“I just need to believe in myself more”: The Mathematical Self-belief of Year 7 Students[1]

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Self-belief can directly predict students’ academic motivation and achievement. Research indicates that mathematical self-belief often decreases during the middle years of schooling. This study explored the mathematical self-belief development of 15 Year 7 students. Data were gathered from a survey, a mathematics achievement test and interviews. Results were analysed and interpreted from a multilevel perspective. Findings indicate that student-level characteristics, such as persistence, were the most influential on mathematical self-belief. While class-level contexts, such as ability grouping, were less influential, interpersonal relationships with teachers played a major role.

Student motivation and engagement have been the focus of extensive research for many years (e.g., Anderman & Maehr, 1994). Studies show that there is a clear connection between motivation and engagement, self-belief and academic performance (Bong, Cho, Ahn, & Kim, 2012). It is also evident that self-belief is a strong determinant of academic achievement and a predictor of success, highlighting its fundamental role in the learning process (Wesson & Derrer-Rendall, 2011). Thus, it is essential that educators possess a sound understanding of how the development of students’ self-belief is affected by educational contexts and experiences.

This paper reports on a study examining Year 7 students’ perceptions of their mathematical ‘confidence’ (referred to as ‘self-belief’ in this paper) and the educational experiences and contexts they believe influence its development. The study utilises selected data from a larger project, which explored middle year (Years 5-7) students’ motivation and engagement in mathematics, to provide a foundation for understanding participants’ mathematical self-belief in more detail.

Literature Review

Mathematics is an essential curriculum area that provides students with fundamental knowledge and skills applicable to contexts both inside and outside the classroom. Thus it is imperative that students are motivated to learn and participate in mathematics. However, many students lack the self-belief required to succeed in mathematics (Chen, 2002). An individual’s perceived self-belief can directly predict their motivation and behaviour, as highlighted in Bandura’s social cognitive theory (Bandura, 1991). A lack of mathematical self-belief among students is problematic as this can affect their motivation to participate in learning the subject. This issue has led to extensive investigations regarding students’ mathematical self-belief and its impact on learning and achievement in mathematics (e.g.,

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Chen, 2002). This section examines relevant literature, establishing the significance of self-belief in the domain of mathematics and likely factors affecting it. It also highlights the concepts and theories that underpin this study.

Self-belief is an individual's confidence in their personal skills and academic abilities (Halikari, Nevgi, & Komulainen, 2008). It is often separated into two 'sets' of self-belief; self-efficacy (cognitive) and self-concept (affective) (Lent, Brown, & Gore, 1997). Self-efficacy refers to an individual's confidence in their cognitive skills towards performing a task and is based around personal judgments. Dweck (2000) found that students who view ability as fixed, generally posses low self-efficacy; considering effort unlikely to lead to academic improvement. Self-concept is concerned with emotional components and reactions, and involves individuals evaluating their competence in comparison to others (Halikari et al., 2008). These self-belief constructs are considered to have a strong connection with students' motivation and engagement thus they can significantly influence learning outcomes (Anderman & Maehr, 1994; Bandura, 1991; Halikari et al., 2008).

The impacts of self-belief have been widely investigated, with various studies asserting that there is indeed a direct correlation between self-belief, motivation and engagement and academic performance (Vandecandelaere, Speybroeck, Vanlaar, De Fraine, & Van Damme 2012). Wesson and Derrer-Rendall (2011) highlight the influential role assumed by an individual's confidence, a key element of self-belief, affirming that a lack of confidence in one's abilities can result in low expectations of their achievement of the task, while higher levels of confidence can result in an individual being more engaged and deeming a task to be achievable. Studies show that students with higher levels of self-belief display greater persistence and effort expenditure in their academic learning (Bandura, 1991). Furthermore, self-belief influences the manner in which students employ their prior knowledge and affects their enjoyment of the subject, consequently influencing learning outcomes (Halikari et al. 2008). An individual's beliefs about their capabilities can be even more powerful than the skills and knowledge they actually possess, as these beliefs determine an individual's effort expenditure and perseverance (Bandura, 1991). Hence, self-belief plays a fundamental role in the learning process.

Self-belief plays a particularly vital role in the domain of mathematics, being a significant predictor of middle years students' mathematics achievement (Chen, 2002). Wesson and Derrer-Rendall (2011) emphasise the importance of mathematical self-belief and feelings of competence, stating that this can determine how individuals approach problems. Consequently, self-belief impacts individuals' levels of interest and motivation, which in turn influences their decisions about engaging in academic and career choices involving mathematics (Wesson & Derrer-Rendall, 2011). Unfortunately, studies demonstrate that students' interest, motivation and mathematical self-belief decrease during the middle years, particularly for girls (Anderman & Maehr, 1994). This decline in self-belief undoubtedly impacts upon students' learning and achievement in mathematics. There is a need for further investigations to verify the experiences and contexts influencing the development of a positive mathematics self-belief in students, particularly during the crucial middle years of schooling.

Theoretical Frame: Multilevel Perspective of Self-belief

While studies previously discussed focus on ascertaining the various aspects of learning that self-belief may impact upon, few studies solely focus on identifying the experiences that influence the construction of self-belief in the first place. Studies that examine factors influencing aspects of human development, such as self-belief, often utilise a multilevel approach informed by theories such as Bronfenbrenner's Ecological Systems theory (1994) (e.g., Martin, Anderson, Bobis, Way, & Vellar, 2012). This multilevel theory recognises that individuals develop in relation to their environment rather than in isolation and focuses on the multifaceted levels of relationships that can impact a child's development. Bronfenbrenner (1994) emphasises the significance of an individual's processing of and interaction with the environment around them at various levels and examines links between the levels themselves. The microsystem involves an individual's daily interactions and relations experienced with significant people in their immediate environment, such as their home, school or peer group. Such multilevel perspectives provide a useful lens through which to examine experiences impacting upon students' mathematical self-belief, particularly at the individual student and class levels.

Individual-level factors influencing self-belief, and consequently academic achievement, include previous study success, prior experiences, enjoyment of the subject, perceived value of the subject and students' personal dispositions (Martin et al., 2012). Research demonstrates that individual-level factors are more significant predictors of learning outcomes than class-level factors, since the greatest variance among factors influencing aspects of student development, such as self-belief, occurs at the individual level rather than at the class or school level (Martin et al., 2012).

Class-level factors can also affect self-belief, including the classroom environment itself. Vandecandelaere et al.'s (2012) findings indicate that student self-belief was influenced by the teacher's provision of feedback and the types of activities utilised. Another significant class-level factor that can affect self-belief in mathematics is the use of ability grouping (Banfield, 2005). Ability grouping refers to the sorting of students into groups according to some measure of ability (e.g., achievement on a test). Studies indicate that students in higher ability groups have higher levels of self-belief than those in lower groups, suggesting that the practice of ability grouping can negatively impact the self-belief of students placed in lower streams, consequently decreasing their levels of motivation and engagement (Banfield, 2005; Zevenbergen, 2003). While school-level factors (ethnic composition, location) can also be influential in affecting self-belief this was not applicable to the present study as all participants attended the same school.

Few studies have examined self-belief in terms of both individual- and class-level factors exclusively focusing on the domain of mathematics. Moreover, many studies do not investigate self-belief from the students' perspective via qualitative means, providing little opportunity for students to explain perceptions about their own self-belief. This study explores individual characteristics and class-level experiences perceived by Year 7 students to impact their mathematical self-belief. The research questions were: (1) What personal beliefs and dispositions influence Year 7 students' mathematical self-beliefs? (2) What experiences and contexts do Year 7 students perceive influence their mathematical confidence (i.e., self-belief)?

Method

Setting and Participants

The 15 participants (eight girls, seven boys) attended a co-educational, comprehensive Catholic high school in a metropolitan area of a major city in Australia. All students were in Year 7 (first year of high school) and placed within either the high or middle ability mathematics class in their grade. Students were purposively selected from different ability classes in consultation with teachers and based on results of a mathematics test in order to gain various levels of achievement and potentially different levels of mathematical self-belief. While it would have been ideal to include participants from the lowest ability class, no students from this class consented to participate.

Instruments, Procedure and Analysis

Survey. Formulated by Martin (2007), the Motivation and Engagement Survey [MES] measures students' motivation and engagement in mathematics through 11 factors (e.g., self-belief, anxiety, persistence, valuing, etc.) whereby students respond to 48 closed-ended statements using a Likert scale ranging from Disagree Strongly (1) to Agree Strongly (5). The survey was administered to all Year 7 students at the school during the first term of the school year (N = 138). This instrument was selected as it enables a large amount of data to be gathered in a standardised way, enables participants to express their opinions and attitudes freely and anonymously, and includes items to assess self-belief. Students' results provided individual student mean scores for each of 11 motivation and engagement factors. This paper focuses solely on self-belief scores obtained from the survey and expands upon this through qualitative data obtained via interview.

Achievement test. The mathematics achievement test involved content-specific achievement testing in the area of fractions using the Fraction Understanding Test (Wong & Evans, 2007). This instrument was selected because of its applicability to middle-year students' content knowledge and was relevant to topics being studied by the students in their normal mathematics class. The test was conducted during normal mathematics lessons in the same week as the MES was administered.

Interviews. Five small-group interviews were conducted with three students per group in an office on the school grounds. The aim of the interviews was to gain a more comprehensive understanding of how participants viewed their mathematical confidence and to determine the experiences and contexts they believe impacted its development. Group interviews took place about a month after the survey and mathematics test were conducted. Each interview lasted approximately 20 minutes and included a range of questions as well as written tasks to guide and prompt dialogue. To stimulate responses, participants were presented with a bank of words (e.g., confident, poor, smart, average, etc.) and asked to select a word that best described how confident they felt in mathematics "most of the time". They were also asked to respond to three self-belief statements, similar to those in the MES, using the same five-point Likert scale (e.g., If I don't give up, I believe I can do maths work that is hard).

While the same stimulus questions were used with each interview, different groups took a slightly different direction depending on participants' responses. This informal structure enabled participants to elaborate upon each other's ideas and contribute freely to the discussion, enabling a 'shared understanding' to be collected while also gaining individual views from specific participants. Each group interview was audio recorded and transcribed. The recordings were listened to numerous times and transcripts were independently analysed by two researchers who came to consensus regarding recurring responses, themes, patterns and inferences made by students regarding the formation of and experiences influencing their mathematical self-belief (Cohen, Manion, & Morrison, 2000).

Results

This section presents the results of the survey, mathematics test and interview data. The participants are described as members of the following interview groups (IG): (1) IG A (students in Class A; IGs 1, 2 and 3; high ability); (2) IG B (students in Class B; IGs 4 and 5; middle ability).

Survey and Mathematics Achievement Test

Students' responses to the MES were scored separately for each motivation and engagement construct, one of these being self-belief. The average self-belief score for students from IG A was 4.64 out of a possible 5. This was slightly higher than the Class A average of 4.41. The average self-belief score for students from IG B was 4.45, also slightly higher than the Class B average of 4.24. Hence, at both the interview group and the class level the average self-belief score was slightly higher among students from Class A.

The mathematics achievement test indicated that students in IG A correctly answered an average of 37.33 questions out of 42. The Class A average was slightly higher (37.52). Students in IG B correctly answered an average of 29.16 questions, whereas the Class B average was only 27. The results seem to affirm the school's allocation of students to each of the two classes based on their prior performances in mathematics.

Interviews

When asked to use the bank of words to describe their confidence in mathematics, all students from IG A selected *confident, smart* or *capable*. However, students from IG B described their confidence towards mathematics using the words *ok, average, confident* and *capable.* One student from IG B used their own phrase to describe their confidence – '*ready to have a go'.* This indicates that students from IG A expressed feeling slightly more confident than those in IG B, though it is important to note that individual students may have different perceptions about the meaning of each of these words.

Students also rated their responses ('1' Disagree Strongly to '5' Agree Strongly) to three self-belief statements. Every student either agreed or strongly agreed with statement one, "*If I don't give up, I believe I can do maths work that is hard*". This indicates a fairly high level of self-belief among participants; they all felt that they could complete difficult mathematics tasks if they persisted. The answers to statement two ("*I believe I don't always do maths well, even when I try hard*") varied. The majority of students disagreed or were neutral towards this statement, indicating that most students felt that they could succeed with mathematics work if they exert enough effort. All students agreed or strongly agreed (apart from one IG B student, who selected neutral) to statement three ("*If I have enough time, I believe I can do well in maths work*"), demonstrating once again a strong level of self-belief among all participants. The responses to these statements did not indicate any distinct differences among students from IG A and IG B, contrasting with the initial assumption that students from IG A would likely be more confident about their ability to achieve well in mathematics than students from IG B, given their placement in the high ability class at school.

Analyses of transcripts indicate that students believed a range of individual student-level and class-level characteristics could influence their confidence levels in mathematics. Tables 1 and 2 outline the most significant elements emerging from the group interviews. Quotes from participants are provided to explain student perceptions.

Table 1
Individual-level Characteristics

Characteristic	Description and quotes
Enjoyment of mathematics	Students discussed their enjoyment of mathematics and often linked this with their learning outcomes: *I've been pretty good at it* [maths] *for a while so I guess I like it because of that* ... Reuben, IG A. *I like maths ... I like the concept of trying to solve all the little puzzles* ... Amy, IG B.
Confidence/belief in their skills	Students discussed their perceptions of their skills and confidence: *I'm reasonably good at it* ... Alison, IG A. *I know that I'm smart, I just need to believe in myself more because I just doubt myself* ... Monica, IG B.
Persistence	Students discussed persistence and the benefits of persisting with difficult mathematics tasks: *I know that I can do it. If I believe in myself that I can do it, I'm capable to do the work* ... Monica, IG B. *I feel like if I work hard at something I can get it* … Hannah, IG A.
Prior knowledge	Students discussed background knowledge and how this impacts mathematics achievement: [Success in mathematics]… *depends if you've learnt that subject in primary school* ... Noah, IG B. *I feel like I have a good span of knowledge* ... Ron, IG A.
Previous success/experiences	Students discussed their previous experiences and success: Reuben (IG A) stated that he was confident and felt 'smart' because he usually performs well in tests (e.g., NAPLAN). *In the past I was terrible, terrible, terrible at math ... Last year I got an A in algebra* ... [that gave me] *confidence* ... Amy, IG B.

Table 2
Class-level Characteristics

Characteristic	Description and quotes
Teacher-student rapport	Students linked positive teacher-student relationships with enjoyment of mathematics: *Our teachers are pretty nice* ... Noah, IG B. *I like the teacher...he makes it fun* … John, IG A.
Level of work	Students discussed the difficulty of tasks: [The work] ... *it's the right level* ... Liam, IG B. *The work is the right balance between easy and challenging* … Reuben, IG A.
Specific mathematics topics	Students discussed their self-belief in terms of specific topics and content areas: *Some parts I do like and some parts I don't like … I don't like*

	decimals and percentages ... Monica, IG B. *I really like geometry more than numeracy …* Noah, IG B.
Classroom environment and influence of peers	Students linked their enjoyment and achievement in mathematics with the classroom environment: *The class is very fun …* Hannah, IG A. *My friend and I are quite competitive with our results ... so it's always a good competition between us …* Reuben, IG A. *Sometimes it can get a bit loud and it's really hard to concentrate ...* Monica, IG B.

The individual-level characteristics identified were reflected and discussed by students from both interview groups. However, students from IG A discussed the influence of the classroom environment in more depth than students from IG B, while students from IG B tended to discuss the influence of specific topics on their mathematical self-belief more. Both groups referred to the influence of teachers and difficulty-level of the mathematics.

Discussion and Conclusion

This study aimed to explore students' beliefs and dispositions that might influence their mathematical self-beliefs and the experiences they perceive influence its development. The findings demonstrate that individual student dispositions (particularly persistence) played a major role in shaping their self-belief. While class-level factors, such as ability grouping, did not have a detrimental impact on self-belief in this instance, it must be noted that there were no students involved from the lowest-streamed mathematics classroom.

Interview data indicate that various factors from both the individual and class level are perceived by students to affect their mathematical confidence (self-belief) and its formation. Students frequently rated their overall confidence levels in mathematics based on personal experiences such as previous results, their willingness to persist when faced with difficulties and their confidence towards particular topics. For example, when asked to explain why they perceived themself as "smart", Reuben (IG A) stated that he based this upon his high test results, while Monica (IG B) cited reasons of belief in her ability and persistence as to why she was able to achieve. In particular, persistence was viewed by students as influential in affecting their achievement in mathematics (see Table 1). This demonstrates that these students were aware that they had the ability to control their mathematical achievement and highlights the influential role of persistence in the formation of a positive mathematical self-belief. This is consistent with the concept of students' theories about their own intelligence having a significant impact upon their learning and academic performance (Dweck, 2000). The findings indicate that many of the students in this study possessed an incremental belief of intelligence, acknowledging that they could control their achievement, as opposed to a belief that intelligence and ability is fixed (Dweck, 2000). This reiterates the instrumental role of individual-level student perceptions and dispositions in shaping self-belief. Naturally this leads to the issue of *how* teachers can inspire this view among their students and thus foster a positive self-belief. Devising and testing practical strategies to improve students' mathematical self-belief is an extremely important area for future research.

Students from all interview groups asserted that they felt they were placed in the appropriate class for their ability and did not express any concerns about ability grouping hindering their mathematical performance or self-belief. This may be due to the implementation of suitable pedagogy, positive teacher-student rapport and/or the enjoyable classroom environment expressed by students from both classes (see Table 2). This suggests that when students perceive that they are in a supportive learning environment they are likely to feel more confident in their ability to learn. Thus, in this instance, ability grouping is not detrimental to the self-belief of students in middle streams and the higher ability students do not inevitably always possess more positive self-beliefs, as some studies have found (Zevenbergen, 2003).

These findings have important implications for the mathematics classroom. They suggest that teachers can have a significant impact on the development of a student's self-belief by utilising appropriate teaching practices, establishing positive relationships with students and maintaining positive learning environments. Moreover, it highlights the significance of teachers knowing their students well—at the individual level—in order to understand how to best support each student. While acknowledging that only students from high and mid-range ability groups were included in this study, the circumstances by which the mathematical self-beliefs of students from mid- and lower-streamed classes remain quite positive could be the focus of future investigations.

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