



Exploring mathematical wellbeing across cultures: insights from diverse students

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Abstract

Across many countries, including New Zealand, diverse groups including indigenous, migrant, and marginalised communities, are under-represented in mathematics, as evidenced by achievement disparities and disengagement from higher-level mathematics. Both research and policy have focused on developing equitable education outcomes for all students. A key aspect of this is wellbeing, including within mathematics classrooms, which includes identifying classroom environments that enable wellbeing. This study examines mathematical wellbeing (MWB) across different ethnicities and genders, with a case study focus on students from Pacific heritages. Analysing qualitative responses from over 12,000 diverse students revealed that positive relationships in the mathematics classroom were most commonly associated with students' MWB. Accomplishment and cognitive factors, including mathematical accuracy, learning new things, and understanding, were also identified as important. Minor gender differences emerged, with female students emphasising mathematical understanding, accuracy, and relationships more than male students. The Pacific student case study highlighted the importance of both cognitive aspects (learning new things and understanding) and relationships (peer and teacher support), uncovering an alignment between cultural values and MWB. This study empirically confirms seven universal values supporting student MWB, previously identified in Australian and Chinese contexts, suggesting that teachers internationally may align pedagogical practices with these values to support most students' MWB. However, the instrumental values serving these universal values appear culturally unique. This research contributes novel insights to the field by examining wellbeing with a subject-specific focus through student-generated responses, offering implications for developing more equitable and culturally inclusive mathematics classrooms.

Keywords Mathematics education · Culture · Affect · Engagement · Relationships · Pacific · Values

Extended author information available on the last page of the article

Introduction

Developing equitable outcomes for all students in STEM education has been an ongoing focus of research and policy (Banerjee, 2016; Keratithamkul et al., 2020). Aligned with this is the need to identify the types of environments that enable wellbeing (De Ruyter et al., 2022). The United Nations' goals of sustainable development include the development of quality education systems, which encompasses equitable lifelong learning opportunities and inclusivity for all, whilst another key goal is the promotion of wellbeing (United Nations, n.d.). These goals are mutually supportive, and the research study presented in this article is at the nexus of equitable mathematics learning and wellbeing. Both in New Zealand and internationally, diverse groups of people, including Indigenous, migrant, and other marginalised communities, are under-represented in mathematics. This is evidenced by ongoing achievement disparity in mathematics in national and international testing and student disengagement with higher-level mathematics (Barton, 1995; Giannelli & Rapallini, 2016; Hastedt, 2016; Hunter & Hunter, 2018; Turner et al., 2015). Notably, in many countries, the number of migrant students is increasing, along with the disparity between the mathematical test scores of migrant and non-migrant students (Hastedt, 2016).

Disengagement and under-achievement indicate potentially poor student wellbeing in mathematics classrooms. Recently, student wellbeing has become a priority for educational institutions worldwide (Denston et al., 2022; Kern & Wehmeyer, 2021). However, subject-specific wellbeing, particularly concerning science, technology, engineering, and mathematics (STEM), remains under-researched. We define wellbeing as both context-specific and value-dependent (Alexandrova, 2017; Tiberius, 2018), encompassing positive feelings and optimal functioning within a given context (Huppert & So, 2013). Wellbeing models propose different conditions of wellbeing. However, each model makes assumptions about aspects important for wellbeing, which connects to values. We draw on Tiberius' (2018) value fulfilment theory of wellbeing which positions wellbeing as "the extent that we pursue, and fulfil or realize, our appropriate values" (p. 34). Applied to mathematics education, we define mathematical wellbeing (MWB) as the fulfilment of students' values (Tiberius, 2018) within the mathematical learning process, accompanied by positive feelings (e.g. fun) and functioning (e.g. engagement) (Hill et al., 2020; Huppert & So, 2013; Tiberius, 2018).

As wellbeing is value-dependent, there is the potential for mismatches in the mathematics classroom when the teachers' values or pedagogical values that are drawn upon during teaching are incongruent with students' cultural values. Previous research studies have shown how such mismatches can contribute to poor student achievement, disengagement, or mathematics anxiety (Clarkson et al., 2010; Hill et al., 2021a; Martin et al., 2012; Seah & Andersson, 2015). In the case of New Zealand, there is a growing population of Pacific people who are both Indigenous to the island nations, who come from within Te Moana-nui-a-Kiwa (the Pacific Ocean region), and are migrants to New Zealand. This grouping is heterogeneous, consisting of multiple generations, differing languages, and cultural

and social ways of being (Coxon et al., 2002). Pacific people share a collectivist approach that shapes their cultural values and contrasts with the individualistic values and approaches often used in New Zealand mathematics classrooms (Hunter, 2021; Podsiadlowski & Fox, 2011; Uehara et al., 2018). Previous studies suggest that this difference in values for Pacific students during mathematics teaching and learning causes dissonance, under-achievement, and disengagement with mathematics (Barton, 1995; Houghton, 2015; Hunter & Hunter, 2018).

We argue that taking a wellbeing approach to teaching and learning mathematics is a means of developing more culturally inclusive and equitable classrooms (Abdulahim & Orosco, 2020; Hunter & Hunter, 2018). This approach involves educators recognising students' values, understanding these, and having a vision of what they might look like in the context of a mathematics classroom. Alignment between teacher and student values means that educators recognise that not all classroom community members share the same values. However, instead, the teachers ensure that all values are in harmony (Seah & Andersson, 2015). This has the potential to strengthen relationships and foster positive outcomes regarding student achievement, engagement, and the overall way students experience mathematics as a subject (Hill et al., 2021a; Martin et al., 2012).

Research studies focused on wellbeing have been dominated by universalistic approaches and Western philosophical constructs that do not necessarily build on the conceptions of Indigenous or migrant groups (Denston et al., 2022; Gall et al., 2021). These also tend to be quantitative, which often fails to capture the rich and complex picture of students' lives and wellbeing (Powell et al., 2018). In the context of New Zealand, there have been some research studies that have focused on conceptions of wellbeing for Pacific people in general as well as in educational settings (e.g. Dunlop-Bennett et al., 2019; Manuela & Anae, 2017; Manuela & Sibley, 2013; Matika et al., 2021; Mila-Schaaf & Robinson, 2010) and other studies have focused on the values and perspectives of Pacific students' related to mathematics teaching and learning (Hill et al., 2019; Hunter, 2021). However, it appears that there have been limited studies that focus on MWB or investigate the MWB of Pacific students who are both an Indigenous yet migrant group within New Zealand. To address this gap in mathematics education, in this paper, we will examine the MWB of students across different ethnicities and genders and then use a case study of Pacific students to explore student perceptions of MWB. In a broader sense, this paper contributes to the international field both with an examination of subject-specific wellbeing and through the focus on the MWB of students from diverse cultural backgrounds.

Conceptualising student wellbeing and student mathematical wellbeing

Models and theories of student wellbeing

Over the years, various wellbeing models, theories, and frameworks have been proposed. Scholars (e.g. Huppert & So, 2013; Kern et al., 2016; Seligman, 2011)

generally agree that wellbeing encompasses both a hedonic (i.e. experience of happiness or pleasure) and a deeper eudaimonic component (e.g. a sense of meaning, close relationships, accomplishments). This concept is often simplified to “feeling good and functioning well” (Huppert & So, 2013, p. 839).

Specific to student wellbeing, several models have been proposed. Seligman’s PERMAH model, often used to assess student wellbeing in schools, encompasses positive emotions, engagement, relationships, meaning, accomplishment, and health (Seligman, 2011). Another framework is Kern’s EPOCH model of adolescent wellbeing, which focuses on engagement, perseverance, optimism, connectedness, and happiness (Kern et al., 2016). The Organization for Economic Co-operation and Development (OECD, 2015) also proposed four dimensions of student wellbeing: psychological, physical, cognitive, and social.

These models provide diverse perspectives on understanding and measuring student wellbeing, each emphasising different aspects of students’ experiences and functioning in educational settings. However, wellbeing can be experienced differently across contexts, including environments, populations, and cultures, and these differences can mainly be attributed to values (Alexandrova, 2017). Our values provide the blueprint for our wellbeing—they act as a compass to guide our decisions, choices, and actions and how we assess how well our lives are going (Halstead, 1996; Tiberius, 2018). Studies show that successfully pursuing and fulfilling our values is linked to higher wellbeing (Sirgy, 2021; Veage et al., 2014). Tiberius (2018) asserts “our lives go well to the extent that we pursue, and fulfill or realize, our appropriate values...your life goes badly to the degree that you live a life that has little value fulfillment” (p. 34). Tiberius (2018) distinguishes between core and “ultimate values” (UVs)—being the highest level of values, the things that are important for their own sake (e.g. close relationships, a sense of meaning), and these are generally consistent across cultures and peoples. However, certain groups or cultures may prioritise these UVs differently. For example, a student from a collectivist culture may prioritise relationships and social ways of working more than personal accomplishments. The opposite might be true for a student from an individualistic culture (Hofstede, 2011). Underneath these UVs are “instrumental values” (IVs), which are the things valued to achieve more UVs; for example, valuing sporting, academic, social, or religious activities can all serve the UV meaning. Unlike UVs, IVs can vary widely and are what differentiates individuals (Tiberius, 2018). This study focuses on students’ IVs because they vary more widely and are more culturally specific than UVs. This is important if we hope to better understand the unique perspectives of marginalised and migrant mathematics learners.

Whilst most wellbeing studies and initiatives focus on global aspects of student wellbeing, less is known about wellbeing across different cultures and school subject domains. This global approach is problematic because wellbeing is context-specific and value-dependent, so people from different cultural groups can interpret the meaning of and experiences of wellbeing differently (Huang et al., 2022; Joshanloo et al., 2021). Likewise, what a student values in mathematics education is likely different from what they value in science, literacy, history, etc. Therefore, how wellbeing is experienced also likely differs across subject domains (Hill et al., 2023). Cultivating student wellbeing is most successful when the language of wellbeing,

or “wellbeing literacy”, is contextualised, considering students’ relevant vocabulary, knowledge, values, and needs in a given context (Oades et al., 2022). Wellbeing literacy refers to the ability to understand, apply, and communicate wellbeing-related knowledge in context-specific ways (Oades et al., 2022). For example, how a student communicates for wellbeing at home with their parents might differ to how they communicate about their wellbeing with teachers in mathematics, or history, or science. In mathematics education, wellbeing literacy involves recognising and articulating factors that contribute to students’ positive experiences and optimal functioning in mathematics classrooms. A central aim of this study is to understand better the language of and factors supporting the wellbeing of culturally diverse students, including Indigenous and migrant students and also contextualised to mathematics education.

A framework of student MWB

Hill et al. (2022) developed a MWB framework to address the need for wellbeing subject specificity. By undertaking a scoping review of 40 studies, they examined how students’ mathematics education values aligned with UVs proposed in the wellbeing literature. Across the literature, they discovered 90 unique IVs that could be deductively categorised into seven UVs. These UVs included Seligman’s (2011) five PERMA dimensions: positive emotions (e.g. enjoyment of mathematics), engagement (e.g. focus or interest completing mathematical tasks); relationships (e.g. social support and care from teachers, peers, family, or others in mathematics); meaning (e.g. valuing purposeful, meaningful, or useful mathematics); and accomplishments (e.g. valuing mathematical achievement, confidence, or mastery). The sixth and seventh UVs, respectively, included perseverance, taken from Kern et al.’s (2016) EPOCH model (e.g. valuing hard work, effort, and practice), and cognitions from Clarkson et al.’s (2010) earlier mathematical wellbeing model (e.g. valuing mathematical knowledge, skills, and understandings).

Several international studies have explored student perspectives of their MWB using this seven-UV framework. For example, Australian Year 8 students mostly referenced relationships, especially the IVs’ teacher support (24% of students) and peer support (21%), also, cognitive IVs like understanding mathematics (28%) (Hill et al., 2021a; 2022). Chinese Year 3 students mostly (97% of students) valued the IV’s good results (UV accomplishment), fun and interesting lessons (UVs positive emotions and engagement, respectively), and teacher praise (UV relationships) (Hill & Seah, 2023; Pan et al., 2022). However, to date, no studies have reported on the perspectives of diverse students, including Indigenous and migrant students, which we focus on here in the current study.

Pacific wellbeing in New Zealand and Pacific perspectives related to mathematics education

In this section, we focus on studies that involve general explorations of Pacific wellbeing in New Zealand settings and those focused on Pacific student values and

perspectives in mathematics education. Manuela and Sibley (2013) contend that Pacific wellbeing concepts can be developed by looking at models related to Pacific health, which are both holistic and dynamic. Commonalities across Pacific health models are the foundational role of the family as an extended grouping (beyond the nuclear family), cultural values and beliefs, and links to the environment, time, and context (Anae, 2016; Kupa, 2009). For Pacific people, identity and wellbeing have strong connections (Manuela & Anae, 2017; Manuela & Sibley, 2013). Manuela and Sibley (2013) developed a general wellbeing model that used a Pacific identity and wellbeing scale and drew on Pacific perspectives. This model drew on five constructs—strong Pacific identity—belonging and connectedness with Pacific people—religious centrality—family, and societal wellbeing. Similarly, an earlier study by Milo-Schaarf and Robinson (2010) focusing on Pacific secondary students highlighted that positive wellbeing was associated with Pacific cultural capital, including pride in their Pacific identity and cultural values, feeling accepted, and language proficiency.

As established earlier in the article, values and fulfilment are important for wellbeing in educational settings. For Pacific people, a collectivist way of life and communal approach to society shape notions of wellbeing and cultural values (Podsiadlowski & Fox, 2011; Uehara et al., 2018). Key cultural values of Pacific people are family, belonging, love, service, spirituality, reciprocal relationships, respect, inclusion, and leadership (New Zealand Ministry of Education, 2013, 2018; Rimoni et al., 2022). Importantly, Hunter (2021) found a relationship between Pacific students' cultural values and their mathematics educational values, which relate to the teaching and learning of mathematics and consequently influence MWB. Two studies (Hill et al., 2019; Hunter, 2021) explicitly examined the mathematics educational values of Pacific students. Both of these studies asked students to provide a ranking for different mathematics educational value statements. Hill et al. (2019) found that the four value statements that were most highly ranked were utility, peer collaboration/group work, effort/practice, and family.

Similarly, Hunter (2021) found that the highest-ranked value statements included practice and family; however, in this study, the students ranked respect (within a reciprocal framing) and persistence within the top two rankings, whilst utility was one of the lowest-ranked values. The differences in these findings may be related to the impact of the classroom contexts in shaping what students value. Other studies have investigated student perspectives related to mathematics teaching and learning which also reflects the values of students. These studies (Anthony, 2013; Averill, 2012; Sharma et al., 2011) demonstrated that Pacific students valued teachers who showed that they cared about their students and provided clear explanations, opportunities for collaboration with peers and group work, and reciprocal relationships with their peers and teachers. Importantly, several researchers highlight that although values may appear similar across cultural groups, the way they are both understood and enacted differs (Hunter, 2021; Rimoni et al., 2022). Of note is that previous studies focusing on wellbeing and mathematics educational values with Pacific people have predominantly used pre-determined models of wellbeing, or value statements, rather than open-response items such as those used within this study.

The current study

In this qualitative exploratory study, we investigate how culturally diverse students in New Zealand conceptualise and describe the factors supporting their wellbeing in mathematics education. This study builds on earlier explorations of student MWB (e.g. Hill et al., 2021a, 2022; Hill & Seah, 2023) by examining the cultural and demographic nuances, particularly the perspectives of marginalised and migrant groups of students. The following research questions guided our study:

- (1) How do students from diverse cultural backgrounds in New Zealand schools conceptualise their MWB?
- (2) How do Pacific students (Indigenous and migrants to New Zealand) conceptualise their MWB?

Research design and methods

The research context

The data reported in this article is from a larger longitudinal study exploring student achievement, wellbeing, and mathematical disposition across a range of primary, middle, and secondary school settings. All the schools involved in the project were participating in a 3-year research-based professional learning and development (PLD) initiative entitled “Developing Mathematical Inquiry Communities” (DMIC). The PLD initiative is set within the central tenets of culturally sustaining practice (Paris, 2012) and the use of ambitious mathematics pedagogy to raise mathematics achievement (Kazemi et al., 2009). Schools in New Zealand that serve marginalised Pacific communities are prioritised for inclusion in the initiative, which is funded by the New Zealand Ministry of Education. The time the schools have been involved in the PLD initiative ranges from the beginning of the year that the data was collected to 4 years or more of involvement.

Participants

In this article, we report on the MWB of 12,962 Grade 3 to 10 students, aged between 8 and 16 years, and attending one of 115 primary, middle, or secondary schools located throughout New Zealand. All of these schools responded positively to an email invitation to participate in the study. Student demographic variables are summarised in Table 1. Ethical approval for the study was obtained from the University Ethics Committee of the first author’s institution. All schools undertaking the professional learning and development initiative were invited to participate in the study. Parents and guardians were informed about the nature of the study and allowed to withdraw their child from the study.

Table 1 Frequencies of student demographics across ethnicities

	African	Asian	Indian/Pakistani	Māori	Middle Eastern	NZ European	Pacific	Unspecified	Totals
All students	274	1083	701	2541	163	5541	2597	62	12,962
Genders									
Male	133	508	331	1161	74	2632	1199	35	6073
Female	138	552	357	1324	86	2812	1361	18	6648
Unspecified	3	23	13	56	3	97	37	9	241
Grades									
3	24	66	44	196	11	405	189	5	940
4	71	202	151	509	34	1015	442	13	2437
5	49	29	223	119	590	1134	1105	497	11
5	49	223	119	590	45	1104	497	11	2668
6	57	230	157	589	39	708	624	10	2810
7	28	102	60	242	11	764	298	9	1458
8	28	115	69	230	13	227	282	6	1507
9	7	67	41	105	7	184	124	3	581

The schools in the study cover a range of geographic locations from both urban and rural areas. New Zealand schools use a decile ranking system to indicate socio-economic status. Decile one indicates that the school is within the lowest socio-economic area, whilst decile ten indicates that the school is in the highest socio-economic area. Overall, students from Pacific and Māori backgrounds are more likely to attend low decile (low socio-economic) schools, whilst European New Zealand and Asian students tend to attend higher decile (high socio-economic) schools. Included here are 92 low decile schools (i.e. deciles 1–3), 59 medium decile schools (deciles 4–7), and 24 high decile schools (deciles 8–10).

Data collection

Students completed an online Qualtrics survey using a digital device (e.g. phone, laptop, tablet) during school time between October and November 2022. In this paper, we focus on students' responses to the open-ended survey question: What makes you feel really good and do really good math? This question is intended to probe culturally diverse students' conceptions of their wellbeing and the factors supporting their wellbeing in mathematics education. Whilst earlier MWB explorations (e.g., Hill et al., 2021) with secondary Australian students incorporated a similar question (i.e. *what makes you feel good and function well in maths?*), pilot studies with primary-aged and linguistically diverse students revealed these students often had trouble interpreting the phrase "function well". For instance, when assisting younger and linguistically diverse students, teachers noted that these students often misunderstood the meaning of "function". Thus, in this study, the survey question was simplified (i.e. "Do really good") to align with other studies focusing on younger primary-aged students (Fredrickson, 2013; Norrish, 2015; Wortham et al., 2020).

Data analysis

Students' responses were imported into NVivo (version 12) software and analysed using a combined deductive/inductive reflexive thematic approach (Braun & Clarke, 2019). Thematic analysis has been widely used in cross-disciplinary studies (e.g. Maguire & Delahunt, 2017) and was appropriate for the current study, which incorporates mathematics education and psychology. First, a data-driven, inductive strategy was used to code for unique IVs. Then, we deductively aligned these IVs to the seven UVs (i.e. accomplishments, cognitions, engagement, meaning, perseverance, positive emotions, and relationship) previously identified through a literature review and empirical studies (e.g. Hill et al., 2021a, 2022, 2023). Table 2 summarises our inductive and deductive strategies alongside corresponding student quotes.

To ensure rigour, the second author and an independent research assistant double-coded 15% of student responses ($n=1950$ students). Inter-rater reliability scores showed a high level of agreement overall (Cohen's $K=0.83$) (McHugh, 2012) for each of the IVs categorised under the seven UVs ($0.78 < K < 0.92$). Coding disagreements were discussed, particularly for UVs with lower K scores such as the UV positive emotions, which was the least reliable UV ($K=0.78$). Table 2 summarises this coding strategy alongside illustrative student quotes.

Given the substantially large (over 10,000 students) dataset, we used a combination of researcher-led and pattern-based auto-coding using the NVivo12 software. Pattern-based auto-coding incorporates a machine learning algorithm allowing a "broad brush" coding of very large volumes of text, which can then be manually reviewed and refined (QSR International Pty Ltd, 2023). The auto-coding function compares the initial 15% of the manually coded data (as outlined above) to the remaining 85% of the data. The NVivo software then groups words with the same stem (e.g. friend, friends, and friendships) together in the same code. The authors manually searched the data for specific terms and their strings to support the auto-coding and ensure accuracy. For example, students mentioning job, employ, future, and everyday were manually coded under the IV *everyday/future utility*, whilst parent, mum, dad, cousin, aunt, uncle, brother, sister, and grand were manually coded under the IV *family support*. Other authors have shown the feasibility and reliability of these hybrid coding methods (i.e. incorporating both manual and auto-coding) to analyse large datasets (Borycki et al., 2022; Chaturvedi & Bansal, 2022; Mortelmans, 2019).

Lastly, both authors scanned through and manually refined these codes for each IV. Some IVs required almost no refining (e.g. accuracy, teacher support, peer support), whilst other IVs with more nuanced or cultural meanings (e.g. family support, reciprocity) required some manual recoding.

Findings and discussion

We begin this section by providing a snapshot of how primary, middle years, and early secondary school students from diverse cultural backgrounds in Aotearoa, New Zealand, conceptualise their MWB. This is followed by presenting a case

Table 2 Ultimate values (UV)s, corresponding instrumental values (IVs), illustrative quotes, and frequencies across each ethnicity

Ultimate values and instrumental values	Illustrative student quotes	African	Asian	Indian/Pakistani	Maori	Middle Eastern	NZ European	Pacific	Female	Male	Total
Accomplishment											
Accuracy	<i>Getting all the questions right</i>	8%	9%	8%	8%	6%	12%	6%	10%	8%	9%
Competition	<i>Competitions they motivate me</i>	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%	<1%
Completing work	<i>When I finish the maths</i>	1%	3%	2%	1%	4%	2%	1%	1%	2%	2%
Confidence	<i>My confidence in maths has made me feel really good</i>	1%	1%	2%	1%	2%	1%	1%	1%	1%	1%
General success	<i>Having success in maths</i>	4%	5%	6%	5%	6%	4%	6%	5%	4%	4%
Good marks	<i>Getting high marks on a test</i>	1%	1%	2%	1%	1%	1%	1%	1%	1%	1%
Cognitions											
Smartness	<i>When I feel smart doing maths</i>	1%	1%	0%	2%	1%	1%	1%	1%	1%	1%
Learning new things	<i>Learning new things and strategies</i>	4%	8%	7%	7%	4%	5%	9%	5%	7%	8%
Multiple solutions	<i>I like to use different strategies to see which ones comes up with the answer</i>	5%	7%	8%	4%	6%	4%	7%	5%	5%	5%
Recall and efficiency	<i>Remembering my timestables is important</i>	6%	6%	7%	4%	6%	4%	4%	4%	5%	5%
Specific maths topics	<i>I feel good when I learn about algebra</i>	7%	6%	11%	4%	7%	4%	5%	5%	5%	5%
Understanding	<i>Understanding the problems and solutions given</i>	6%	10%	8%	5%	7%	8%	9%	11%	5%	8%
Engagement											
Challenging tasks	<i>challenging tasks because the thrill of trying to figure it out</i>	3%	7%	5%	3%	4%	6%	3%	4%	5%	5%
Easy working	<i>When maths is easy</i>	3%	2%	2%	2%	4%	1%	1%	2%	1%	2%
Focus and attention	<i>Staying focused on my work</i>	1%	3%	2%	3%	0%	3%	2%	3%	2%	3%

Table 2 (continued)

Ultimate values and instrumental values	Illustrative student quotes	African	Asian	Indian/Pakistani	Maori	Middle Eastern	NZ European	Pacific	Female	Male	Total
Interesting maths	<i>When I'm interested in what we're learning</i>	2%	1%	1%	0%	0%	1%	0%	1%	0%	1%
Quietness/independence	<i>A quiet space to work and learn</i>	2%	3%	2%	2%	1%	4%	2%	3%	2%	3%
Technology/maths games	<i>Online maths games</i>	1%	1%	1%	1%	0%	1%	1%	1%	1%	1%
Meaning	<i>Learning something that will help me in everyday life</i>	0%	1%	1%	0%	0%	0%	1%	1%	0%	1%
Perseverance											
Hard work/effort	<i>When I am working really hard in maths</i>	3%	3%	3%	3%	3%	3%	3%	3%	3%	3%
Practice	<i>Revising my work and practising before bed each night</i>	1%	2%	1%	1%	1%	1%	0%	1%	1%	1%
Positive emotions											
Energy and sleep to promote mood	<i>I need energy to be able to feel good to do maths</i>	< 1%	< 1%	< 1%	< 1%	< 1%	< 1%	< 1%	< 1%	< 1%	< 1%
Fun/enjoyment	<i>Doing fun maths activities</i>	2%	3%	3%	3%	5%	3%	3%	3%	3%	3%
Music for enjoyment	<i>Listening to music it makes maths more fun</i>	< 1%	< 1%	< 1%	< 1%	< 1%	< 1%	< 1%	< 1%	< 1%	< 1%
Relaxed/no pressure	<i>When I have a relaxed environment to do maths and no stress</i>	1%	1%	0%	0%	0%	1%	1%	1%	0%	1%
Relationships											
Family support	<i>When my mum sits down with me and helps me with a hard problem</i>	1%	1%	1%	1%	1%	1%	1%	1%	1%	1%

Table 2 (continued)

Ultimate values and instrumental values	Illustrative student quotes	African	Asian	Indian/Pakistani	Maori	Middle Eastern	NZ European	Pacific	Female	Male	Total
General support	<i>The people around me supporting me with my maths</i>	5%	6%	5%	6%	2%	7%	7%	8%	5%	7%
Reciprocity	<i>When I am helping others in my group</i>	4%	4%	3%	4%	4%	4%	6%	5%	4%	5%
Peer support/care	<i>When I have a buddy to help me</i>	18%	15%	15%	18%	14%	21%	20%	21%	17%	19%
Teacher support/care	<i>My teachers support</i>	5%	6%	9%	6%	8%	6%	8%	8%	4%	7%

The frequency counts are the percentages of students from each ethnicity mentioning the IVs

study focused on the perspectives of MWB from a marginalised group of students—those from the Pacific nations who live in Aotearoa New Zealand. We use this case study to examine how equitable outcomes in mathematics may be developed by recognising the factors that support the wellbeing of a marginalised group of students. We argue that documenting student-identified factors associated with MWB allows educators to take a wellbeing-oriented approach to teaching mathematics to develop more culturally inclusive and equitable classrooms.

Research question one: exploring student MWB across the whole New Zealand sample

Table 2 summarises the seven UVs, corresponding to 28 IVs, with descriptors and example student quotes. As shown in Fig. 1, across the whole New Zealand sample (RQ1), students mostly associated their MWB with positive relationships in the mathematics classroom, especially peer support (19%, $n=2469$ students); general support from others (7%, 850); teacher support and care (7%, $n=840$); and reciprocity, and helping others (5%, $n=587$). Accomplishment and cognitive factors were also often mentioned, including the IVs' mathematical accuracy (9%, $n=1192$), learning new things (8%, 1066), and students understanding their mathematics (8%, 1014).

Ethnic differences

Across ethnicities, we found many similarities. For example, peer support/collaboration was noted substantially more than all other IVs (between 4 and 11%) and was the most frequently mentioned IV across all ethnicities. This highlights the significance of peer support and collaboration for New Zealand students' MWB. For example, one European New Zealand student noted he has high MWB when "I can work in a group and help people succeed and succeed myself at the same time". This explanation points to both peer support and reciprocity. An Asian student indicated that group work enhanced their positive emotions and supported their ability to solve mathematical problems and share ideas:

I like doing maths mostly with friends or other people to ask ideas with them so it is easy for me to solve out the question but if i do it myself it is not easy for me I will run out of ideas then I won't be able to find out the answer...It also makes it [mathematics] more fun

Similarly, a student of Indian/Pakistani heritage noted that working with friends contributed to their mathematical engagement "working with my friends makes me work way better".

In this study, we note that across the different ethnicities, students consistently espoused the IV's peer support and peer reciprocity. This contrasts with earlier studies, which showed less uniformity of IVs across different ethnicities. Previous studies (Hill, 2018; Podsiadlowski & Fox, 2011; Uehara et al., 2018)

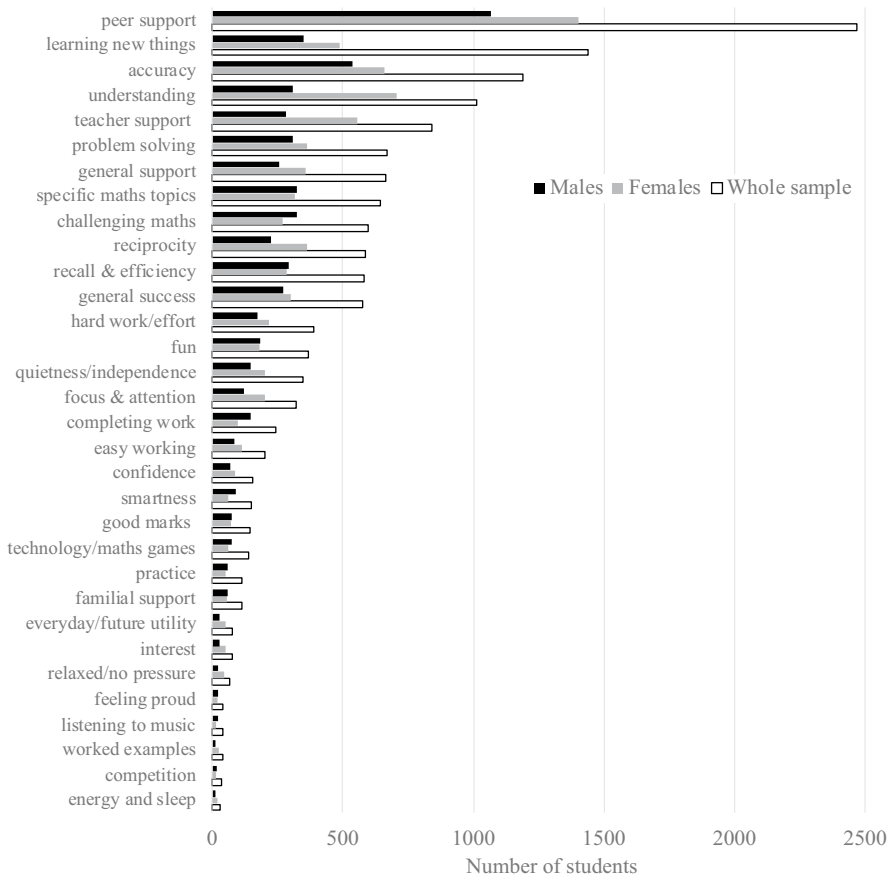


Fig. 1 The overall frequency of instrumental values for the whole sample, males and females. Note. Female students often mentioned more than more IVs than males. Thus, the frequency of IVs for males and females is not equal

have illustrated that students from Pacific and Māori backgrounds generally espouse stronger alignment with collectivist values, including peer support and reciprocity compared to students from individualist cultures. For example, Hill (2018) examined the mathematics educational values of middle school students in New Zealand. The findings showed that Pacific and Māori students valued peer support and collaboration as significantly more important for their mathematics learning than European New Zealand and Asian students who rated peer support and collaboration as their least important mathematics educational values. Other earlier studies (e.g. Hill et al., 2021b; Hill & Seah, 2023) from international contexts have highlighted ethnic differences in students' valuing of peer support and collaboration. For example, a study with Year 8 students investigating MWB found that students who identified as Asian, Indian, Indigenous Australian, and Indian/Pakistani valued teacher support more often than

peer support (Hill et al., 2021a). In contrast, students identifying as Australian mentioned teacher and peer support equally; five times more students identifying as Asian mentioned teacher compared to peer support as important for their MWB (Hill et al., 2021a). Similarly, Year 3 students in China rated the IVs high marks, fun, interesting learning, and teacher praise as more supportive of their MWB than peer support and collaboration (Hill & Seah, 2023).

Although the uniformity of peer support in this study contrasts with findings from other studies, there are several possible explanations for this finding. In New Zealand educational settings, there has been an increasing recognition of the need to develop culturally responsive pedagogy for diverse students (Hunter & Hunter, 2018). Aligned with this, there has been the development of policy documents (New Zealand Ministry of Education, 2018) and research studies (Berryman & Eley, 2017; Rimoni et al., 2022) that advocate for pedagogy that aligns with Māori and Pacific cultural values. Another recent New Zealand survey study (Hill & Hunter, 2023) found culturally diverse students (i.e. European New Zealand, Asian, Māori, and Pacific Nations students) all rated respect as their most important mathematics education value, which may reflect the emphasis of cultural values in their classrooms. Notably, students in the current study also attended schools participating in a professional learning and development initiative focused on culturally sustaining mathematics pedagogy. Within the professional learning and development initiative, there is a focus on teaching students to work productively and collaboratively, and this may have contributed to the identification of this value concerning MWB across different cultural groups.

Interestingly, this would suggest that prosocial values such as peer collaboration and reciprocity can be taught and developed through mathematics education. However, we note that whilst peer support was consistently valued across the New Zealand cohort, the same value might have different meanings and interpretations across ethnicities (Hunter, 2021; Rimoni et al., 2022). Future studies should explore the deeper cultural nuances and meaning behind students' valuing of peer support for their MWB.

Similarly, relationships and feelings of connectedness are central to students' conceptions of and factors promoting their wellbeing more broadly across different age groups (Duckett et al., 2008; Eriksson et al., 2010; Oyarzún-Gómez & Loaiza de la Pava, 2020; Powell et al., 2018). This includes physical relationships with significant others (e.g. peers, school staff, family, community) and subjective assessments of feeling cared for, respected, valued, supported, and belonging. Adolescents especially seek out peers to support their wellbeing in schools (Allen & Kern, 2017) and the absence of close relationships undermines students' wellbeing (Powell et al., 2018). Specific to mathematics education, peer support can improve students' problem-solving abilities (Fawcett & Garton, 2005), enhance mathematical performance (Whicker et al., 1997), and promote positive self-concept and attitudes towards mathematics (Tsuei, 2012). Students often report higher enjoyment of mathematics when they have opportunities to work collaboratively (Whicker et al., 1997). However, traditionally, mathematics teaching and learning have aligned with individualistic value systems with students working individually and independently (Hodge, 2008). Potentially, the

absence of social ways of working may, in part, explain the high levels of illbeing that are often reported in mathematics education research because students' social values are not being fulfilled (Hill et al., 2021a; Mullis et al., 2020a, b).

Aligned with the high levels of valuing peer support in the current study, students from all ethnicities often described the importance of reciprocal learning for their MWB. Reciprocal learning refers to respectful interactions to support others in the mathematics classroom, for example, openly sharing mathematical ideas and knowledge to help others (Hunter & Miller, 2022). Reciprocity was particularly valued by the Pacific students, which aligns with Pacific cultural values (New Zealand Ministry of Education, 2013; 2018). An earlier study from New Zealand found that respectful relationships were rated as the most important value in mathematics education by culturally diverse Year 7 and 8 students (Hill & Hunter, 2023). It is well-recognised that altruistic social behaviours, like acts of kindness, helping others, and generosity, can predict the wellbeing of all parties, including the giver (Hui, 2022). For example, adults who volunteer and help others are happier, healthier, and live longer than non-givers regardless of age, education, or socio-demographic status (Borgonovi, 2008; Haski-Leventhal, 2009). Adolescents who were judged to engage in more altruistic and prosocial behaviours (e.g. generosity, community service) were more likely to thrive at school (e.g. academic success, friendships, valuing diversity, and overcoming adversity) (Benson et al., 2007). Altruistic adolescents also experience greater happiness, calmness, and better physical health later in adulthood (Dillon, 2009). Thus, promoting student reciprocity in the classroom (and beyond) is potentially an effective strategy for teachers to enhance students' MWB.

Gender differences

Concerning gender, overall, we found that the IVs were relatively similar. We note some minor differences, including females noting the importance of mathematical understanding and accuracy (11% and 10% of females, respectively) more than males (5% and 8% of males); females mentioned all the relationship IVs more than males (i.e. peer, teacher, general support, reciprocity). The findings of females espousing greater prosocial values than males in mathematics align with earlier studies (Barkatsas et al., 2019). In contrast to our findings, Barkatsas et al. (2019) found that males valued problem-solving processes with mathematical understanding, meaningfulness, effort, and practice more than girls. Notably, in this study, we discovered that female students mentioned almost all the IVs more than boys, as shown in Fig. 1, except for technology/mathematical-related games, smartness, challenging mathematics problems, and completing work—which was mentioned slightly more by males. The higher proportion of females noting these IVs suggests females are perhaps more aware of the aspects that support their MWB. The reasons behind these gender differences warrant further investigation.

Comparing students' ultimate and instrumental values across international contexts

The New Zealand students' IVs could be categorised into the same seven UVs reported in other countries, including Australia (Hill et al., 2021a) and China (Hill & Seah, 2023; Pan et al., 2022). That is accomplishments (e.g. good marks, completing tasks); cognitive aspects (e.g. understanding, problem-solving); meaning (e.g. everyday utility); perseverance (e.g. effort); positive emotions (e.g. fun, relaxing); and relationships (peer support, family support). The consistency of these seven UVs across countries and cultures points to the importance of these experiences and pedagogical practices in the mathematics classroom. For example, teachers worldwide might emphasise these seven UVs in their classroom, knowing that each of these UVs supports culturally diverse students MWB. However, as our results show, how these seven UVs might be fulfilled (i.e. the IVs serving these UVs) can differ across cultures and countries. For example, the New Zealand students emphasise IVs relating to reciprocity and respect—each serving the UV relationships, with these two UVs less evident in Australia or China (e.g. Hill et al., 2022; Pan et al., 2022). In contrast, studies in other countries have more often noted that teacher support is emphasised more than peer support by students (Hill et al., 2022; 2023). These findings indicate that whilst UVs might be common across different countries, cultural values are likely to highly influence students' IVs. Given that in many countries, there are equity issues in mathematics related to diversity (migrant students, culturally diverse, socio-economic factors), this finding indicates the importance of further investigating the interplay between cultural values and students' MWB. For example, it would be useful to explicitly investigate the extent to which certain values and aspects of MWB are emphasised differently across students from a range of cultural groups.

Research question two: perspectives of Pacific students' MWB

In this section, we use a case study of Pacific students in New Zealand to unpack further students' perspectives of their IVs and to gain additional insights into the MWB of a group of diverse students, in this case, both from an Indigenous and migrant background. We focus here on the most frequent IVs noted by these students, as shown in Fig. 2: peer support, learning new things, understanding mathematics, and teacher support and care. Interestingly, concerning MWB, we note that two of these (learning new things and understanding) are related to the UV cognitions, whilst the other two (peer support and teacher support and care) relate to the UV relationships. Thus, we conjecture that these aspects (i.e. cognitions and relationships) are potentially the most important for Pacific students MWB. We present and analyse the student explanations provided to the open-response survey item to provide a more nuanced understanding of why Pacific students espoused these IVs in mathematics. We also provide insights into potential sources of MWB for these Pacific students.

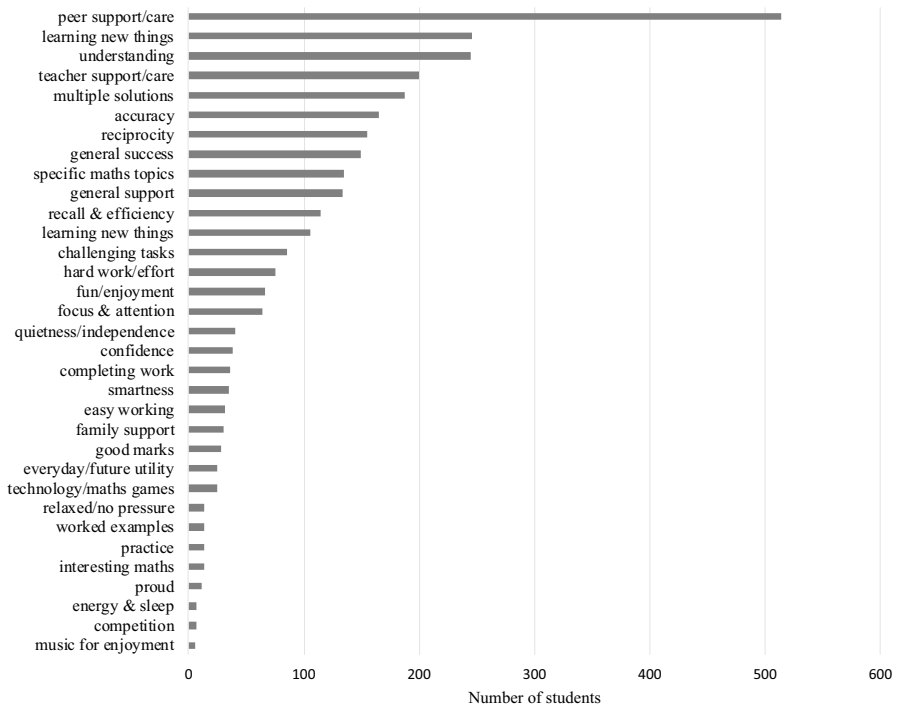


Fig. 2 The most frequent instrumental values for Pacific students

Peer support Most commonly, Pacific students (over 500 students and 20% of the total) provided explanations of their MWB related to peer support. At the simplest level, students referenced that they felt good and did well in mathematics when working with friends, a partner, or a small group. This included having help from a partner and helping others in their group. Several students described a key benefit of peer support as having multiple viewpoints: “because then they give me another picture of how to do the math”. Also viewed as beneficial for MWB was the opportunity to help others: “I like it when I am sharing my thinking because I am helping others”. Furthermore, students referenced the opportunity to ask and answer others’ questions during collaborative work.

For many students who valued peer support, they also noted that when working collaboratively, there was a benefit between “teaching” others and learning themselves. Interestingly, this connects to an Indigenous Pacific and Māori concept called *ako*, a single word that means both teaching and learning, highlighting the reciprocal relationship between these actions (Pale, 2019). For example:

Something that makes me feel good about learning in maths is when I try new techniques and when it actually helps others in their learning. Another thing is when I share my ideas and people actually understand me and so that gives me

motivation to keep sharing. One last thing that makes me feel good in maths is when I am sharing, I have the right words and really understand what I am doing.

This finding aligns with earlier research studies (e.g. Anthony, 2013; Averill, 2012; Hill et al., 2019; Sharma et al., 2011) which identified that Pacific students value opportunities for collaborative work. The current study further extends these findings by documenting from Pacific student perspectives how peer support is beneficial for their MWB, including providing new ideas and aligning with their values of reciprocity, service, and relationships (New Zealand Ministry of Education, 2018; Rimoni et al., 2022).

Learning new things Approximately 10% of the Pacific students ($n=246$) referenced learning new things as a key aspect of their MWB. This included learning new techniques or solution strategies for mathematical tasks. Students also explicitly identified feeling good about learning new things in specific areas of mathematics, including algebra, solving equations and rational numbers (decimals, fractions). Commonly, these students associated the IV of learning new things with the IV of being challenged as they perceived that they learnt new things through challenge: “What makes me feel good in maths is that I can learn new things. I also like it when it gives my brain a hard time to think because I know that I’m learning something I don’t already know”. Both challenge and learning new things were described as interesting and positive about the utility of mathematics.

Interestingly, it is documented that teachers often hold deficit beliefs about the capabilities of marginalised students, including teachers from New Zealand (Adiredja & Louie, 2020; Rubie-Davies & Peterson, 2016). For instance, one study revealed that New Zealand teachers held significantly lower expectations of Māori and Pacific compared to Asian and European New Zealand students, with one teacher expressing that Pacific students were “very lazy and they do not spend enough time studying and learning” (Turner et al., 2015, p. 62). When students work on challenging tasks, they think independently, determine their approaches, discuss mathematics, and make connections—thus, they seek out understanding (Ingram et al., 2020). However, when working through challenging mathematical tasks, many students experience negative emotions (e.g. anxiety, frustration, and confusion), contributing to poor mathematical resilience (Ingram et al., 2020; Johnston-Wilder, 2010; Larkin & Jorgensen, 2016). This often leads to students giving up rather than persisting with the task at hand (i.e. poor mathematical resilience). Importantly, our findings indicate that this group of Pacific students had high MWB when engaged in new learning whilst also demonstrating mathematical resilience, which counters the deficit theorising often related to these groups of students.

Understanding Like learning new things, approximately 10% ($n=245$) of Pacific students identified understanding as an important aspect contributing to their MWB. The IV understanding was explained in two central ways by the students. First, many students referred to their mathematical understanding. These included descriptions of wellbeing being associated with understanding specific mathematical topics and concepts. Other students identified the role of asking questions to help

their understanding: “when I am confused, I ask questions, and it helps me become better in maths” or being questioned themselves: “when other people ask me deeper questions to help me go further”. Implicit in the students’ explanation was the role of peer support; this was also referenced explicitly as a way of developing an understanding of mathematics and, therefore, supporting MWB. Beyond peer support, these Pacific students also noted the role of the teacher as an important aspect of supporting their mathematical understanding and related this to their MWB. Second, a number of these students referred to the importance of understanding the mathematical task they were solving and accessing the question: “when I basically understand the question, it becomes really easy”. Analysis of the student explanations showed that this was related to MWB because the students felt positive when they could engage with the mathematical task and feel successful in solving it. Understanding is central to learning mathematics, which is defined here as connected knowing (Mousley, 2004). Many students perceive mathematics to be linear and progressive, which means that a lack of understanding can contribute to anxieties about falling behind in a fast-paced curriculum (Geist, 2010). On the contrary, many of the Pacific students in our study often framed a lack of understanding (e.g. confusion) in an optimistic viewpoint, using these instances as an impetus to gain understanding, for example, asking questions, seeking support from others, or engaging in reflection to develop understanding autonomously. Again, this taps into these students’ strong mathematical resilience (Johnston-Wilder, 2010) because feeling confused was often seen optimistically and as a commitment to action, contributing to these Pacific students’ MWB.

Teacher support and care The importance of teacher support for Pacific students’ MWB was noted by 8% or 200 Pacific students. These students described how the teacher supported their cognitive UVs, providing explanations and further examples or giving students ideas. Other students referenced listening to their teacher as an important aspect of their MWB. This aligns with the cultural heritage of Pacific students, where listening is often explained as both a sign of respect and central to learning (Hunter, 2021; Uehara et al., 2018). Students also noted how a supportive teacher promoted positive dispositions towards mathematics by making mathematics lessons and learning fun, thus enhancing MWB. Additionally, other students reflected on the importance of teachers using encouragement or praising the students’ efforts. For example, one student noted, “my teacher encouraging me to be better at maths”. Earlier research attests to the importance of teacher-student relationships for students’ positive mathematics learning outcomes like achievement, belonging, and MWB (e.g. Averill, 2012; Hattie, 2008; Hill et al., 2021a). Respectful and positive relationships are especially important for people from Pacific nations, given the collectivist elements of this cultural group (MoE, 2013, 2018; Podsiadlowski & Fox, 2011; Uehara et al., 2018). The importance of teacher support and care aligns with earlier studies demonstrating that Pacific students valued teachers who cared about their students and provided clear explanations (Anthony, 2013; Averill, 2012; Sharma et al., 2011).

Conclusion and implications

Our findings have several practical implications, which we explore here whilst also noting the limitations of this study. Firstly, we discovered that the same seven UVs supported New Zealand students MWB in concordance with research with Australian and Chinese students (e.g. Hill et al., 2021a, 2022; Hill & Seah, 2023). An important contribution of this study is empirically confirming these seven UVs using a much larger (over 10,000 students), and more culturally and developmentally diverse cohort of students compared to these earlier MWB studies. This suggests that teachers in many classrooms around the world might draw upon these seven UVs to fulfil the MWB of most students in their classroom. However, the large sample size also presented some limitations of our study. For instance, manually coding all students' responses was unfeasible and thus, an auto-coding approach was used, which may have overlooked some of the more implicit IVs. Future research might incorporate more in-depth methodologies (e.g. classroom observations) with a smaller cohort to unpack more of the cultural nuances in MWB and complement the survey findings reported here. Also, given that the current study was exploratory, we focused only on cultural differences in MWB, whilst other demographic variables were not investigated (e.g. age groups and socio-demographics). Future studies might investigate these other demographic differences in MWB, for example, if younger students espouse the same IVs and hierarchy of UVs as older students.

Whilst the seven UVs appear to support students' MWB across different countries and cultures, the IVs that serve these UVs are perhaps culturally unique. For instance, the New Zealand students in this study noted more peer support than students from other countries (Hill et al., 2021a; Hill & Seah, 2023), reflecting the cultural norms and classroom practices of students from these specific schools. This could have been potentially linked to the focus on collaborative interaction and culturally sustaining mathematics pedagogy in the PLD with which these students' teachers were involved. Further studies across different school settings and schools that were not participating in the PLD would be useful in unpacking the influence of the PLD on students' MWB.

Given our focus on wellbeing, another implication of this research is counteracting the pervasive deficit theorising often embedded within mathematics education more broadly, particularly for marginalised students. Mathematical discourses are often deficit-focused, for example, emphasising what students cannot do, their misconceptions, the achievement gaps, and the lack of skills or content knowledge to undertake mathematics at school (Adiredja & Louie, 2020). We term this the "mathematics negativity bias", meaning that mathematics education research often tends to focus on these negative aspects more than the positive aspects of the strengths that students bring to mathematics learning. This study challenges these deficit discourses by emphasising what aspects of learning mathematics work well for students across diverse cultural groups and noting the students' strengths and assets connected to their cultural heritage. For example, the willingness to support peers and see learning as a collective process has many positive benefits for all classroom community members.

To our knowledge, this study is the first to report on the perspectives of Pacific students regarding their wellbeing in mathematics education. Thus, we lay the foundations for making the MWB of Pacific students "visible" to researchers and educators. How we

conceptualise wellbeing determines how we respond to it (Foot & Hopkins, 2010). Other studies (e.g. Anae, 2016; Kupa, 2009; Manuela & Anae, 2017; Manuela & Sibley, 2013) have explored the wellbeing of Pacific people more broadly and often in conjunction with health; however, these wellbeing frameworks have elements that are not directly relevant to student wellbeing in mathematics. Indeed, we discovered the importance of cognitive aspects identified by Pacific students to support their MWB, broadening current understandings. This suggests that student wellbeing should be examined more contextually, including across different subject disciplines in education.

Research studies indicate that educators often need help integrating wellbeing principles and strategies into their curricular and classroom practice (Waters, 2021). Often, this is because many educators still need to be provided with tools and strategies to contextualise wellbeing into their subject disciplines (Allison et al., 2020). Houghton and Anderson (2017, p. 18) asserted that for wellbeing education, “to avoid a tokenistic, or bolt-on, approach, it is important to integrate and embed mental health and wellbeing resources into the curriculum relevant to the disciplines”. Concerning mathematics education, a key issue is how teachers can develop pedagogy that addresses MWB in their mathematics classroom. As this study has highlighted, an important first step is to establish students’ IVs and UVs. Further research studies should examine the specific pedagogical approaches that can address MWB by building on IVs and UVs.

To conclude, there has been increasing international attention paid to the role of student wellbeing in school. Despite this attention, there needs to be more research that specifically focuses on wellbeing in a subject-specific framing within schooling. In this article, we sought to examine how diverse middle school students conceptualised and described the factors supporting their MWB. We used data from a free-response survey question in previous studies to explore the IVs espoused by students who supported their MWB. We also examined data from a group of Pacific students to highlight the perspectives of a diverse group of students, noting that these students associated their MWB with cognitive aspects (i.e. acquiring new knowledge and understanding) and positive classroom relationships (i.e. peer and teacher support). This article makes a novel contribution to the field through the methodological approach of using a free-response item and examining wellbeing with a subject-specific focus.

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Data availability The data that support the findings of this study are available on reasonable request from the corresponding author (Jodie Hunter). The data are not publicly available due to them containing information that could compromise research participant privacy.

Declarations

Ethical approval The research study that underpins this publication was provided by Massey University, Registration number NOR 19/54. Informed consent was obtained through the provision of written information sheets to parents and caregivers and an opt-out protocol.

Competing interests The authors declare no competing interests.

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