



Academic engagement in high-ability Mathematics students: An examination of interpersonal relationships and personal best (PB) goals

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Kate Caldecott-Davis is a registered psychologist who has worked in the role of School Counsellor at Barker College since 2008. She holds a Bachelor's Degree and Postgraduate Diplomas in Psychology, a Master's Degree in Research, and a Master's Degree in Gifted Education (With Excellence). In addition to Kate's professional practice, and work in the area of gifted education, she conducts quantitative research investigating the motivational processes underlying optimal psycho-social functioning of students and teachers within educational settings. Kate is passionate about empowering all students to thrive at school, which is reflected in her approach to working with students, and her research into social and emotional learning which will be the focus of her doctoral studies in 2021.

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Abstract

Research has sought to understand the trajectory of engagement and subsequent achievement of gifted students in order to develop effective interventions to reduce and reverse academic underachievement (McCoach & Siegle 2003). Previous studies have demonstrated the link between high-quality interpersonal relationships and academic engagement, mediated by personal best (PB) goal setting within general student populations (e.g. Collie et al. 2016; Martin et al. 2016; Martin et al. 2019). Grounded within a self-determination theory framework, this study examines the associations between three interpersonal relationships (teacher, parent, and peer), PB goal setting, and academic engagement within a sample of high-ability middle school students. A cross-sectional, self-report survey was undertaken with a sample of 66 male, high-performing Year 8 mathematics students, enrolled at an independent school located in Sydney, Australia. Consistent with previous research, general linear model analyses found teacher and peer relationships, but not parent relationships, to be positively associated with academic engagement. PB goal setting uniquely predicted academic engagement above and beyond each interpersonal relationship subtype. The findings of this investigation indicate the importance of fostering high quality interpersonal relationships and PB goal setting previously found in studies of general student populations also extend to gifted and talented students.

Key Terms

Self-determination theory

A broad framework for understanding factors that facilitate or undermine motivation and psychological wellness.

Personal best (PB) goals

Competitively self-referenced growth-based goals.

Interpersonal relationships

Social interactions and regard between two or more individuals.

Academic engagement

Observable cognitive, behavioural, and emotional connection and participation with a specific concept, process, or activity.

Body

Introduction

In the context of prescriptive curriculum standards, school rankings, and university admission requirements, there is significant national interest in the academic achievement of Australian students (Rudd & Gillard 2008). With interventions aimed at minimising the number of students failing to meet minimum benchmarks, 'at-risk' populations benefit from the majority of allocated educational resourcing (Jarvis & Henderson 2012). Whilst efforts to provide equitable access to targeted educational interventions, and resourcing for these student populations is vital, there remains another, overlooked and frequently neglected, student population – Australia's gifted students.

Whilst the onset of gifted underachievement and declining engagement is well established within the literature, there is less consensus regarding the underlying reasons for such an ability-achievement trajectory. In a review of the gifted underachievement literature, Reis and McCoach (2000) identified associations between achievement and environmental perceptions (e.g. attitudes about teacher relationships and school), goal valuation, self-efficacy, and self-regulation. They found relationships with peers to be positive influences on underachieving gifted students, and may support the reversal of underachievement (Reis & McCoach 2000).

Personal best (PB) goal setting is a growth goal currently receiving much research attention, with studies suggesting that PB goals enhance student outcomes to a greater extent than traditional performance and mastery goals (Bostwick et al. 2020; Burns et al. 2018a; 2018b). Given that interpersonal relationships are known positively to predict growth goals, and that PB goals are related to positive student outcomes, associations between interpersonal relationships → PB goals → academic engagement are a focus in this paper.

By conducting multiple linear regression analyses of high-ability Year 8 mathematics students' self-reported survey responses, this study sought to determine the extent to which PB goal setting is associated with academic engagement when controlling for the influences of interpersonal relationships with teachers, parents, and peers within gifted students.

Characteristics of gifted students

Within the research literature, Gagné's Differentiated Model of Giftedness and Talent 2.0 (DMGT; Gagné 2010) has achieved near universal consensus for conceptualising giftedness. The DMGT is a talent development model that recognises individual factors, including the possession of innate abilities (i.e. gifts), which are influenced by environmental (e.g. parents, teachers, and peers) and interpersonal catalysts (e.g. motivation, volition, and self-awareness), and developmental processes (e.g. access to education and training, and resources), leading to the expression of abilities into observable competencies (Gagné 2010; Preckel et al. 2006; Rubenstein et al. 2012). According to the DMGT, giftedness refers to the possession of inherent natural abilities or aptitudes, in at least one domain of human functioning, that places an individual within the top 10% of same-aged peers (Gagné 2010). Talents, a construct related to, yet distinct from giftedness, refer to exceptional mastery of one or more domains of expressed competencies (knowledge and skills) to the extent that places the individual within the top performing 10% of peers within their field (Gagné 2010). Within this study, mathematical-talented students are those performing within the top 10% of their grade level in the area of mathematics. Whilst not directly examined here, it is expected that the majority of mathematically talented students included in this study, also possess high intellectual ability (viz. giftedness).

There is a dearth of research investigating motivation and growth goals within gifted and talented students, and to the author's knowledge, there are no studies of this kind within an Australian context. Thus, this study aims to consider the existing body of literature regarding academic engagement within general student populations and explore the applicability to a talented student population within the participant school.

Self-Determination Theory

Self-determination theory (SDT; Ryan & Deci 2017), a conceptual framework of human motivation, posits that fulfilment of three basic needs – autonomy, relatedness, and competence - facilitate optimal autonomous motivation and associated positive outcomes. Within classroom-based contexts, need-supportive practices are associated with greater motivation, wellbeing and academic achievement (Jang et al. 2012). Of particular interest here, 'relatedness' refers to an individual's experience of feeling valued, accepted, and cared for by others (Ryan & Deci 2017). In line with the SDT theoretical framework, this paper operationalises students' need for relatedness as quality interpersonal relationships with teachers, parents, and peers. The notions of self-determination and internalisation within SDT provide support for the hypothesised relationship between interpersonal relationships and PB goals (Collie et al. 2016). Deci and Ryan (2012) argue that high quality interpersonal relationships increase the probability that the individual will internalise the beliefs and values of significant others. Thus, it is expected that within this school context, high relatedness with others (viz. teachers, parents, and peers) will increase the likelihood, and perhaps the extent to which, the schools' (via individuals within the school community) values of learning and academic growth are internalised by individual students. Collie et al. (2016), suggest that it is this internalisation process that promotes PB goal setting by enhancing autonomous motivation through the satisfaction of SDT basic psychological needs.

Interpersonal relationships

For school students, three types of interpersonal relationships have been identified as influential on school functioning: teachers, parents, and peers (Collie et al. 2016; Martin & Dowson 2009; Martin & Mainhard 2015). Each of these interpersonal relationships will be introduced next.

Teacher relationships

Positive teacher relationships are important for student functioning, and promote internalisation of the teachers' values and beliefs regarding school and learning (Martin & Dowson 2009; Ryan & Deci 2017). Teacher relationships refer to the students' experience of positive interactions with their teacher which include perceptions of teacher's demonstrated interest and support of the student. Longitudinal research has shown high-quality student-teacher relationships to be associated with positive student outcomes, such as academic achievement (Martin & Dowson 2009), academic engagement (Furrer & Skinner 2003), and motivation (Opdenakker et al. 2012). Causal links have been established within empirical research investigating the importance of student relationships with teacher, locating these interpersonal relationships as reliable predictors of a range of positive student outcomes (Wentzel 2010).

Parent relationships

Similarly, interpersonal relationships with parents are associated with positive student outcomes such as motivation and engagement (Fan & Williams 2010), academic goal setting (Martin et al. 2009), and academic achievement (Jeynes 2007). High-quality parent relationships have been found to predict academic connectedness (Dumont et al. 2012), in addition to school engagement and achievement (Hong & Ho 2005; Wang & Eccles 2012). In this paper parent relationships are operationalised as the extent that students' feel understood and fairly treated by their parents, and how well they like and get along together.

Peer relationships

The experience of positive relationships with peers is associated with a range of positive wellbeing and school-related outcomes (Wentzel 2009). Peer relationships are defined in this paper as a sense of reciprocal positive regard and interest between the student and their peers. Consistent with interpersonal relationships with parents and teachers, peer relationships have been found to be positively associated with academic engagement (Wang & Eccles 2013; Wentzel 2009), goal setting (Martin et al. 2009), and perceived academic competence (Guay et al. 1999). Wentzel (2009) suggests that these outcomes can be attributed to the resources, emotional validation, and modelling resulting from supportive peer relationships.

Summary

Taken together, research literature highlights commonalities amongst these three types of student interpersonal relationships (viz. teacher, parent, and peer), with high quality relationships being predictive of academic and non-academic, positive student outcomes. Prior research (e.g. Collie et al. 2016; Deci & Ryan 2012; Wentzel 2010) posits that, in combination with SDT theory, empirical evidence indicates a causal relationship between interpersonal relationships and student wellbeing and academic outcomes. Despite this, researchers have not yet investigated the importance of relatedness within high-ability student populations. Should these research findings extend to gifted and talented students, resulting implications for educational practice may augment strategies to reverse gifted underachievement.

Personal Best (PB) Goals

PB goal setting is a growth-based approach focusing on superseding an individual's previous performance or behaviours. Martin (2006) defines PB goals as being competitively self-referenced, challenging, and specific in nature. In contrast to traditional goal setting, such as mastery and performance goals, which reference success compared to a specific achievement outcome (e.g. learning mathematical times tables), or relative to another's performance (e.g. being top of the maths class), PB goals aim to outperform one's past efforts or achievements (Burns et al. 2018; Collie et al. 2016; Martin 2006). A growing body of literature is demonstrating positive associations between PB goal setting on academic engagement and academic achievement (Burns et al. 2017; Martin 2013; 2015). Furthermore, PB goal setting has been shown positively to predict academic outcomes beyond that explained by mastery and performance goals (Martin & Elliot 2015; 2016; Yu & Martin 2014). Prior research has found that sufficiently challenging goal setting, may enhance intrinsic motivation, leading to increased performance outcomes (Senko et al. 2011). Given the self-referenced focus on personal improvement, it is anticipated that PB goals will elicit such intrinsic motivation (Burns et al. 2018). Within the SDT framework, PB goals are likely to support autonomy- and competency-need fulfilment, as they necessitate the self-reflection of previous personal achievements and involve control over PB goal development. The self-determined nature of PB goals, emphasising students' volition and autonomy are expected to be enhanced by relatedness need-supportive practices within the school setting (Collie et al. 2016). Due to the established association with relatedness support via interpersonal relationships in previous research (e.g. Collie et al. 2016), PB goal setting has been included in the present investigation as a crucial variable related to improved academic outcomes (e.g. Burns et al. 2018; Martin & Elliot 2015; 2016).

Although the importance of the association between PB goal setting and engagement has been established within the general student population, it is not yet known whether this association holds true for gifted students. Should PB goal setting be found to positively predict academic engagement within gifted and talented students, the resulting implications may hold promise for pedagogical interventions targeting achievement in gifted populations.

Academic Engagement

Academic engagement is a multidimensional concept, comprised of three factors: cognitive, behavioural, and emotional engagement (Collie & Martin 2017; Fredricks et al. 2004). Cognitive engagement refers to the extent to which an individual is willing to actively engage in thinking, understanding, and learning novel ideas or skills. Behavioural engagement encompasses agentic action to participate in social and learning activities. Emotional engagement refers to the extent to which the student is affected by their school, schoolwork, and members of the school community. Engagement research has consistently demonstrated positive student outcomes emanating from high levels of engagement in domain-general (Collie et al. 2016; Jang et al 2010; Wang & Eccles 2012), and, more recently, domain-specific school contexts (e.g. Baroody et al. 2016; Collie & Martin 2017). In this study, academic engagement draws upon the three-component model of engagement (Fredricks et al., 2004), using a domain-general approach to measurement within a sample of mathematics students. High academic engagement is associated with a range of short- and long-term outcomes (Skinner et al. 2008). Academically engaged students are more likely to experience positive self-concept (Liem & Martin 2011), healthy functioning (Liem et al. 2008), and academic achievement (Jang et al. 2012). Thus, educational practices that support high levels of student engagement may hold significant promise for increasing achievement in gifted students.

The Present Study

There is an abundance of empirical research concerning the alarming rates of disengagement amongst middle-school students. Given the unique socio-affective characteristics and learning needs of high-ability students, it is important to understand how the interpersonal relationships of high-achieving students impact upon their academic engagement and how these differ from their low-achieving peers. Additionally, the emerging body of literature showing the benefits of growth approaches, specifically PB goal setting, to increase student motivation and academic achievement may hold promise for interventions targeting gifted underachievement. To date, research investigating PB goal setting and interpersonal relationships, has been conducted within general education populations, and with reference to 'at risk' groups of students (e.g. diagnosed ADHD, culturally and language diverse). In order to address this gap in the literature, this study represents the first investigating interpersonal relationships and PB goal setting within a high-ability student population.

This study addresses the following research question:

1. To what extent are PB goals associated with academic engagement over and above the association with interpersonal relationships in mathematically gifted students?

Building upon previously established temporal relations between interpersonal relationships and academic engagement, together with prior research on PB goal setting, it is expected that PB goals will positively predict academic engagement over and above each type of interpersonal relationship.

Method

Participants

Data was collected from Year 8 students enrolled at an Independent school, located in Sydney. Participating students were identified as mathematically-talented using standardised measures of mathematics achievement (stanine 8). A sample of 66 male children aged 12-14 years (Mean Age= 12.89, SD= 0.468) agreed to participate in the study. All students in the school's Year 8 cohort are male and attend as day students. The majority of students list English as their primary language

(72%), have one or more university educated parents (undergraduate qualification 14%; postgraduate university degree 72%). This sample represents students originating from families with an above-average socio-economic status.

Measures

The single online questionnaire included participant information and consent as the initial item. The following items included all measures rated on a 7-point Likert scale ranging from 1 (Strongly Agree) to 7 (Strongly Disagree), and demographic items.

Interpersonal Relationships

Student perceptions on three interpersonal relationship factors were measured: relationships with teachers, parents, and peers. Four items assessed perceived teacher relationships (e.g. 'In general, my teachers are interested in me') (Martin & Marsh 2008); four items measured perceived parent relationships (e.g. 'My parents treat me fairly') (Marsh 1992); and four items assessed peer relationships (e.g. 'Overall, I am liked by other students at this school') (Marsh 1992). Each of these scales have shown evidence of validity and reliability in previous research (e.g. Collie, et al. 2016; Marsh 1992; Martin & Marsh 2008). Data from the current sample demonstrated good internal consistency (Cronbach's alpha = 0.864).

PB Goals

Items from the Personal Best Scale (Martin 2006; Martin & Liem 2010) were used to measure academic PB goals (e.g. 'When I do my schoolwork, I try to improve on how I've done before'; 4 items). Previous research has shown sound psychometric properties for this scale (e.g. Collie et al. 2016; Martin 2006). Internal consistency based on data from the current sample was excellent (Cronbach's alpha = 0.909).

Academic Engagement

Following previous research (e.g. Collie & Martin 2017; Collie et al. 2016), academic engagement was measured using a composite scale, aligned with Fredricks and colleagues' (2004) three-component model of engagement, including cognitive, behavioural, and emotional constructs. Operationalising academic engagement by incorporating these components provided sound theoretical construct validity whilst circumventing multicollinearity between these engagement constructs (Collie & Martin 2017). Internal consistency based on data from the current sample was good (Cronbach's alpha = 0.861).

Statistical Analyses

To address the central research question, the extent that PB goals predict academic engagement over and above interpersonal relationships in mathematically talented students, a series of multiple linear regression analyses were conducted. The unique effects of interpersonal relationships and PB goal setting on student academic engagement were examined by regressing PB goals with each of the interpersonal relationships simultaneously on academic engagement. Hierarchical multiple linear regression analyses were conducted for each of the interpersonal relationships (teacher relations, parent relations, and peer relations).

Results

Preliminary Analyses

Descriptive statistics and assumption testing

The mean, standard deviation, distribution data, and reliability statistics for each scale in the total data set (gifted and maths support) is presented in Table 1. This data is comparable with prior research (e.g. Collie et al. 2016; Martin & Liem 2010, Martin et al. 2013). Skewness and kurtosis statistics indicate that data from each scale fits a relatively normal distribution. As shown in Table 1 reliabilities ranged from .85 to .95 indicating good internal consistency. Continuous data were

screened for violations of parametric test assumptions (Field 2016), with all assumptions being met.

Table 1: Descriptive Statistics

	Mean	Std. Deviation	Skewness		Kurtosis		a
			Statistic	Std. error	Statistic	Std. error	
Interpersonal relationships							
Teacher relationships	9.47	3.52	1.21	0.30	1.72	0.58	.83
Parent relationships	7.62	4.42	1.89	0.30	3.47	0.58	.87
Peer relationships	9.88	3.84	1.01	0.30	1.66	0.58	.87
Goals							
PB goals	8.48	3.66	1.21	0.30	2.55	0.58	.91
Academic engagement	7.53	2.55	1.90	0.30	6.15	0.58	.86
Academic intentions	6.85	2.34	1.33	0.30	2.39	0.58	.61
Class participation	7.92	3.36	1.81	0.30	6.86	0.58	.92
School enjoyment	7.80	4.21	2.41	0.30	8.37	0.58	.89

Inferential Statistics

Bivariate associations between study measures

Pearson's product-moment correlations were estimated to examine bivariate associations between academic engagement and PB goals, teacher relationships, parent relationships, and peer relationships (see Table 2). Within this sample all of the predictor variables were significantly associated with academic engagement, PB goals ($r = .672$, $p < .01$), teacher relationships ($r = .682$, $p < .01$), parent relationships ($r = .437$, $p < .01$), peer relationships ($r = .537$, $p < .01$).

Table 2: Pearson's Rank Order Bivariate Correlations

	1.	2.	3.	4.	5.
1. Age					
2. Teacher relationships	-.016				
3. Parent relationships	.099	.455**			
4. Peer relationships	-.144	.449**	.208		
5. PB goals	.039	.713**	.561**	.346**	
6. Academic engagement	-.154	.682**	.437**	.537**	.672**

Note. * Correlation is significant at the .05 level (2-tailed), ** Correlation is significant at the .01 level (2-tailed)

Associations between interpersonal relationships, PB goals, and academic engagement in talented students

The central research question investigated the extent to which PB goals are related to academic engagement over and above the association with interpersonal relationships in high-ability mathematics students. To examine this association beyond the bivariate correlations described above (see 3.2.1; Table 2), a simultaneous multiple regression was conducted to predict academic engagement from PB goals, teacher relationships, parent relationships, and peer relationships. These variables statistically significantly predicted academic engagement, $F(4, 61) = 22.779$, $p < .001$, $R^2 = .599$. With the exception of parent relationships ($t = .602$, ns), each of the variables (teacher relationships, peer relationships, and PB goals) added statistically to the model, $p < .05$ (see Table 3).

Table 3: Simultaneous Regression Model of Predictors of Academic Engagement

	b	SE B	b
Teacher relationships	.634	.266	.291**
Parent relationships	.103	.171	.059**
Peer relationships	.554	.181	.278**
PB goals	.702	.262	.335**
R ²	.599		
F	22.779***		

Notes. * $p < .05$, ** $p < .01$, $p < .001$

To examine the unique contribution of PB goals in the explanation of academic engagement, hierarchical regression analyses were performed. Predictor variables associated with academic engagement were entered in two steps. Based on prior theorising and longitudinal research, interpersonal relationships were entered in the first step equation, followed by PB goals in the second step. Results of the variance inflation factor (all < 3.0), and collinearity tolerance (all > 4.90) indicate that the estimated β s are well established in the following regression models.

In the first analysis, a multiple linear regression was calculated to predict academic engagement based on teacher relationships (step 1) and PB goals (step 2). The results of step 1 indicated a significant association with academic engagement $F(1, 64) = 55.766$,

$p < .001$, $R^2 = .465$. The second step of this analysis, which included PB goals, significantly predicted academic engagement, $F(2, 63) = 36.305$, $p < .001$, $R^2 = .535$. In this sample, PB goals significantly predicted academic engagement over and above teacher relationships, $\Delta R^2 = .070$, $p < .01$. The unstandardized regression coefficients, intercept, and standardised regression coefficients for the full model are reported in Table 4.

Table 4: Linear Model of Predictors of Academic Engagement (95% Confidence Intervals Reported in Parentheses).

	b	SE B	b	p
Step 1				
Constant	8.530 (4.521, 12.539)	2.007		< .001
Teacher relationships	1.483 (1.086, 1.880)	.199	.682	< .001
Step 2				
Constant	7.361 (3.518, 11.203)	1.923		< .001
Teacher relationships	.896 (.364, 1.429)	.266	.412	.001
PB goals	.793 (.280, 1.306)	.257	.378	.003

Note. $R^2 = .465$ for Step 1; $\Delta R^2 = .070$ for Step 2 ($ps < .01$).

In the final analysis a multiple linear regression was calculated to predict academic engagement based on peer relationships (step 1) and PB goals (step 2). The results of step 1 indicated a significant association with academic engagement $F(1, 64) = 25.903, p < .001, R^2 = .288$. The second step of this analysis, which included PB goals, significantly predicted academic engagement, $F(2, 63) = 39.609, p < .001, R^2 = .557$. In this sample, PB goals significantly predicted academic engagement over and above peer relationships, $\Delta R^2 = .269, p < .001$. The unstandardized regression coefficients, intercept, and standardised regression coefficients for the full model are reported in Table 6.

Table 5. Linear Model of Predictors of Academic Engagement (95% Confidence Intervals Reported in Parentheses).

	b	SE B	b	p
Step 1				
Constant	12.001 (7.552, 16.450)	2.227		< .001
Peer relationships	1.070 (.650, 1.491)	.210	.537	< .001
Step 2				
Constant	5.942 (1.898, 9.986)	2.024		.005
Peer relationships	.689 (.333, 1.045)	.178	.345	< .001
PB goals	1.158 (.784, 1.533)	.187	.553	< .001

Note. $R^2 = .288$ for Step 1; $\Delta R^2 = .269$ for Step 2 ($ps < .001$).

Discussion

The aim of this study was to examine associations among high-ability middle school students' perception of their interpersonal relationships, PB goal setting, and academic engagement. Results revealed that PB goals were positively associated with academic engagement over and above each of the three interpersonal relationships. Of the three types of interpersonal relationships, teacher and peer relationships yielded a significant association with academic engagement, with no significant association being found between parent relationships and academic engagement.

Interpersonal relationships, PB goals, and academic engagement in high-ability students

Consistent with previous research (e.g. Collie et al. 2016) the findings of this investigation show teacher and peer relationships, but not parent relationships, associated with academic engagement when controlling for PB goal setting. As with previous SDT research, it is likely that relatedness-support increases autonomous motivation, which in turn leads to greater levels of engagement (Deci & Ryan 2012). This study uniquely contributes to existing literature by replicating these findings within a high-ability student population.

Collie and colleagues (2016) assert, that the positive influence of peers on student engagement is contrary to common parental and educator concerns regarding the disruptive impact that peer influence may have on student learning during this developmental period (Martin 2006). Aligned with SDT, this study highlights the importance of positive peer relationships, within a relatedness-supportive school environment, to be conducive to greater levels of academic engagement.

Although significant bivariate correlations were found between parent relationships, and PB goal setting and academic engagement, no unique parent relationship association was found when controlling for teacher and peer relationships. Again, these findings are comparable to previous studies of general student populations (e.g. Collie et al. 2016) and add weight to existing evidence regarding proximal influence of relatedness-need satisfaction on academic outcomes.

PB goals positively predicted academic engagement over and above each of the interpersonal relationships within this sample of high-ability students, replicating prior research findings in general student populations. Thus, significant attention should be given to the potential PB goals may have to narrow the ability-achievement gap of gifted students. As such a prominent construct within this study along with previous research, further research investigating the discrete benefits of PB goal setting within motivation and engagement models could be expected to have significant implications for practice (Collie et al. 2016), which may yield important benefits to academic achievement in gifted student populations. The self-determined nature of PB goal setting aligns closely with the SDT model, from which heightened experiences of autonomy, together with perceived relatedness is known to be associated with increased student engagement (Jang et al. 2012; Pianta et al. 2012).

Implications for practice

The findings of this investigation indicate the importance of fostering high quality interpersonal relationships and PB goal setting previously found in studies of general student populations also extend to high-ability students. Aligned with practice recommendations emerging from research emphasised in general and special education contexts, to support relatedness within the classroom, teachers are encouraged to be interested and respectful of student's opinions, sensitive to their learning needs, avoid punitive measures, and create a warm and nurturing classroom climate (Collie et al. 2016; Pianta et al. 2012). For high-ability students, relatedness-support may be particularly salient to facilitate autonomous motivation for high levels of academic engagement that lead to learning beyond curriculum requirements. In addition to classroom-

based efforts, policy and practice should foster more broadly an inclusive sense of belonging within the school community and provide opportunities for social and emotional learning (Martin & Dowson 2009). To achieve these goals, school executives should provide support and training for teachers to build their skills and personal resources to develop positive relationships with their students, particularly during instances of challenging student behaviours (Collie et al. 2015; 2016; Martin & Dowson 2009). As students' interpersonal relationships with teachers and peers were found to yield the greatest impact on academic engagement within the classroom setting, an important focus for schools will be to focus on enhancing the quality of those relationships most proximal to the learning environments.

In addition to high-quality interpersonal relationships, the significant association found between PB goals and academic engagement over and above the association of each interpersonal relationship type, highlights the potential value of focusing resourcing and teacher training to promote PB goal setting of high-ability students. Teachers can support gifted students by encouraging students to set competitively self-referenced goals regarding learning behaviours (e.g. increasing requests for teacher feedback, spending more time preparing for assessments) or outcomes (e.g. completing more practice questions, achieving a higher maths result than on previous attempts) (Collie et al. 2016; Martin & Elliot 2015).

Limitations and future directions

Whilst this study has yielded some interesting results, there are a number of limitations that warrant consideration when interpreting the findings. Firstly, the cross-sectional research design precludes causality when considering the temporal association between interpersonal relationships → PB goals → academic engagement. Whilst there is substantial longitudinal research (e.g. Furrer & Skinner 2003; Opdenakker et al. 2012; Skinner et al. 2008) and sound theoretical basis (viz. SDT framework) for the temporal (causal) ordering between the study variables, there is also suggestions within the literature of an iterative process involving these motivational and engagement mechanisms underlying academic achievement (Creasey et al. 1997; Guay et al. 2009; Martin et al. 2015; Sameroff 2009; Siegle et al. 2017). In order to establish causation and clarify these complex motivational processes, it will be important that future research incorporates experimental and longitudinal research designs.

The self-reported quantitative data used in this study is subjective as it represents participants' perceptions of each of the variables, and may not align with the perceptions of others, due to the uniquely personal nature of each of the included constructs (most notably interpersonal relationships). Individual perceptions of relationship quality are likely to exert greater influence over relatedness need-fulfilment, and motivational processes than third-party or objective measures. Therefore, self-reported data is considered an appropriate approach to examine students' perceived school experiences.

Within this study domain-general measures for each of the study variables were used to investigate the relationships between constructs. The inclusion of the same domain-general survey items found in prior research involving general student samples (e.g. Collie et al. 2016), enabled comparisons between the findings from the current sample of high-ability students with previous studies of general student populations. Whilst these results are limited to the extent that they assess students' perceived experiences broadly and over time; and prohibit inferences to be drawn regarding the influence that specific interpersonal relationships, PB goal types, and specific domain of engagement (in this case, mathematics teacher and peers, PB mathematics goals, and engagement in mathematics), they do provide important findings from which significant practice implications result. As the body of motivation and engagement research in gifted students emerges, focuses on domain-general versus domain-specific differences will be important to

enhance understanding of the unique influences of each dimension, and further to refine research-informed educational practice.

The fourth and most significant limitation of this study relates to sampling issues. In order to identify high-ability students without undertaking extensive and onerous individual cognitive testing, recruitment focused on existing mathematics ability-grouped classes. Whilst this recruitment strategy enabled identification of mathematics students demonstrating achievement within the top 10% of their peers, thus talented in this area (Gagné 2010), interpretation of these findings is limited to the extent to which these students may be achieving beneath their potential albeit within an advanced mathematics class. It would be prudent for related, larger-scale research to control for these factors, and to include prior achievement as an important covariate (Burns et al. 2019; Martin 2011; Yu & Martin 2014).

Despite the limited scope of this project, results replicated previous research findings of the association between interpersonal relationships, PB goals, and academic engagement (e.g. Collie et al. 2016; Martin et al. 2009) within a sample of talented mathematics students. Notwithstanding the limitations of this study, these results suggest that prior research within general student populations may be generalisable to gifted students.

Conclusion

In the current study, Year 8 mathematics students' self-reported perceptions of three types of interpersonal relationships (viz. teacher, parent, and peer), their PB goals, and their level of academic engagement were investigated. Quantitative analyses examined the association between each of the interpersonal relationships and PB goals with academic engagement in mathematically talented students. Results revealed significant positive associations between teacher and peer relationships with academic engagement, but not parent relationships. PB goal setting was found to be a significant predictor of academic engagement over and above each of the three types of interpersonal relationships, suggesting an important educational strategy to support academic engagement in high-ability students by incorporating PB goal setting opportunities in the classroom. The central findings of this study provide preliminary evidence of the generalisability of prior interpersonal relationships, PB goal setting, and SDT research findings within a sample of high-ability students. Further research in this area will be important to augment academic achievement in gifted students.

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Notes

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