Effects of a Mathematics acceleration course on achievement and continued Mathematics study

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A thesis submitted to Flinders University in fulfilment of the requirements for the degree of Master of Education (Gifted Education)

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Abstract

The purpose of this mixed methods research was to investigate the achievement outcomes, future enrolment in higher-level Mathematics courses, and program experiences of 13 students involved in a secondary Mathematics acceleration course. Differences in academic results (investigated using a Mann-Whitney U test) and enrolment choices (using proportions and confidence intervals) of accelerated students compared to equally high-achieving students who did not enroll in the acceleration course were analysed. Participants' experiences of Mathematics study were explored through a focus group interview (of accelerated students) and qualitative survey (of non-accelerated students), findings from which helped explain the quantitative results. Findings indicated no statistically significant group differences in achievement outcomes or prevalence of enrolment in high-level Mathematics courses, suggesting that students are not advantaged or disadvantaged by accelerating in relation to academic achievement. Course enrolment data has practical significance due to the high percentage differences in enrolment, indicating further investigation would be appropriate. Students' program experiences were generally negative, most participants indicating they felt they were not adequately supported in the program. Overall, the majority of participants felt that they were left alone to work through the program independently and that teachers were not able to provide them with regular support in the classroom environment. Most were appreciative of the opportunity to accelerate and the extra options at Year 12 that this provided, but were concerned that the program needed adjustment to meet the needs of the students. The findings are discussed relative to previous research on acceleration and implications for the design and implementation of acceleration programs.

Keywords: mixed methods, academic acceleration, Mathematics, student experiences, academically gifted

Table of Contents

List of Figures

List of Tables

List of Equations

Declaration

I certify that this thesis does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any university; and that to the best of my knowledge and belief it does not contain any material previously published or written by another person except where due reference is made in the text.

Rachel Neil

[June 30, 2022]

Acknowledgements

Words cannot truly express the gratitude I have for my husband Ian, who throughout this journey was my biggest supporter. For always encouraging me and picking up the slack at home with our children and household chores. I could not have found the time to put this project together without you and I appreciate everything you do for me and our family. I also want to thank my beautiful children Tayah and Archer, who somehow found the patience to let mummy work on her research. I know they are both glad that this is finally finished and look forward to more time to play together. To my larger support network of family and friends, for their endless support and encouragement, giving me the confidence to give research a go, I will always be thankful to you all. A special thank you to my mum Karen, and my sisters Roxanne and Michelle for always believing in me.

Thank you to my work colleagues for your endless support and encouragement. To the College for allowing me to complete my research with our students and especially to Justin who took the time to source and de-identify all the quantitative data used in the project. Your willingness to discuss ideas and general enthusiasm to find out the conclusions kept me excited to continue.

To my research supervisor, Jane Jarvis, for the endless hours of editing and feedback, I am so appreciative of all your time and support throughout this process. For sending me extra articles to consider, guiding me through the research process which was entirely out of my comfort zone and for your amazingly calm approach that helped to keep me grounded. Thank you for taking the chance on an unknown student.

Chapter 1: Introduction

Education has the lofty goal of meeting the diverse needs of all students for whom it is intended. The recent Alice Springs (Mparntwe) Declaration and its earlier 2008 iteration, the Melbourne Declaration, outline Australia's national goal of promoting equity and excellence in our young people through the provision of a world class education system (Ministerial Council on Education Employment Training and Youth Affairs (MCEETYA), 2008, 2019). Policy makers acknowledge that this is a joint effort between education providers, families and other supports within our society (MYCEETYA, 2019). Australia's national curriculum is written with the intention of fulfilling these declarations and ensuring that all students achieve both excellence and equity through education (Australian Curriculum Assessment and Reporting Authority (ACARA), n.d.-b). Yet, there are concerns that evidence from national literacy and numeracy testing (NAPLAN) reflects a decline in achievement over time and more recently, stagnation when comparing Year 9 students across years (McGaw et al., 2020). In 2018, results of the Programme for International Student Assessment (PISA) showed that Australian students were ranked 29th for Mathematics and were several years behind other countries, with continual decline since testing began in 2000 (Australian Council for Educational Research (ACER), 2018). In fact, fewer than 60% of the Australian 15-year-olds tested in 2018 were achieving the national proficient standard. In addition, data from Australian schools shows that for the highest achieving learners, academic growth can be least in terms of year-to-year progress (ACER, 2015; Dodd, 2015), suggesting that learning experiences and outcomes for this group of students warrants further attention.

Research suggests that educators and policy makers should be giving more attention to stretching academically high achieving students. In the literature, these individuals are sometimes referred to as ‘academically gifted’ or simply ‘gifted’. Providing appropriate learning opportunities to meet the specific needs of learners who have advanced academic abilities is the goal of gifted education (Duchesne & McMaugh, 2016; Farrall & Henderson, 2015; Gagne, 2018). While there are many different definitions of giftedness offered in the research literature, the Australian Government, through the ACARA, subscribes to Gagné’s model (ACARA, n.d.-a), although state policies include varied definitions. Gagne’s Differentiated Model of Giftedness and Talent (DMGT) considers a gifted individual to be someone who is in the top 10 percent of age peers and has an outstanding natural ability in one or more of the intellectual, creative, social or physical domains of human ability (Gagne, 1985, 2004, 2005, 2015, 2018). This model considers giftedness to be the potential of the individual, while talent is the positive expression of giftedness that can be seen or measured in the form of outputs (Gagne, 2004, 2018). The DMGT definition sits within the talent development paradigm in gifted education. Catalysts such as the psychosocial variables of self-regulation and motivation are “…determining factors in the successful development of talent” (Subotnik et al., 2011, p. 4). Within Gagne’s model there is an emphasis on developing capabilities and potentialities (gifts), placing catalytic importance on “…helpful adults and teachers who can cultivate the development of psychosocial skills (Olszewski-Kubilius et al., 2015, p. 145).” Formal selection, quantitative and qualitative assessments and self-selection opportunities are provided to help develop inclusive and diverse capabilities and aptitudes (talents) in individuals (Dai & Chen, 2013).

For the purposes of this study, high ability learners are defined as those who display high aptitude for Mathematics at Year 9, and through provided opportunities, continue to develop this talent throughout the acceleration intervention. Students in the current study, while not necessarily having formal diagnoses of giftedness, have been selected for an advanced academic opportunity in Mathematics, where selection is based on high performance in prior studies. It is due to the nature of the educational opportunity examined in this research that the literature on gifted students and impacts of acceleration can help to frame this study for these high achieving students.

Regardless of the definition of giftedness or high academic ability used, researchers agree on the nature of academic experiences likely to be appropriate. Little (2012) makes the connection between challenging curriculum and motivation, suggesting that the most able Mathematics learners are likely to flourish when provided with appropriately challenging academic tasks. The provision of challenging learning tasks in the classroom is consistently advocated as non-negotiable by gifted education researchers (VanTassel-Baska & Baska, 2019) and has been shown to benefit high-ability, underachieving students when implemented in a South Australian high-school based program (Long & Erwin, 2020). Alongside challenging academic curriculum is the idea that the social climate of the classroom can be considered a curriculum in itself and this in turn affects how students feel, interact and therefore learn (Henderson, 2018b). To address the affective needs of gifted learners, protective factors might include challenging curriculum (Neumeister, 2017) (compacting, acceleration, enrichment) which supports growth mindsets (Siegle & Langley, 2016), modelling mistakes and coping mechanisms as well as valuing effort (Neumeister, 2017). A cohesive approach to the education of academically advanced learners considers multifaceted and competing factors and aims to holistically support the development of these individuals.

A common and well-researched approach to the education of gifted students is acceleration—an umbrella term capturing a range of approaches whereby students access advanced content sooner or move through curriculum content at a faster pace than their chronological age peers. These approaches include early entry to school or university, or grade skipping (Assouline et al., 2018). At the site in this study, acceleration has been offered in the form of subject acceleration in Mathematics, using an additional supplementary course in Grade 9 followed by year level acceleration in Grade 10 and beyond. The purpose of this study is to determine the impact of the accelerated Mathematics course across several groups of students at an independent secondary school in Adelaide. Evaluation is an important component of academic intervention that is often lacking from many of the programs offered to advanced learners, particularly in Australian schools. Lack of evaluation of programs for gifted or academically advanced students in South Australian schools is evident from research conducted by Jarvis and Henderson (2012). It is intended that the conclusions from this research will help inform the future of the accelerative program at the site and have the potential to add to our current knowledge base of mathematical acceleration as an option for helping to address inadequate academic progress for high achieving students within Australian schools.

Research context

Participants were from four independent Middle Schools located within R-10 schools and one independent Senior School; together, these schools form One College in South Australia. During 2021 (there is no data currently available for 2022) the ACARA (2022), via the My Schools website, reported that the Middle School student numbers were between 650-891, and the Index of Community and Socio-economic Advantage (ICSEA) scores ranged from 61-69%; the Senior School had 591 enrolments and the ICSEA score was 64%. The ICSEA scores reflect that these sites are more educationally advantaged than this percentage of schools in Australia. The schools are all located in the outer metro region of Adelaide.

At each of the Middle Schools, students were selected for the accelerated Maths program from four Year 9 Extension Mathematics classes across each of the Middle Schools, based on achievement of an A grade and teacher recommendation. These students were offered the opportunity to engage in an extra course, *9 Accelerated*, which looked at Year 10 concepts not covered in Year 9 in the areas of geometry, statistics, and algebra (refer to Table 1 below).

Table 1

Curriculum content in 9 Extension and 9 Accelerated

Year 9 Extension Curriculum Content	9 Accelerated (Advanced Program)
Real Number	
Indices	
Patterns and Algebra	Inequalities
	Algebraic Fractions
Pythagoras Theorem	
Trigonometry	
Money and Financial Mathematics	Financial Mathematics
Geometry	Geometry
Linear and Non-Linear Relationships	Linear Equations
Chance	Chance
Measurement	Measurement
Data Representation	
	Statistics

Upon achievement of an A grade for both *9 Extension* and *9 Accelerated*, these students were offered the opportunity to undertake the course, Year 10 Stage 1 Mathematical Methods, which is usually undertaken in Year 11, whilst they were still in Grade 10. Students who accepted this offer completed this course in a Year 10 Extension Mathematics classroom for four or five 50-minute lessons and some in a Year 11 class for one 50-minute lesson per week (this was only available in Semester 1 of 2019 and only offered to students from 2 out of the 4 schools due to geographical constraints). An additional after school support lesson was offered to all students across the four schools once per week. Students were expected to be primarily independent and to require minimal support from the Year 10 Extension Mathematics teacher while working on the Stage 1 course. Students independently accessed online course material and followed a program outline to work through concepts and complete set class work. It was not expected that the Year 10 classroom teacher would be able to offer regular support to these students. Following this, some of the students progressed to Stage 2 Mathematical Methods whilst in Year 11 with some students electing to also study Stage 1 Specialist Mathematics. Some of these students also elected to continue to Stage 2 Specialist Mathematics the following year. The mathematical pathways observed by students in the study are outlined in Table 2 below.

The researcher is a current staff member at the Senior School in the Mathematics and Research Project Faculties and has taught a high proportion of the students relevant to the study at both Middle and Senior level. A challenge associated with the research conducted is the researcher's investment in the acceleration program. Being open to hearing about students' experiences of the program that were of a critical nature and avoiding biases were important in order to examine the outcomes of the program and inform the researcher's own practice.

Determining if the needs of these advanced learners is being met, through evaluation of the program in conjunction with the literature on gifted education will allow both the researcher and the site to make informed decisions about the future of the acceleration program. While the research will focus on addressing the academic outcomes and future Mathematics study choices of this group of students, it will also investigate the experiences of the students in regard to social, and to a lesser extent, psychological outcomes.

Table 2

Combinations of mathematical study observed in the research

Year 10	Year 11	Year 12
	Accelerated study pathways	
11 Mathematical Methods (full year)	12 Mathematical Methods 11 Specialist Mathematics (full year)	12 Specialist Mathematics
11 Mathematical Methods (full year)	12 Mathematical Methods 11 Specialist Mathematics (full year)	
11 Mathematical Methods (full year)	12 Mathematical Methods	
11 Mathematical Methods (full year)	11 Specialist Mathematics (full year)	
11 Mathematical Methods (one semester)	11 Mathematical Methods (full year)	12 Mathematical Methods
11 Mathematical Methods (one semester)	11 Mathematical Methods (one semester) 11 General Mathematics (one Semester)	12 General Mathematics
	Non-accelerated study pathways	
10 Extension Mathematics	11 Mathematical Methods (full year) 11 Specialist Mathematics (full year)	12 Mathematical Methods 12 Specialist Mathematics
10 Extension Mathematics	11 Mathematical Methods (full year) 11 Specialist Mathematics (one semester)	12 Mathematical Methods
10 Extension Mathematics	11 Mathematical Methods (full year) 11 Specialist Mathematics (full year)	
10 Extension Mathematics	11 Mathematical Methods (full year)	
10 Extension Mathematics	11 Mathematical Methods (full year)	12 General Mathematics

Chapter 2: Literature Review

This chapter reviews the research related to the outcomes of academic acceleration for students of high academic ability, in order to frame the current research and underscore its significance. What follows is an overview of research on acceleration of all forms as well as a more specific focus on acceleration in Mathematics. The review is a mixture of Australian and international research and encompasses the academic, social and emotional outcomes arising from academic acceleration.

Academic acceleration is the process whereby a student is moved through educational situations at a faster rate or at a younger age than is conventional (Assouline et al., 2018). There are numerous forms of acceleration including both subject and grade-based acceleration. Subject based acceleration typically allows the student to access higher level content, skills or understanding while remaining with same aged peers; grade-based acceleration or grade skipping occurs when students enter the schooling system earlier than is usual or the total length of time in the schooling system is reduced by means of skipping grades or compacting of the curriculum (Assouline et al., 2018).

Assouline et al. (2018) write about the effectiveness of academic acceleration for high ability learners, which is supported through their review of the extensive research on this subject. Some of these studies are compiled in their 2015 report, 'A Nation Empowered: Evidence Trumps the Excuses holding back America's brightest students'. Overall, they conclude that for accelerated students on average, there are positive academic (Rogers, 2015), social (Cross et al., 2015; Rogers, 2015), and psychological (Rogers, 2015) outcomes in both the short and long term (Assouline et al., 2018). Research has consistently shown that academic acceleration is a viable option to cater for the needs of academically advanced learners (Assouline et al., 2018; Dare et al., 2019; Maher & Geeves, 2013; Robinson & Shore, 2006; VanTassel-Baska, 1986). In fact, it is among the strategies with the strongest research evidence to support its implementation to address the needs of high ability students (National Association for Gifted Children, n.d.-b; Steenbergen-Hu et al., 2016). This evidence derives from research including multiple case studies, evaluations, meta-analyses, retrospective and prospective longitudinal studies of accelerated students, and studies of participants in talent search programs which include access to accelerated coursework (Assouline et al., 2018). It is important to consider the outcomes of academic acceleration in terms of several facets including, but not limited to, the academic performance of accelerated students, future study choices and the experiences of these students that helps to explain their outcomes and choices. Summarised below is the evidence from studies in relation to academic, social and psychological outcomes for talented learners, and discussion of the importance of evaluating interventions to ensure best practices are applied.

Academic, Social and Psychological Outcomes of Acceleration

Academic Outcomes

There is a considerable base of evidence that highlights the academic outcomes for advanced learners who are accelerated during their academic careers. This includes studies that investigate the futures of these young people and the experiences they have in the different forms of acceleration offered.

Studies reveal mixed findings about whether mathematically accelerated students perform better than same aged talented peers (Young et al., 2011), with some studies indicating they do better (Kulik & Kulik, 1984) while others have found no difference (Swiatek & Benbow, 1991). It is unfortunate that some evaluative studies have lacked control groups with which to compare outcomes (Kulik & Kulik, 1984); however more studies are taking place to compare accelerated students with equally able non-accelerated peers in order to get a better sense of the impact of this form of intervention on advanced learners. A 2009 US study investigating longitudinal data from the National Educational Longitudinal Study (NELS) and the Educational Longitudinal Study (ELS) looked at factors associated with grade acceleration and found that throughout high school, accelerated students showed greater gains in academic achievement, outperforming equally able non-accelerated peers (Wells et al., 2009). Students accelerated into university and working across multiple levels showed superior academic results at the highest levels (Hannah et al., 2011). Results of a study by McClarty (2015b) suggest that, on average, accelerated students consistently and significantly outperform non-accelerated peers of equal ability. In conjunction with the longitudinal data, these studies show that many of the common fears surrounding academic acceleration are unfounded. Research suggests that accelerated students achieve better than or at least equal to their non-accelerated peers of similar ability.

A case study by Scheibel (2010) explored the lived experiences of two highly gifted learners and concluded that academic acceleration enhanced and increased their achievement. Similarly, Victorian case study research on female accelerated students found that the participants generally had a higher mean score in Mathematics achievement than their Year 12 counterparts (Bartley-Buntz & Kronborg, 2018). These case studies add to the body of research supporting the implementation of acceleration for academically talented learners. VanTassel-Baska et al. (2021) report on research findings from evaluative studies indicates differentiation can have a significantly positive impact on the outcomes of gifted learners, with its implementation in Mathematics classrooms being the most successful of all subjects. They also discuss how best practices in differentiation were being underutilised in classrooms and the need for training to ensure there is a match between strategies and instructional purposes (VanTassel-

Baska et al., 2021), supporting the need for professional training (Almukhambetova & Hernandez-Torrano, 2020; Bickley, 2001). It is noted however, that for the most able learners, working in the highest Mathematics class in their age-determined year level may not meet that student's needs regardless of the differentiation offered (Rongel & Pello, 2004). Instead, it may be necessary to undertake detailed assessment of the learning needs of the individual student and this approach could mean that students who are capable of understanding high level mathematics would be chosen to participate in an advanced content program.

Aligning identification with programming is highlighted in the literature on best practices in gifted and talented education, with acceleration featuring among recommended service delivery options (Gubbins et al., 2021). In a study of German data (Kretschmann & Vock, 2014), students who were accelerated via grade skipping had comparable outcomes to equally able non-accelerated students. Other studies such as that completed by McClarty (2015b) confirm that grade skipped learners consistently achieve better than their older grade level peers of similar academic and demographic backgrounds. A 2016 study concluded that when provision is delivered by well-trained teachers, there may be positive results for students' academic achievement, attitude and motivation (Dimitriadis, 2016). This further demonstrates the need to align theory with practice and ensure that research is the foundation upon which gifted programming is built.

A 2016 meta-analytic study that analysed a century's worth of research data found that most forms of ability grouping and acceleration have a positive impact on academic achievement for advanced learners (Steenbergen-Hu et al., 2016). Similar results were found for the meta-analysis of studies between 1984-2008 by Steenbergen-Hu and Moon (2011), which indicated positive academic outcomes for accelerated students. In his chapter in the seminal report 'A

Nation Deceived: How schools hold back America's brightest students', Kulik (2004) also supports research on the positive effects experienced by accelerated students in terms of academic outcomes. However, he also discusses how the use of meta-analytic techniques have added precision and weight to reviews of research in this area allowing researchers to determine the strength of the effects in individual studies as well as the evidence in answering questions about acceleration (Kulik, 2004). This supports the conclusions drawn about the neutral and positive impacts of acceleration found from meta-analyses.

Intervention via academic acceleration is ranked highly in terms of impact on student achievement and is supported by Australian researcher John Hattie's (2017) meta-analytic research, which espouses the benefits of implementing approaches with effect sizes of greater than 0.4—the average for impact of an intervention over a given year (Hattie, 2017; Waack, 2019). Evidence from meta-analyses suggests that acceleration has a mean effect size of 0.68 (The Visible Learning Plus Program, 2017) which is equivalent to more than a year of academic growth and hence demonstrates the significant impact this form of intervention can have for advanced learners. Academically, Mathematics acceleration caters for the unique need arising from asynchronous development, due to the sequential nature of the subject allowing for logical progression at rates faster than normal.

A slightly different research angle is to consider future outcomes for accelerated individuals, with a number of longitudinal studies adding weight to the argument that this intervention type is successful for advanced learners. A report by McClarty (2015a) found that the impact of acceleration could be understood via both short and long term effects. Using the NELS, both survey responses of parents identifying that their child had skipped a grade and an age-based approach, accelerated students were identified and it was found that accelerants were more successful in their careers than equally able non-accelerated peers, both during the initial acceleration phase and then maintaining this into future career opportunities (McClarty, 2015a). Overall, this study found that accelerated students are generally more productive, tend to work in what are considered more prestigious occupations and are more satisfied in their jobs compared to peers of similar ability who did not accelerate (McClarty, 2015a). Surprisingly, Dossenbach (2017) found that accelerated students did not make significantly different choices in their selections for further mathematical studies than nonaccelerated students. It might be expected that the motivational levels of these students would be high, leading them to choose to continue their mathematical studies at higher rates than non-accelerated students. For example, Hannah et al. (2011) found that accelerated New Zealand students undertook broader university course selections, including more double degree enrolments, than equally able non-accelerated students. It is also possible that non-accelerated students of equal ability to accelerated students might have their motivation towards mathematics be negatively influenced by not being selected for accelerated classes. This leads to questions surrounding why eligible students choose to accelerate, whether it is their choice or that of the school system, and what experiences determine whether they continue along their accelerated path.

The long-running US Study of Mathematically Precocious Youth (SMPY) suggests no adverse implications on average for talented individuals accelerating, but instead suggests that they have a significant advantage through the ‘gain in time’ that they achieve (Swiatek, 2002). This links with other studies that show the positive impacts of academic acceleration on the future career aspirations and opportunities that accelerants experience and have access to (McClarty, 2015a). Further to this, the SMPY provides longitudinal research data to challenge myths such as accelerated students having gaps in their knowledge or that they might overwork themselves and ‘burn out’ (Swiatek, 2002).

Evidence from research should be utilised to implement best practices and ensure advanced learners are provided with programs that respond to their needs in both the short and long term. This is highlighted by Gross (2006) in her 20-year longitudinal study involving 60 exceptionally gifted young Australians. In this study, she highlights that those students who were provided opportunities for extensive acceleration were more likely to embark upon professional careers or undertake research degrees at high ranking universities than those who were limited to a year or less of acceleration (Gross, 2006). Further to this, Bartley-Buntz and Kronborg (2018) report that female accelerants were appreciative of the extra options for study at Year 12 following their acceleration, while Olszewski-Kubilius (1998) found in her study on validity and effects of talent search educational programs that students who were involved in summer or accelerated school programs were more likely to study higher level courses.

The experiences of accelerants can help to explain the academic outcomes observed both in the short and long term. Bartley-Buntz and Kronborg (2018) found that female accelerated students in Victoria valued the experience. A recent international study reported that participants valued their academic experience as it provided them with “…opportunities to develop personally, raise their aspirations, contribute to the development of the society, and build personal relationships with other fellow gifted students” (p. 127). Not providing opportunities for independent, self-regulated learning, which is within their current zone of proximal development (McInerney & McInerney, 2006), could mean that the unique needs of these students are not being met without access to accelerated opportunities. In a study by Smedsrud (2018), it was noted that “…few of the informants felt their needs were met through participation in the regular classroom, rather, acceleration opportunities made a difference for these students" (p. 8). The extensive literature on the academic outcomes of advanced learners who are accelerated highlights the importance of this intervention for performance, future achievement and overall experience.

Social Outcomes

The social outcomes of acceleration are largely discussed in terms of the asynchrony experienced by gifted learners. Asynchrony is defined by the National Association for Gifted Children (NAGC) as "the mismatch between cognitive, emotional and physical development of gifted individuals" (n.d.-a) There are concerns surrounding the implications that arise from moving younger students into social situations that they may not be ready for. Evidence to dispel concerns and address the social aspects of acceleration is increasingly being discussed in the gifted education literature and is outlined in the following paragraphs.

High ability learners often exhibit asynchronous development in that they are ready to move beyond grade level curriculum much sooner than is usual, in one or more academic domains (Wiley, 2018). It is important to consider the unique consequences of being out of sync cognitively and physically (Silverman, 1997), where your mental capabilities mirror that of older peers but physical attributes are more in line with same aged peers. "Asynchrony comprises uneven development, complexity, intensity, heightened awareness, risk of social alienation, and vulnerability" (Silverman, 1997, p. 36). With such high stakes outcomes, it is the supports put in place that can help advanced learners to adjust and experience positive outcomes that would otherwise go unrealised (Bickley, 2001).

Due to their asynchronous development, some advanced learners may be more cognitively and emotionally ready to pursue independent accelerative study than their same aged peers (Hannah et al., 2011). Opportunity to develop these skills is consistent with research on Self-determination Theory (SDT), which contends that autonomous motivation is beneficial for high engagement, performance and psychological wellbeing (Liem & Chua, 2016). This theory describes the need of all humans to satisfy three psychological needs: autonomy, competence, and relatedness (Hornstra et al., 2020). Autonomy refers to being an active participant in making educational choices; competence relates to having some control and being able to extend oneself academically; relatedness is about making meaningful connections and feelings of belonging (Hornstra et al., 2020). Persisting to become an expert in a field of talent is mediated by motivation which is a variable factor, but is viewed as the most important for attaining advanced performance in a particular domain (Neihart, 2016; Phillips & Lindsay, 2006).

Becoming an independent, self-regulated and motivated individual requires opportunity for practice in order to develop these skills to a level that will allow students to effectively set goals, monitor progress and seek feedback independently (McInerney & McInerney, 2006). A 2020 study applying the lens of SDT found that a learner's sense of self-determination was integral to their adjustment and achievement in higher education settings, where the learning environment and influence of key people were contributing factors (Almukhambetova & Hernandez-Torrano, 2020). Therefore, it is the responsibility of the academic setting, in conjunction with other key people such as parents, to provide opportunities to develop intrinsic and extrinsic motivation to support the development of high ability learners and promote positive self-determination, which are crucial for the success of these young people.

For advanced learners, readiness to become more independent may occur earlier than for their same aged peers as exhibited by the asynchronous development often demonstrated by these students (Hannah et al., 2011; Wiley, 2016b). This asynchrony may see these advanced students not just more cognitively but also more emotionally ready to pursue independent accelerative study than their same aged peers. In their study, Young et al., (2015) discuss accelerated students' preference for less formal support structures and how being self-motivated prior to university entry may have been a contributing factor in the participants' overall success during acceleration and beyond. This is consistent with Little (2012), who discusses the need for curriculum that is challenging and formulated within a supportive learning environment. When the right level of challenge is made available to students of high ability, the evidence suggests that there are positive outcomes academically, socially and psychologically (Assouline et al., 2018).

An Australian study that features in the 2015 report 'A Nation Empowered: Evidence Trumps the Excuses holding Back America's brightest students', reported that accelerated students flourished when in environments where they felt challenged and were able to engage with intellectual peers (Young et al., 2015). On the other side of the argument, Ma (2002) suggests that a lack of well-developed study skills may cause issues for students who are accelerated in Mathematics, which may impact not only on their academic success but also their self-esteem. This reinforces the need for practice and monitoring of students as they develop these skills to a high level and teachers should have a role in this process. The support of family, friends and teaching staff to engage and assimilate into environments where high ability learners can make connections with intellectual peers is crucial in this process (Young et al., 2015). Planned and monitored implementation of mentoring programs that support accelerated students can mean the difference between an intervention being successful or not (Wardman & Hattie, 2012). While the current study does not specifically examine the variables of motivation, self-esteem or study skills, the qualitative component provides an opportunity to explore accelerated students' experiences and shed light on factors that may be associated with their academic achievement and choices.

Psychological Outcomes

Accelerated learners often find themselves in situations that require them to assimilate and negotiate academic and social climates that are more pronounced than those of same aged peers. Consideration of the socio-affective implications of acceleration highlights the need to utilise research evidence to ensure best practices are applied to the education of high ability students. This includes the impact of key individuals, psychosocial variables and in particular the role of motivation and provision of appropriate challenge.

Neihart (2007) discusses the socio-affective benefits of various forms of acceleration for gifted students who are selected based on reasonable criteria and how the converse is true for those who are arbitrarily selected, leading to negative effects. This study highlights the need for research-based selection criteria for accelerated programs.

The overwhelmingly positive academic and neutral results for social and emotional concerns when analysing research on the social and emotional impact of acceleration (Wiley, 2016a) further supports the use of this provision for highly able learners, although it is acknowledged that students should still be selected on a case-by-case basis taking into account individual circumstances. Steenbergen-Hu and Moon (2011) in their meta-analysis found evidence that there is a slightly positive effect on social-emotional development arising from academic acceleration. Kulik (2004) also agrees with the positive effects experienced by accelerated students in terms of social-emotional outcomes. Bernstein et al. (2021) compiled a 35-year longitudinal study that refutes the claims of negative long term social and emotional implications for high potential students who choose to accelerate. Each of these studies add to the evidence that the effects experienced by accelerated students are typically either somewhat positive or reflect social-emotional outcomes comparable with non-accelerated peers, and many of the proposed negative impacts are unfounded. In her 20-year longitudinal study, Gross (2006) highlights that those students who were provided opportunities for extensive acceleration reported higher degrees of life satisfaction, as well as more positive social outcomes than those who were limited to a year or less of acceleration (Gross, 2006). Cavilla (2019) argues for support of social-emotional learning for school aged children, which in turn caters for the unique affective needs of gifted learners.

Literature on the influence of key individuals such as parents, peers and teachers in the psychosocial development of gifted learners is well documented and emphasises the impact they can have in helping, or hindering, a persons' adjustment and achievement (Almukhambetova & Hernandez-Torrano, 2020). Psychosocial variables such as self-perception, motivation, task commitment, resilience, grit, growth mindset, social supports, and environment (Subotnik et al., 2011), which are malleable (Callahan et al., 2018), directly influence talent development and play a large role in optimal development (Subotnik et al., 2016). Academic and affective curriculum can aid in the development of social and emotional literacy and has the potential to directly affect talent development of gifted learners. Provision of "domain-specific talent development programs that simultaneously cultivate and enhance psychosocial skills critical to success in chosen fields" (p. 149) is advised and argued for in the development of talent for high-ability learners (Subotnik et al. (2016). Research highlights these important relationships as well as the dual nature of academic and affective curriculum that is vital in supporting high ability learners to reach their potential.

In the same way that a student with learning difficulties needs support in the form of appropriate challenge, so too do high ability learners. Academic acceleration is one available option that has consistent research to show that it is a viable option to cater for the unique needs of talented learners (Assouline et al., 2018; Maher & Geeves, 2013; Robinson & Shore, 2006; VanTassel-Baska, 1986; Young et al., 2015). Mathematics is the subject most likely to use acceleration to cater for the needs of advanced learners (Anthony et al., 2002; Jarvis & Henderson, 2012; Ma, 2002) because students with high ability can progress at much faster rates.

Acceleration has a considerable evidence base to support its implementation (Assouline et al., 2018; *A Nation Empowered: Evidence trumps the excuses holding back America's brightest students*, 2015; National Association for Gifted Children, n.d.-b; Steenbergen-Hu et al., 2016) however, Australian research suggests that school leaders are reluctant to introduce it, citing fears for the social and emotional development of students, both gifted and otherwise (Gallagher et al., 2011). Issues such as adequate timetabling, program funding and support from school leaders significantly impact the implementation of interventions (Wardman & Hattie, 2012). The Australian Association for the Education of the Gifted and Talented (AAEGT) compiled an information sheet aimed at educators to discuss some of the common concerns that are highlighted. General concerns include whether acceleration may cause undue stress to the child, whether the Australian Curriculum allows for this type of intervention, whether it will cause gaps in the child’s knowledge, are there equity issues, the impact on the social and emotional development of the student and non-accelerated students losing their ‘role models’ (AAEGT, 2021).

A study by Dimitriadis (2016) highlights the need to utilise gifted theory and research to inform appropriate identification and provisions to meet the needs of mathematically advanced learners. This begins with appropriate identification of gifted and talented learners which is more successful when undertaken by teachers who are comfortable to make recommendations based on having training in this area (Bickley, 2001; Johnsen, 2017; Lakin & Rambo-Hernandez, 2019; Merrick & Targett, 2004).

The psychosocial variable of motivation plays a large role in the optimal development of talent (Neihart, 2016; Subotnik et al., 2011; Subotnik et al., 2016). An individual's mindset is a crucial factor in self-perception and the mediation of the thoughts and behaviours that impact effort and motivation (Dweck, 2014; Henderson, 2018a; Liem & Chua, 2016; Neihart et al., 2016; Siegle & Langley, 2016; Tan et al., 2016). The Fullerton longitudinal project reported that "… cognitive potential, intrinsic motivation, and enriched environments reciprocally interact with one another to foster precocious intellectual development…" (Dai et al., 1998, p. 54). The impact of intrinsic motivation on gifted and talented development is highlighted through the findings of this study. Challenging curriculum supports the development of a growth mindset (Siegle & Langley, 2016) because advanced potential is a defining component of giftedness in most conceptions (Little, 2012) and positive responses to failure can lead to greater academic achievement (Sisk et al., 2018). Due to research linking motivation to task engagement (Liem & Chua, 2016), implementing strategies like providing challenging curriculum, compaction, acceleration, enrichment and teaching at a conceptual level (Neumeister, 2017) can be used to enhance motivation in learning.

Scaffolding learning to allow for individualised options including independent study, self-paced learning and acceleration can also help to increase academic motivation (Lee, 2016). It is evident from research that active promotion of motivation via engagement and appropriate curriculum should be utilised and acceleration as an option, features heavily in this evidence.

Providing suitable challenge to all students, including those who demonstrate high ability has a direct link with engagement and intrinsic value placed on learning (Little, 2012; Rich, 2018).

Lack of challenge can lead to disinterest and poor motivation (Liem & Chua, 2016; Siegle et al., 2018; Tan et al., 2016) and may result in underachievement (Gagne, 2018; Maher & Geeves, 2013; Siegle et al., 2018; Tan et al., 2016). Underachievers are individuals who demonstrate a higher potential than what is exhibited through the work they produce (Siegle et al., 2018). There is evidence to suggest that for some gifted learners who are underachieving, acceleration can be a useful tool to re-engage them in a low risk environment whilst also allowing them to make the connection between effort and success that they may have otherwise not learned (Rimm & Lovance, 1992), assuming that they are identified for programs in the first place. A failure to promote a sense of autonomy, or to allow learners to function independently in less structured environments may contribute to gifted underachievement (Almukhambetova & Hernandez-Torrano, 2020).

All students are entitled to rigorous and challenging curriculum and learning experiences that meet their individual needs (ACARA, n.d.-c; Maher & Geeves, 2013; MCEETYA, 2008). In order to address the affective needs of gifted learners, protective factors (variables that promote positive outcomes by shifting developmental pathways (Reis et al., 2005)) might include challenging curriculum (Neumeister, 2017) (compaction, acceleration, enrichment) which supports growth mindsets (Siegle & Langley, 2016). This supports the idea that challenging curriculum can have a positive impact both academically and socio-affectively.

The large number of case studies, instrument evaluations, meta-analyses, retrospective and prospective longitudinal studies of accelerated students, and studies of participants in talent search programs (Assouline et al., 2018) show that it is the strategy that has the most research evidence to support its implementation (National Association for Gifted Children, n.d.-b; Steenbergen-Hu et al., 2016). In their concluding chapter of "the Social and Emotional Development of Gifted Children: What Do We Know?" Neihart et al. (2016) highlight "the importance of challenge and a 'match' with the environment for optimal social and emotional adjustment" (p. 283). The evidence presented from decades of research highlights the need for providing appropriate challenge, affective as well as academic curriculum and training for key individuals to ensure they can utilise best practices to support advanced learners and to help them flourish.

The Need to Evaluate Educational Interventions

While research has established the importance and benefits of acceleration for high ability learners, there is a gap in knowledge regarding evaluation of these interventions. This is particularly true in an Australian and locally in a South Australian context (Jarvis & Henderson, 2012). It is critical to effective professional learning that educators of the gifted and talented collaborate on examining student work (Ingvarson et al., 2003). This allows for professional dialogue at the local level which is an important component in the overall evaluation of an intervention. At the next level, representation from all key stakeholder groups is necessary to alleviate any concerns regarding equity and to ensure the evaluation process is transparent (Fitzpatrick et al., 2004). Understanding when and why gifted programs are effective is crucial to advancing the science of gifted education (Lakin & Rambo-Hernandez, 2019). An educator who is proficient at determining program effectiveness can be more efficient and provide greater flexibility to meet the needs of learners (Lakin & Rambo-Hernandez, 2019).

In general, evaluation is a key component of evidence-based practice that aims to enhance the quality of research and curricular theories in the provision of gifted education (Lakin

& Rambo-Hernandez, 2019). The benefit of this is a body of conclusive, research evidence that ultimately leads to better programming to meet the needs of advanced learners. This research aims to contribute to bridging the gap in current understanding of interventions by allowing for evaluation of the acceleration program being run in a South Australian secondary school.

Research Questions

Through a mixed-methods research design, this study addresses the following research questions related to the evaluation of an accelerated secondary Mathematics program:

1. How do students who were accelerated from Year 9 Extension Mathematics into Year 10 Stage 1 Mathematical Methods and beyond perform (in terms of academic achievement in Stage 1 and 2 Maths courses) compared to students with similar Year 9 achievement who were not accelerated?
2. To what extent do accelerated students choose to continue into Year 11 Stage 2 Mathematical Methods and/or Stage 1 and Stage 2 Specialist Mathematics?
3. What are the experiences of accelerated students that help to explain their performance in Year 10 Stage 1 and Year 11 Stage 2 Mathematical Methods and their decision relating to continued study of higher-level Mathematics?

Chapter 3: Methods

This chapter introduces the methods used to investigate the research questions leading to evaluation of the Mathematics acceleration course for academically advanced secondary students. First, a rationale for the use of the mixed methods research design is outlined to highlight the suitability of this method to answer the research questions. Following this is a detailed description of the data collection methods, which consisted of accessing and analysing de-identified quantitative data from the site, conducting a focus group interview with accelerated students, and surveying a comparison group of equally able non-accelerated students. Issues related to the credibility of the study, limitations and ethical considerations are discussed.

Research Design

This study employed an explanatory sequential mixed methods design to explore the research questions. A mixed methods design was able to provide more comprehensive understanding of the data than a single method alone (Creswell & Guetterman, 2019c). This research design allows the mixing of quantitative and qualitative methods in a single study to have one type of data explain the other (Creswell & Guetterman, 2019c). The explanatory sequential design (as represented in Figure 1) was most appropriate as the quantitative data (achievement data and course selections) was first collected, followed by qualitative data (focus group interview and survey) to help explain and elaborate on the quantitative findings (Creswell & Guetterman, 2019c).

Figure 1

Explanatory Sequential Mixed Methods Design

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A pragmatic paradigm was adopted by the researcher to integrate the collection and analysis of quantitative and qualitative data. Pragmatism embraces the extremes of positivism and constructivism, offering a flexible and more reflexive research design where the researcher can make choices about the research design and methodology whilst being actively involved in creating data as well as theories (Kaushik & Walsh, 2019). Guided by a pragmatic paradigm, the initial focus was on research questions 1 and 2—determining the impact of the acceleration intervention for the accelerated group compared to their non-accelerated, equally high-achieving peers. As the purpose was to look at the overall outcomes of the course, the experiences of the participants were particularly important to explore. To fully answer this question the researcher needed to consider research question 3—the experiences of the students that helped to explain the results of the quantitative analysis.

The pragmatic approach to inquiry informed a process of planning that began with the research question; after consideration of options for investigating the problem, this led to the mixed methods research design and finally the explanatory sequential design (Morgan, 2018). The social construction of knowledge in this context was relevant to students' own experiences (Kaushik & Walsh, 2019; Morgan, 2018) within each group and across groups on multiple levels, adding a dynamic component to the research that could only be evaluated from a pragmatic perspective.

Participants and Recruitment

Participants were 26 secondary school students (15 female, 11 male; approximate age range 16-18). No information about participant ethnicity was available. The initial population of participants was selected using convenience sampling from the Grade 9 Extension classes across four Middle School sites that form part of an independent school in suburban Adelaide, South Australia, based on data for the 2018-2019 Australian school years. The 2018 cohort were the first students to participate in the 9 Accelerated course and completed Stage 1 Mathematical Methods in 2019 and Stage 2 in 2020. The 2019 cohort followed the same pattern in the following year. There were 17 students across the two years who successfully completed the 9 Accelerated course and were offered the opportunity to accelerate past Year 10 Mathematics into Stage 1 Mathematical Methods whilst in Grade 10. Prior to recruitment, any students with incomplete data (less than a full year of Stage 1 Mathematical Methods) were excluded from the sample, leaving a total of 26 students (13 accelerated and 13 non-accelerated participants) whose grades and subject pathways were included in the analysis.

The researcher contacted potential participants and parent/guardians of students under the age of 18, requesting signed consent to participate in the study. Students taught directly by the researcher in 2021 were not invited, to avoid ethical concerns. From this process, eight participants (out of a possible 13) formed the accelerated sample for the focus group interview. This included 3 female and 5 male participants, with ages ranging from 16 to 18 years. The email explained the purpose of the research, details relating to the privacy, confidentiality, and anonymity (where appropriate) for the proposed study as well as details for the intended publication of data (see Appendix B(a)).

Over the same period there were 14 students (13 with complete data) who were eligible to complete the 9 Accelerated course who either did not achieve the requisite 'A' grade, chose not to accelerate to the Stage 1 Mathematical Methods course, or chose not to participate in 9 Accelerated. Of the 13 non-accelerated students (7 female, 6 male), five (3 female, 2 male) were current students in 2022 who the researcher was not teaching. In February of 2022, these students were emailed, inviting them to participate in the study by gaining consent from both them and their parents (see Appendix B(b) for alternate consent form). From these five students, three (2 female, 1 male) returned the survey. Ages ranged from 16 to 17. The eight students who graduated in 2021 were emailed with an introduction to the study, inviting them to participate. From this, two students responded they would like to be involved, with one also requiring

Table 3

Summary of participation

Accelerated	Non-accelerated	
8 female	7 female	
5 male	6 male	
Focus group participants	Survey participants	
	Current students	Graduated students
3 female	2 female	none
5 male	1 male	

Note. N=26, female (n = 15), male (n = 11).

parental consent. However, from the remaining graduated students (4 female, 4 male), none returned the survey, and no age data were available. Participants for each component of the study are summarised in Table 3 above.

Procedures: Data Collection

Data were collected from three sources. The first source (Source A) was the de-identified quantitative grade and course selection data. This data was used to compare the accelerated and non-accelerated results and choices of students to determine if there were any differences in achievement or pathway choices in later Mathematics. The second source of data (Source B) was the transcript from the focus group interview with accelerated students. This data was used to explore the experiences of the accelerated students and to help explain the quantitative findings based on Source A. The focus group allowed for time efficient collection of data and allowed the researcher to explore experiences from participants via shared discussion. The third source of data (Source C) was the opinions of students who achieved 9 Extension Mathematics grades that would allow them to participate in the 9 Accelerated course and/or accelerate further, but who chose not to. An open-ended survey was conducted in order to be time efficient and to include some perspectives and experiences from a comparison group.

Quantitative Data Collection

Source A – Quantitative grade and courses studied

The de-identified data were first emailed to the researcher by school leaders in December of 2021. Following the publication of SACE results later that month, the data were updated and re-sent in January 2022. These data included results in the form of letter grades for Semester 1 and Semester 2 of Grades 9-11 Mathematics and a full year for Grade 12. Additionally, the Grade 12 data were broken down into results in the form of a number from 0-15 correct to 1 decimal place (reported by the SACE board), that included the students' school grade (70% of assessment contributing to the overall grade), external grade (30% external examination) and the final grade (100% of assessment) for a total of 31 students (14 who accelerated to start 11 Methods in Year 10 and 14 who continued in their age defined progression. The remaining 3 students left the school at the end of Year 9 and no further data was available). Within the document, the courses studied by these students was indicated by the presence of a grade for that semester or year.

Qualitative Data Collection

The second phase of data collection was the qualitative component, which included a focus group interview with accelerated students and a survey of non-accelerated students.

Source B – Focus group interview

The focus group interview ran for approximately 70 minutes and was conducted at the Senior School of the College. Information relating to privacy, confidentiality, and the ability to withdraw without consequence was repeated at the beginning of the focus group interview. The research questions were written and adapted in consultation with the research supervisor, and were informed by the review of literature. Questions were initially written to gain understanding of students' experiences with the 9 Accelerated course which then developed into later experiences of full year acceleration during Year 10 (completing Stage 1 Mathematical Methods) and Year 11 (completing Stage 2 Mathematical Methods). These questions aimed to find out how students found the program and potential improvements that could be made. During the focus group interview, questions (see Appendix C for the full list of focus group questions) were posed to the group of accelerated students, and their responses and dialogue were audio-recorded and later transcribed by the researcher. These questions related to the reasons for students' decisions to study particular Mathematics courses, what their experiences were of the different components of the acceleration intervention (including the social climate within the classroom and the out of school support sessions) and how this compared to previous experiences.

Source C – On-line survey

For the surveys sent to the three current students, the research questions were adapted from the original focus group interview questions with a focus on the initial 9 Accelerated course intervention the developed into the outside perspectives of the students who were achieving similarly in Mathematics but did not accelerated (see Appendix D for a full list of survey questions sent to non-accelerated). These questions related to the reasons for students' decisions to study (or not study) particular Mathematics courses, what their experiences were of the 9 Accelerated intervention, and how this compared to previous experiences. They were also asked to discuss their perception of the social climate of the classroom while completing 9 Accelerated. These students were surveyed to gain the perspectives of those who may have been eligible to participate in the 9 Accelerated course who either chose not to participate, chose not to accelerate further, or did not achieve the requisite grades to continue acceleration. The viewpoints of these students are important to gain insight into their perspectives relating to both the acceleration intervention and subsequent acceleration that followed. These perspectives will be considered along with those of the accelerated group to better understand the results of the study.

Procedures: Data Analysis

Quantitative Data Analysis

Data were first analysed by considering the de-identified quantitative results provided by the school. Prior to data analysis, five cases were removed from the data set due to incomplete data. To begin answering whether accelerated students perform as well as non-accelerated students, letter grades were converted into numerical data. This was accomplished by taking each letter grade (E- to A+) with each successive grade being one point higher out of an overall 15-point scale. For example, a C- would be 7 out of a possible 15 points and was changed to 46.67%. The grade to percentage conversion is shown in Table 4 below, with only A+ down to C- shown as no grades went below this value. Conversions of letter grades using this method is supported in the literature for South Australia at Stage 2 (SACE Board of South Australia, n.d.) and has been applied to the data across Grades 9 to 12 in the research.

Table 4

Conversion from letter grade to percentage used for analysis

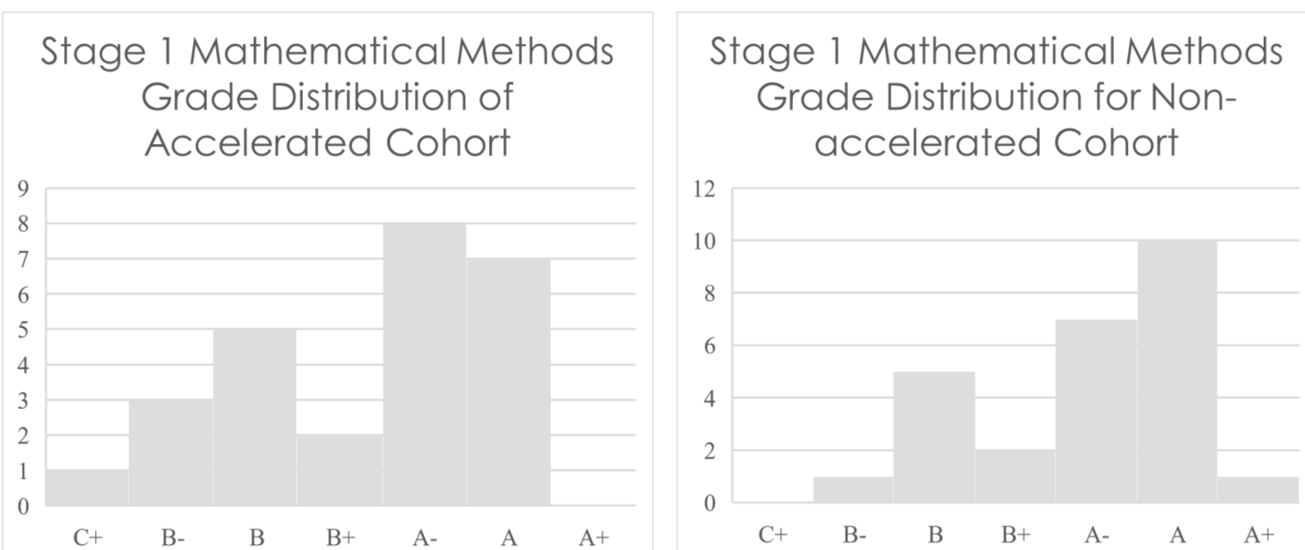
Letter Grade	Score out of 15	Percentage
A+	15	100
A	14	93.33
A-	13	86.67
B+	12	80
B	11	73.33
B-	10	66.67
C+	9	60
C	8	53.33
C-	7	46.67

It was evident from the grade data that results were negatively skewed as the E- to D+ range did not feature in results as shown in Figure 2. Due to the non-normal distribution of the data, it was determined that a non-parametric test would be most appropriate (Creswell & Guetterman, 2019b).

The Mann-Whitney U Test is most appropriate for non-parametric statistics where there is one variable across two independent groups and there is no relationship between observations in each group or between them. As both groups had a similarly negatively skewed distribution, this test can be used to compare the mean ranks to form conclusions from the data (Lund & Lund, 2018). Statistical program IBM SPSS Statistics for Windows version 28.0 (SPSS) was used to compare the mean percentage scores of students in 9 Extension Mathematics to determine if it was appropriate to compare the Accelerated and Non-Accelerated groups. The same statistical tests were then applied to data for Stage 1 Mathematical Methods and Stage 1 Specialist Mathematics for Semesters 1 and 2 separately. This was due to the Methods course being completed in separate years by the students in each of the accelerated and non-accelerated groups, and there being a potential change in teacher from one semester to the next in each Stage 1 course.

Figure 2

Grade distributions in Stage 1 Mathematical Methods



Stage 2 data for Mathematical Methods and Specialist Mathematics were a full year with the final score being reported as a number out of 15 (correct to 1 decimal place) from the SACE Board of South Australia. This data was also converted to a percentage value using the following formulae:

Equation 1:

Conversion of scores out of 15 to percentage values for analysis

$$\%score = \frac{score\ out\ of\ 15}{15} \times 100$$

At this point the SPSS package was used to run the Mann-Whitney U Test on corresponding sets of data to compare the following sets of results: Stage 1 Semester 1 and Semester 2 results (separately) and Stage 2 (full year) results for Mathematical Methods and Specialist Mathematics. The effect size for the Mann-Whitney U Test was calculated using the formulae for the Glass rank biserial correlation coefficient (r_g):

Equation 2:

Calculation for the Glass rank biserial correlation coefficient

$$r_g = \frac{2|M_1 - M_2|}{n_1 + n^2}$$

where M_1 and M_2 are the mean ranks of the scores in the two groups and n_1 and n_2 are the corresponding samples sizes (Gray & Kinnear, 2012). Following calculations for the Glass rank biserial correlation coefficient, interpretation of the strength of the relationship, based on the calculated effect sizes, was made using guidelines from Leech et al. (2008).

Data related to research question 2, regarding prevalence of higher-level Mathematics study, were analysed by first coding data so that a student who participated in a particular course was labelled 1, and those that didn’t were labelled as 0. Initially this was done to represent students who accelerated (1) and those who did not accelerate (0) to complete Stage 1 Mathematical Methods. This then extended to Stage 2 Mathematical Methods, as well as Stage 1 and 2 Specialist Mathematics where a student who completed the course was labelled (1) and those who did not were labelled (0) across both groups of students. This data was a discrete random variable, and it was appropriate to analyse by finding the sample proportion of students who elected to complete each subsequent course. The formulae used for sample proportion ($\hat{p}$) (Haese et al., 2016):

Equation 3:

Calculation for the sample proportion for a population

$$\hat{p} = \frac{number\ completing\ course}{total\ students\ in\ group}$$

This value was entered into the online calculator Epitools (Ausvet, 2022) along with the sample size for each group. The level of significance was set to *0.05* to determine results with 95% confidence. The test was two-tailed so that the 5% of uncertainty would be equally distributed at either end of the distribution. In the Epitools online program, this produced the difference, 95% confidence interval, z-value, p-value, interpretation, and n by pi for this data set allowing for analysis of the results for each mathematical course.

The confidence interval for the accelerated population was manually found using the formulae:

Equation 4:

Calculation for the 95% confidence interval

$$\hat{p} - 1.96\sqrt{\frac{\hat{p}(1-\hat{p})}{n}} \leq p \leq \hat{p} + 1.96\sqrt{\frac{\hat{p}(1-\hat{p})}{n}}$$

Where $\hat{p}$ is the sample proportion, 1.96 is the z-score for a 95% confidence level, n is the sample size and p is the population proportion and $1.96\sqrt{\frac{\hat{p}(1-\hat{p})}{n}}$ is the margin of error for the confidence interval (Haese et al., 2016). The confidence interval for the accelerated group was compared to that found from Equation 4 to ensure the online calculator was accurate before using for further data analysis and evaluation.

Qualitative Data Analysis

The qualitative portion of the research utilised thematic analysis to code and interpret data (focus group interview transcript and open-ended survey responses) to address the research question about participants' program experiences. Clarke and Braun (2017) discuss how using this form of analysis allows the researcher to code and subsequently form themes through a two-stage review process, thus producing rigorous and high-quality analysis. It is described as a

Figure 3

Visual Model of the Coding Process in Qualitative Research

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powerful method that is appropriate to use when researchers want to "understand a set of experiences, thoughts or behaviours across a data set" (Kiger & Varpio, 2020, p. 847). The process of coding is represented in Figure 3 above.

Thematic analysis was applied to the focus group transcript to explore the experiences and perspectives of the accelerated groups in relation to the intervention to see if this could help to explain the quantitative results. This process was repeated for the survey responses collected from the non-accelerated group in order to compare to the experiences of the accelerated group as well as explaining their own results and decisions.

Coding the data

The coding process adopted for the study followed the model shown in Figure 3 above. The first step in analysing the qualitative data was to individually read through the transcript and survey responses. This provided an overall sense of each data set. Following this, key words and phrases were taken from the data using a combination of in vivo codes (participants' actual words) and using standard educational terms (Creswell & Guetterman, 2019a). This provided an initial coding scheme as recommended by Creswell and Guetterman (2019a), with codes placed into the left hand margins of the document. Other themes and ideas were placed to the right of the text allowing the researcher to take note of any patterns, interesting quotes and potential themes (Creswell & Guetterman, 2019a). Broad themes were identified from the transcript of focus group data with accelerated participants and separately for the survey responses of non-accelerated students. Each data set was used to create a table to summarise the overarching themes, sub-themes and supporting quotes.

Integrating the results

The results from the quantitative and qualitative analysis were summarised and integrated as presented in the findings chapter of the thesis. The themes identified through analysis were used to provide a framework for understanding the quantitative results and drawing inferences about how the experiences and perceptions of students can help to explain these outcomes.

Validity and Reliability

The small number of respondents to the survey of non-accelerated students, with only the 2019 cohort responding, limits the overall perspectives of this group. The small sample for the focus group was partially limited by a reduced participant pool due to ethical concerns (no current students of the researcher were included in the group).

The small sample size involved in the project limits the statistical power of data analysis and makes results less reliable as they are not generalisable to larger populations. The unique aspects of the intervention also limit generalisability as the program is specific to the site and not one that is being run across a larger population outside of the college involved in the current research. It is acknowledged that this small study can best be considered site-specific, but findings may add an additional voice to the literature on acceleration and highlight important areas for further research.

There is also the issue of comparability from one year to the next. The participants included in the study span a total of two years across the initial years of the intervention (*9 Accelerated*) in 2018 and 2019, which adds to confounding effects as over this time there were different assessment measures and teachers involved with the program. There may have been differences in assessment level, teacher marking standards, and consequences due to the absence of qualified teachers at the Stage 1 level. There is an overall ceiling effect of testing measures due to the obvious skew associated with results given the academically advanced population (refer to results chapter).

Ethical Considerations

Prior to data collection, an application to the ethics board of Flinders University was made. During the data collection process across 2021 and 2022 the researcher was employed by the Senior School and was the Mathematics teacher for several students in Stage 1 and 2 Mathematical Methods as well as Stage 1 Specialist Mathematics from both the accelerated and non-accelerated populations. To conduct the research ethically, it was decided that no students currently being taught by the researcher during data collection would be asked to participate. This ensured that no student would feel coerced to be a part of the research being conducted.

During the data collection process for the focus group interview and survey, the participant information form clearly outlined participants' rights regarding their participation, sharing of information and ability to withdraw at any time with no adverse consequences. At the beginning of the interview, this information was reiterated so all participants were aware that they could leave, choose not to answer any questions, or withdraw their information at any time following the interview.

Anonymity of results and subject choices was ensured by provision of de-identified data provided by the Senior School where students finalised their Mathematical acceleration. Anonymity was also possible for the non-accelerated students who provided survey data. While they were not anonymous to the researcher, no identifiable information was reported or shared in the presentation of research findings. The focus group data was kept confidential and not shared beyond the researcher and their supervisor. It is confidential as these students were known to each other via participation in the focus group and it is recorded within the school that these students participated in the acceleration program across several years.

Chapter 4 – Findings

This chapter outlines the results of the analysis of grade and subject choice data, as well as the findings from the thematic analysis of focus group interviews and surveys. These findings address the following research questions posed in this study:

1. How do students who were accelerated from Year 9 Extension Mathematics into Year 10 Stage 1 Mathematical Methods and beyond perform (in terms of academic achievement in Stage 1 and 2 Maths courses) compared to students with similar Year 9 achievement who were not accelerated?
2. To what extent do accelerated students choose to continue into Year 11 Stage 2 Mathematical Methods and/or Stage 1 and Stage 2 Specialist Mathematics?
3. What are the experiences of accelerated students that help to explain their performance in Year 10 Stage 1 and Year 11 Stage 2 Mathematical Methods and their decision relating to continued study of higher-level Mathematics?

Determining if the initial populations are comparable

The literature suggests that high ability learners who are accelerated will achieve equally as well (Swiatek & Benbow, 1991), if not better than peers of similar academic ability (Kulik & Kulik, 1984) who did not accelerate. To begin, analysis of the results of students in Year 9 Extension who were paired based on participation in the acceleration group and those who were deemed to be of similar academic ability in Mathematics were compared to determine if there were any significant differences in achievement prior to participation in the initial course (*9 Accelerated*). Table 5 shows the summary statistics for Semesters 1 and 2 for the non-accelerated (0) and accelerated (1) groups. The mean values of achievement in both Semesters 1 and 2 are slightly higher for the accelerated than the non-accelerated groups.

Table 5

Summary Statistics for 9 Extension Mathematics

	Semester 1		Semester 2	
	Accelerated (1)	Non-accelerated (0)	Accelerated (1)	Non-accelerated (0)
M	91.1	89.3	95.6	94.7
Mdn	93.3	86.7	100	93.3
Range	6.7	6.7	13.3	13.3
SD	3.8	3.7	7.7	5.6

Note. N=26. Accelerated (n=13) and Non-accelerated (n=13).

To further support this, the Mann-Whitney U Test was applied to the results from both semesters. The results for 9 Extension are shown in Table 6 below.

Table 6

Mann-Whitney U test for 9 Extension Mathematics

Statistical test	9 Extension Semester 1	9 Extension Semester 2
Mann-Whitney U Test	66.5	66.5
z-score	-1.029	-1.005
Asymp. Sig. (2-tailed)	0.303	0.315

[a] Asymp. Sig. (2-tailed) = Asymptotic significance (2-tailed)

$* p < 0.05$

There were no outliers in the data, as assessed by inspection of a boxplot (see Appendix A). Achievement scores for both groups were negatively skewed, as seen on the representation of histograms (see Figure 2 above). The achievement of both groups was not statistically different in Semester 1 $U(n_1 = n_0 = 13) = 66.5, z = -1.029, p < .05$ and Semester 2 $U(n_1 = n_0 = 13) = 66.5, z = -1.005, p < .05$. The z-score in both semesters indicates that achievement was approximately 1 standard deviation below the mean but found inside the 95% confidence interval. The Glass rank biserial correlation coefficient was calculated and the effect size was interpreted using Leech et al.'s (2008) table for interpretation of the strength of a relationship using the r value. These results indicate that there is no statistically significant difference between the groups; comparison of data across years to determine whether accelerated students continue to achieve to a high standard and whether they select higher level Mathematics courses at similar rates to non-accelerated groups is appropriate. Results for Year 9 Extension indicate that the

Table 7

Glass rank biserial correlation coefficient test for 9 Extension Mathematics

Group	Glass rank (r_g)	Strength of relationship (Effect Size)	Statistical significance
9 Extension Semester 1	0.21	Small	Not statistically significant
9 Extension Semester 2	0.21	Small	Not statistically significant

[a] Interpretations of r_g are based on the values in the table reported by Leech et al. (2008), for the r Family, using the r and φ values.

initial data is consistent between groups and there is no difference in achievement at this stage of the program.

Academic achievement outcomes

To determine the answer to research question 1 regarding whether accelerated students continue to achieve to a level at least commensurate with non-accelerated peers of similar academic ability (at Year 9 level when the acceleration program began), the results for Stage 1 Mathematical Methods (2 semesters), Stage 1 Specialist Mathematics (2 semesters), Stage 2 Mathematical Methods and Stage 2 Specialist Mathematics were statistically analysed and compared.

Stage 1 Mathematical Methods was undertaken in Grade 10 for Accelerated students and Grade 11 for Non-Accelerated students. The measures of centre, spread, the Mann-Whitney U Test, z-score and the Glass rank biserial correlation coefficient are summarised in Table 8 below for the accelerated (1) and non-accelerated (0) groups. In both semesters of study, the non-accelerated group had a higher mean score. The median was the same for both groups with the range being the same in semester 1. In semester 2 the range of achievement was greater for the accelerated group and the standard deviation was higher for the accelerated group in both semesters. A Mann-Whitney U Test revealed that there is no significant difference in achievement for the Semester 1 Stage 1 Mathematical Methods course between the accelerated (Mdn = 11.31, n = 13) and non-accelerated (Mdn = 15.69, n = 13) groups; U = 56, z = -1.528, p = 0.127, and r = 0.337. Similarly, in Semester 2, a Mann-Whitney U Test again revealed no significant difference in achievement for accelerated (Mdn = 12.69, n = 13) and non-accelerated

(Mdn = 14.31, n = 13) groups; U = 74, z = -0.555, p = 0.579, and r = 0.125. The z-score in both semesters indicates that achievement was between -1.5 and -0.6 standard deviations below the mean but still within the 95% confidence interval. The Glass rank biserial correlation coefficient (r_g) in Semester 1 showed medium or typical effect size in favour of the non-accelerated group and in Semester 2 was smaller than typical. Overall, the statistical results indicate that there is no significant difference in mean achievement between the two groups.

Stage 1 Specialist Mathematics was undertaken in Grade 11 for both groups of students. From Table 8 the Mann-Whitney U Test revealed no significant difference in achievement of the Semester 1 Specialist Mathematics course between the accelerated (Mdn = 11.00, n = 10) and non-accelerated (Mdn = 7.63, n = 8) groups; U = 25, z = -1.384, p = 0.166, and r = 0.374. The same was evident in Semester 2: accelerated (Mdn = 9.55, n = 10) and non-accelerated (Mdn = 8.21, n = 7); U = 29.5, z = -0.585, p = 0.558, and r = 0.158. Differences in achievement were again within the 95% confidence interval and the Glass rank biserial correlation coefficient (r_g) in Semester 1 showed medium or typical effect size this time in favour of the accelerated group and then in Semester 2 was smaller than typical. Overall, the statistical results indicate that there is no significant difference in mean achievement between the two groups.

Stage 2 Mathematical Methods was undertaken in Grade 11 for accelerated students and Grade 12 for non-accelerated students. The Mann-Whitney U Test revealed that there is no significant difference in achievement of the Stage 2 Mathematical Methods course between the accelerated (Mdn = 10.38, n = 12) and non-accelerated (Mdn = 10.69, n = 8) groups; U = 46.5, z = -0.116, p = 0.908, and r = 0.031. Differences in achievement were within the 95% confidence interval and the Glass rank biserial correlation coefficient was smaller than typical, leading to the conclusion that results are not statistically different between the two groups.

Table 8

Summary statistics for Stage 1 and 2 Mathematics courses

Mathematics Course	M	Mdn	Range	SD	U	z	Asymp. Sig. (2-tailed)	Glass rank (r_g)
St 1 Meth S1 Accel(1)	82.05	86.67	26.67	9.56	56	-1.528	0.127	0.337
St 1 Meth S1 Non-accel(0)	87.18	86.67	26.67	8.37				
St 1 Meth S2 Accel(1)	82.05	86.67	33.33	11.34	74	-0.555	0.579	0.125
St 1 Meth S2 Non-accel(0)	84.62	86.67	26.67	9.58				
St 1 Spec S1 Accel (1)	84.00	86.67	33.33	11.42	25	-1.384	0.166	0.374
St 1 Spec S1 Non-accel(0)	77.50	80.00	46.67	14.67				
St 1 Spec S2 Accel (1)	86.67	86.67	33.33	9.94	29.5	-0.585	0.558	0.158
St 1 Spec S2 Non-accel(0)	86.67	86.67	13.33	3.85				
St 2 Meth Accel (1)	81.28	85.34	35.34	11.60	46.5	-0.116	0.908	0.031
St 2 Meth Non-accel(0)	81.58	86.00	36.67	12.49				
St 2 Spec Accel(1)	74.22	79.33	34.00	17.57	7	-0.149	0.881	0.068
St 2 Spec Non-accel(0)	77.87	80.67	40.00	14.89				

Note. This table contains the summary statistics, Mann-Whitney U test, z-scores, asymptotic significance (2-tailed) and Glass rank biserial correlation coefficient for each of the Mathematics courses. Statistical test abbreviations are: Asymp. Sig. (2-tailed) = Asymptotic significance (2-tailed), and Glass rank (r_g) = Glass rank biserial correlation coefficient. Abbreviations for groups are: accelerated = Accel(1) and non-accelerated Non-accel(0).

[a] Interpretations of r_g are based on the values in Table 6 for The r Family, using the r and φ values.

$* p < 0.05$

Stage 2 Specialist Mathematics was undertaken in Grade 12 for both student groups. A Mann-Whitney U Test revealed no significant difference in achievement for the Stage 2 Specialist Mathematics course between the accelerated (Mdn = 4.33, n = 3) and non-accelerated (Mdn = 4.60, n = 5) groups; U = 7, z = -0.149, p = 0.881, and r = 0.068. There was negligible difference, with results falling close together within the 95% confidence interval and the Glass rank biserial correlation coefficient was again smaller than typical, leading to the conclusion that there is no significant difference in mean achievement for the group of students who accelerated.

In summary, the findings from analysis of grade data showed that there were no statistical differences in achievement for any of the Mathematics courses studied.

Extent of Mathematics course enrolment

Research question 2 concerned the choice to continue with higher-level Mathematics study across the two groups (accelerated and non-accelerated). Data were analysed to investigate what choices these students are making in their high school Mathematics careers. As participants were selected based on their involvement (or not) in 9 Accelerated and choosing to study Stage 1 Mathematical Methods, all participants in the study completed 2 semesters of this course. Hence, there is no difference between the groups at this stage of the research.

To investigate the choice to study the different options of Mathematics courses (Stage 1 Specialist Mathematics across 2 semesters and Stage 2 Mathematical Methods and Specialist Mathematics for a full year) the sample proportion was used in the online computer program, Epitools (Ausvet, 2022) to run a z-test to compare two proportions in each course. This involved constructing a 95% confidence interval, z-value, and p-value for each group. One of the pre-requisites for students selected for these groups was that they studied Stage 1 Mathematical

Methods in Semester 1. Students who chose not to accelerate further were excluded from the data set.

The results for Semester 1 Specialist Mathematics are summarised in Table 9 below. These results show that approximately 15% more students from the accelerated group enrolled in Semester 1 Specialist Mathematics than the non-accelerated group. Referring to the significant overlap observed for the confidence interval in Figure 4 below, it is evident that the null hypothesis that the accelerated and non-accelerated groups choose to study Stage 1 Specialist Mathematics at equal rates is accepted.

Table 9

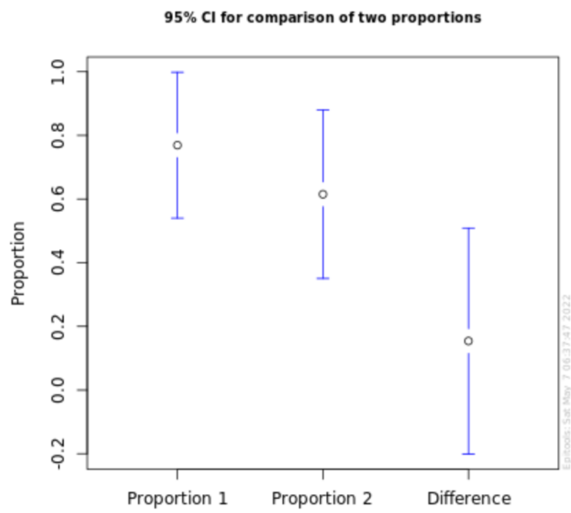
Comparison of two proportions for Semester 1 Specialist Mathematic in Stage 1

Statistical test	Accelerated (1)	Non-Accelerated (0)	Difference
Sample proportion	0.769	0.615	0.154
95% confidence interval (asymptotic)	0.5399 – 0.9981	0.3505 – 0.8795	-.2009 – 0.5089
z-value	0.9		
p-value	0.3951		

$* p < 0.05$

Figure 4

95% confidence interval for Semester 1 Specialist Mathematics in Stage 1



Referring to Table 10 and Figure 5 below, there was approximately a 23% higher enrolment rate for Semester 2 Stage 1 Specialist Mathematics by the accelerated group however the results are again not statistically different, and the null hypothesis is accepted.

Table 10

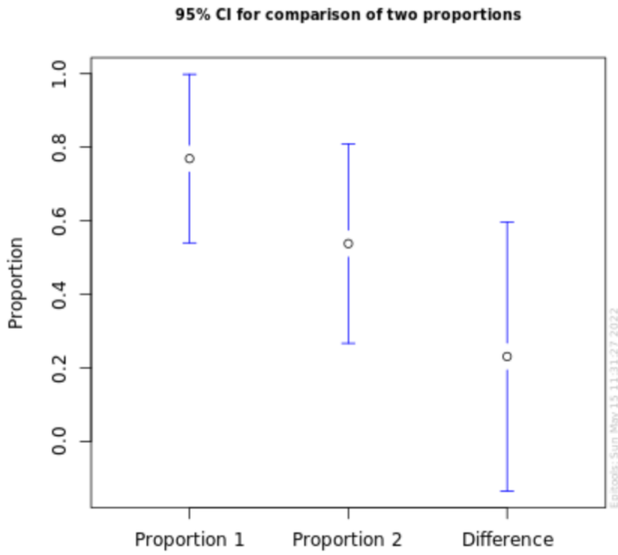
Comparison of two proportions for Semester 2 Specialist Mathematics in Stage 1

Statistical test	Accelerated (1)	Non-Accelerated (0)	Difference
Sample proportion	0.769	0.538	0.231
95% confidence interval (asymptotic)	0.5399 – 0.9981	0.267 – 0.809	-.1348 – 0.5968
z-value	1.2		
p-value	0.2158		

$* p < 0.05$

Figure 5

The 95% confidence intervals for students studying Semester 2 Specialist Mathematics in Stage 1



Stage 2 Mathematical Methods had approximately a 31% (see Table 11) higher enrolment rate from accelerated students, but the null hypothesis is again accepted due to overlap observed in Figure 6.

Table 11

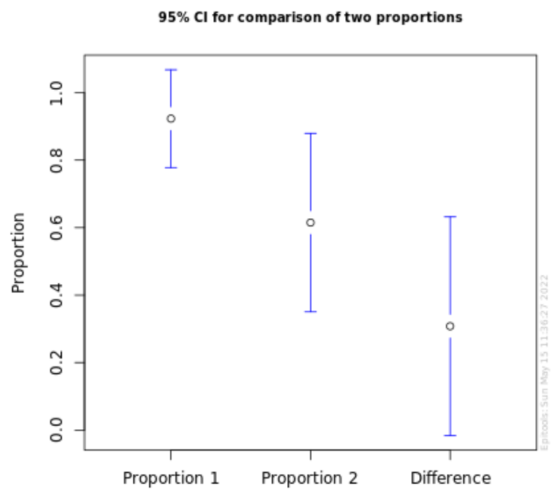
Comparison of two proportions Stage 2 Mathematical Methods

Statistical test	Accelerated (1)	Non-Accelerated (0)	Difference
Sample proportion	0.923	0.615	0.308
95% confidence interval (asymptotic)	0.7781 – 1.0679	0.3505 - 0.8795	-0.016 – 0.632
z-value	1.9		
p-value	0.0624		

$* p < 0.05$

Figure 6

The 95% confidence intervals for students studying Stage 2 Mathematical Methods



The results for Stage 2 Specialist Mathematics are summarised in Table 12 below. The non-accelerated group enrolled in Stage 2 Specialist Mathematics approximately 11% more than the accelerated group however the overlap of confidence intervals was again significant (refer to Figure 7 below) and the null hypothesis was again accepted.

Table 12

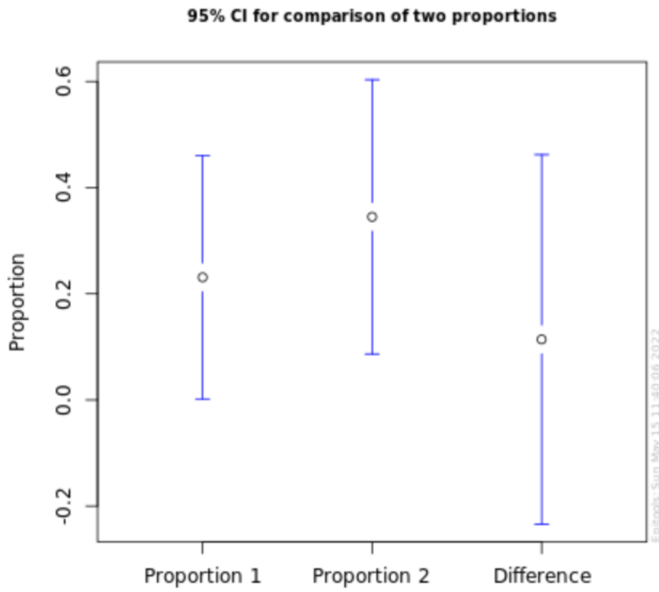
Comparison of two proportions Stage 2 Specialist Mathematics

Statistical test	Accelerated (1)	Non-Accelerated (0)	Difference
Sample proportion	0.231	0.345	0.114
95% confidence interval (asymptotic)	0.0019 – 0.4601	0.0866 – 0.6034	-0.2341 – 0.4621
z-value	0.6		
p-value	0.521		

$* p < 0.05$

Figure 7

The 95% confidence intervals for students studying Stage 2 Specialist Mathematics



Largely, due to the relatively small sample size of the research, the results were statistically insignificant as to whether accelerated students enrol in more high-level Mathematics courses than their non-accelerated counter parts. Overall, there was a 15% difference in the uptake of the Stage 1 Mathematical Method course in favour of the accelerated group in Semester 1, 23% in Semester 2 and then 31% the following year at Stage 2.

Thematic summary

The thematic analysis of the focus group interview with accelerated students resulted in four broad themes that are summarised in Table 13 below. Overarching themes include social structures: support networks, self-learning & regulation, opportunity versus expectations, and motivation & enjoyment.

Table 13

Summary of thematic analysis of focus group interview

Overarching Theme	Sub-theme	Supporting quotes
Social structures: Support networks	Independence from the class: social isolation and connections	"We were basically an independent entity of the class, like we were on the roll, but that was as far as it extended." "I ended up being the only student doing it in my year and I was basically teaching myself." "…Year 11's weren't very welcoming to us and like, some of them made comments and everything, so I felt very uncomfortable. I never liked going to those lessons." "I think being isolated was detrimental to the whole thing." "We became really close… bouncing ideas off each other, helping each other get through the process." "I really relied on them being in a class with Year 12's." "I had to ask my friends who are learning that in class to be like, oh yeah, that's what that is."
	Independence from the class: lack of support and teacher training	"Well, we were told to Google it." "…getting sent from teacher to teacher with no conclusion. In like an endless circle of like, not knowing. Or using online calculators but stopping if it didn't make immediate sense. It was a longer process than having a knowledgeable teacher." "You end up just getting used to not asking questions and doing it yourself and I think that impacted Stage 2 when the content was a lot more difficult." "[another student] asked for help and basically he just got shut down straight up." "…we fell so far behind then we just were not supported and so we relied heavily off each other."
	Independence from the class: feelings of guilt	"I felt like I couldn't ask my teacher when I was confused about things." "They had the rest of the class so I always felt guilty … because the questions took longer." "In my experience, if I came across a question that I didn't understand, I didn't know how to do, I'd just move on. It was if Google didn't return any

Overarching Theme	Sub-theme	Supporting quotes
		meaningful answers, I can’t really interrupt the class, I’d just move on.”
Self-learning and regulation	Lack of structure affecting ability to learn effectively	“Not having a structure in Stage 1 impacted me in Stage 2 because I probably didn’t do as well as I could have done.” “… I wasn’t trying to keep up, I was trying to catch up with the work because I kept falling behind with amount of topics and content I had to do.” It’s a good thought, but a little bit of a poor execution, I think.” “I hope it would be different now, wish there was more info to make better choices.”
	Surface learning: the how but not the why	“[fast pace] impacted Stage 2 because the like knowledge that I got was very much memory, like I just memorised what I needed for the test and then wrote my cheat sheet and everything. So then when I got to Year 12, I found that I didn’t have a very good understanding of the Stage 1 course.” “…I didn’t really understand it and so the day before every test I skipped school… learn the whole unit, write out my cheat sheet…and then I’d go to the test the next day and I managed to do like pretty well, but then I didn’t do very well in the exam.”
Opportunity vs Expectation	Pressure: internal and external factors	“…felt that expectation of you’re already doing it so if you drop out, your kind of like copping out of it.” “Didn’t feel pressured to start doing it, but once I was doing it, I was like, ah, it’s not sort of point dropping out now.” “Once you’re in, you’re sort of stuck there.” “No choice to stop.” “Just keep going.” “Already done it. Might as well keep going.” “I felt that certain people expected me to do well in that and that if I copped out, they would look down as if like, you failed this.” “I have to go through it, otherwise it’s failure.”
	Lack of confidence in own ability	“[I was worried] about whether I was smart enough or like mature enough to actually learn all that content in a pretty short amount of time without a lot of help in Year 11.”

Overarching Theme	Sub-theme	Supporting quotes
	Getting ahead and playing the SACE game	"I felt so behind and then I was teaching it to myself as well." "I have been able to do more subjects." "Doing the year early did help, I'd say it influenced me to choose Spec because I was like then I'll have more room in Year 12 if I want to do other subjects." "Every grade counts." "[there was an] aspect of relief getting to Year 12 and only having the Spec left." "…ability to repeat and get a better grade." "…wasn't thinking long term at the beginning."
	Feelings of accomplishment	"The idea of saying that I did Year 12 maths in Year 11… was an achievement that I wanted…"
	Confusion about purpose	"I felt kind of clueless when I was doing it. I wasn't quite sure what it was leading to." "…we felt like lab rats, we felt like the test run."
Motivation and enjoyment	Overcoming negative implications of independence	"I still enjoy maths when I get it, but it was definitely a harder process being by yourself and find[ing] the motivation to want to learn the topics." "Poor work ethic from Stage 2, isolated, didn't really work, killed the motivation early in Stage 2. Had to build that up through the year." "…motivation probably still hasn't recovered as much as it could have…"

Qualitative open-ended survey results from non-accelerated students produced the common broad themes of social structures: support networks, opportunity versus expectation and perceptions of motivation. These are summarised in Table 14 below.

Table 14

Summary of thematic analysis of open-ended surveys

Overarching Theme	Sub-theme	Supporting quotes
Social structures: support networks	Pressure to give it a go	"I felt quite pressured by the school to give it a go." "My parents also thought it would be a good idea." "I was encouraged by my parents to consider studying the course and my teacher gave the class a list of pros and cons…"
	Competing perspectives from within and observation of the program	"…there was a sense of comradery and compassion…" "…more stress amongst my peers who studied the course." "In my opinion, the student was often isolated, completing their own work and tests, and missed the social interaction of the class." "…some students being more stressed." "…the social aspect and isolation of completing the subject alone deterred me."
	Improvement through structure and information	"…less work has to be [in the] year 9 extension program if year 9 accelerated is being undertaken." "More information about what it would mean for me in later years." "…spread over more of the year." "…our teacher was less able to help her as he was less familiar with the stage 1 course than that of year 10."
Opportunity vs Expectation	Getting ahead	"My parents also thought it would be a good idea for me to 'get ahead of the curb' and keep myself challenged with my maths, however they did not fully understand the program or its advantages/disadvantages." "I believed it would be beneficial for Mathematics skills." "…I was doing well at Mathematics and saw the course as a way of extending myself."
	Lack of confidence	"…I was worried about whether I would be able to balance the extra commitment…" "I at the time was worried about the workload…" "…I believed I would struggle with the workload along with my co-curricular studies."

Overarching Theme	Sub-theme	Supporting quotes
		"I did not want the stress or commitment of completing an accelerated subject."
Perceptions of motivation	Student perceptions vary according to experiences	"I was daunted when listening to the students studying 9 Accelerated…" "…completing the 9 Accelerated course increased my motivation for learning Mathematics…" "This interest in Mathematics partially stemmed from the 9 Accelerated course." "My level of motivation towards maths has not changed and I still find it to be a subject I enjoy once I understand." "…maths is not relevant to the areas I am likely to pursue at university or as a career, thought this may have changed had I studied the 9 Accelerated course."

Participants' academic experiences of the program

When considering the perspectives of the accelerated students, there was a general sense of experiencing feelings of guilt and abandonment. Within the overarching theme of social structure: support networks, the sub-theme of independence through the lenses of social isolation and connections, lack of support and teacher training and feelings of guilt were identified. This theme looked at the views of students who felt, or were perceived as being, isolated from the Grade 10 Extension and Grades 11 and 12 Mathematical Methods classes, which was a common experience amongst most participants as well as the view of some non-accelerated members. For those whose experience was within a group environment, the community of support in this social situation was deemed to be crucial to not just success but the motivation to persist with the course. Students from three of the four campuses described a lack of teacher support and felt that their teachers in Grade 10 did not have adequate training to support their progress with advanced maths content; meanwhile, all students reported experiencing feelings of guilt that they were taking away from other students when trying to engage with their teacher.

Accelerated students reported being in a situation where they did not feel that they could ask their teachers questions. This ranged from students who were the sole participant in the acceleration intervention through to larger groups of up to five at a time. Examples of this experience are evident from students who said, “they had the rest of the class so I always felt guilty…because the questions took longer” and “you end up just getting used to not asking questions and doing it yourself…”. In some situations, students talked about removing themselves to other locations because they felt they were disruptive to the remaining Year 10 Extension students or felt disrupted by those students in return. Either way they did not feel that the Year 10 teacher was able to answer their questions adequately as evidenced by comments such as, “we were told to Google it” or “getting sent from teacher to teacher with no conclusion, in like an endless circle of like, not knowing.” This appears to indicate general structural issues associated with the accelerated course, further compounded by lack of teacher knowledge and understanding of the Stage 1 course.

Themes around independent learning and self-regulation were evident and focused on a perceived lack of structure, which participants felt affected their ability to learn effectively and resulted in surface-level learning. Most students agreed that lack of structure at Stage 1 impacted on their achievement in Stage 2, with a single student indicating that their ability to engage in self-directed learning meant that this was not an issue for them. There were two students who directly commented on their approach becoming one of surface learning, with general agreement from most participants.

Accelerated students discussed the compounding effects stemming from the perceived lack of structure during the Stage 1 component of accelerating during Year 10. In general, many of the students found that the high level of independence required, coupled with the lack of support in the structure of the course hindered their ability to learn effectively and this is highlighted in the self-learning and regulation theme emerging from the focus group data. Many discussed that they focused on the ‘how’ but not the ‘why’, discussing that memorisation was a key component to their initial success but also their eventual difficulties as the work became more complex. One student reflected that

> “[Pace] impacted Stage 2 because the like knowledge that I got was very much memory, like I just memorised what I needed for the test and then wrote my cheat sheets and everything. So then when I got to Year 12, I found that I didn’t have a very good understanding of the Stage 1 course.”

Another student revealed that “I [had] to make a mindset of you only need to know how, not why”, when considering how they made it through the process of being independent and regulating their own learning. The compounding effect of lack of fundamental understanding culminated in situations where one student,

> “didn’t really understand it and so the day before every test I skipped school…learn the whole unit, write out my cheat sheet…and then I’d go to the test the next day and I managed to do like pretty well…but then I didn’t do very well in the exam.”

The surface learning evident in the coping mechanisms adopted by the students is indicative of a systemic issue, with students not having the appropriate skills in self-regulation and independence to be able to maintain high level achievement without a significant cost to overall motivation and enjoyment of Mathematics. There was a divide between participants in relation to how they feel about math overall with one student saying, “[I] used to enjoy it, now hate it”, and another saying, “I still enjoy maths when I get it, but it was definitely a harder process being by yourself and finding the motivation to want to learn the topics”. A single student felt empowered through the process and gained a greater enjoyment of Mathematics leading to further study that they had previously been unsure about. Overall, it is summed up well for the majority of the group by the quote, "…motivation probably still hasn't recovered as much as it could have…".

Outside perspectives of students eligible to accelerate who chose not to, centre around observations of isolation and stress. Students noticed "…more stress amongst my peers who studied the course", and "in my opinion, the student was often isolated, completing their own work and tests, and missed the social interaction of the class." While on average, accelerated students were neither advantaged nor disadvantaged in their achievement due to the acceleration intervention, there is evidence to suggest that the negative social and affective implications are ongoing.

Participants' enrolment experiences of the program

The themes identified through the focus group interview suggest that accelerated students felt high levels of pressure and expectation to continue their accelerated paths through both internal and external factors. One student found that they were pressured significantly by both a teacher and a parent and this heavily influenced their decision in which Mathematics courses they studied. Other students did not experience as much of this until the Stage 1 level where parents and teachers suggested that it would be good for them to get ahead, have more opportunities at Year 12 and to 'play the SACE game'. Two students made specific comments about the feelings of accomplishment associated with accelerating but also feelings of confusion as to the purpose of it. These feelings of accomplishment were in opposition to feelings of lack of confidence in their own ability both prior to accelerating and then throughout, when feeling constantly behind.

Students expressed that they “felt that expectation of you’re already doing it so if you drop out, you’re kind of like copping out of it”, and that “once you’re in, you’re sort of stuck there”. This linked to feelings of expected failure if you were to stop the acceleration process prior to completion. These feelings of being judged may help to explain this higher level of enrolment compared to the non-accelerated group in the Mathematical Methods course. Non-accelerated students made comments around pragmatic choices of subject selection largely based on knowledge that they would not need higher levels of Mathematics in their university studies and/or future career aspirations. The overarching theme of perceptions of motivation through the sub-theme of student perceptions vary according to experiences may help to explain this as one student said “…maths is not relevant to the areas I am likely to pursue at university or as a career, though this may have changed had I studied the 9 Accelerated course.”

Further to this, some students mentioned that they would not have made it through if not for the social connections formed through the shared experience, to the point where some even said that it was an all or nothing model, where all of the students would continue to Stage 2 Mathematical Methods in Year 11 or none at all. This socially constructed support network was seen as both a saviour in terms of both academic and emotional support during this time, but also a hindrance in terms of the day-to-day work ethic of the cohort. This is evidenced through conversations surrounding the conflicting idea of peers being distracting, which was detrimental to learning, but also that it would have been worse without them. One student reflected, “we became really close… bouncing ideas off each other, helping each other get through the process” and another who said, “I really relied on them being in a class with Year 12’s.” The social structures: support networks that resulted in experiences of independence from the class that were both social isolation and connections that had mutually positive and negative implications for students.

At Stage 2 Specialist Mathematics, there was an 11% difference in enrolment in favour of the non-accelerated group. This might be explained through the themes of Motivation & Enjoyment and Opportunity vs Expectation. Motivation and enjoyment centred around the need to overcome the negative implications of independence associated with the acceleration intervention. Most students indicated that they had enjoyment for Mathematics prior to accelerating but had lost this when things became more difficult, and motivation suffered as a result of this. Many students indicated that future career aspirations became a crucial deciding factor at Stage 2 as to whether they would study the Specialist Mathematics course. It was here there was a noticeable tipping point moving away from the expectation that they would continue in contrast to the opportunity to make choices more in line with their current needs.

Both students who accelerated or did not, were heavily motivated by career aspirations and enjoyment. Some students who accelerated, felt that having the option for an extra Stage 2 subject meant they could ‘relax’ in the Stage 2 Specialist course because they had a ‘fall-back option’. Or that there was an “aspect of relief getting to Year 12 and only having the Spec left”. Other students felt that knowing what it was they wanted allowed them to make decisions as to what would best fit their purposes for the future.

General experiences

In general, accelerated students felt that they did not have enough information as to what they were committing to when starting the acceleration intervention. For example, “I was probably not old enough to be jumping into such independent learning…we need experience in independent study before that sort of thing” and I was “too young and not experienced enough to be in that situation". From the perspective of non-accelerated students, they felt that "clearer information" to help "reduce uncertainty and confusion" would have been beneficial, particularly at the 9 Accelerated stage of the intervention. Some also said they wanted "more information about what it would mean for me in later years" and "clearer information given to my parents; they were confused but supportive". Multiple participants acknowledged that they understood the benefits of 'getting ahead' or 'playing the SACE game' by completing the course ahead of time, but that some were "not thinking long term at the beginning" and it was clear that some felt pressured into doing Stage 2 to get ahead in SACE.

Not all students had the same experience, and it is noteworthy that students with more positive experiences tended to report less internal and external pressures. When talking about the course and their experiences, they often said that "it was ultimately my decision" and that "I felt little parental pressure". They more often mentioned that they "found that [they] enjoyed the challenge of trying to keep up and [they] enjoyed missing out on the tedium" to varying degrees. They were less concerned with grades and more focused on enjoying the challenge associated with the level of Mathematics they were undertaking. Two students mentioned being unsure of taking the Stage 2 Specialist Mathematics course, but their experience with the acceleration program helped them to decide whether to continue or not. One student found the experience positive and decided to continue into the course, while the other was left jaded by their experiences and was not willing to put themselves in that position again. Interestingly, the same student also expressed feelings of regret that they did not study any maths courses in Grade 12 as it was an area they were good at and had enjoyed up until that point.

Summary

In conclusion, this study found no statistically significant differences in achievement levels and prevalence of enrolment in higher-level Mathematics courses of accelerated students when compared to equally able non-accelerated peers. Overall, the experiences of the students in the accelerated program appeared to be influenced by their reasons for accelerating, and the skills of independent self-directed learning and self-regulation. The majority of students felt that they did not learn the course content for Stage 1 Mathematical Methods to a high standard and this impacted achievement at Stage 2. Multiple participants reported feeling “abandoned” at Stage 1 and perceived that their Year 10 teachers did not have the time nor mathematical knowledge to support them in their learning. The vast majority of participants reported feeling that they could not stop the acceleration process and were generally unsure if that was even a possibility. While they acknowledged the benefits of completing a Stage 2 course early and were generally appreciative of the opportunity, most felt that the program required fine tuning to better support future students.

Chapter 5 – Discussion

This research set out to explore the achievement of accelerated students compared to non-accelerated peers of equal ability, prevalence of higher-level Mathematics course enrolment and the experiences of students who enrolled in a secondary school accelerated maths program. This was achieved through a mixed-methods research study that included analysis of grade and course enrolment data coupled with focus group interview and survey responses from accelerated and non-accelerated students respectively.

The results of this study indicate that accelerated students in this particular program achieved consistently relative to their non-accelerated peers of equal ability. In each course from Stage 1 and 2 Mathematical Methods and Specialist Mathematics, the results showed no statistical difference between the two groups. This indicates that there is no academic benefit (in terms of grade achievement) for students who choose to accelerate in this Mathematics course; however, there is also no noticeable disadvantage. This is consistent with some literature such as Kretschmann and Vock (2014) and Swiatek and Benbow (1991) also found no academic differences based on acceleration. However, other research including that of Bartley-Buntz and Kronborg (2018), Kulik (2004), Kulik and Kulik (1984), (McClarty, 2015b), Rogers (2015), Steenbergen-Hu et al. (2016), Steenbergen-Hu and Moon (2011), and Wells et al. (2009), has found that on average, achievement is higher for students who engage in academic acceleration. In this study, the divergent findings might be explained by the small sample size available and the issue of ceiling effects with the common testing implemented at the research site. It is interesting to note that in Stage 1 Mathematical Methods, and particularly in Semester 1, the accelerated group achieved a lower mean score compared to the non-accelerated cohort. The Glass rank biserial correlation coefficient for Stage 1 Semester 1 Mathematical Methods indicated a medium effect size suggesting that further exploration at this stage of the acceleration intervention is worthwhile.

When looking at the social structure of the program, students in the accelerated group were placed into a 10 Extension Mathematics class with accelerated group sizes ranging from 1-5 students across the four school sites, who were nested within class groups of up to around 30. At three of the four school sites, students perceived that their teacher did not have enough recent knowledge and experience of the Stage 1 Mathematical Methods course to be able to assist them with their learning. Literature suggests that teachers who have knowledge and skills in gifted education are more effective at differentiating and supporting high ability learners (Dimitriadis, 2016). It was the perception of the participants that most of their teachers during Stage 1 were unable to support them due to lack of current curriculum knowledge. This lack of support could help to explain this difference in achievement at this stage and is further supported by the results from Stage 1 Specialist Mathematics where the mean score was higher for the accelerated group when back in a classroom environment with a specialist teacher. This is also supported by Bickley (2001) and Almukhambetova and Hernandez-Torrano (2020) who found a need for professional training to support high ability learners. This indicates that further research might be necessary to ascertain whether it is teacher knowledge that is lacking or perhaps that the structure of the course, with such a high degree of reliance on students to work independently, might have been of greater impact or perhaps a combination of both.

Accelerated students' feelings of guilt and abandonment, particularly during Stage 1 Mathematical Methods, is an interesting finding as it is contrary to most of the literature about the positive implications for social and affective outcomes of acceleration for gifted students (Neihart, 2007; Steenbergen-Hu & Moon, 2011; Young et al., 2015). This is somewhat surprising, but may relate to a lack of participants' skills in being independent and using self-directed learning and self-regulation strategies effectively, and is supported in the literature on Mathematics acceleration by Ma (2002) who discussed problems around "initial academic failure, lack of well-developed study skills, and social isolation" (p. 445). There was no specific preparation for students taking the accelerated option to build their skills of self-directed learning, and this would be an area to further investigate in relation to the current intervention and similar programs.

The gifted education literature suggests that gifted or advanced learners often express a preference for less formal structures (Young et al., 2015); however, this is inconsistent with the findings of this study. Lee (2016) suggests that independent, self-paced learning and acceleration can increase motivation; however, careful scaffolding of this process should also occur. The findings of this study highlight the importance of considering scaffolding and explicit teaching of skills related to independent learning to support students' success as they navigate acceleration in this type of intervention.

Overall, the conclusion from analysis of Mathematics enrolment in higher level courses indicates that both accelerated and non-accelerated students enrol at rates that are commensurate. This is consistent with research findings from Dossenbach (2017), but counter to findings of a study by Hannah et al. (2011) which found that they were more likely, on average, to enrol at higher rates. It is professionally noteworthy that there were some large percentage differences in enrolment at different course levels. This research indicates that pressure to study the courses and expectations from teachers and parents may play a significant role in determining whether a student studies a higher-level course. The social climate of the environments for acceleration may also be a contributing factor, especially in some of the larger groups and is somewhat supported by Henderson (2018b). This research also showed that once the acceleration was completed, most students only studied Specialist Mathematics if it was relevant to future career aspirations. The percentage differences in enrolment indicate that it would be worthwhile to investigate this in a future study and with a larger sample across different settings and acceleration models.

Furthermore, students in this study expressed that the opportunity to study more Stage 2 subjects was an advantageous outcome of acceleration. This is supported in the literature by Bartley-Buntz and Kronborg (2018), whose study of Victorian maths students had similar findings, and also that of Swiatek (2002) in regard to the advantage perceived through time gained. While not a primary factor in the implementation of the intervention, it appears that this was a focal selling point when encouraging students to consider involvement in the program.

An interesting finding was that students generally enjoyed the challenge of the initial 9 Accelerated program and felt that they were supported during this time. This is consistent with literature on the benefits and links between challenging curriculum and motivation (Little, 2012; VanTassel-Baska & Baska, 2019); however, the experience was short lived for the majority of participants who are still struggling to regain their motivation. Students indicated that motivation decreased when the work became more challenging and the perception was they felt unsupported by the independent environment and teachers who were unfamiliar with the mathematics content of the Stage 1 course. The difference in experiences between Grades 9 and 10 indicate that exploration of differentiation within the regular classroom might be beneficial for these students.

Limitations

Methodological limitations included the small sample size, lack of available data, and issues around self-reported data. Further limitations were longitudinal effects and potential bias of the researcher. These limitations are discussed and lead into implications for further research and practice.

The small sample size of the project limited the statistical power of analysis as having small amounts of data to compare between groups led to difficulties in determining statistically significant differences. This was particularly evident in the prevalence of continued study where percentage differences suggested that there might be significant disparities between the accelerated and non-accelerated groups, but the statistical analysis was not able to determine any meaningful differences. The lack of overall available data was related to the relatively short-term nature of the project.

As is the nature of focus group interviews and open-ended surveys, the data being collected is self-reported, and in this case it was retrospective as participants were reflecting up to four years into their prior experiences. Focus groups are an important method for exploring participants' lived experiences in their own voices, but it is acknowledged that these issues could have affected the findings.

The researcher was a teacher at the site of the study, and highly familiar with many of the participants through past teaching experiences. This created a potential bias relating to the analysis and interpretation of results throughout the research. While all care was taken to remain neutral, it is possible that bias has affected conclusions formed. It also limited the number of potential participants for focus groups and surveys as no students who were being taught by the researcher at the time of data collection were involved in this component of the research.

Implications for further research

To overcome the limitations involved with having a small sample size, a more long-term approach to data collection and analysis may help to distinguish differences on a statistical level to further inform practice. As the course is an ongoing curriculum offering, this presents the opportunity both for longitudinal data collection to help answer the research questions more conclusively and the ability to conduct research with current students at every stage of the acceleration intervention.

A key finding of this project suggests that while academic acceleration has considerable support from the research, context matters in the way a program is structured and delivered. Simply providing an acceleration opportunity is no guarantee of positive academic or social/ affective outcomes. In this study, it was clear that students required support to be successful in a highly independent program, through explicit preparation in self-directed learning and self-regulation strategies. This is an area that could be further explored through research.

Implications for practice

While there are many benefits of the acceleration program (similar achievement, possibly a higher uptake of courses, opportunities for social construction, more opportunities for Year 12 courses) there are also limitations to the current program (negative effect on motivation and enjoyment, feelings of coercion and abandonment) that this research has uncovered. Regular evaluation and updating of the program to ensure the needs of the students are being met across academic, social and academic domains is highly recommended. This would also be important at schools offering similar acceleration programs.

Professional development of teachers should be prioritised at this and similar schools to support gifted or advanced students both academically and affectively, throughout each stage of the acceleration intervention. The importance of teachers having well developed content knowledge so they can ask deep and thought-provoking questions that allows their students to think critically and creatively, cannot be understated. Provision of appropriate professional development may help equip teachers with the knowledge and skills to alleviate feelings of guilt and abandonment for students and provide appropriate academic support to ensure deep rather than surface learning of content. In addition, equipping staff to support students to become successful independent, self-directed learners should be considered. It cannot be assumed that because gifted students often express a preference for independent work, they have the skills required to be successful, or that any form of independent program will address their needs. It is likely that they will need to develop and cultivate some new skills as they work through more complex problems.

Finally, a concerted effort to engage students in regular social interactions is strongly encouraged to build rapport and a social network of peers in a safe and supportive environment. This is particularly important for students who are the sole participant in an accelerated independent program at their school. Utilising technology may help to support some of the more isolated students.

Conclusion

Evaluation of the acceleration program found no statistically significant differences in Mathematics achievement or prevalence of enrolment into high-level Mathematics courses. Exploring the experience of participants revealed that, in general, they perceived the program to have overall structural issues; teachers requiring professional development for the curriculum at Stage 1 and more information about the purposes of and implications for involvement. It was reported that there was a lack of overall support during the Stage 1 component that had lasting negative consequences for motivation and enjoyment of Mathematics. Participants reported that the acceleration experience wasn’t generally positive but that they appreciated the opportunities it provided at Stage 2 and that to a large extent, were happy that they had completed the program.

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Appendices

Appendix A

Descriptive Statistics Output for the different groups created in SPSS:

	A_NA			Statistic	Std. Error
9 Ext S1	0	Mean		89.3333	1.63299
		95% Confidence Interval for Mean	Lower Bound	84.7994	
			Upper Bound	93.8672	
		5% Trimmed Mean		89.2593	
		Median		86.6667	
		Variance		13.333	
		Std. Deviation		3.65148	
		Minimum		86.67	
		Maximum		93.33	
		Range		6.67	
		Interquartile Range		6.67	
		Skewness		.609	.913
		Kurtosis		-3.333	2.000
	1	Mean		91.1111	2.22222
		95% Confidence Interval for Mean	Lower Bound	81.5497	
			Upper Bound	100.6726	
		5% Trimmed Mean		.	
		Median		93.3333	
		Variance		14.815	
		Std. Deviation		3.84900	
		Minimum		86.67	
		Maximum		93.33	
		Range		6.67	
		Interquartile Range		.	
		Skewness		-1.732	1.225
		Kurtosis		.	.
9 Ext S2	0	Mean		94.6667	2.49444
		95% Confidence Interval for Mean	Lower Bound	87.7410	
			Upper Bound	101.5923	
		5% Trimmed Mean		94.8148	
		Median		93.3333	
		Variance		31.111	
		Std. Deviation		5.57773	
		Minimum		86.67	
		Maximum		100.00	
		Range		13.33	
		Interquartile Range		10.00	
		Skewness		-.512	.913
		Kurtosis		-.612	2.000
	1	Mean		95.5556	4.44444
		95% Confidence Interval for Mean	Lower Bound	76.4327	
			Upper Bound	114.6785	
		5% Trimmed Mean		.	
		Median		100.0000	
		Variance		59.259	
		Std. Deviation		7.69800	
		Minimum		86.67	
		Maximum		100.00	
		Range		13.33	
		Interquartile Range		.	
		Skewness		-1.732	1.225
		Kurtosis		.	.

S1_Meth_11	0	Mean		87.1795	2.32189
		95% Confidence Interval for Mean	Lower Bound	82.1205	
			Upper Bound	92.2385	
		5% Trimmed Mean		87.9772	
		Median		86.6667	
		Variance		70.085	
		Std. Deviation		8.37171	
		Minimum		66.67	
		Maximum		93.33	
		Range		26.67	
		Interquartile Range		6.67	
		Skewness		-1.660	.616
		Kurtosis		2.316	1.191
	1	Mean		82.0513	2.65646
		95% Confidence Interval for Mean	Lower Bound	76.2634	
			Upper Bound	87.8392	
		5% Trimmed Mean		82.2792	
		Median		86.6667	
		Variance		91.738	
		Std. Deviation		9.57799	
		Minimum		66.67	
		Maximum		93.33	
		Range		26.67	
		Interquartile Range		16.67	
		Skewness		-.440	.616
		Kurtosis		-1.076	1.191

S2_Meth_11	0	Mean		84.6154	2.65646
		95% Confidence Interval for Mean	Lower Bound	78.8275	
			Upper Bound	90.4033	
		5% Trimmed Mean		84.3875	
		Median		86.6667	
		Variance		91.738	
		Std. Deviation		9.57799	
		Minimum		73.33	
		Maximum		100.00	
		Range		26.67	
		Interquartile Range		20.00	
		Skewness		.041	.616
		Kurtosis		-1.554	1.191
	1	Mean		82.0538	3.14630
		95% Confidence Interval for Mean	Lower Bound	75.1987	
			Upper Bound	88.9090	
		5% Trimmed Mean		82.6524	
		Median		86.6667	
		Variance		128.690	
		Std. Deviation		11.34414	
		Minimum		60.00	
		Maximum		93.33	
		Range		33.33	
		Interquartile Range		20.00	
		Skewness		-.688	.616
		Kurtosis		-.797	1.191

S1_Spec_11	0	Mean		77.5000	5.18507
		95% Confidence Interval for Mean	Lower Bound	65.2393	
			Upper Bound	89.7607	
		5% Trimmed Mean		78.3333	
		Median		80.0000	
		Variance		215.079	
		Std. Deviation		14.66558	
		Minimum		46.67	
		Maximum		93.33	
		Range		46.67	
		Interquartile Range		16.67	
		Skewness		-1.511	.752
		Kurtosis		2.472	1.481
	1	Mean		84.0000	3.61068
		95% Confidence Interval for Mean	Lower Bound	75.8321	
			Upper Bound	92.1679	
		5% Trimmed Mean		84.8148	
		Median		86.6667	
		Variance		130.370	
		Std. Deviation		11.41798	
		Minimum		60.00	
		Maximum		93.33	
		Range		33.33	
		Interquartile Range		11.67	
		Skewness		-1.539	.687
		Kurtosis		1.376	1.334

S2_Spec_11	0	Mean		86.6667	1.45479
		95% Confidence Interval for Mean	Lower Bound	83.1069	
			Upper Bound	90.2264	
		5% Trimmed Mean		86.6667	
		Median		86.6667	
		Variance		14.815	
		Std. Deviation		3.84900	
		Minimum		80.00	
		Maximum		93.33	
		Range		13.33	
		Interquartile Range		.00	
		Skewness		.000	.794
		Kurtosis		3.000	1.587
	1	Mean		86.6667	3.14270
		95% Confidence Interval for Mean	Lower Bound	79.5574	
			Upper Bound	93.7759	
		5% Trimmed Mean		87.0370	
		Median		86.6667	
		Variance		98.765	
		Std. Deviation		9.93808	
		Minimum		66.67	
		Maximum		100.00	
		Range		33.33	
		Interquartile Range		10.00	
		Skewness		-1.006	.687
		Kurtosis		.788	1.334

Meth_12	0	Mean		81.5838	4.41527
		95% Confidence Interval for Mean	Lower Bound	71.1433	
			Upper Bound	92.0242	
		5% Trimmed Mean		82.4636	
		Median		86.0000	
		Variance		155.957	
		Std. Deviation		12.48827	
		Minimum		55.33	
		Maximum		92.00	
		Range		36.67	
		Interquartile Range		16.67	
		Skewness		-1.548	.752
		Kurtosis		2.289	1.481
	1	Mean		81.2775	3.34915
		95% Confidence Interval for Mean	Lower Bound	73.9061	
			Upper Bound	88.6489	
		5% Trimmed Mean		81.7528	
		Median		85.3350	
		Variance		134.601	
		Std. Deviation		11.60179	
		Minimum		59.33	
		Maximum		94.67	
		Range		35.34	
		Interquartile Range		17.83	
		Skewness		-.949	.637
		Kurtosis		-.286	1.232

Spec_12	0	Mean		77.8660	6.65861
		95% Confidence Interval for Mean	Lower Bound	59.3787	
			Upper Bound	96.3533	
		5% Trimmed Mean		78.3698	
		Median		80.6667	
		Variance		221.685	
		Std. Deviation		14.88910	
		Minimum		53.33	
		Maximum		93.33	
		Range		40.00	
		Interquartile Range		23.00	
		Skewness		-1.366	.913
		Kurtosis		2.712	2.000
	1	Mean		74.2222	10.14220
		95% Confidence Interval for Mean	Lower Bound	30.5839	
			Upper Bound	117.8606	
		5% Trimmed Mean		.	
		Median		79.3333	
		Variance		308.593	
		Std. Deviation		17.56680	
		Minimum		54.67	
		Maximum		88.67	
		Range		34.00	
		Interquartile Range		.	
		Skewness		-1.198	1.225
		Kurtosis		.	.

Mann-Whitney U Test Statistical Results from SPSS for Stage 1 and 2 Mathematics courses for the Accelerated (1) and Non-accelerated (0) groups:

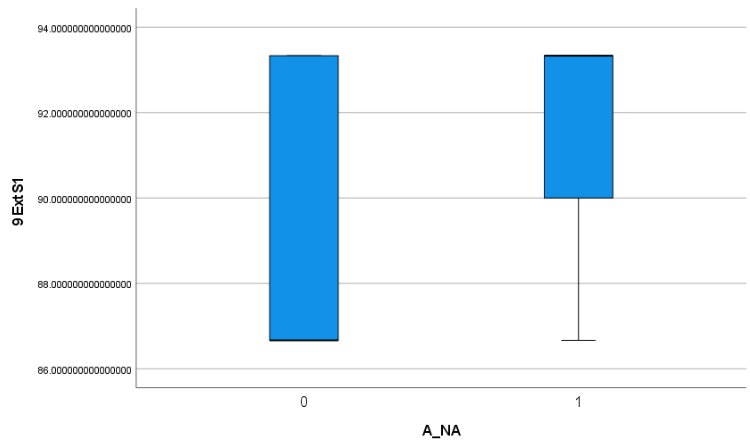
Ranks

	A_NA	N	Mean Rank	Sum of Ranks
S1_Meth_11	0	13	15.69	204.00
	1	13	11.31	147.00
	Total	26		
S2_Meth_11	0	13	14.31	186.00
	1	13	12.69	165.00
	Total	26		
S1_Spec_11	0	8	7.63	61.00
	1	10	11.00	110.00
	Total	18		
S2_Spec_11	0	7	8.21	57.50
	1	10	9.55	95.50
	Total	17		
Meth_12	0	8	10.69	85.50
	1	12	10.38	124.50
	Total	20		
Spec_12	0	5	4.60	23.00
	1	3	4.33	13.00
	Total	8		

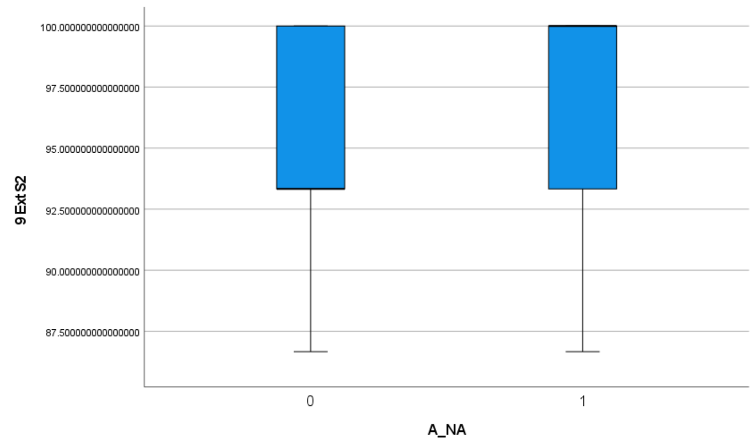
	S1_Meth_11	S2_Meth_11	S1_Spec_11	S2_Spec_11	Meth_12	Spec_12
Mann-Whitney U	56.000	74.000	25.000	29.500	46.500	7.000
Wilcoxon W	147.000	165.000	61.000	57.500	124.500	13.000
Z	-1.528	-.555	-1.384	-.585	-.116	-.149
Asymp. Sig. (2-tailed)	.127	.579	.166	.558	.908	.881
Exact Sig. [2*(1-tailed Sig.)]	.153[b]	.614[b]	.203[b]	.601[b]	.910[b]	1.000[b]

a. Grouping Variable: A_NA

b. Not corrected for ties.



Boxplot for the 9 Extension data from Semester 1



Boxplot for the 9 Extension data from Semester 2

Appendix B(a)

PARTICIPANT INFORMATION SHEET AND CONSENT FORM

Flinders UNIVERSITY ADELAIDE • AUSTRALIA

Title: Effects of a Mathematics acceleration course on achievement and continued Mathematics study.

Chief Investigator

Senior Lecturer, Dr Jane Jarvis

College of Education, Psychology and Social Work

Flinders University

Tel: 08 8201

Co-Investigator

Master of Education Student, Mrs Rachel Neil

College of Education, Psychology and Social Work

Flinders University

Tel: 08 8522 0608

My name is Rachel Neil and I am a Flinders University Masters student. I am undertaking this research as part of my degree. For further information, you are more than welcome to contact my supervisor. Her details are listed above as the Chief Investigator.

Description of the study

This project will investigate the experiences and outcomes of academic acceleration for students of Mathematics. Although academic acceleration has been widely researched, systematic evaluation of school-based acceleration programs such as the one offered at Trinity College is not common in South Australia. This project will investigate the experiences of students who undertook an accelerated program in Mathematics and explore how these can help to explain students' achievement outcomes and choices regarding further study of higher-level Maths courses. The research involves analysis of quantitative data in the form of Mathematical achievement and enrollment in higher-level Mathematics courses. These outcomes and choices will be compared between students who completed the acceleration program and matched peers who did not. I will then invite students to participate in qualitative focus group interviews to explore their experiences of studying Maths. This project is supported by Flinders University, College of Education, Psychology and Social Work and Trinity College.

Purpose of the study

The purpose of this project is to explore the experiences of students who have been accelerated from Grade 9 Extension Mathematics into Grade 10 Stage 1 Mathematical Methods, based on attainment of an A grade for 9 Extension and the add-on course, 9 Accelerated. It also aims to evaluate the outcomes of the Year 9 acceleration program across campuses by investigating the achievement outcomes of students who completed the program, and examining their choices regarding further Maths study.

The researcher requests your assistance as a student participant because you were part of the acceleration group, and can therefore offer insight into the experience of undertaking the course and have achievement data that can help to evaluate program outcomes. As a parent/caregiver your assistance is requested to provide your consent for your child to participate.

Benefits of the study

Finding out about students' experiences and examining their achievement and subject choices will help to inform the future of the acceleration program by allowing the College to gain a better understanding of its impact and understanding how it could be improved.

Participation is completely voluntary, and no incentive will be given.

Participant involvement and potential risks

If you agree to participate in the research study, you will be asked to:

- attend a focus-group interview with a researcher that will be audio recorded.
- respond to questions regarding your views about the acceleration program.

The interview will take about 60 minutes and participation is entirely voluntary. The interview will take place at your school.

In participating in the interview, there are no anticipated risks, however potential risks could include:

- Experiencing anxiety
- Unwanted self-knowledge
- Feelings of self-doubt and lack of confidence
- Social risk/disadvantage

These have been minimised by ensuring that you have the right to withdraw at any time throughout the interview. Should you feel uncomfortable at any time, it is recommended you ask the researcher to stop the interview immediately. Furthermore, you have the right to decline any questions that you do not feel comfortable answering. You will have the opportunity to debrief with the principal supervisor at the conclusion of the interview. To protect you from social disadvantage, you will not be identified in the research. Group interview information will be analysed collectively with no identifiable information being used. This is to ensure you have confidentiality beyond the interview in this research. Your participation in this research will not be revealed to any other member of the College community, and should therefore not provide an opportunity for social disadvantage. Similarly, your responses will not affect the working relationship you have with the principal researcher. While feelings of self-doubt or lack of confidence are unlikely, should you feel these it is encouraged that you withdraw from the interview and speak to the principal researcher at the end of the session.

- Lifeline – 13 11 14, www.lifeline.org.au
- Beyond Blue – 1300 22 4636, www.beyondblue.org.au

Withdrawal Rights

You may, without any penalty, decline to take part in this research study. If you decide to take part and later change your mind, you may, without any penalty, withdraw at any time without providing an explanation. To withdraw, please contact the Chief Investigator or you may just leave Focus Group discussions at any time.

Data recorded during focus group discussions may not be able to be destroyed. However, the data will not be used in this research study without your explicit consent.

Confidentiality and Privacy

Only researchers listed on this form have access to the individual information provided by you. Privacy and confidentiality will be assured at all times. The research outcomes may be presented at conferences, written up for publication or used for other research purposes as described in this information form. However, the privacy and confidentiality of individuals will be protected at all times. You will not be named, and your individual information will not be identifiable in any research products without your explicit consent. No data will be shared or used in future research projects without your explicit consent.

Data Storage

The information collected may be stored securely on a password protected computer and/or Flinders University server throughout the study. Any identifiable data will be de-identified for data storage purposes unless indicated otherwise. All data will be securely transferred to and stored at Flinders University for an extended period of 10 years after publication of the results. Following the required data storage period, all data will be securely destroyed according to university protocols.

Recognition of Contribution / Time / Travel Costs

If you would like to participate, in recognition of your contribution and participation time, you will be provided with snacks during the focus group interview.

How will I receive feedback?

On project completion, a short summary of the outcomes will be available to all participants via email.

Ethics Committee Approval

The project has been approved by Flinders University's Human Research Ethics Committee (project number 4546).

Queries and Concerns

Queries or concerns regarding the research can be directed to the research team. If you have any complaints or reservations about the ethical conduct of this study, you may contact the Flinders University's Research Ethics & Compliance Office team via telephone 08 8201 2543 or email human.researchethics@flinders.edu.au.

Thank you for taking the time to read this information sheet which is yours to keep. If you accept our invitation to be involved, please sign the enclosed Consent Form.

CONSENT FORM

Consent Statement

☐ I have read and understood the information about the research, and I understand I am being asked to provide informed consent to participate in this research study. I understand that I can contact the research team if I have further questions about this research study.

☐ I am not aware of any condition that would prevent my participation, and I agree to participate in this project.

☐ I understand that I am free to withdraw at any time during the study.

☐ I understand that I can contact Flinders University's Research Ethics & Compliance Office if I have any complaints or reservations about the ethical conduct of this study.

☐ I understand that my involvement is confidential, and that the information collected may be published. I understand that I will not be identified in any research products.

☐ I understand that I will be unable to withdraw my data and information from this project. I also understand that this data **will be used** for this research study.

I further consent to:

- ☐ participating in a Focus Group discussion
- ☐ having my information audio recorded
- ☐ sharing my de-identified data with other researchers
- ☐ my data and information being used in this project and other related projects for an extended period of time (no more than 10 years after publication of the data)
- ☐ being contacted about other research projects

Signed:

Name:

Date:

If under 18 years of age please have a parent or guardian also sign the consent form

Signed:

Name:

Date:

Appendix B(b)

CONSENT FORM

Consent Statement

- ☐ I have read and understood the information about the research, and I understand I am being asked to provide informed consent to participate in this research study. I understand that I can contact the research team if I have further questions about this research study.
- ☐ I am not aware of any condition that would prevent my participation, and I agree to participate in this project.
- ☐ I understand that I am free to withdraw at any time during the study.
- ☐ I understand that I can contact Flinders University's Research Ethics & Compliance Office if I have any complaints or reservations about the ethical conduct of this study.
- ☐ I understand that my involvement is confidential, and that the information collected may be published. I understand that I will not be identified in any research products.
- ☐ I understand that I will be unable to withdraw my data and information from this project. I also understand that this data **<u>will be used</u>** for this research study.

I further consent to:

- ☐ participating in a written survey
- ☐ sharing my de-identified data with other researchers
- ☐ my data and information being used in this project and other related projects for an extended period of time (no more than 10 years after publication of the data)
- ☐ being contacted about other research projects

Signed:

Name:

Date:

If under 18 years of age please have a parent or guardian also sign the consent form

Signed:

Name:

Date:

Appendix C

Focus Group Interview Questions

I am trying to find out about students' experiences of the Year 9 Accelerated course. I am going to ask you some questions about how you found the program as a student, and I am hoping your answers will help us understand the outcomes from the program and what we might be able to improve.

(Reminders about confidentiality/ withdrawing/ audio-recording, etc.)

1. Tell me about why you choose to study the 9 Accelerated course in Year 9.

   (Possible follow up: Did your parents help you decide? Did you feel any pressure to take the course? Did you have any reservations or concerns about taking the course?)
2. Tell me about how you found the 9 Accelerated course. (*Was it a good experience for you? Was it what you expected? Was it easier/ more difficult than you thought it would be?)*
3. How does your experience with the 9 Accelerated course compare to previous experiences in Maths classes? *(Had you enjoyed Maths classes in the past? Did you find 9 Accelerated more or less academically challenging than other classes? How did the amount of work compare? Did you notice any change in your motivation or enjoyment of Maths? Did you feel more engaged in 9 Accelerated?)*
4. 9 Accelerated has worked a bit differently in different campuses and years. How did you find the social climate of your classroom while you completed the 9 Accelerated course? *(By social climate, I mean, what was the social experience like in your 9 Accelerated class?)*

5. Why did you choose to study Stage 1 Mathematical Methods in Year 10? What are some of the factors you considered when making your decision?
6. How does your experience with the Stage 1 Methods course compare to previous experiences in Maths classes?
7. How did you find the social climate of your classroom while you completed the 10 Methods course?
8. If you attended the afterschool support sessions, how did you find the social climate?
9. How do you feel your experience with acceleration has impacted on your motivation for learning Mathematics?
10. Have you undertaken further Mathematical courses like Stage 2 Methods, or Specialist Mathematics? Why or why not?
11. Do you think that taking the Accelerated course in Year 9 helped you to prepare better for accelerating in Year 10? Can you explain why you think that? What about beyond Stage 1 Methods?
12. To what extent do you think participating in the accelerated course has supported your achievement in Maths?
13. If you could go back to Year 9, would you still complete the Accelerated course? Why or why not?
14. If you could make any changes or improvements to the acceleration program, what would they be?
15. Is there anything else you think it would be helpful for me to know about your experience of the accelerated program?

Appendix D

Survey Questions

I am trying to find out about students' experiences of the Year 9 Accelerated course and why some student may have chosen not to participate or not to continue to accelerate following involvement in the program. Below are a list of questions about how you found the program (if you participated) as a student, including some questions relating to your choice not to participate, and I am hoping your answers will help us understand the outcomes from the program and what we might be able to improve. Please answer the questions that relate to your circumstances and type in the space provided (your responses should come up in red font).
Your answers to the survey questions will remain confidential and you are able to withdraw your responses at any time by letting the researcher know that you would like to do so.

1. Tell me about why you chose to study the 9 Accelerated course in Year 9 or what led to your decision not to study the course.
   (Consider things such as: Did your parents or teachers help you decide? Did you feel any pressure to take the course? Did you have any reservations or concerns about taking the course?)

2. Tell me about how you found the 9 Accelerated course. **If you did not do this course please go to Qu. 4.** (*Was it a good experience for you? Was it what you expected? Was it easier/ more difficult than you thought it would be?)*

3. How does your experience with the 9 Accelerated course compare to previous experiences in Maths classes? *(Had you enjoyed Maths classes in the past? Did you find 9 Accelerated more or less academically challenging than other classes? How did the amount of work compare? Did you notice any change in your motivation or enjoyment of Maths? Did you feel more engaged in 9 Accelerated?)*

4. 9 Accelerated has worked a bit differently in different campuses and years. How did you find the social climate of your classroom while you completed the 9 Accelerated course? What was your perception of the social climate if you did not participate? *(By social climate, I mean, what was the social experience like in your 9 Accelerated class?)*

5. If you chose not to study 9 Accelerated, what was your perception of the course? *(Did you notice a difference in your peers who were doing the course? How did you feel about your decision not to complete 9 Accelerated?)*

6. Why did you choose not to study Stage 1 Mathematical Methods in Year 10? **Ignore this question if you did not complete 9 Accelerated. Go to Qu. 7.** What are some of the factors you considered when making your decision?

7. How did you find the social climate of your classroom while the accelerated students completed the 10 Methods course?

8. How do you feel your experience with acceleration (9 Accelerated only or not participating at all) has impacted on your motivation for learning Mathematics?

9. Have you undertaken further Mathematical courses like Stage 2 Methods, or Specialist Mathematics? Why or why not?

10. To what extent do you think participating in the accelerated course at Year 9 has supported your achievement in Maths? **Ignore if you did not complete 9 Accelerated. Go to Qu. 11.**

11. If you could go back to Year 9, would you still complete/not complete the Accelerated course? Why or why not?

12. If you could make any changes or improvements to the acceleration program, what would they be?

13. Is there anything else you think it would be helpful for me to know about your experience of the accelerated program?