Mind the Gap: Investigating Misaligned Mathematics Study Intentions and Perceived Capabilities

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Strengthening lower secondary students' attitudes toward mathematics is key to addressing declining enrolments in higher-level courses. This mixed-methods study examined the alignment between students' perceived mathematics capability and study intentions, as well as demographic and attitudinal differences. Results suggest that students with aligned intentions had more adaptive attitudes than those with an intentions-capability gap. Many who intended to study below their perceived capability cited low utility value, suggesting that enhancing mathematics' perceived utility could increase higher-level enrolments.

Over the past two decades, the proportion of students participating in advanced senior mathematics courses in Australia has declined, falling from 34.9% in 2008 to 26.7% in 2022 (AMSI, 2024). In most Australian states, calculus-based courses are available at intermediate and higher levels with a 50% gender balance in intermediate courses, but only 37.5% representation for females in higher level courses (Marchant & Kennedy, 2024). There is also evidence of declining enrolments in mathematics-based university level courses (AMSI, 2024) despite predictions of growth in industry demands for STEM-skilled employees (Office of the Chief Scientist, 2014). To address declining enrolments in senior mathematics courses it is important to examine student attitudes and enrolment plans in the junior years of high school, well before students make subject selections and potentially opt out of mathematics study.

The intrinsic value, utility value, ability beliefs, and cost constructs from expectancy-value theory (EVT) are widely used in motivational research to understand student attitudes and intentions towards STEM subjects in secondary school and beyond (Wigfield & Eccles, 2000).

Intrinsic value measures students' enjoyment and interest in the subject, with enjoyment a predictor of students' intentions to continue studying a subject once it is no longer compulsory (Mackenzie et al., 2024). *Utility value* refers to students' perceptions of the usefulness, importance, or applicability of a subject in other contexts such as a future career (Berger et al, 2020). Utility value is an important predictor of gendered enrolment patterns for university courses, for instance, student's expectations of a mathematically oriented career in adolescence explains approximately 15% of the gender gap in mathematically intensive majors (Law, 2018). *Ability beliefs* refer to students' views of competence in a subject and may be operationalised several ways, including confidence, self-efficacy, and self-concept (Berger et al., 2020). In this paper, we use perceived talent as an indicator of ability beliefs. Higher ability beliefs about STEM subjects have been associated with intentions to pursue mathematically intensive senior subjects, university degrees, and careers (Berger et al, 2020; Law, 2018).

Costs are students' perceptions of the sacrifices needed to succeed or engage in a task and can include effort, opportunity, and psychological costs (Lee et al., 2022). In this paper, we use mathematics anxiety as a well-known measure of psychological costs. Mathematics anxiety is a "feeling of tension and anxiety that interferes with […] the solving of mathematical problems in […] ordinary life and academic situations" (Richardson & Suinn, 1972, as cited in Dowker et al., 2016). Mathematics anxiety is associated with poorer performance and opting out of

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mathematics at higher levels, with girls also tending to express more mathematics anxiety than boys (Dowker et al., 2016).

Students' perceptions of their ability to cope with the academic challenge of mathematics may also influence their intentions to study higher level courses. *Academic buoyancy* refers to students' everyday resilience in dealing with academic challenges that occur in the ordinary course of schooling (Martin & Marsh, 2008). Academic buoyancy is moderately related to achievement in mathematics (Colmar et al., 2019) but importantly is also related to greater persistence and lower anxiety (Martin et al., 2010). Thus, academic buoyancy may serve as an important protective attitude towards pursuing mathematics at higher levels, especially given that mathematics is often perceived as being challenging and difficult (Li & Schoenfeld, 2019).

During the junior years of high school, adolescents build a view of what level of mathematics they are capable of studying in the senior years. This view may be informed by internal (attitudes, aspirations, prior achievement) and external (advice from others, school structures) factors (Hine et al., 2024). While previous research has examined how attitudes are related to students' intentions to study mathematics (e.g. Sheldrake et al., 2014), we were unable to locate any studies that have investigated the extent to which the level of mathematics that students perceive themselves as *capable* of studying is aligned with the level of mathematics they *intend* to study. Theoretically there may be two groups of students: those who intend to study the same level of mathematics that they feel capable of (aligned aspirers) and those who intend to study a level different to that they feel capable of. This second group demonstrates a mathematics study intention and perceived capability gap which indicate under-aspiration (studying below the level of perceived capability) or over-aspiration (studying above the level of perceived capability). Under-aspiring students may be a group with whom there is an opportunity to intervene to support increased enrolments in senior mathematics. On the other hand, over-aspiring students may require additional supports to increase their chances of success in courses that are more difficult than they believe they are capable of studying.

As such, in this study we aimed to investigate differences in the demographic profiles and attitudes of secondary students who do and do not display a mathematics study intention and perceived capability gap. Further, given that under-aspiring students may be a group in which interventions to increase mathematics enrolments can be targeted, we examined their reasons for selecting a lower level of mathematics. As such, the research questions for this study are:

(i) How do demographic profiles and attitudes differ between groups that intend to study a mathematics level (i) lower than their perceived capability, (ii) equal to their perceived capability, and (iii) higher than their perceived capability?

(ii) Why do adolescents choose a lower level of mathematics study lower than their perceived capability?

Method

Participants

The participants in this study were 1390 students (544 boys, 796 girls, 50 other or preferred not to disclose) drawn from 21 public secondary schools across NSW, Australia. There were 452 students in Year 7, 329 in Year 8, 296 in Year 9, and 313 in Year 10, and 30% reported that they received mathematics tutoring outside school. The schools that participated in this study ranged in the Index of Community Socio-educational Advantage (ICSEA) from 863 to 1147 (M = 1007.29, SD = 76.89), suggesting that the sample was diverse in terms of relative educational and socioeconomic status. 856 (61.6%) students attended comprehensive schools, while 185 (13.3%) attended selective and 347 (25.0%) attended partially selective schools. Most of the sample (n = 1114, 80.1%) attended schools in metropolitan areas and 273 (19.6%) attended schools in regional and remote areas.

Measures

Mathematics Study Intentions and Perceived Capability

Participants were asked which level of senior (Year 11-12) mathematics they intended to study using four options: no mathematics/numeracy, standard mathematics (lowest), advanced mathematics (moderate), or extension mathematics (highest). They were also asked to identify the highest level of mathematics they felt capable of studying using these options.

Perceived Talent and Intrinsic Value in Mathematics

Perceived talent and intrinsic value in mathematics were measured using four and three items respectively from Watt et al. (2019) (sample perceived talent item: *Compared with other students in your class, how talented do you consider yourself to be at maths?;* sample intrinsic value item: *How interesting do you find maths?*). Participants were asked to respond on a 7-point scale from 1 (not at all) to 7 (extremely). Both scales demonstrated excellent reliability: perceived talent $\alpha = .91$, $\omega = .91$; intrinsic value $\alpha = .94$; $\omega = .94$.

Utility Value

Participants' level of utility value in mathematics was measured using five items adapted from PISA 2006 (OECD, 2007) (sample item: *I study maths because I know it is useful for me*). Participants were asked to respond on a 7-point scale from 1 (strongly disagree) to 7 (strongly agree). This scale demonstrated excellent reliability ($\alpha = .94$; $\omega = .94$).

Mathematics Anxiety

Mathematics anxiety was measured using eight items from Bai (2010) (sample item: *Maths makes me feel nervous*). Participants were asked to respond on a 6-point scale from 1 (strongly disagree) to 6 (strongly agree). This scale demonstrated excellent reliability ($\alpha = .94$; $\omega = .94$).

Academic Buoyancy in Mathematics

Academic buoyancy in mathematics was measured using four items adapted from Martin and Marsh (2008) (sample item: *I think I'm good at dealing with maths schoolwork pressures*). Participants were asked to respond on a 7-point scale from 1 (strongly disagree) to 7 (strongly agree). This scale demonstrated good reliability ($\alpha = .84$; $\omega = .84$).

Reasons for Intending to Study Mathematics Level Below Perceived Capability

Participants who reported that they intended to study a level of mathematics below the level they felt they were capable of were asked to provide reasons for this decision (*Why aren't you studying the highest level that you feel capable of?*) in an open comment field.

Procedure

Purposive sampling was used to recruit participants from diverse school contexts under the direction of the funding body. First, the principal of each identified school was contacted to seek consent for their school's participation. After this consent had been received, parents/caregivers of all students in Years 7-10 at each school were provided with a participant information sheet and asked to provide informed consent for their child to take part in an online survey. Students with parental consent to participate completed the survey via the Qualtrics platform during a timetabled mathematics lesson.

Analysis Strategy

Statistical analyses were conducted in SPSS 29. First, participants were placed into one of three groups using their responses to the mathematics study intentions and perceived capability items: *under-aspirers* indicated their intention to study a level of mathematics lower than their

perceived capability, *aligned aspirers* indicated that they intended to study a level of mathematics equal to their perceived capability, and *over-aspirers* indicated their intention to study a level of mathematics higher than their perceived capability. Following group assignment, five chi-square tests were conducted to compare the demographic profiles of each group with a Bonferroni correction of $p < 0.01$ applied to control for Type 1 error. Standardised adjusted residuals were used as post hoc tests to identify significant differences between the groups with a Bonferroni correction applied. All attitudinal variables demonstrated acceptable levels of skewness and kurtosis, indicating approximately normal distributions. This enabled attitudinal differences between the groups to be examined using five ANOVA tests with a Bonferroni correction of $p < 0.01$. Eta-square was used to determine main effect sizes with those under .01 deemed to be small, between .01 and .06 to be moderate, and over .06 to be large (Cohen, 1988). Welch's ANOVA was used in place of a standard ANOVA when Levene's Test for homogeneity of variance was violated. Post hoc tests were then conducted to identify where groups differed (Tukey if variances were equal, Games-Howell if variances were unequal).

Qualitative responses provided by under-aspirers were coded independently by two members of the research team, initially examining the responses for evidence related to the constructs measured in the survey (perceived talent, intrinsic value, utility value, mathematics

Table 1

Chi-Square Tests Comparing Group Demographics

Demographics	X^2 Frequencies (percentage of group)			
	Under (*n* = 189)	**Aligned (*n* = 943)**	**Over (*n* = 258)**	**Total (*n* = 1390)**
Gender	X^2 (4, 1390) = 18.09, p = .001			
Male	84 (44.4%)	382 (40.5%)	78 (30.2%)↓	544 (39.1%)
Female	99 (52.4%)	521 (55.2%)	176 (68.2%)↑	796 (57.3%)
Other	6 (3.2%)	40 (4.2%)	4 (1.6%)	50 (3.6%)
School type	X^2 (4, 1388) = 44.00, p < .001			
Comprehensive	147 (77.8%)↑	572 (60.8%)	137 (53.1%)	856 (61.7%)
Partially selective	36 (19.0%)	247 (26.2%)	64 (24.8%)	347 (25.0%)
Selective	6 (3.2%)↓	122 (13.0%)	57 (22.1%)↑	185 (13.3%)
School location	X^2 (2, 1388) = 13.41, p = .001			
Metropolitan	134 (70.9%)↓	764 (81.2%)	217 (84.1%)	1115 (80.3%)
Regional	55 (29.1%)↑	177 (18.8%)	41 (15.9%)	273 (19.7%)
Year level	X^2 (6, 1390) = 37.48, p < .001			
Grade 7	47 (24.9%)	293 (31.1%)	112 (43.4%)↑	452 (32.5%)
Grade 8	49 (25.9%)	216 (22.9%)	64 (24.8%)	329 (23.7%)
Grade 9	56 (29.6%)↑	191 (20.3%)	49 (19.0%)	296 (21.3%)
Grade 10	37 (19.6%)	243 (25.8%)↑	33 (12.8%)↓	313 (22.5%)
Tutored outside school	X^2 (2, 1390) = 29.84, p < .001			
Tutored	25 (13.2%)↓	303 (32.1%)	89 (34.5%)	417 (30.0%)
Not tutored	164 (86.8%)↑	640 (67.9%)	169 (65.5%)	973 (70.0%)

Note. X^2 = chi-square; ↓ = significantly fewer than expected; ↑ = significantly more than expected.

anxiety, academic buoyancy) while allowing additional themes to emerge. Some responses were coded to more than one theme if applicable. The initial independent coding across eight categories generated a pooled kappa of 0.87. Differences in the application of the codes were discussed, and codes were added or deleted until agreement was reached on all codes.

Results

Most students (67.8%) were aligned aspirers, indicating that they intended to study the level of mathematics that they felt capable of. The remaining students reported a mathematics intention-capability gap: 18.6% were over-aspirers and 13.6% were under-aspirers.

Demographic Profile Differences

Results of five Pearson chi-square tests investigating demographic profile differences between the groups are shown in Table 1. All five tests were significant at $p < 0.01$, indicating that there were differences in the demographic profiles of the three groups. In the under-aspiring group, students from comprehensive schools, regional schools, in Year 9, and those not being tutored outside school were overrepresented. Conversely, students from selective schools, metropolitan schools, and those being tutored outside school were underrepresented. In the aligned group students from Year 10 were overrepresented. A significant gender difference was observed in the over-aspiring group, with girls overrepresented and boys underrepresented. Students from selective schools and in Year 7 were overrepresented in the over-aspiring group, while students in Year 10 were underrepresented.

Attitudinal Differences

Results of five ANOVAs examining attitudinal differences between the groups are shown in Table 2. All main effects were significant with effect sizes (η^2) ranging from small (mathematics anxiety) to moderate (perceived talent, intrinsic value, academic buoyancy) to large (utility value). Post hoc tests revealed that over-aspiring students had significantly lower levels of perceived talent and higher levels of mathematics anxiety than aligned students. Under-aspiring students exhibited significantly lower levels of intrinsic and utility value than aligned and over-aspiring students. Finally, aligned students reported significantly higher levels of academic buoyancy than under-aspiring and over-aspiring students.

Table 2

ANOVA Results and Group Means of Attitudinal Variables

Attitude	ANOVA	***M* (*SD*)**		
		Under	**Aligned**	**Over**
Perceived talent	$F(2,1337) = 9.02, p < .001, \eta^2 = .01$	4.36 (1.44)	4.60 (1.44)^a	4.18 (1.53)^a
Intrinsic value	$F(2,1337) = 24.70, p < .001, \eta^2 = .04$	2.99 (1.52)^{ab}	3.97 (1.76)^a	3.86 (1.71)^b
Utility value	$F(2,395.38) = 41.79, p < .001, \eta^2 = .06$^	4.44 (1.40)^{ab}	5.36 (1.31)^a	5.55 (1.16)^b
Mathematics anxiety	$F(2,1337) = 5.60, p = .004, \eta^2 = .01$	3.37 (1.26)	3.15 (1.23)^a	3.41 (1.20)^a
Academic buoyancy	$F(2,1337) = 13.81, p < .001, \eta^2 = .01$	4.43 (1.52)^a	4.74 (1.38)^{ab}	4.45 (1.31)^b

Note. η^2 = eta-squared; ^ = Welch's ANOVA due to unequal variances; ^{a} = significant difference between groups; ^{b} = significant difference between groups.

Reasons for Selecting Below Perceived Capability

Of the 189 students in the under-aspiring group, 41 (21.7%) planned to study no mathematics or numeracy, 81 (42.9%) planned to study standard mathematics, and 67 (35.4%) planned to study advanced mathematics. These students were invited to provide reasons why they were intending to study a level of mathematics lower than their perceived capability. After coding, eight themes emerged with 252 codes allocated across 189 open-ended student

responses. The frequency of responses coded within each category is detailed in Table 3 along with example responses for each category.

Table 3

Frequency of Reasons for Choosing Level of Mathematics Below Their Capability and Example Responses

Reason	Frequency (female *n*)	*Example responses*
Utility value	56 (29)	Because I don't really need advanced maths in the job I want to do (female, Y10)
Perceived talent	41 (28)	I know that I am not as talented in mathematics compared to other subjects (male, Y7)
Intrinsic value	39 (19)	Because I hate maths (male, Y9)
Cost (time)	28 (16)	I feel like I could do it, but I also think it would take a lot of energy and time that I'm not willing to give up (male, Y10)
Difficulty of subject	28 (20)	I know they will complicate it so what's the point of going through that difficulty? (female, Y9)
Mathematics anxiety	21 (12)	I don't want to put too much effort into something I'm not all that passionate about, so I don't burn myself out or get too stressed over nothing (female, Y9)
Academic buoyancy	11 (7)	Because it will be too hard and I won't be able to handle it unless I get extra help (female, Y8)
Other	28 (14)	e.g. I don't know; I'm not sure why; I don't want to.

Students most frequently (29.6% of responses) cited reasons related to the perceived lack of utility of higher mathematics levels for their lives and/or future careers. Further, students cited their perceptions of their ability to do mathematics at higher levels as influential on their aspired level of mathematics (21.7%) followed by the extent to which they liked the subject (20.6%). Many students felt that the substantial time that it would take to succeed at higher levels was a deterrent (14.8%), as was the perceived difficulty of mathematics as a subject (14.8%). Just over 10% of students expressed being influenced by anxiety, stress and pressure related to mathematics and almost 6% were concerned about coping with higher levels.

Discussion

Education systems across Australia have agreed on the aim that "young Australians of all backgrounds are supported to achieve their full educational potential" (Education Council, 2019, p.5). For this aim to be achieved students must be provided with opportunities, support and encouragement to fulfil their potential across the curriculum. This is particularly important in mathematics, which acts as a gatekeeper discipline for many post-school educational and career pathways (Li & Schoenfeld, 2019). When students opt out of more advanced levels of mathematics, especially when they feel capable of participating, they may inadvertently curtail future options of interest. It is important, therefore, to understand which students are opting to take lower levels than they are capable of, and their reasons for doing so.

Our study found that the aligned group displayed the most adaptive attitudes towards mathematics. For example, these students had higher levels of academic buoyancy than either of the other groups, indicating they felt capable of handling minor setbacks experienced during their study of mathematics. While it is positive that most students were in this group, it is of concern that, the average intrinsic value score indicated that most students do not enjoy or find mathematics interesting ($M = 3.97$ on a 7-point scale). Given the critical nature of intrinsic value for continued study of mathematics (Watt et al., 2012), interventions to increase students' intrinsic value may be useful for all students regardless of their intention-capability alignment.

Our demographic profile analysis of the groups in this study found that students in comprehensive schools, in regional areas and who were not receiving tutoring, were over-represented in the under-aspiring group. Conversely, students in academically selective schools were over-represented in the over-aspiring group. On one level, these findings may be explained by the levels of support available to these groups of students, either financially in the form of extra tutoring or in terms of encouragement and high expectations that may be more prevalent in selective and/or metropolitan school communities.

In terms of attitudes towards mathematics, students in the under-aspiring group indicated that they liked mathematics less and found it less relevant to their lives and futures than other students. These quantitative results were also reflected in the open-ended comments made by these students, where utility value emerged as the most frequent reason given for choosing lower levels. It could be that students are making accurate assessments of the expected mathematical demands in their future careers and lives. It may also be the case that they are misinformed in this regard, potentially impacting negatively on their range of career opportunities. In both cases, the findings imply a role for schools to ensure that students are accurately informed about the levels of mathematics required for various careers, and an imperative for teachers to foster more positive attitudes to the subject for all students.

For those students in under-aspiring group, further insights were gained from their open-ended responses asking them to explain their reasoning. Mathematics was perceived by many in this group as an overly time-intensive subject at the higher levels, potentially taking time away from other subjects that they were more interested in. Relatedly, it was also viewed as a subject that was difficult in comparison to other subjects and students feared the stress and pressure than might result from attempting higher levels.

While the under-aspiring group raises important issues for schools to address, other issues arose for the over-aspiring group. These students were more anxious and perceived themselves to be less talented in mathematics than those in the aligned group. This may be explained in part by the fact that girls were overrepresented in this group: in previous research girls have been found to experience higher levels of mathematics anxiety (Dowker et al., 2016) and lower levels of perceived talent than boys, even when their attitudes towards mathematics are very positive (Berger et al., 2020). Given that mathematics anxiety can negatively influence mathematics performance (Dowker et al., 2016), these findings suggest that interventions designed to address mathematics anxiety and strengthen ability beliefs may be particularly useful for over-aspiring students (especially girls).

Stereotypically, mathematics is viewed as a challenging and difficult subject (Li & Schoenfeld, 2019) and this view continues to be represented in our study, especially for those students in the under-aspiring group. In addition to viewing the subject negatively they also see little use for mathematical knowledge in their futures, possibly reducing their future options prematurely. The over-aspiring group suffered from higher levels of mathematics anxiety than the aligned group. This suggests that both groups with an intentions-capability gap are potentially at risk for different reasons, pointing to a role for schools and teachers in ensuring that students are feeling adequately prepared for higher levels of mathematics and sufficiently informed about the mathematics knowledge that they will need for their future lives.

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