received to participate and achieve in advanced levels of mathematics. School mathematics's social capital (Dumais, 2002) appeared lower for rural-based females than metropolitan-based females. A lower educational capital is a combination of cultural transmission from the family and the teachers (Habibis & Walter, 2015). This result proposes a contradiction as the percentage of rural mothers with a degree (26.1% of the sample) was larger than the metropolitan mothers (25.2%), with both being greater than the fathers with a degree (rural: 18.3% and Metropolitan: 19.8%) as seen in Figures 5.5 and 5.6. The importance of role models to encourage females to participate in advanced mathematics is considered relevant, but daughters can feel anxious about emulating successful mothers (Buckley, 2016). This concern was not apparent in the comments from the teachers in their observations around capacity and support for their female students. The rural-based teachers did not describe any explicit strategies to develop educational capital in their female students. The teachers' comments showed no gender bias, except for those made by the teachers from St Kathleen's and St Paul's (see Section 6.4) that indicated the females were better behaved than the males who were at times considered disinterested and exhibited behaviour problems.

Teachers interviewed indicated they provided scaffolded learning and regular feedback to students to guide their knowledge acquisition and build confidence, resilience and motivation practices advocated in the literature (Hattie, 2009; Wiggins & McTighe, 2007). Both rural and metropolitan based teachers of the sample agreed that a major part of their role as a proxy agent was to identify the "next step" for each student to learn in building the mastery of concepts (Bransford et al., 2000). Teachers interviewed were well aware of scaffolding mechanics, considered it a standard pedagogical tool, and described examples of implementing strategies (Bruner, 1966). Feedback from students is part of a teacher's self-appraisal of their success of the teaching task and selecting the next element of the learning scope and sequence (Wiliam, 2011). For most of the teachers interviewed, feedback on student learning was informal and ordinarily passive regardless of geolocation. Gathering formative evidence of student learning was predominantly observed by the teachers by "walking around the classroom", "watching the students" body language and facial expressions and checking the students' workbooks during lessons'. Another method used was by asking their students to volunteer an answer to gauge their understanding. However, Wiliam warns against this method as often students opt out of volunteering to answer a question, "not because they don't know, but because they can't be bothered to think" (p. 83).

Feedback through explicit formative assessment strategies, such as a quick quiz at the start or the end of a lesson, asking students to explain a concept, displaying the students' working on mini-whiteboards, and giving feedback on a class blog, were also identified. Actively seeking feedback is the preferred strategy suggested through literature as it gathers information on the learning of all students, not just those who volunteer to be engaged (Marzano, 2017). Hence, the option of explicit formative assessment strategies that call on students to be active in giving feedback opens the opportunity to prompt thinking and transference. Selecting appropriate peer models and monitoring grouping practices was a suggested strategy for increasing self-efficacy (Pajares, 2006), although only one teacher identified a designated seating plan as a deliberate strategy to assist with peer modelling.

Pajares (2006) identified several actions based on social persuasion: focus on skill development rather than self-enhancement, facilitate mastery goal orientation, foster and model self-reflection, provide instructional (instrumental) help, facilitate adaptive interpretations by students of the feedback, provide effective and appropriate models, foster optimism and reduce self-handicapping strategies. The deliberate use of these strategies to provide transference of information and motivation was restricted in this sample of teachers and had the potential to reduce the capacity of mathematical self-efficacy that builds students' conception of their ability to engage in advanced mathematics as independent learners.

A fuller influence of the student's micro-system required the sample teachers to be more explicit and strategic with parents and the students. Unfortunately, only St Catherine's principal and teachers articulated a proactive communication strategy with parents and community in building the worth of mathematics as relevant through a STEM day (Bryk et al., 2010). In many schools of the sample, parents were seen as passive participants in mathematics learning and occasionally as an adversary. For example, at St Paul's, MT1 indicated communication was with parents was through "the class average and grade average comparison", while MT2 felt that while the efforts of building "work culture is on the improve, … kicking butts and support of the parents is not there". Teachers have great potential to further engage with parents in developing a high level of expectation and worth of advanced mathematics (DuFour, DuFour, Eaker & Karhanek, 2010).

7.4.2 The impact of the school's meso- and exo-systems

Extending from the micro-system, is when the two-person system (or dyad) is aligned with third parties, forming triads, tetrads and larger groups. The school environmental structures, such as timetable, courses provided, and students' experience of junior secondary mathematics, have some impact (McPhan et al., 2008). Teachers interviewed were driven by the confines of the school regarding the teaching programs, the lesson timetable and the focus on student performance which were imposed strategies to operationalise the school's "shared purpose" (Fullan & Quinn, 2016). Often, depending on the school's view of assessment, the teachers' commentary implied they were constrained by ensuring the content was taught so that the end-of-topic test could be given simultaneously. Regardless of whether the cohort had met mastery in their classwork, the assessment would be sat. This meant that lessons would move on to the next unit and outcome even if students were not showing competence. The reality of "moving on" regardless of whether the students had learnt the concepts was reflected in rural and metropolitan based schools. RT4 identified the negative influence this had on students' conception of their ability, RT8 and MT1 suggesting this approach led to students' rely on the test to indicate learning

(Dweck, 2006). This imposed operation restricted the teachers' ability to select and create opportunities to ensure proficiency (DuFour, DuFour, Eaker & Karhanek, 2010). The teachers at St Sarah's had been given some flexibility with the style and timing of their assessments and spoke positively of the school's limits on written assessments. As noted by MT7, the use of problem-solving, research, topic tests or a quick quiz meant "the students know failure is not bad, so we use it as a revision to show if they are doing well or not so well." The teachers interviewed identified the school's imposed procedures to support problem-solving as a crucial influence on their teaching and students' learning. As seen in Section 6.4, teachers often noted that students performed better in classwork than in tests and were often more anxious in exams.

The *exo-system* describes the entities that may not directly impact the individual but indirectly impact micro- and meso- systems. In this study, the school's structure, procedures and culture, community aspirations and expectations were discriminating factors (Alloway et al., 2004). A crucial role of the school was to provide an intersection between the prescriptions of the collective and the individual's desires. Schools thus develop their own internal "culture" that determine the operative environments they select, create and impose. The teachers, principals and school websites of this sample articulated the desire to prepare students for contemporary society (NESA, 2018b), however as can be seen by the assertions discussed in Section 7.3, there was often a disconnect between this aim and the operations established and used by the school.

Students' questionnaire responses indicated that remembering methods to solve questions, "putting maths questions into their own words", using "maths techniques in other subjects", and being able to "tell others how to solve questions" was considered most difficult in both geolocations. Hence while the teachers knew the curriculum contained these processes, it did not mean that they were taught (Cavannah, 2006). Unfortunately, all but St Sarah's and St Catherine's used only formal school assessments to measure mastery and reward students' mathematical knowledge and fluency. Most teachers of this sample did not regularly and explicitly embed the Working Mathematically process strand. The teachers needed to go beyond the mechanics of the algorithms and embody the activity that deepens learning that then builds confidence and willingness to experiment and be challenged (Fullan et al., 2018). While the teachers believed that higher levels of fluency in computations would lead to students wanting to study higher levels of mathematics because they were able, they seemed not to realise that students were seeking purpose and relevance (Alloway et al., 2003). Hence a dedicated strategy to build knowledge through application appeared to be missing in most schools.

7.4.3 The impact of the macro-system

The *macro-system* is influenced by Government policy and school sector ideology and impacts the exo-system through mandatory requirements. Through his study, the principals and teachers indicated they felt their role was to respond to government or system policy requirements without the opportunity to influence their policy. Hattie (2015b) and Fullan and Quinn (2016) argue that political expediency can be the "wrong driver" for building a quality education system. Fullan (2005) calls for "lateral capacity" and that system and district policy needs to be both "bottom-up" and "top-down". The prescription placed on schools that focus on surface learning (Zhao, 2012) can be restrictive and not facilitate deep and transference opportunities (Hattie et al., 2017). In order to optimise the development of the conceptions needed by students to engage in the learning needed by contemporary society, the principals and teachers of this study suggested that the policy and regulations set by systems and governments, commentary need to be less focussed on formal assessments and geared towards promoting challenge and deep thinking.

7.5 **Conclusion**

This chapter used student questionnaire data mixed with teacher interview responses and comments from the principals to investigate student thinking regarding the value placed on studying mathematics from a collective, proxy and individual agentic view.

The triadic relationship between the perceived personal, behavioural and environmental determinants (Bandura, 1997) means that the collective environments influence the school sits within the state, the system and the local culture. The imposed elements affect the macro-system. The system and school initiatives impacted the principal and the teachers who were able to select and create the exo- and meso-systems that react to the family and community influences. Unfortunately, there was a perceived lack of value placed on advanced mathematics within the family, with both rural and metropolitan based students assuming that "standard levels" mathematics satisfied community needs. In their role as a proxy agent, teachers have a part to play in breaking open beliefs about education and the relevance of higher learning. However, teachers will need to find a path that builds resilience within students so that the concept of challenge does weaken student self-belief. Through this, the students will have more opportunity to develop sophisticated, refined mathematical understanding, fluency, and logical reasoning skills that enhance their ability to problem-solve (ACARA], 2015a).

In response to the broad research question of whether self-efficacy in secondary school mathematics influences rural based students in developing their individual agency to achieve in the study of higher mathematics, this discussion argues for this case. However, the influences on this agency go beyond that of geolocation. Hence the interpretations and recommendations identified in the final chapter are both a deduction and an induction from the student Self-Belief in Mathematics questionnaire, school and principal, statement and comments from the teacher interviews. The initial concept of this study was an investigation into the cause and effect of rural students in their study of mathematics. However, it has exposed the complex array of influences that impact students' capability and motivation to be agents in their study of advanced level mathematics.

It is not surprising that many rural or metropolitan students questioned the relevance and applicability of the various topics studied in mathematics and did not consider that seeing adults doing mathematics motivated them to improve their achievement.

Chapter 8: Summary, interpretations and recommendations

8.1 Introduction

This study was initiated by the concern of education leaders, industry leaders and governments within Australia at the declining results and participation levels of Australian youth in the advanced secondary school mathematics courses. This problem was considered worse in regional and rural areas where benchmark test results such as NAPLAN, PISA and TIMSS (AMSI, 2017), external public mathematics exams, the NSW HSC (CESE, 2013) have been weaker than those in metropolitan areas. The researcher wanted to explore whether the rural environment impacted student achievement and participation in advanced levels of high school mathematics. Brofenbrenner's (1981) ecological systems model was used to analyse the environmental influences of the context and the impact these conditions have on learning. Previous research has established a link between achievement and self-efficacy as part of the social cognitive theory (Bandura, 1997). The social cognitive theory identifies triadic reciprocity between perceived personal attributes, behaviour and environment, where self-efficacy is a major mechanism in building human agency. Hence the research explored whether the environmental differences in the micro-, meso-, exo- and macro- systems of the rural sample of students made a difference in student perceptions of their capability in mathematics and that studying advanced mathematics was the desired result for them. The study initially sought to explore the impact of the rural and metropolitan geolocations on these student perceptions.

In seeking to understand and respond to this problem, the research questions of this study were determined as:

> *Do rural and metropolitan secondary students differ significantly in their perceived self-efficacy in secondary school mathematics?*
>
> *What are the major influences on the perceived self-efficacy in secondary school mathematics for rural students?*

A mixed methods research methodology was used to compare the perceptions of 540 rural based students from four rural schools and 329 metropolitan based students from two metropolitan schools. Students from years 7, 9 and 11 provided their perceptions of mathematical self-efficacy in the six sub-strands of the NSW Mathematics syllabus (Number, Algebra, Measurement, Geometry, Statistics, Probability) and one process strand (Working Mathematically) across three levels of difficulty in keeping with the suggestions of Bandura (2006) and Bong (2006). The students also provided their perceptions on their agreement for the sources of their self-efficacy (enactive mastery, vicarious experience, social persuasions and affective states) and parents'/carers' and teachers' attitudes to mathematics using a symmetrical Likert style scale measuring strong disagreement to strong agree.

In order to deepen the understanding of the collective and proxy influences and the transference from proxy to individual agency, further information was gathered through interviews from nine rural based and seven metropolitan based teachers, discussions with the school principals and descriptions from school websites for the schools of the sample. These data provide information on the school's mico-, meso- and exo-systems and, hence, the imposed, selected, and created operative environments. These were summarised as assertions from each school. A common theme emerged where teachers focussed on confidence building through the repetition of work that the students knew rather than constructing scaffolds that challenged them. The school placed importance on the end of unit assessment, which resulted in teachers focusing on preparing students for the test, meaning that applied learning strategies were restricted.

This chapter brings together the summary and interpretations of the discussion (Chapter 7) in answer to the above research questions, recommendations for further research stemming from areas of this study and the limitations of this study.

8.2 Similarities and difference

8.2.1 Similarity and differences in mathematical self-efficacy

This study used the *Student Self-Belief in Mathematics questionnaire*, and the analysis considered student perceived confidence to solve questions from the six sub-strands of the NSW mathematics and the Working Mathematically process strand. The content strands reflected basic, intermediate and advanced concepts. However, the student's perceptions of these questions loaded as those perceived by the students as most difficult (all the number, algebra and Working Mathematically questions and the advanced level geometry and probability questions) and those perceived as least difficult (all the measurement and statistics questions, and the basic and intermediate geometry and probability questions). A key finding was that rural and metropolitan based students were similar in their perceived mathematics self-efficacy for both the least and most difficult questions.

Hence, the students' responses indicated they had lower self-efficacy with the number, algebra and working questions in both the rural and metropolitan based schools of the sample mathematically, as seen in Chapter 5 through an analysis of their factor scores (Distefano et al., 2009; Field, 2009; Grice & Iwasaki, 2007). The predictive capability in mathematics, as measured by self-efficacy, was unaffected by geolocation for least difficult and most difficult.

A focus on building confidence

Many of the teachers interviewed provided work based on the knowledge and skills that the students had already mastered to build their confidence. In response to this approach, both rural and metropolitan based students reported low levels of anxiety and tension in mathematics through both the student questionnaire and teacher commentary. The teachers felt this approach was building the student's mathematics confidence but often sacrificed developing environments that promoted challenge for the surety of students getting the problems correct. This resulted in students being confident in repeating the questions based on surface knowledge but did not extend them deeper and transfer knowledge (Hattie et al., 2017). However, self-efficacy is more than the confidence to replicate previous work. Rather it is a predictive construct to have the confidence to identify and attain new knowledge to develop human agency (Bandura, 1997).

There appeared to be a gap in teachers from rural and metropolitan based schools understanding that students needed more than perceived mastery of previous knowledge and skills to inspire them to seek and acquire new knowledge. The teachers were responding to the school, system, and state policies on pedagogy, and assessment placed more value on performance than on challenge. Teachers from rural and metropolitan schools stated that they felt driven by assessments and the value placed on the students getting a good mark on these tests and could not give time to challenging activities.

Number, algebra and Working Mathematically

The students, regardless of geolocation, had lower perceived mathematical self-efficacy with the number and algebra questions which was problematic in building their beliefs in their capability to seek and acquire the generalisations that lead to new knowledge and skills (Ernest, 2010). Sophisticated mathematical understanding in fluency, logical reasoning, analytical thought processes and problem-solving skills are considered the building blocks for proficiency and critical thinking in advanced secondary school mathematics (NESA, 2018b). Such proficiency allows them to make connections, identify patterns, evaluate arguments and construct meaningful knowledge as they develop critical thinking and deep learning (Fullan et al., 2018).

The students' mathematical self-efficacy for the transference of mathematical knowledge into Working Mathematically processes (such as remembering mathematical techniques, putting "maths" into their own words, telling others how to solve a question and using "maths" in other subjects) was perceived as most difficult for both the rural and metropolitan sample. Only a minority of the teachers interviewed, from either rural or metropolitan based schools, used these application processes to provide greater engagement with students and was a necessary inclusion in their lessons (Sullivan et al., 2013). Hence, making connections and constructing meaningful knowledge was not a regular component of lessons. The lessons focused on procedural knowledge of mathematical theories and objects of (character, origins and relationship with language) rather than applications that included relating mathematics with the knowledge of other disciplines (Ernest, 1998). Teachers noted that many students did not see the mathematics they studied at school as relevant and did not assign value to it as a school course. Hence, this lack of applicability implied that students also perceived a lack of purpose for them in learning the more difficult elements of mathematics. While many students and parents considered mathematics an important subject, and their teachers promoted competency and fluency in the "basics", studying the advanced mathematics courses was not considered relevant.

8.2.2 Similarities and differences in the sources of self-efficacy

In order to identify the influences on mathematical self-efficacy, the students were asked to rate their perceptions of the four sources of self-efficacy: enactive mastery, vicarious experience, social persuasion and affective states. The questions loaded to these sources and were found to be statistically similar between rural and metropolitan based students.

Mathematical self-efficacy is a mechanism to provide students with exercise over personal control. Human behaviour has many dimensions (Alexander et al., 2012), and the social cognitive theory explains the complex relationship and perceptions between behaviour, environment and personal capabilities (Bandura, 1997). The analysis of the teachers' and principals' commentary and the school's websites was used to identify other sources from the students' environmental systems that were influential on the students' mathematical self-efficacy as an exercise of control.

The proxy role of teachers and parents and the collective role of the school through imposed, selected and created environments (Bandura, 1997) were identified as crucial elements within the micro-, meso- and exo-systems of the students. The student's socio-cultural environment influenced their mathematical self-efficacy, which informed and motivated student participation and achievement in advanced mathematics.

Collective agency

The schools chosen in this study were coeducational, comprehensive, Catholic system schools with ICSEA values between 1000 and 1070. The researcher considered selecting schools with these common characteristics to reduce possible distracting factors from the discussion about self-efficacy. This resulted in many items of the collective environment being similar. School vision statements, discussions with the principals and interviews with teachers indicated that all schools had a moral purpose that articulated the primacy of student learning (Dinham, 2016). School and system policy had some influence, but the contentions made by the principal and teachers about pedagogy, assessment and guided mastery towards challenging mathematical concepts surfaced as the dominant influences. Internal school policies and operations strongly influence developing students' mathematical self-efficacy (Bandura, 1997).

Proxy agency

Bronfenbrenner (1981) describes the micro-system as the interactions that involve personal relationships such as those with family members, peers and classmates and influential adults, including teachers, coaches and mentors. All the teachers interviewed were mathematics trained teachers, described a desire to support their students to learn mathematics, and expressed a thorough understanding of the scope and sequence of the NSW mathematics curriculum. Teachers fill a unique place within the school as they act both with and upon the imposed classroom environment as proxy agents for the students and the school. The concept of self-efficacy resonated with their understanding of student confidence and the impact that the student's perception of their capability had on their motivation (Pajares, 2006). However, the teachers generally considered confidence was aimed at ensuring the student's capability on previous knowledge rather than developing the predictive confidence to build knowledge. These views influenced how and what they taught.

Scaffolding lessons to guide challenges relies on the teacher monitoring the student's learning. Those teachers who actively sought feedback stated they used this information to determine the teaching strategies for the ensuing lessons. However, it appeared that the pressure of performance in assessments impacted teachers and was a driver for the sequence of their lessons. As a result, lessons were assessment-focussed rather than incorporating real-world applications and challenging mathematical concepts. An unfortunate response was that students from all schools acknowledged their teachers were interested in their progress in mathematics, but they would not talk to teachers about careers in mathematics (see Section 5.3.3).

Contrary to the suggestions of previous research (Alloway et al., 2004; McPhan et al., 2008), modelling by adults appeared to have a limited influence on the students of this sample. For example, both rural and metropolitan based students disagreed that seeing "adults do mathematics" motivated them to learn mathematics (see Section 5.3.2). In addition, around 30% of rural and metropolitan-based students were unaware of their parent's education level, which implied they were not seeking or recognising this parent's vicarious influence in education.

It is noted that parents'/carers' and teachers' attitudes to mathematics had some significant difference. Rural based females perceived their parents/carers were less positive about the importance and encouragement of mathematics at school and in the workforce than metropolitan females. Given that students reported that rural mothers with a degree (26.1% of the sample as seen in Figures 5.5), and hence adult models for academic learning, it is possible that as Buckley (2016) notes, daughters of successful mothers can be fearful of not being able to emulate their mothers.

Outcome expectancy

Students questionnaire results showed that they did not perceive their parents thought advanced mathematics was needed for a good job even though many students knew people who used advanced mathematics in their work. Compounding the perceived low social capital of studying advanced mathematics was the view that students who were considering a pathway to university gained an advantage by studying the standard mathematics course rather than the advanced courses. While some students valued the intrinsic reward of a challenge, according to the teachers, the school promoted performance in assessments and that gaining a higher ATAR as a higher priority. Teachers were resigned to a system that seemed to reward high achievement on lower level concepts and skills, and it became apparent that they supported the students to "game the system". Hence many students saw limited value in applying the extra effort required in advanced mathematics.

Fortunately, the scaling process for mathematics for ATAR included common test elements in 2020, and it is envisaged that it will positively bias the advanced courses in the ATAR (BOSTES, 2016) and encourage students to participate in the advanced mathematics courses. This change to the imposed environment is a crucial step in the anticipated realignment of students valuing the effort needed to study advanced levels of mathematics.

8.2.3 **Similarities and difference: Summary**

A key finding of this research is that there are more similarities than differences between the rural and metropolitan based students from this sample. Specifically, self-efficacy for syllabus strands and levels of difficulty were the same. Following this finding, teachers, whether rural or metropolitan, focused on confidence-building through fluency of previously learned material rather than predictive confidence and desire to deepen mathematical knowledge. The perception that number, algebra and Working Mathematically were difficult for both rural and metropolitan based students meant that these essential building blocks needed higher levels of self-efficacy. Similarly, there was a lack of an explicit strategy to develop the relevance and application of mathematics in the students' eyes.

Unfortunately, the school, system and state policies on pedagogy and assessment (particularly the HSC) placed more value on performance than on providing challenging mathematics in this sample. Students' outcome expectancy indicated that studying advanced levels of mathematics generally was not valued. Any change to this view will be reliant on the collective and proxy operations of the school that are developed and implemented by their teachers and leaders to respond to the new direction of NESA.

While vicarious experiences have an effect, the data from this study suggests that passive modelling does not impact students of this sample based on an ICSEA between 1009 and 1074. There was, however, a gap between rural and metropolitan based students in their perceptions of parents/carers and teachers' attitudes to mathematics.

While the findings of this study are significant, additional investigations are still required in order to gain a further understanding of the reasons for the decline in students engaging in "advanced" mathematics at school and tertiary areas, and the reasons for this decline being exacerbated in rural areas – which is an educational dilemma that remains a challenge for this nation.

8.3 Recommendations for Future Research

The findings of this study presented data that provide a basis on which additional investigations can uncover and deepen our understanding of the reasons for the decline in students engaging in "advanced" mathematics at school and tertiary areas, and the reasons for this decline exacerbated in rural areas.

1. Further research is recommended on the impact of mathematics assessment policies that focus only on performance, especially in number, algebra and Working Mathematically, on students' mathematics self-efficacy. These studies need to consider the influence of the assessment policies on developing sophisticated and refined mathematical understanding (ACARA, 2015a). Hence they could provide advice for teachers, schools and systems on the collective (macro) environments that enhance creativity and critical thinking (Fullan et al., 2018) and the predictive dimension of mathematical self-efficacy that builds human agency (Bandura, 1997).
2. Students, teachers, principals, and school websites were used in this study were from coeducational, comprehensive, Catholic System schools with ICSEA between 1009 and 1074 to reduce extraneous factors. However, these excluded factors may have an impact on mathematical self-efficacy. Hence, it is recommended to further articulate the influence of schools' external environments with different ICSEA values, governance arrangements (Government, Independent and Catholic), and single-gender organisations.
3. The findings of this research supported the views of the "Maths Why Not?" (McPhan et al., 2008), the impact of outcome expectancy and the relevance of advanced mathematics to the experience of a rural family. Further investigation on strategies to enhance the usefulness of the school mathematics curriculum in the world of work for rural based students is suggested.
4. The students' lack of knowledge of their parents' background education was unexpected. This result could be tested to see if it was an anomaly for this sample of schools or if, in fact, generally, adolescent students know little of their parents' education. If this was the case, an investigation into the Australian context could be cross-referenced with the work of Caprara, Scabini and Regalia (2006) on the impact of the perceived family efficacy on adolescent development.
5. NESA instigated a reform of the HSC after the students and teacher data had been collected (BOSTES, 2016). The impact of outcome expectancy on the preferred choice of mathematics courses for stage 6 was a resounding comment by the teachers. The reforms from NESA recommend a change in the type of assessment to be used and to the inclusion of a common paper to improve scaling between the mathematics courses in stage 6. Hence a study focussed

on measuring student self-efficacy, outcome expectancy, and participation levels in stage 6 advanced mathematics and post-school STEM courses will inform government and industry on the effect of this strategy.

8.4 Limitations of the Study

Mertens (2015, p. 435) argues, "it is not possible to design and conduct the 'perfect' research study in educational psychology" and calls on the researcher to consider the limitations of the study.

Hence, to minimise influences that cloud the discussion, this study chose to only invite schools with ICSEA values within a range between 1009 and 1074 to compare "like schools". While the use of schools from a similar range of ICSEA allows for a comparison of "like schools", it also means that schools with different ICSEAs may possess factors that are not identified in this study. This limitation considers the ability to generalise beyond these findings schools from this selected ICSEA.

While self-efficacy was considered a strong predictor of achievement (Pietsch et al., 2003), the drivers of student motivation are complex, with self-constructs such as self-concept, self-regulation, and self-esteem providing alternate focusses. This study was restricted to analysis through the lens of self-efficacy and, as such, only describes students' perceived predictive confidence within the definition of self-efficacy.

The student questionnaire measured the students' perceptions of confidence to predict their mathematical capacity. As the students did not solve the questions, the study only reports on students' perceptions of their ability to solve them. While student perceptions of their ability may not be accurate (Bong, 2006), substantial research has validated a link between self-efficacy and achievement (Bandura, 1997). This study did not determine the accuracy of students' perceptions of their mathematics self-efficacy against their recorded capability as the questionnaire was anonymous. The choice of anonymity of all respondents was intended to encourage accuracy in the student's capacity to rate their perceived confidence. This meant, however, that student perceptions of their self-efficacy could not be cross-checked against performance in benchmark tests or through interviews.

The quantitative data analysis undertaken in Chapter 5 showed that the levels of significance were moderate to medium. Hence, using this data analysis alone may not be sufficient to ensure the probability of Type II error is at a reasonable low level. As a result, a potential shortcoming of the study may be in confounding of the results due to the variable estimates being unadjusted. Similarly, while the student profiles of location, gender, grade, indigeneity, language spoken at home and the number of people known to use advanced mathematics in their jobs reported were analysed as unweighted samples, the proportions of students of the sample noted in chapter 5.2 means that year 7 (45.6% of the rural sample and 55.9% of the metropolitan sample) response may dominate the results.

Schools that volunteered to be in this study were required to indicate an interest in the study. Parents were required to accept the nomination of involvement for their child, and students were allowed to withdraw. This meant that the proportion of students' involvement was a small proportion of the school's enrolment (between 3% and 25% of the cohort), suggesting a potential bias in the results. This implication was noted within the analysis of these schools.

This study's results are specific to the New South Wales secondary mathematics syllabus for Grades 7, 9 and 11. The study was further limited to Catholic system schools and hence should be taken when generalizing these results to other populations.

8.5 **Summary**

Over many years, various institutions and government bodies have investigated the issue of student achievement and participation in advanced secondary school mathematics. The literature reviewed in Chapter 2 argued that the underperformance was not due to a drop in natural capability (Gardner, 2004) but that students were influenced by their context (Thomson et al., 2017). Many students study mathematics in the senior years, but a growing proportion is studying at the general level (AMSI, 2017). Public commentators want students to participate in advanced mathematics subjects at school, especially as they graduate into career pathways. They want to get students to build their capacity past the "basics" and to "develop increasingly sophisticated and refined mathematical understanding, mathematical understanding, fluency, logical reasoning, analytical thought processes and problem-solving skills" (ACARA, 2015a).

For students to achieve at this level, they need the capability and confidence to learn new knowledge and skills and the desire to implement them. While mastery is important in determining this end, just because one has the skill does not mean one uses the capability (Pajares, 2006). Bandura considered forethought, intentionality, self-regulation and self-evaluation all formed part of human self-determination and agency.

Based on the significant evidence generated from this study, the dissertation argues that there were many more similarities than differences between the mathematics self-efficacy of rural and metropolitan based students considering the age, gender, Indigeneity and parent background of this sample. This is a significant finding that addresses previous concerns about seemingly inadequate schooling in rural regions. The evidence confirms that there was very little difference between the sources of self-efficacy between the two groups, challenging earlier theorising that the superior performance outcomes in metropolitan regions were based on environmental perceptions. This thesis makes an important contribution to knowledge in the field of mathematics education in revealing that the drivers of the school were not based on the geolocation but the culture of the school's system, the school's organisation and the quality of the teaching and teachers. Geolocation did not pre-destine good structure, teaching or learning.

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Appendices

Appendix A The NSW Mathematics Curriculum

The Australian Curriculum is provided to NSW schools from the NSW syllabuses.

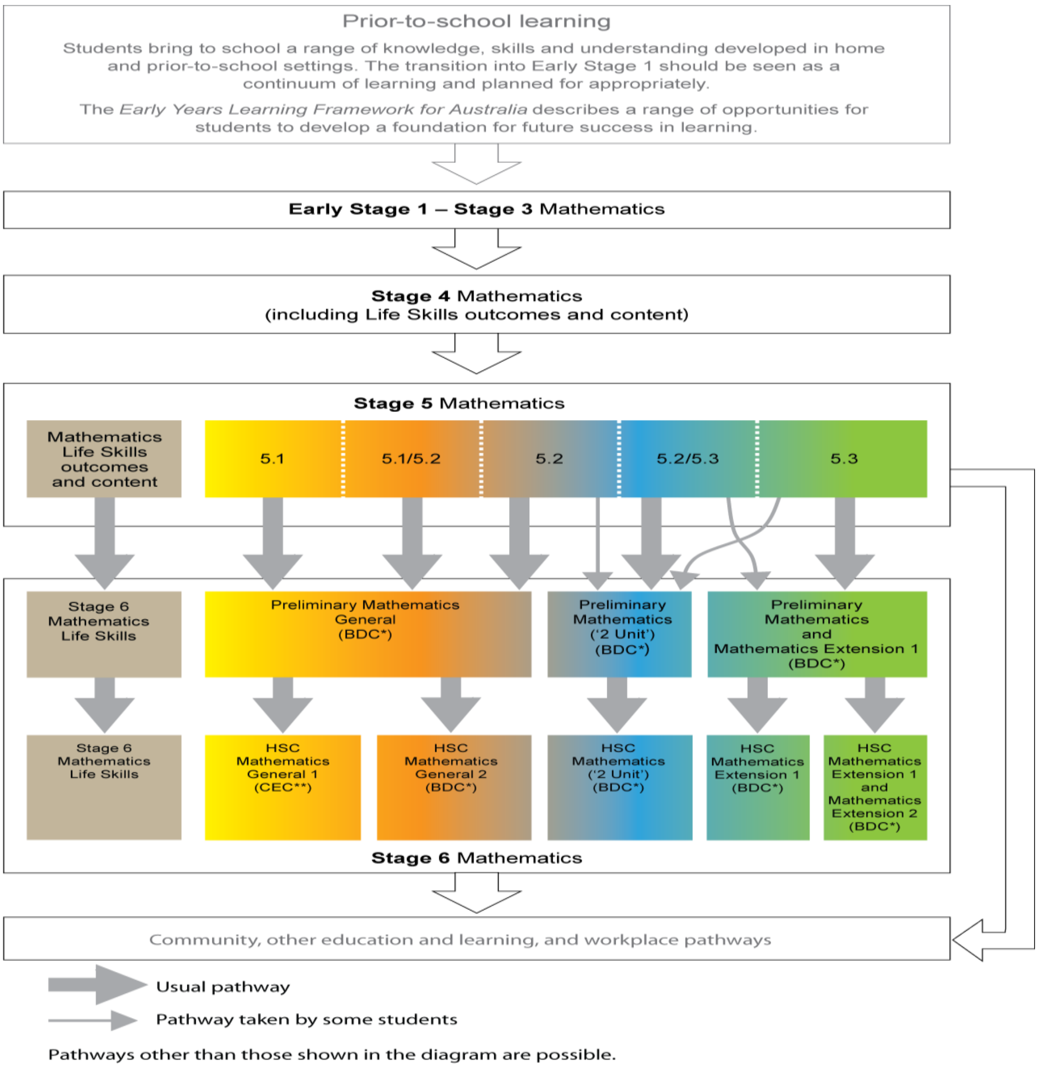
Below is an outline of the scope, sequence and continuous design of the NSW curriculum.

- The NSW Mathematics continuous design

The NSW Mathematics syllabus is based on a continuum from Kinder to Year 10 (referred to as Early Stage 1 to Stage 5) with further alignment with course offerings in Stage 6 (Year 11 and 12).

Mathematics is compulsory in Kinder to Year 10, although in Years 9 and 10 (Stage5) students can choose between three courses, as can be seen in Figure 6.1 below. (5.1 which is a basic course of study, 5.2 an intermediate course of study and 5.3 an advanced course geared to support the advanced mathematics courses in Stage 6). The curriculum is expected to flow between the grades with flexibility within the two years of a stage group. In most schools in NSW, the majority of students in stage 5 would study mathematics 5.2 or 5.3. It is expected that students would be proficient in the content of these course for them to progress through to an intermediate or advanced course in Stage 6. Some schools establish classes to bridge courses such as 5.2/5.3 or 5.1/5.2 to provide as many options for students as possible, as can be indicated below.

NSW Mathematics Syllabus continuum



BDC – Board Developed Course (HSC BDCs are examined at the HSC).

*** CEC – Content Endorsed Course (HSC CECs are not examined at the HSC).*

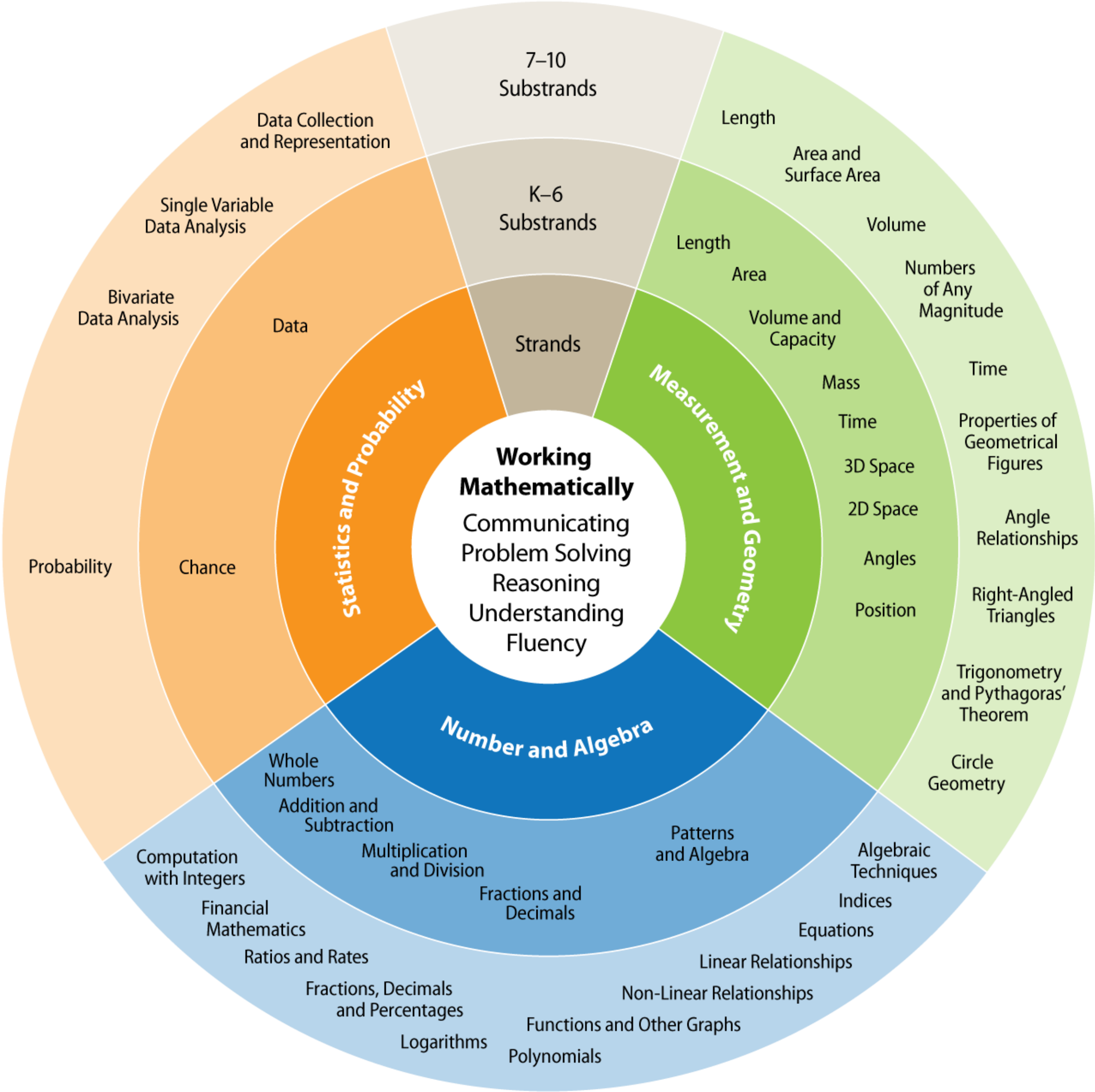
(BOSTES, 2016b)

- The Content Strands and Working Mathematically

The syllabus has three content strands (Number and Algebra, Measurement and Geometry and Statistics and Probability) and a Working Mathematically strand that goes across and through the content. Working Mathematically has five components: Communicating, Problem Solving, Reasoning, Understanding and Fluency. The Working Mathematically strand provides a vehicle to map the school work as "connected and meaningful" within the application to problem solving and 'novel situations'.

The content strands are expected to be seamlessly integrated into each other to maximise working mathematically in problem solving, communication, reasoning and understanding. The graphic below reflects the continuous flow of knowledge and skills between the stage groups and in a sequential nature within the stage groups.

The NSW Mathematics Syllabus: Content Strands and Working Mathematically K- 10



The diagram represents the relationships between the strands and substrands only.
It is not intended to indicate the amount of time spent studying each strand or substrand.

(BOSTES, 2016c)

Appendix B Self-Belief in Mathematics student questionnaire

Students' Self-Belief In Mathematics

INSTRUCTIONS
- Complete each question by marking the appropriate circle
- Use a 2B or HB pencil or blue or black pen only.

Please MARK LIKE THIS ONLY: ⓪ ① ② ● ④

NOT LIKE THIS:

SECTION 1 – Please provide the following information

Gender: Ⓜ Male Ⓕ Female

Are you an Aboriginal or Torres Strait Islander? Ⓨ Yes Ⓝ No

Mother's Education:
- ① Left school before Year 12
- ② Year 12
- ③ Trade Certificate or Diploma
- ④ Degree
- ⑤ Don't know

Father's Education:
- ① Left school before Year 12
- ② Year 12
- ③ Trade Certificate or Diploma
- ④ Degree
- ⑤ Don't know

Language spoken at home:
- ① English
- ② Mostly English
- ③ Mostly my parents' native language
- ④ My parents' native language

STUDENT NUMBER: (provided by your teacher)

Write the number in the boxes, then fill in the corresponding ovals in each column underneath. Eg: '1201'

How many people, other than your Maths teacher, do you know who use advanced maths for their job? eg. engineer, accountant, scientist. You can use '0' if you don't know anyone. ⓪ ① ② ③ ④ ⑤ 6+

SECTION 2

Please show the degree to which you agree or disagree with the following statements by filling in the appropriate circle. Respond to each statement as you feel at this point in time. Note the scale ranges from **1** (definitely disagree) to **6** (definitely agree).

①	②	③	④	⑤	⑥
Definitely disagree	Disagree	Disagree more than agree	Agree more than disagree	Agree	Definitely Agree

1. I get good marks in maths tests.	①	②	③	④	⑤	⑥
2. I have always been successful with maths.	①	②	③	④	⑤	⑥
3. Even when I study hard I do poorly in maths.	①	②	③	④	⑤	⑥
4. I got good grades in maths on my last school report.	①	②	③	④	⑤	⑥
5. I do well in maths classwork.	①	②	③	④	⑤	⑥
6. I do well even in the most difficult maths questions.	①	②	③	④	⑤	⑥
7. Seeing adults do well in maths motivates me to do better.	①	②	③	④	⑤	⑥
8. When I see how my maths teacher solves a problem I can picture myself solving the problem the same way.	①	②	③	④	⑤	⑥
9. Seeing my classmates do better than me in maths motivates me to do better.	①	②	③	④	⑤	⑥
10. When I see how another student solves a maths problem, I can see myself solving the problem the same way.	①	②	③	④	⑤	⑥
11. I imagine myself working through challenging maths problems successfully.	①	②	③	④	⑤	⑥
12. I compete with myself at maths.	①	②	③	④	⑤	⑥
13. My maths teacher told me I am good at learning maths.	①	②	③	④	⑤	⑥
14. People have told me I have a talent for maths.	①	②	③	④	⑤	⑥
15. Adults in my family have told me I am a good maths student.	①	②	③	④	⑤	⑥
16. I have been praised for my ability in maths.	①	②	③	④	⑤	⑥
17. Other students have told me I am good at learning maths.	①	②	③	④	⑤	⑥
18. My classmates like to work with me in maths.	①	②	③	④	⑤	⑥
19. Just being in maths class makes me feel nervous.	①	②	③	④	⑤	⑥
20. Doing maths gives me energy.	①	②	③	④	⑤	⑥
21. I start to feel stressed-out as soon as I begin my maths work.	①	②	③	④	⑤	⑥
22. My mind goes blank and I am unable to think clearly when doing maths work.	①	②	③	④	⑤	⑥
23. I get anxious when I think about learning maths.	①	②	③	④	⑤	⑥
24. My whole body gets tense when I have to do maths.	①	②	③	④	⑤	⑥

Please turn over...

Please turn over...

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Students' Self-Belief In Mathematics

INSTRUCTIONS
- Complete each question by marking the appropriate circle
- Use a 2B or HB pencil or blue or black pen only.

Please MARK LIKE THIS ONLY:
NOT LIKE THIS:

SECTION 1 – Please provide the following information

Gender: Ⓜ Male Ⓕ Female

Are you an Aboriginal or Torres Strait Islander? Ⓨ Yes Ⓝ No

Mother's Education:
① Left school before Year 12 ③ Trade Certificate or Diploma
② Year 12 ④ Degree ⑤ Don't know

Father's Education:
① Left school before Year 12 ③ Trade Certificate or Diploma
② Year 12 ④ Degree ⑤ Don't know

Language spoken at home:
① English ③ Mostly my parents' native language
② Mostly English ④ My parents' native language

STUDENT NUMBER: (provided by your teacher)

Write the number in the boxes, then fill in the corresponding ovals in each column underneath.
Eg: '1201'

How many people, other than your Maths teacher, do you know who use advanced maths for their job? eg. engineer, accountant, scientist. You can use '0' if you don't know anyone. ⓪ ① ② ③ ④ ⑤ ⑥+

SECTION 2

Please show the degree to which you agree or disagree with the following statements by filling in the appropriate circle.
Respond to each statement as you feel at this point in time. Note the scale ranges from **1** (definitely disagree) to **6** (definitely agree).

①	②	③	④	⑤	⑥
Definitely disagree	Disagree	Disagree more than agree	Agree more than disagree	Agree	Definitely Agree

1. I get good marks in maths tests.	①	②	③	④	⑤	⑥
2. I have always been successful with maths.	①	②	③	④	⑤	⑥
3. Even when I study hard I do poorly in maths.	①	②	③	④	⑤	⑥
4. I got good grades in maths on my last school report.	①	②	③	④	⑤	⑥
5. I do well in maths classwork.	①	②	③	④	⑤	⑥
6. I do well even in the most difficult maths questions.	①	②	③	④	⑤	⑥
7. Seeing adults do well in maths motivates me to do better.	①	②	③	④	⑤	⑥
8. When I see how my maths teacher solves a problem I can picture myself solving the problem the same way.	①	②	③	④	⑤	⑥
9. Seeing my classmates do better than me in maths motivates me to do better.	①	②	③	④	⑤	⑥
10. When I see how another student solves a maths problem, I can see myself solving the problem the same way.	①	②	③	④	⑤	⑥
11. I imagine myself working through challenging maths problems successfully.	①	②	③	④	⑤	⑥
12. I compete with myself at maths.	①	②	③	④	⑤	⑥
13. My maths teacher told me I am good at learning maths.	①	②	③	④	⑤	⑥
14. People have told me I have a talent for maths.	①	②	③	④	⑤	⑥
15. Adults in my family have told me I am a good maths student.	①	②	③	④	⑤	⑥
16. I have been praised for my ability in maths.	①	②	③	④	⑤	⑥
17. Other students have told me I am good at learning maths.	①	②	③	④	⑤	⑥
18. My classmates like to work with me in maths.	①	②	③	④	⑤	⑥
19. Just being in maths class makes me feel nervous.	①	②	③	④	⑤	⑥
20. Doing maths gives me energy.	①	②	③	④	⑤	⑥
21. I start to feel stressed-out as soon as I begin my maths work.	①	②	③	④	⑤	⑥
22. My mind goes blank and I am unable to think clearly when doing maths work.	①	②	③	④	⑤	⑥
23. I get anxious when I think about learning maths.	①	②	③	④	⑤	⑥
24. My whole body gets tense when I have to do maths.	①	②	③	④	⑤	⑥

Please turn over...

Appendix C

Appendix C1 Students Self-Belief in Mathematics Section 3 Year 7

STUDENTS SELF-BELIEF IN MATHEMATICS

YEAR 7

SECTION 3: QUESTION SHEET

Each of the questions in Section 3 presents a problem in mathematics. Read each question on this handout first.

Then you decide **MENTALLY** the level of your **CONFIDENCE** to do or solve the activity.

- To record the level of your confidence, fill in the number between 0 and 10 that best suits your level of confidence for each question.
- YOU DO NOT NEED TO SOLVE any of the activities or the problems.

5.

We are interested in knowing the level of your confidence in maths. If you are NOT AT ALL confident of your ability to solve the activity, select 0. If you believe you ARE confident that you can do the activity, select 10. Of course you may choose any of the other numbers between 0 and 10 that represents your confidence.

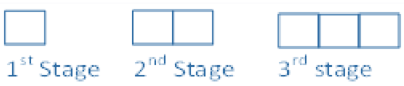
1. Add two decimals together (e.g. 6.39 and 2.46).

2. Work out how much Anne saved if she saved twice as much as John, and together they saved $180?

3. Calculate, without using a calculator, the closest whole number to 4.8 squared.

4. Find the value of ☆ to make 5 x ☆ greater than 30.

5. Imagine a pattern of shapes is made of sticks to make up the sides.

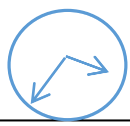


4 sticks 7 sticks 10 sticks

How confident are you that you could work out the number of sticks needed for the 7^{th} stage?

6. How confident are you to use algebra to express a word problem like this?
A medium chocolate bar costs a dollar more than a small chocolate bar. A large chocolate bar is double the cost of a small chocolate bar. How much for a medium chocolate bar if you are told the cost of a large bar?

7. Read the time on a clock with hands.

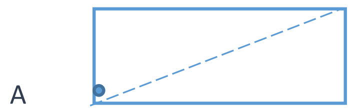


8. Convert half a litre into millilitres.

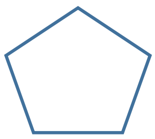
9. Calculate the area of a rectangle if its length is given and you know the perimeter.

10. Open the screen of a laptop computer so that it is at a right angle to the keyboard.

11. Mark the point that A moves to if the rectangle is folded along this line.

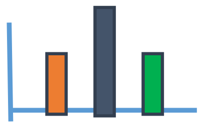


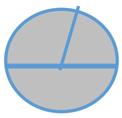
12. Work out the smallest angle between lines of symmetry in a regular polygon like this.



13. Draw a line graph to show temperatures from 9 am to 3.00 pm if you are given the temperatures.

14. Convert a column graph into a pie chart.



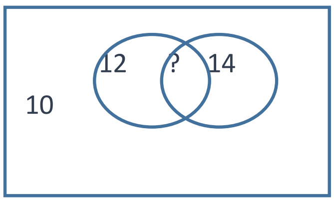


15. Work out the scale of a column graph if you know the height of each column.

16. Work out the chance of rolling an even number on a dice (with six sides).

17. Calculate the chance of selecting a red button from a bag, without looking, if you know how many of the colours are in the bag.

18. Determine the missing element of a Venn diagram when given the total.



19. I can remember ways of the solving hard questions.

20. I can put maths questions into my own words.

21. I can use maths techniques in other subjects.

22. I can tell others how to solve a question.

STUDENTS SELF-BELIEF IN MATHEMATICS

YEAR 9

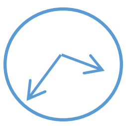
SECTION 3: QUESTION SHEET

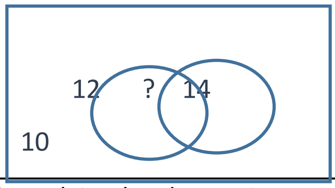
Each of the questions in Section 3 presents a problem in mathematics. Read each question on this handout first.

Then you decide **MENTALLY** the level of your **CONFIDENCE** to do or solve the activity.

- To record the level of your confidence, fill in the number between 0 and 10 that best suits your level of confidence for each question.

We are interested in knowing the level of your confidence in maths. If you are NOT AT ALL confident of your ability to solve the activity, select 0. If you believe you ARE confident that you can do the activity, select 10. Of course you may choose any of the other numbers between 0 and 10 that represents your confidence.

1. Add two decimals together without using a calculator (e.g. 6.39 and 2.46).
2. Work out how much Anne saved if she saved twice as much as John and together they saved $180?
3. Calculate the average speed if a trip if you know the distance in kilometres and it took 1 hour 30 minutes to the venue and 1 hour 45 minutes home.
4. If 2004 is the <u>first leap year</u> in the 21st Century, when is the 8th leap year?
5. Write an expression for washing "n" cars if Jo earns $40 for washing 8 cars.
6. Solve the value of the missing number in this equation (a) if *(a plus 53.1) divided by 4 equals 31.5.*
7. Read the time on a clock with hands. 
8. Read a scale where divisions on the scale are 0.2 cm.
9. Calculate the volume of a cylinder if you are given the formula.
10. Identify the net of a cube.

11. Using Pythagoras' Theorem find the length of the side of a triangle.
12. Work out an angle in a shape that is made up of a rectangle and an equilateral triangle. 
13. Draw a line graph to show temperatures from 9 am to 3.00 pm if you are given the temperatures.
14. Determine the median house selling price when you know the selling price of seven houses.
15. Work out the scale of a column graph if you know the height of each column.
16. Work out the chance of rolling an even number on a dice (with six sides).
17. Calculate the chance of selecting two red buttons from a bag, without looking, if you know how many of each of the colours are in the bag.
18. Determine the missing element of a Venn diagram when given the total. 
19. I can remember ways of the solving hard questions.
20. I can put maths questions into my own words.
21. I can use maths techniques in other subjects.
22. I can tell others how to solve a question.

STUDENTS SELF-BELIEF IN MATHEMATICS

YEAR 11

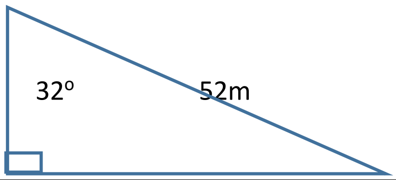
SECTION 3: QUESTION SHEET

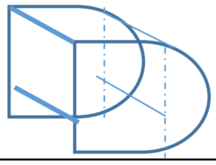
Each of the questions in Section 3 presents a problem in mathematics. Read each question on this handout first.

Then you decide **MENTALLY** the level of your **CONFIDENCE** to do or solve the activity.

- To record the level of your confidence, fill in the number between 0 and 10 that best suits your level of confidence for each question.
- YOU DO NOT NEED TO SOLVE any of the activities or the problems.

We are interested in knowing the level of your confidence in maths. If you are NOT AT ALL confident of your ability to solve the activity, select 0. If you believe you ARE confident that you can do the activity, select 10. Of course you may choose any of the other numbers between 0 and 10 that represents your confidence.

1.	Work out how much Anne saved if she saved twice as much as John and you know how much they saved together?
2.	Determine the normal pay if you know the total pay for a week that includes 5 hours paid at time and a half for overtime.
3.	Convert kilometres per hour into metres per second.
4.	Solve the value of the missing number in an equation such as (a plus 53.1) divided by 4 equals 31.5
5.	Find the size of the side of a triangle using trigonometry. 
6.	Solve linear equations involving one or more simple algebraic fractions such as. $\frac{2x+5}{3} = \frac{x-1}{4}$
7.	Calculate the volume of a cylinder if you are given the formula.
8.	Solve a variety of practical problems related to the volumes and capacities of composite right prisms. Example: Find the capacity of a swimming pool.

9. Find the surface areas of composite solids involving right prisms and cylinders. Example 
10. Using Pythagoras' Theorem find the length of the side of a triangle.
11. Work out an angle in a shape that is made up of a rectangle and an equilateral triangle. 
12. Explain your reasoning using geometrical facts or properties to find the sizes of unknown sides and angles in shapes.
13. Determine the median house selling price when you know the selling prices of seven houses.
14. Construct and interpret box plots.
15. Explain if there is bias in a survey.
16. Calculate the chance of selecting two red buttons from a bag, without looking, if you know how many of each of the colours are in the bag.
17. Describe the results of three-step chance experiments, *e.g. the chance of getting three sixes with the roll of three dice*.
18. Evaluate the likelihood of winning a prize in competitions such as the lotto where six numbers are drawn from 40 numbers.
19. I can remember ways of the solving hard questions.
20. I can put maths questions into my own words.
21. I can use maths techniques in other subjects.
22. I can tell others how to solve a question.

Appendix D: Student Questionnaire Means and Standard Deviations

Appendix D1 Section 2 Sources of Self-Efficacy

Student Questionnaire: Section 2 Sources of Self-efficacy	Mean	Standard Deviation
1. I get good marks in maths tests.	3.88	1.178
2. I have always been successful with maths.	3.54	1.354
3. Even when I study hard I do poorly in maths.	4.39	1.360
4. I got good grades in maths on my last school report.	4.07	1.402
5. I do well on maths classwork.	4.42	1.096
6. I do well even on the most difficult maths questions.	3.40	1.250
7. Seeing adults do well in maths motivates me to do better.	3.26	1.416
8. When I see how my maths teacher solves a problem I can picture myself solving the problem the same way.	3.88	1.352
9. Seeing my classmates do better than me in maths motivates me to do better.	4.06	1.450
10. When I see how another student solves a maths problem, I can see myself solving the problem the same way.	3.85	1.236
11. I imagine myself working through challenging maths problems successfully.	3.82	1.285
12. I compete with myself at maths.	3.84	1.460
13. My maths teacher told me I am good at learning maths.	3.69	1.421
14. People have told me I have a talent for maths.	3.23	1.580
15. Adults in my family have told me I am a good maths student.	3.72	1.523
16. I have been praised for my ability in maths.	3.20	1.557
17. Other students have told me I am good at learning maths.	3.40	1.486
18. My classmates like to work with me in maths.	3.98	1.437
19. Just being in maths class makes me feel nervous.	4.47	1.496
20. Doing maths give me energy.	2.33	1.354
21. I start to feel stressed-out as soon as I begin my maths work.	4.42	1.496
22. My mind goes blank and I am unable to think clearly when doing maths work.	4.30	1.476
23. I get anxious when I think about learning maths.	4.59	1.417
24. My whole body gets tense when I have to do maths.	4.92	1.368

Appendix D2 Section 3 Mathematical Self-Efficacy

	Strand	Difficulty	Mean	Standard Deviation
S3_Q1	Number	Basic	8.70	1.949
S3_Q4	Patterns & Algebra	Basic	7.44	2.777
S3_Q7	Measurement	Basic	8.94	2.070
S3_Q10	Geometry	Basic	9.02	1.926
S3_Q13	Statistics	Basic	8.53	2.004
S3_Q16	Probability	Basic	8.89	1.967
S3_Q2	Number	Intermediate	7.61	2.454
S3_Q5	Patterns & Algebra	Intermediate	7.83	2.494
S3_Q8	Measurement	Intermediate	7.71	2.593
S3_Q11	Geometry	Intermediate	7.92	2.391
S3_Q14	Statistics	Intermediate	7.79	2.446
S3_Q17	Probability	Intermediate	8.48	2.098
S3_Q3	Number	Advanced	6.96	2.701
S3_Q6	Patterns & Algebra	Advanced	6.51	2.769
S3_Q9	Measurement	Advanced	8.19	2.273
S3_Q12	Geometry	Advanced	7.17	2.480
S3_Q15	Statistics	Advanced	7.58	2.410
S3_Q18	Probability	Advanced	7.23	2.862
S3_Q19	Working Mathematically		6.81	2.704
S3_Q20	Working Mathematically		7.10	2.587
S3_Q21	Working Mathematically		7.05	2.715
S3_Q22	Working Mathematically		7.53	2.569

Appendix D3 Section 4 Percevied Parents/Carers and Teachers Attitudes to Mathematics

Student's Self-Belief in Mathematics Questionnaire Section 4: Perceived parents/carers and teacher attitudes to mathematics	Mean	Standard Deviation
1. My parents/carers think maths is one of the most important subjects I study.	4.92	1.216
2. My parents/carers strongly encourage me to do well in maths.	5.14	1.013
3. My parents/carers have always been interested in my progress in maths.	4.83	1.183
4. My parents/carers think I am the kind of person who could do well at maths.	4.68	1.211
5. As long as I have passed my parents/carers don't care how I go at maths.	4.39	1.426
6. My parents/carers think I will need harder maths to get a good job when I leave school.	3.75	1.468
7. My parents/carers show no interest in whether I do harder maths courses.	4.55	1.447
8. My teacher thinks I am the kind of person who could do well at maths.	4.22	1.204
9. Maths teachers have made me feel I have the ability to do the harder maths courses at school.	3.96	1.387
10. My maths teachers have been interested in my progress in maths.	4.17	1.256
11. I have found it hard to win the respect of my maths teachers	4.24	1.426
12. I would talk to my maths teacher about careers that use maths.		

Appendix E: Correlation Matrices

Appendix E1 Section 2 Sources of Self-Efficacy Correlation coefficients

	S2_Q1	S2_Q2	RS2_Q3	S2_Q4	S2_Q5	S2_Q6	S2_Q7	S2_Q8	S2_Q9	S2_Q10	S2_Q11	S2_Q12	S2_Q13	S2_Q14	S2_Q15	S2_Q16	S2_Q17	S2_Q18	RS2_Q19	S2_Q20	RS2_Q21	RS2_Q22	RS2_Q23	RS2_Q24
S2_Q1	1.00																							
S2_Q2	0.65	1.00																						
RS2_Q3	0.50	0.43	1.00																					
S2_Q4	0.69	0.51	0.44	1.00																				
S2_Q5	0.55	0.44	0.27	0.47	1.00																			
S2_Q6	0.63	0.62	0.42	0.56	0.59	1.00																		
S2_Q7	0.23	0.22	0.08	0.21	0.30	0.28	1.00																	
S2_Q8	0.37	0.29	0.26	0.29	0.40	0.41	0.34	1.00																
S2_Q9	0.36	0.27	0.24	0.27	0.36	0.36	0.45	0.41	1.00															
S2_Q10	0.34	0.26	0.22	0.28	0.40	0.33	0.31	0.54	0.44	1.00														
S2_Q11	0.56	0.52	0.38	0.47	0.51	0.62	0.39	0.48	0.40	0.44	1.00													
S2_Q12	0.42	0.34	0.19	0.36	0.39	0.39	0.37	0.34	0.38	0.34	0.52	1.00												
S2_Q13	0.51	0.41	0.27	0.47	0.47	0.47	0.29	0.38	0.31	0.32	0.48	0.43	1.00											
S2_Q14	0.55	0.62	0.37	0.46	0.41	0.59	0.24	0.29	0.30	0.27	0.53	0.38	0.49	1.00										
S2_Q15	0.59	0.60	0.38	0.47	0.44	0.59	0.28	0.32	0.31	0.29	0.52	0.39	0.49	0.74	1.00									
S2_Q16	0.52	0.52	0.33	0.41	0.44	0.56	0.29	0.32	0.30	0.29	0.51	0.40	0.47	0.70	0.68	1.00								
S2_Q17	0.56	0.50	0.37	0.46	0.45	0.54	0.27	0.35	0.31	0.33	0.51	0.43	0.51	0.69	0.64	0.68	1.00							
S2_Q18	0.31	0.30	0.17	0.29	0.34	0.33	0.27	0.26	0.30	0.35	0.32	0.29	0.35	0.33	0.37	0.39	0.47	1.00						
RS2_Q19	0.30	0.31	0.39	0.26	0.30	0.37	0.05	0.20	0.11	0.15	0.32	0.15	0.20	0.28	0.28	0.24	0.22	0.17	1.00					
S2_Q20	0.31	0.29	0.16	0.31	0.32	0.36	0.37	0.29	0.29	0.23	0.38	0.35	0.39	0.38	0.39	0.38	0.37	0.17	0.15	1.00				
RS2_Q21	0.30	0.31	0.36	0.29	0.31	0.34	0.11	0.16	0.12	0.08	0.28	0.16	0.24	0.28	0.28	0.25	0.24	0.15	0.58	0.19	1.00			
RS2_Q22	0.42	0.40	0.43	0.36	0.37	0.44	0.19	0.28	0.21	0.17	0.38	0.26	0.28	0.38	0.41	0.36	0.35	0.23	0.55	0.22	0.63	1.00		

RS2_Q 23	0.37	0.37	0.44	0.36	0.36	0.41	0.13	0.22	0.14	0.17	0.38	0.21	0.27	0.33	0.33	0.31	0.30	0.25	0.67	0.20	0.70	0.65	1.00	
RS2_Q 24	0.32	0.34	0.37	0.32	0.31	0.36	0.10	0.23	0.12	0.16	0.33	0.15	0.23	0.29	0.33	0.26	0.27	0.22	0.59	0.10	0.63	0.63	0.74	1.00

Appendix E2 Section 3 Mathematics Self-Efficacy for the strand of the NSW Mathematics Syllabus Correlation Matrix

	S3_Q1	S3_Q4	S3_Q7	S3_Q10	S3_Q13	S3_Q16	S3_Q2	S3_Q5	S3_Q8	S3_Q11	S3_Q14	S3_Q17	S3_Q3	S3_Q6	S3_Q9	S3_Q12	S3_Q15	S3_Q18	S3_Q19	S3_Q20	S3_Q21	S3_Q22
S3_Q1	1.00																					
S3_Q4	0.44	1.00																				
S3_Q7	0.36	0.31	1.00																			
S3_Q10	0.40	0.30	0.38	1.00	0.46																	
S3_Q13	0.43	0.35	0.39	0.46	1.00																	
S3_Q16	0.43	0.33	0.42	0.44	0.47	1.00																
S3_Q2	0.50	0.51	0.36	0.30	0.42	0.39	1.00															
S3_Q5	0.40	0.48	0.35	0.40	0.44	0.38	0.48	1.00														
S3_Q8	0.46	0.44	0.48	0.40	0.48	0.36	0.51	0.45	1.00													
S3_Q11	0.39	0.39	0.40	0.38	0.48	0.33	0.42	0.44	0.46	1.00												
S3_Q14	0.34	0.35	0.31	0.32	0.52	0.36	0.40	0.37	0.41	0.36	1.00											
S3_Q17	0.36	0.36	0.40	0.39	0.47	0.62	0.37	0.38	0.44	0.37	0.40	1.00										
S3_Q3	0.44	0.52	0.32	0.32	0.34	0.31	0.56	0.48	0.48	0.38	0.36	0.33	1.00									
S3_Q6	0.40	0.51	0.35	0.37	0.41	0.34	0.53	0.49	0.51	0.45	0.41	0.42	0.51	1.00								
S3_Q9	0.46	0.42	0.47	0.52	0.52	0.39	0.37	0.43	0.53	0.53	0.41	0.47	0.40	0.48	1.00							
S3_Q12	0.37	0.40	0.40	0.36	0.46	0.32	0.44	0.45	0.52	0.60	0.47	0.42	0.40	0.57	0.53	1.00						
S3_Q15	0.35	0.41	0.35	0.37	0.49	0.44	0.46	0.43	0.46	0.41	0.53	0.48	0.44	0.47	0.43	0.48	1.00					

S3_Q18	0.30	0.38	0.36	0.31	0.33	0.40	0.45	0.40	0.40	0.36	0.40	0.42	0.38	0.49	0.38	0.47	0.42	1.00				
S3_Q19	0.46	0.51	0.38	0.38	0.44	0.42	0.50	0.48	0.54	0.46	0.45	0.50	0.53	0.58	0.50	0.55	0.49	0.54	1.00			
S3_Q20	0.45	0.46	0.33	0.38	0.44	0.40	0.49	0.50	0.47	0.41	0.40	0.43	0.45	0.53	0.47	0.50	0.46	0.47	0.74	1.00		
S3_Q21	0.44	0.45	0.39	0.32	0.38	0.35	0.43	0.40	0.44	0.42	0.35	0.40	0.45	0.45	0.45	0.48	0.43	0.43	0.66	0.67	1.00	
S3_Q22	0.42	0.42	0.31	0.33	0.40	0.41	0.44	0.40	0.40	0.43	0.36	0.40	0.41	0.43	0.45	0.44	0.42	0.39	0.64	0.63	0.66	1.00

Appendix E3 Section 4 Percieved Parents/Carers and Teachers Attitudes to Matheamtics Corelation Matrix

	S4_Q1	S4_Q2	S4_Q3	S4_Q4	RS4_Q5	S4_Q6	RS4_Q7	S4_Q8	S4_Q9	S4_Q10	RS4_Q11	S4_Q12
S4_Q1	1.00											
S4_Q2	0.63	1.00										
S4_Q3	0.49	0.62	1.00									
S4_Q4	0.44	0.48	0.49	1.00								
RS4_Q5	0.20	0.23	0.23	0.13	1.00							
S4_Q6	0.34	0.34	0.26	0.27	0.04	1.00						
RS4_Q7	0.19	0.26	0.27	0.21	0.30	0.16	1.00					
S4_Q8	0.30	0.35	0.32	0.56	0.10	0.19	0.16	1.00				
S4_Q9	0.28	0.35	0.32	0.44	0.09	0.24	0.21	0.57	1.00			
S4_Q10	0.24	0.30	0.36	0.32	0.07	0.13	0.13	0.51	0.54	1.00		
RS4_Q11	0.10	0.08	0.07	0.09	0.14	-0.06	0.11	0.20	0.23	0.24	1.00	
S4_Q12	0.18	0.17	0.21	0.20	0.04	0.18	0.02	0.29	0.31	0.32	0.11	1.00

Appendix F: Teacher interview

Appendix F1 Teacher Interview 1 Prompting Questions

STUDENT SELF-BELIEF WITH MATHEMATICS

TEACHER INTERVIEW TEMPLATE

Section 1: Background Information

<table>
<tr><td rowspan="2">School:</td><td rowspan="2">Gender</td><td>M</td><td></td><td rowspan="2">Aboriginal or Torres Strait Islander</td><td>Y</td><td></td></tr>
<tr><td>F</td><td></td><td>N</td><td></td></tr>
<tr><td>School Postcode:</td><td colspan="6">Classes taught</td></tr>
</table>

General Points:

- This is a semi-structured interview and will last no more than 30 minutes.
- The researcher will begin with a prompt question, and you are asked to answer it from your experience with the classes you have this year.
- If you don't have an answer, please say you don't know.
- If you want to build on the answer, please do so.
- If you have additional information, please add it.
- The interview is being taped. If at any stage you want the tape stopped, please say so, and the taped will be stopped.
- Alternatively, if you do not want the interview taped, notes can be taken and read back to you. A transcript of the interview will be provided to you for verification.
- If at any stage you wish to terminate the interview, please say so and the interview will stop.
- If the interview is stopped for any reason there will be no adverse reaction towards you.
- Your name will be replaced by a pseudonym.
- Please do not refer individual students by name.
- Do you have any questions?
- Are you happy to begin?

Section 2:

On a scale of 1 basic work, 10 advanced work with 5 for intermediate	Yr 7 1 2 3 4 5 6 7 8 9 10 6.

1. How would you describe your class' ability in Mathematics? Yr 7, Yr9, Yr 11,	 Yr 9 1 2 3 4 5 6 7 8 9 10 Yr 11 1 2 3 4 5 6 7 8 9 10
2. Please comment on how easy or hard your students find these topics. 7. *On a scale of 0 to 10* 8. *0 is cannot do at all, 5 is Moderately can do, 10 is Highly certain can do* How would you describe your students' ability in	
Number	Yr 7 1 2 3 4 5 6 7 8 9 10 Yr 9 1 2 3 4 5 6 7 8 9 10 Yr 11 1 2 3 4 5 6 7 8 9 10
Algebra	Yr 7 1 2 3 4 5 6 7 8 9 10 Yr 9 1 2 3 4 5 6 7 8 9 10 Yr 11 1 2 3 4 5 6 7 8 9 10
Measurement	Yr 7 1 2 3 4 5 6 7 8 9 10 Yr 9 1 2 3 4 5 6 7 8 9 10 Yr 11 1 2 3 4 5 6 7 8 9 10

Geometry	Yr 7 1 2 3 4 5 6 7 8 9 10 Yr 9 1 2 3 4 5 6 7 8 9 10 Yr 11 1 2 3 4 5 6 7 8 9 10
Statistics	Yr 7 1 2 3 4 5 6 7 8 9 10 Yr 9 1 2 3 4 5 6 7 8 9 10 Yr 11 1 2 3 4 5 6 7 8 9 10
Probability	Yr 7 1 2 3 4 5 6 7 8 9 10 Yr 9 1 2 3 4 5 6 7 8 9 10 Yr 11 1 2 3 4 5 6 7 8 9 10
3. Please comment on how your students would react if you gave them harder work in each of the strands. Is there a difference in their reaction between the strands of Mathematics:	
a) Algebra and Number 9.	
b) Measurement and Geometry 10.	
c) Statistics and Probability 11.	12.
On a scale of 0 to 10 *0 is not confident at all, 5 is Moderately can do, 10 is Very confident*	Yr 7 1 2 3 4 5 6 7 8 9 10 Yr 9 1 2 3 4 5 6 7 8 9 10

13. How **confident** are they to attempt harder work?	Yr 11 1 2 3 4 5 6 7 8 9 10
How **anxious** are they in attempting the harder work? *0 is not anxious at all, 5 is Moderately can do, 10 is Very anxious*	Yr 7 1 2 3 4 5 6 7 8 9 10 Yr 9 1 2 3 4 5 6 7 8 9 10 Yr 11 1 2 3 4 5 6 7 8 9 10
How **energised** are they in attempting the harder work? *0 is not energised at all, 5 is Moderately can do, 10 is Very energised*	Yr 7 1 2 3 4 5 6 7 8 9 10 Yr 9 1 2 3 4 5 6 7 8 9 10 Yr 11 1 2 3 4 5 6 7 8 9 10
4. Please comment on how your students would react if **you only gave them work they already knew how to do.** Is there any difference between the strands of Mathematics:	
a) Algebra and Number	
b) Measurement and Geometry 14.	
c) Statistics and Probability 15. 16.	
What proportion of them prefers a **challenge**? *0 is none, 5 is Moderately, 10 all*	Yr 7 1 2 3 4 5 6 7 8 9 10 Yr 9 1 2 3 4 5 6 7 8 9 10

	Yr 11 1 2 3 4 5 6 7 8 9 10
What proportion of them to get 10/10 without much challenge? *0 is none, 5 is Moderately, 10 all*	Yr 7 1 2 3 4 5 6 7 8 9 10 Yr 9 1 2 3 4 5 6 7 8 9 10 Yr 11 1 2 3 4 5 6 7 8 9 10
5. Please comment on whether students will **attempt a harder question if they see one of their classmates being able to solve the problem.** *0 is none, 5 is Moderately, 10 all*	Yr 7 1 2 3 4 5 6 7 8 9 10 Yr 9 1 2 3 4 5 6 7 8 9 10 Yr 11 1 2 3 4 5 6 7 8 9 10
6. In summary, please comment on whether or not your students feel successful in maths and how you know this.	
7. Please comment how many of the students in your class would say: ***17. As long as I have passed my parents/carers don't care how I go at maths.*** *0 is none, 5 is Moderately, 10 all*	Yr 7 1 2 3 4 5 6 7 8 9 10 Yr 9 1 2 3 4 5 6 7 8 9 10 Yr 11 1 2 3 4 5 6 7 8 9 10
8. Please comment on the availability of the instructional materials (resources) and equipment you need for your class. *0 is none, 5 is Moderately, 10 very well*	Yr 7 1 2 3 4 5 6 7 8 9 10 Yr 9 1 2 3 4 5 6 7 8 9 10

resourced	Yr 11 1 2 3 4 5 6 7 8 9 10
9. How do you **get feedback** from students on whether they have learnt the concept?	
10. How do you adjust the study programme to suit the needs of the students in my class for either those who need extending or those who need extra help?	
11. Please comment on your ability or the ability of the Mathematics faculty to Influence the decisions that are made in the school. *0 is none, 5 is Moderately, 10 all*	0 1 2 3 4 5 6 7 8 9 10
12. Please comment on the quality of the professional learning you receive for your Mathematics classes. *0 is none, 5 is Moderately, 10 very good quality*	0 1 2 3 4 5 6 7 8 9 10
13. Please comment on the involvement of community groups, local businesses, and universities in the workings of your classes or school. *0 is none, 5 is Moderately, 10 very involved*	0 1 2 3 4 5 6 7 8 9 10

Appendix F2: Teacher Interview 2 Prompting Questions

STUDENT SELF-BELIEF WITH MATHEMATICS

TEACHER INTERVIEW TEMPLATE

INTERVIEW 2

Section 1: Background Information

<table>
<tr><td rowspan="2">School:</td><td rowspan="2">Gender</td><td>M</td><td></td><td rowspan="2">Aboriginal or Torres Strait Islander</td><td>Y</td><td></td></tr>
<tr><td>F</td><td></td><td>N</td><td></td></tr>
<tr><td>School Postcode:</td><td colspan="6" rowspan="2">Classes taught: 2016

Classes taught at this school 2015</td></tr>
<tr><td>Date of interview</td></tr>
</table>

General Points:

- This is a semi-structured interview and will last no more than 30 minutes.
- The researcher will begin with a prompt question, and you are asked to answer it from your experience with the classes you have this year.
- If you don't have an answer, please say you don't know.
- If you want to build on the answer, please do so.
- The interview is being taped. If at any stage you want the tape stopped, please say so, and the taped will be stopped.
- Alternatively, if you do not want the interview taped, notes can be taken and read back to you. A transcript of the interview will be provided to you for verification.
- If at any stage you wish to terminate the interview, please say so and the interview will stop.
- If the interview is stopped for any reason there will be no adverse reaction towards you.
- Your name will be replaced by a pseudonym.
- Please do not refer individual students by name.
- Do you have any questions?
- Are you happy to begin?

Section 2:

Learning	Tell me about Year 7/9/11 and your experience in teaching them maths a. What do you emphasise most in your teaching of Year 7, 9, 11? … such as key concept attainment, fluency, problem solving, b. How do you scaffold the learning for the different abilities of your students? c. Do you show students how the maths topics can be used in other subjects, such as science or geography or any other subject? How?	
Problem Solving	How do you emphasise problem solving in your classes? 18. a. Do students come with their own ways of solving problems sometimes? Do you do anything to promote or facilitate this? b. Is there anything you would like to do in order to promote or facilitate problem-solving, but you can't at the moment	
Support	How do you support students who don't "get" the concepts of the topic? a. What do you do for the students who get the concept easily or already know it? b. Are you doing anything different this year from what you did last year or the year before in teaching Year 7, Year9?	

Appendix G: Ethics Approval

ETHICS APPROVAL

Dear Applicant,

Principal Investigator: A/Prof Shukri Sanber

Student Researcher: Vincent Connor

Ethics Register Number: 2015-35H

Project Title: A comparative study between rural and non-rural contexts on student self-efficacy in secondary school Mathematics

Risk Level: Low Risk

Date Approved: 15/06/2015

Ethics Clearance End Date: 30/06/2016

This email is to advise that your application has been reviewed by the Australian Catholic University's Human Research Ethics Committee and confirmed as meeting the requirements of the National Statement on Ethical Conduct in Human Research subject to the following conditions:

The researchers advise the following people/organisations that the research will be occurring and some background information on the research. The ACU HREC would consider a letter to both organisations advising them of the research as a matter of courtesy would suffice. Please provide HREC with copies once sent.

1. Mary Senj - State Coordinator Aboriginal Education, Catholic Education Commission NSW; and
2. the NSW AECG (http://www.aecg.nsw.edu.au/).

The data collection of your project has received ethical clearance, but the decision and authority to commence may be dependent on factors beyond the remit of the ethics review process, and approval is subject to ratification at the next available Committee meeting. The Chief Investigator is responsible for ensuring that outstanding permission letters are obtained, interview/survey questions, if relevant, and a copy forwarded to ACU HREC before any data collection can occur. Failure to provide outstanding documents to the ACU HREC before data collection commences is in breach of the National Statement on Ethical Conduct in Human Research and the Australian Code for the Responsible Conduct of Research. Further, this approval is only valid as long as approved procedures are followed.

Clinical Trials: You are required to register it in a publicly accessible trials registry prior to enrolment of the first participant (e.g. Australian New Zealand Clinical Trials Registry http://www.anzctr.org.au/) as a condition of ethics approval.

If you require a formal approval certificate, please respond via reply email, and one will be issued.

Researchers who fail to submit a progress report may have their ethical clearance revoked and/or the ethical clearances of other projects suspended. When your project has been completed, please complete and submit a progress/final report form and advise us by email at your earliest convenience. The information researchers provide on the security of records, compliance with approval consent procedures and documentation and responses to special conditions is reported to the NHMRC on an annual basis. In accordance with NHMRC, the ACU HREC may undertake annual audits of any projects considered to be of more than low risk.

It is the Principal Investigators / Supervisors responsibility to ensure that:

1. All serious and unexpected adverse events should be reported to the HREC with 72 hours.
2. Any changes to the protocol must be reviewed by the HREC by submitting a Modification/Change to Protocol Form prior to the research commencing or continuing. http://research.acu.edu.au/researcher-support/integrity-and-ethics/
3. Progress reports are to be submitted on an annual basis.http://research.acu.edu.au/researcher-support/integrity-and-ethics/
4. All research participants are to be provided with a Participant Information Letter and consent form unless otherwise agreed by the Committee.
5. Protocols can be extended for a maximum of five (5) years after which a new application must be submitted. (The five year limit on renewal of approvals allows the Committee to fully re-review research in an environment where legislation, guidelines and requirements are continually changing, for example, new child protection and privacy laws).

Researchers must immediately report to HREC any matter that might affect the ethical acceptability of the protocol, e.g. changes to protocols or unforeseen circumstances or adverse effects on participants.

Please do not hesitate to contact the office if you have any queries.

Kind regards,

Kylie Pashley

on behalf of ACU HREC Chair, Dr Nadia Crittenden

Ethics Officer | Research Services

Office of the Deputy Vice-Chancellor (Research)

Australian Catholic University

Appendix H Letters to CECNSW and NSW AECG

Appendix H1 Contact Letter AECG

Vince Connor
6 Carbine Close
BATHURST
v.connor@bth.catholic.edu.au

Ms Cindy Berwick
President
Association Management Committee
NSW Aboriginal Education Consultative Group.
http://www.aecg.nsw.edu.au/

Information relating to the Gathering of Research in Secondary School Mathematics

Dear Ms Berwick,

I am writing to you as part of my application to the Higher Education Research Committee (HREC), Australian Catholic University, for my research proposal in a Doctorate in Philosophy (PhD). My doctoral research proposal is a comparative study of secondary student perceived self-efficacy in years 7, 9 and 11 between rural and non-rural schools. I have received approval to conduct the research (2015-35H).

Self-efficacy refers to beliefs in one's capabilities to organise and execute the courses of action to manage prospective situations. In short, it reflects the self-fulfilling view of students who tend to achieve if they believe they can and not to achieve if they believe they cannot. As you will be aware, students in rural areas trend to attaining weaker achievement in NAPLAN and Higher School Certificate (HSC) Mathematics than do students from non-rural locations. Research has also shown that achievement affects self-efficacy, and self-efficacy affects achievement.

My research seeks to survey students to gain a measure of their perceived self-efficacy in Mathematics and the sources that impact on the development of this self-efficacy. It also seeks to gather data from teachers pertaining to their self-efficacy to teach mathematics. It is a comparative study and will analyse data from rural schools against data from non-rural schools in an attempt to identify similarities and differences. The student questionnaire will be completed during normal class time with the administration being done by the classroom teacher. The research intends to gather data from schools within the Catholic system of schools in the Diocese of Bathurst, Diocese of Wagga Wagga, Diocese of Parramatta the Arch-diocese of Sydney. It is possible that some Indigenous students, as students in their school community, may form part of the research.

The research methodology will take care to preserve the anonymity of all those involved. I am writing to affirm with you that all students, including indigenous students, who take part in the study, will have their individual responses to the questionnaire de-identified. General school-based data from individual schools will be made available to that school. There will not be an opportunity to track individual students. The objective of the study is to understand student variations in self-efficacy of mathematics based on rural and non-rural locality.

The involvement of participants will be voluntary. Consent will be required from the parent/carers and Principal before students can be involved in the questionnaire. Students not involved in the questionnaire will be provided with normal school work during the period when the questionnaire is administered. Communication with the community will be through the school. Advertising about the study will take place through school newsletters and other school practices. Feedback from the research will include data from the individual school and the broader trends of the research.

It is anticipated that this research will contribute to understanding the current differences in achievement trends between rural and non-rural students with a view to recommending potential interventions.

Kind regards,

Vince Connor (Student Number [redacted]

Appendix H2 Contact letter NSWCEC

Vince Connor
6 Carbine Close
BATHURST
v.connor@bth.catholic.edu.au

Ms Mary Senj
State Co-ordinator Aboriginal Education, Catholic Education Commission NSW.
Mary.Senj@cecnsw.catholic.edu.au

Information relating to the Gathering of Research in Secondary School Mathematics

Dear Mary,
I am writing to you as part of my application to the Higher Education Research Committee (HREC), Australian Catholic University, for my research proposal in a Doctorate in Philosophy (PhD). My doctoral research proposal is a comparative study of secondary student perceived self-efficacy in years 7, 9 and 11 between rural and non-rural schools. I have received approval to conduct the research (2015-35H).

Self-efficacy refers to beliefs in one's capabilities to organise and execute the courses of action to manage prospective situations. In short, it reflects the self-fulfilling view of students who tend to achieve if they believe they can and not to achieve if they believe they cannot. As you will be aware, students in rural areas trend to attaining weaker achievement in NAPLAN and Higher School Certificate (HSC) Mathematics than do students from non-rural locations. Research has also shown that achievement affects self-efficacy, and self-efficacy affects achievement.

My research seeks to survey students to gain a measure of their perceived self-efficacy in Mathematics and the sources that impact on the development of this self-efficacy. It also seeks to gather data from teachers pertaining to their self-efficacy to teach mathematics. It is a comparative study and will analyse data from rural schools against data from non-rural schools in an attempt to identify similarities and differences. The student questionnaire will be completed during normal class time with the administration being done by the classroom teacher. The research intends to gather data from schools within the Catholic system of schools in the Diocese of Bathurst, Diocese of Wagga Wagga, Diocese of Parramatta the Arch-diocese of Sydney. It is possible that some Indigenous students, as students in their school community, may form part of the research.
The research methodology will take care to preserve the anonymity of all those involved. I am writing to affirm with you that all students, including indigenous students, who take part in the study, will have their individual responses to the questionnaire de-identified. General school-based data from

individual schools will be made available to that school. There will not be an opportunity to track individual students. The objective of the study is to understand student variations in self-efficacy of mathematics based on rural and non-rural locality.

The involvement of participants will be voluntary. Consent will be required from the parent/carers and Principal before students can be involved in the questionnaire. Students not involved in the questionnaire will be provided with normal school work during the period when the questionnaire is administered. Communication with the community will be through the school. Advertising about the study will take place through school newsletters and other school practices. Feedback from the research will include data from the individual school and the broader trends of the research.

It is anticipated that this research will contribute to understanding the current differences in achievement trends between rural and non-rural students with a view to recommending potential interventions.

Kind regards,

Vince Connor (Student Number [redacted]

Appendix I Approval for conduct of research

Appendix I1 Diocese of Bathurst

Catholic Education Office
DIOCESE OF BATHURST

November 27 2014

Dear Vince,

Thank you for your letter of November 25 in which you provide details in regard to your Doctoral Research Proposal.

I am fully supportive of both the broad aim of your study and the methodology you propose. Your investigation into students' self-efficacy in Mathematics resonates with the strategic focus of our diocesan system of schools, so I will be particularly interested in following the progress and outcome of your research.

I also fully endorse the approach you are taking in conducting the research as outlined in your letter. I am fully satisfied that you are adopting an ethical approach.

With my congratulations for the work you have undertaken to date and I look forward to supporting your endeavours in relation to this Doctoral activity.

Every best wish,

[redacted]

Jenny Allen
Executive Director of Schools

Appendix I2 Diocese of Parramatta

Catholic Education
Diocese of Parramatta

31 July 2015

Mr Vince Connor

Schools Consultant — Catholic Education Office Bathurst

Gilmore Street

Bathurst, NSW, 2795.

Em: v.connor@bth.catholic.edu.au

Dear Vince,

Thank you for your Application to Conduct Research entitled A comparative study between rural and non-rural contexts on student self-efficacy in secondary school Mathematics with schools under the auspices of Catholic Education, Diocese of Parramatta (CEDP). The research has been approved.

This letter approves you and/or your research team to approach the principals of the schools named in your application-

- McCarthy Catholic College, Emu Plains
- St John Paul Il Catholic College, Schofields

Please note the following points in relation to the research request:

- This approval letter must accompany any approach by your team to a school principal • It is the school principal who will provide final permission for research to be carried out in the school
- Confidentiality needs to be observed in reporting and must comply with the requirements of the Commonwealth Privacy Amendment (Private Sector) Act 2000. • Feedback should be provided to schools and a copy of the findings of the research forwarded to the email address shown below.

I look forward to the results of this study and wish you the best over the coming months. If you would like to discuss any aspect of this research in our diocese, please do not hesitate to contact me on 02 9407 7070 or pbarrett@parra.catholic.edu.au .

Yours sincerely,

[redacted]

Mr Patrick Barrett
Manager of Programs (Special Purpose)
Catholic Education, Diocese of Parramatta 12 Victoria Road, Parramatta, NSW, 2150 Locked Bag 4,
North Parramatta, NSW 1750
Ph: 02 9407 7070
Mb: 0439 440 032
Em: pbarrett@parra.catholic-edu.au

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DIOCESE OF WOLLONGONG
Serving Catholic systemic school communities in the Illawarra, Macarthur, Shoalhaven & Southern Highlands
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29 September 2015

Vince Connor
Catholic Education Office
PO Box 308
Bathurst NSW 2795

Dear Vince

Re: Application to undertake the research project entitled:
"A comparative study between rural and non-rural contexts on student self-efficacy in secondary school Mathematics"

Acknowledgement is made of your application to conduct the above mentioned doctoral research within the Diocese of Wollongong. Approval has been granted for you to proceed in the Diocese of Wollongong and to directly approach the Principals of the following schools:

[redacted]

In accordance with the agreement permitting you to conduct your research within the Wollongong Diocese, I would ask that you provide a summary report of the project at your earliest convenience and within 6 months of the completion. Alternatively, inform me if the research project is discontinued, as this information will enable us to keep our records and files updated.

Please do not hesitate to contact me on 4253 0876 if you have any further enquiries.

I wish you well with this undertaking and look forward to receiving updates and your final report.

Yours sincerely,

[redacted]

Mark Raue
Professional Assistant to the Director
Strategic Planning & Policy

Office of the Director
Catholic Education, Diocese of Wollongong

CATHOLIC EDUCATION OFFICE• Wollongong
86 - 88 Market Street (Locked Mail Bag 8802)
Wollongong NSW 2500 • PH 02 4253 0800

CATHOLIC EDUCATION CENTRE• Macarthur
5 Allman Street Campbelltown NSW 2560 • PH 02 4253 0886

Lighting the Way
through faith and learning

Appendix J Information Letters

Appendix J1 School Principals

STUDENT SELF-BELIEF IN MATHEMATICS

PROJECT TITLE:	A comparative study between rural and non-rural contexts on student self-efficacy in secondary school Mathematics
PRINCIPAL INVESTIGATOR:	Associate Professor Shukri Sanber
STUDENT RESEARCHER:	Vince Connor
STUDENT'S DEGREE:	Doctor of Philosophy

Dear (Principal),

The problem of students not engaging in higher-order Mathematics in secondary school is often discussed by schools. Whilst I am currently a secondary schools consultant with the Catholic Education Office Bathurst, I have experience as a secondary school mathematics educator with many years experience in low SES, rural and indigenous communities. I am investigating student self-belief and the sources of these beliefs as part of my PhD. Attached is a letter of introduction from the Executive Director of Schools, Jenny Allen. I would appreciate the opportunity to discuss involving xxxxxx students in the project.

What is the project about?

I am completing my doctoral studies at the Australian Catholic University. As part of the degree, I am researching students in Year 7, 9 and 11 from rural and metropolitan secondary students in regard to their perceptions on how well they can do in Maths by investigating their "self-efficacy" in Mathematics.

Self-efficacy refers to a student's beliefs that they can organise and execute courses of action in prospective situations. In short, students tend to achieve if they believe they can achieve in an activity, such as "harder Mathematics", and not to achieve if they believe they cannot. The study seeks to measure students' self-efficacy in Mathematics and the sources that impact on the development of their self-efficacy. The research is a comparative study and will analyse general data from rural schools against data from metropolitan schools in an attempt to identify similarities and differences. Students will be asked to complete a questionnaire of about 30 minutes. The questionnaire is titled "Student Self-Belief with Mathematics". The questionnaire would be completed in the students' normal class time with their normal class teacher. Completion of the questionnaires will be anonymous. Parent/carer consent will be sought, and participation in this study is completely voluntary.

A follow up interview may occur with teachers to help develop a deeper understanding of the sources of self-efficacy. Access to de-identified NAPLAN results for the students in Numeracy for 2013 and

2015 may also be requested to further understand the impact of self-beliefs and their sources. Anonymity is assured, and student and schools will not be identified by name.

By studying student perceptions of their self-belief and their sources of self-belief in Mathematics, it is hoped that this research will help to understand the current trends in Maths achievement and engagement by rural and metropolitan students so that ways of improving student achievement and engagement can be recommended. Specific data from your school and conclusions from the research will be shared with your school. Findings, only in the form of general data from this study, may also be used in other research. Actual questionnaires will be destroyed at the conclusion of the research.

What will my school be asked to do?

Students will be asked to complete a questionnaire of about 30 minutes at a time negotiated with you. Parent/carer consent forms will be supplied. Your school is asked to send them to parent/carers and collect them using your normal processes. Class teachers will be asked to administer the questionnaire to those students who have parent/carer consent during a normal lesson. You are asked to provide arrangements to cater for students should they wish not to participate in the questionnaire (e.g. supervision). Some teachers may also be asked to be involved in a semi-structured interview of no more than 30 minutes within approximately two months of the questionnaire being completed by students. Involvement in these interviews will be completely voluntary. Some schools may be asked to provide de-identified student Numeracy data from the 2015 and 2013 NAPLAN tests as a way of further understanding student self-belief and its sources. All consent forms and questionnaires will be provided. Coding will be provided to de-identify students, teachers and schools. Student, teacher and school anonymity are assured.

Who is undertaking the project?

This project is being conducted by Vince Connor under the supervision of Associate Professor Shukri Sanber. Mr Connor is currently employed as a Consultant to Schools (for secondary schools) with the Catholic Education Office Bathurst and is a former Mathematics teacher.

Can my school or students withdraw from the study?

Participation in this study is completely voluntary. If you agree to participate, you can withdraw from the study at any time without adverse consequences. If you are in a professional relationship with any of the researchers, non-participation or withdrawal will not affect ongoing your professional relationship. As the questionnaire is anonymous, once completed, the answers on the questionnaire cannot be withdrawn as the answers on the questionnaire cannot and will not be related back to an individual student.

Will I be able to find out the results of the project?

A copy of the aggregated results from the questionnaires for the students from your school, the generalised findings and any recommended interventions will be provided to your school.

Who do I contact if I have questions about the project?

Please contact Mr Vince Connor ([redacted] or v.connor@bth.catholic.edu.au) for further information.

What if I have a complaint or any concerns?

The study has been reviewed by the Human Research Ethics Committee at Australian Catholic University (review number 2015-35H). If you have any complaints or concerns about the conduct of the project, you may write to the Manager of the Human Research Ethics Committee care of the Office of the Deputy Vice-Chancellor (Research).

Manager, Ethics

c/o Office of the Deputy Vice-Chancellor (Research)

Australian Catholic University

North Sydney Campus

PO Box 968

NORTH SYDNEY, NSW 2059

Ph.: 02 9739 2519, Fax: 02 9739 2870

Email: resethics.manager@acu.edu.au

Any complaint or concern will be treated in confidence and fully investigated. You will be informed of the outcome.

I want to participate! How do I sign up?

Your participation in this project would be appreciated. If you are willing to participate, please complete the attached agreement form and return it to **Mr Vince Connor** at the address listed below. Please ensure you sign both copies of the consent form.

Mr Vince Connor

c/o Catholic Education Office

PO Box 308

Yours sincerely,

Vince Connor

Student Number [redacted]

AUSTRALIAN CATHOLIC UNIVERSITY

AGREEMENT FORM

PROJECT TITLE:	A comparative study between rural and non-rural contexts on student self-efficacy in secondary school Mathematics
PRINCIPAL INVESTIGATOR:	Associate Professor Shukri Sanber
STUDENT RESEARCHER:	Vince Connor
STUDENT'S DEGREE:	Doctor of Philosophy

I agree to my school participating in this research using student questionnaires (Phase 1) from Year 7, 9 and 11. These questionnaires will take approximately 30 minutes and be administered by the students' normal mathematics teacher. Only students who have parent/carer consent will be involved in the questionnaire. Arrangements will be made by the school to cater for students should they wish not to participate in the questionnaire (e.g. supervision). If my school is selected, I agree to participate in Phase 2 of the research, a semi-structured interview with teachers of no more than 30 minutes that will be taped. Phase 2 of the research will occur within approximately 2 months of Phase 1. I understand that student, teacher and school names will be de-identified. I may be asked to provide de-identified NAPLAN Numeracy data for students in Year 7 and 9 for their scores in 2015 and 2013 in order to further understand student self-belief and its sources. I realise that I can withdraw my consent at any time without adverse consequences. I agree that research data collected for the study may be published or may be provided to other researchers in a form that does not identify me or my school in any way.

Name of School: ....

Name of Principal: ....

Signature: .... Date: ....

Associate Professor Shukri Sanber	Vince Connor
Principal Researcher	Student
Australian Catholic University	Australian Catholic University

Appendix J2 Parent/carers

PARENTS/CARERS INFORMATION LETTER

August 2015

RESEARCH TITLE: A comparative study between rural and non-rural contexts on student self-efficacy in secondary school Mathematics

PRINCIPAL INVESTIGATOR: Associate Professor Shukri Sanber

STUDENT RESEARCHER: Vince Connor

STUDENT'S DEGREE: Doctor of Philosophy

Dear Parents/Carers,

My name is Vince Connor, and I am currently a Consultant to Schools with the Catholic Education Office Bathurst. I am also an experienced secondary school mathematics educator and have many years of experience in low SES, rural and indigenous communities.

I am writing to you to invite your sons or daughters in year 7, 9 and 11 at XXXXXXX to participate in the research about student self-belief in Maths. Contact has already been made with Mr Gallagher who has given consent for this project.

What is the project about?

By studying student's perceptions on how well they can do Maths, it is hoped that this research will help in to understand the current trends in Maths achievement in rural and metropolitan students and that ways of improving student achievement can be recommended.

In order to help understand how students perceive their skills to solve Maths questions, students will be asked to complete a questionnaire of about 30 minutes. The questionnaire is titled *"Student Self-Belief with Mathematics"*. The questionnaire will be completed in students' normal classes with their normal class teacher. The questionnaires will be anonymous, so please be assured that individual students and individual schools will not be identified.

Conclusions from the research will be shared with your school. Findings, in the form of general data, from this study may also be used in other research. Actual questionnaires will be destroyed at the conclusion of the research.

Who is undertaking the project?

This project is being conducted by Vince Connor under the supervision of Associate Professor Shukri Sanber. Mr Connor is currently employed as a Consultant to Schools with the Catholic Education Office Bathurst and is a former Mathematics teacher.

Who do I contact if I have questions about the project?

Please contact Vince Connor ([redacted] or v.connor@bth.catholic.edu.au) for further information.

Can I withdraw from the project?

Participation in this study is completely voluntary, and you or your child can withdraw from doing the questionnaire at any time, even if you initially agree they can participate. If they are not involved in the questionnaire, the school will provide an alternate option. As the questionnaire is anonymous, once completed, the answers on the questionnaire cannot be withdrawn. Please note: The answers on the questionnaire cannot and will not be related back to an individual student.

What if I have a complaint or any concerns?

The study has been reviewed by the Human Research Ethics Committee at Australian Catholic University (review number 2015 35H). If you have any complaints or concerns about the conduct of the project, you may write to the Manager of the Human Research Ethics Committee care of the Office of the Deputy Vice-Chancellor (Research).

Manager, Ethics
c/o Office of the Deputy Vice-Chancellor (Research)
Australian Catholic University
North Sydney Campus
PO Box 968
NORTH SYDNEY, NSW 2059
Ph.: 02 9739 2519
Fax: 02 9739 2870
Email: resethics.manager@acu.edu.au

Any complaint or concern will be treated in confidence and fully investigated. You will be informed of the outcome.

What do I need to do to sign up?

The participation of your son(s) or daughter(s) in this project would be of great help in the student becoming more confident in Maths. If you are willing for them to participate please complete the attached consent form and return it to **Mr Vince Connor** at your school. Please ensure you sign both copies of the consent form.

Yours sincerely,

Vince Connor

Student Number [redacted]

PARENTS/CARERS CONSENT FORM

August 2015

RESEARCH TITLE:	A comparative study between rural and non-rural contexts on student self-efficacy in secondary school Mathematics
PRINCIPAL INVESTIGATOR:	Associate Professor Shukri Sanber
STUDENT RESEARCHER:	Vince Connor
STUDENT'S DEGREE:	Doctor of Philosophy

I agree that my son(s) or daughter(s) in Year 7, 9 and 11 at XXXXXXX can take part in the student questionnaire as part of this research. I understand that I can withdraw my consent at any time and that the names of students and schools will not be used in publications.

Name: ………………………………………………… Signature: …………………………………… Date:

Name (s) of Child/Children: ………………………………………………………… Year: …………

………………………………………………………… Year: …………

………………………………………………………… Year: …………

Thank you for your support.

Associate Professor Shukri Sanber
(Principal Researcher)
Australian Catholic University

Vince Connor
(Student)
Australian Catholic University

Appendix J3 Teacher Interview Consent form

Students Self-Belief with Mathematics

TEACHERS INFORMATION LETTER

RESEARCH TITLE:	*A comparative study between rural and non-rural contexts on student self-efficacy in secondary school Mathematics*
PRINCIPAL INVESTIGATOR:	*Associate Professor Shukri Sanber*
STUDENT RESEARCHER:	*Vince Connor*
STUDENT'S DEGREE:	*Doctor of Philosophy*

Dear Teacher

My name is Vince Connor, and I am currently a Consultant to Schools with the Catholic Education Office, Bathurst. I am also an experienced secondary school mathematics educator and have many years of experience in low SES, rural and indigenous communities.

I am writing to ask your consent to interview you in regard to students in year 7 and 9 at St XXXXXX Catholic School, XXXXXX, to participate in the research about student self-belief in Maths. Contact has already been made with Mr Gallagher who has given consent for this project.

What is the project about?

By studying student's perceptions on how well they can do Maths, it is hoped that this research will help to understand the current trends in Maths achievement in rural and metropolitan students. This research also seeks to recommend ways of improving student achievement.

In order to help understand how students perceive their skills to solve Maths questions, you will be asked to take part in a semi-structured interview of about 30 minutes. The interview is titled *"Student Self-Belief with Mathematics: a teacher's perspective"*. Your responses will be anonymous, so please be assured that individual teachers and individual schools will <u>not</u> be identified. I understand I have the choice as to whether my interview will be taped or summarised and that I will verify the content of the interview.

Conclusions from the research will be shared with your school. Findings, in the form of general data, from this study may also be used in other research. Actual questionnaires will be destroyed at the conclusion of the research.

Who is undertaking the project?

This project is being conducted by Vince Connor under the supervision of Associate Professor Shukri Sanber. Mr Connor is currently employed as a Consultant to Schools with the Catholic Education Office Bathurst and is a former Mathematics teacher.

Who do I contact if I have questions about the project?

Please contact Vince Connor ([redacted] or v.connor@bth.catholic.edu.au) for further information.

Can I withdraw from the project?

Participation in this study is completely voluntary, and you or your child can withdraw from doing the questionnaire at any time, even if you initially agree they can participate. If they are not involved in the questionnaire, the school will provide an alternate option. As the questionnaire is anonymous, once completed, the answers on the questionnaire cannot be withdrawn. Please note: The answers on the questionnaire cannot and will not be related back to an individual student.

What if I have a complaint or any concerns?

The study has been reviewed by the Human Research Ethics Committee at Australian Catholic University (review number 2015 35H). If you have any complaints or concerns about the conduct of the project, you may write to the Manager of the Human Research Ethics Committee care of the Office of the Deputy Vice-Chancellor (Research).

Manager, Ethics
c/o Office of the Deputy Vice-Chancellor (Research)
Australian Catholic University
North Sydney Campus
PO Box 968
NORTH SYDNEY, NSW 2059
Ph.: 02 9739 2519
Fax: 02 9739 2870
Email: resethics.manager@acu.edu.au

Any complaint or concern will be treated in confidence and fully investigated. You will be informed of the outcome.

What do I need to do to sign up?

The participation of your son or daughter in this project would be of great help in supporting students to become more confident in Maths. If you are willing for your child to participate in this questionnaire, please complete the attached consent form and return it to **Mr Vince Connor** at your school. Please ensure you sign both copies of the consent form but only return the "*Copy for Researcher*" to your school.

Yours sincerely,

Vince Connor

Student Number [redacted]

TEACHER'S CONSENT FORM

August 2015

Copy for Teacher: Please keep.

RESEARCH TITLE: A comparative study between rural and non-rural contexts on student self-efficacy in secondary school Mathematics

PRINCIPAL INVESTIGATOR: Associate Professor Shukri Sanber

STUDENT RESEARCHER: Vince Connor

STUDENT'S DEGREE: Doctor of Philosophy

I agree that I can be interviewed with my responses recorded in regard to student's self-belief in Mathematics at Year 7 and 11 at St XXXX. I understand I have the choice as to whether my comments will be summarised or taped. Summaries or transcripts will be verified by me before they are documented. I can withdraw my consent at any time, and my name, the names of students, and the school will not be used in publications.

Name: ………………………………………………… Signature: ………………………………………… .... Date:

Thank you for your support.

Associate Professor Shukri Sanber (Principal Researcher) *Vince Connor (Student)*

Australian Catholic University