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# Examining the mathematics education values of diverse groups of students

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**ABSTRACT**

In recent years, there has been increasing interest in examining values in relation to mathematics education research. Our exploratory study examines the mathematics education values of culturally diverse middle school students in New Zealand. We investigated how student values differed across demographic variables including school, ethnicity, gender and grades. Students completed an online survey to indicate the importance of 14 different mathematics education values. The overall mean ratings for each of the 14 values determined the relative value importance across the sample. One-way ANOVA assessed demographic group differences. Findings showed that respect was rated as the most important value across all student groups. Students from Pacific nations placed significantly greater importance on accuracy, communication, family and recall compared to the other ethnicities. Female students emphasized family, practice, respect, risk-taking and utility more than males. We argue that to provide equitable mathematics classrooms that support wellbeing, we need to recognize what diverse student groups value and then transform pedagogy to align with and build from students' values. This article provides a contribution by offering a way of understanding and highlighting similarities and differences in student values which impact on students' learning experiences and wellbeing.

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Affect; mathematics education values; equity; culture; well-being; wellbeing; engagement; respect

## 1. Introduction

Values are central to education underpinning both purpose and practice within schools (Allen et al., 2017). Over many years, mathematics teaching and learning typically focused on students' cognitive outcomes including knowledge, skills and academic performance with less attention to cultural and holistic variables including values and wellbeing (Fan, 2021). Accordingly, mathematics education was positioned as a universal subject transcending culture and values (Bishop et al., 2003). However, there has been growing recognition that mathematics is embedded in culture and values and that mathematics is a cultural product (D'Ambrosio, 1985). Mathematics education is influenced by the values

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of multiple stakeholders including broader society and community, curriculum designers, school principals, teachers, and students themselves (Zhang & Seah, 2021). Considering values are subjective and environmentally constrained, this paper will focus on students' perspectives of values in mathematics teaching and learning.

Increasing interest in exploring students' values in mathematics education is evidenced in the growth of publications in this area (Clarkson et al., 2019; Zhang & Seah, 2021), and the international research collaboration based around the 'What I Find Important' (WIFI) questionnaire (Seah & Wong, 2012). The WIFI studies aim to identify and map co-constructed valuing through examining student and teacher values and classroom interactions. Many of these studies have examined the values of groups of culturally homogenous samples within a country or have undertaken comparisons of student values across countries (e.g. Law et al., 2012; Pang & Seah, 2021; Zhang et al., 2016). It appears that there have been limited studies focusing on the values of marginalized groups of students or the diversities of values of differing groups of students within the same system (e.g. classroom, city, or country).

Students from different cultural groups frequently espouse different values and accordingly their worldview is influenced by their cultural background. Similar to many countries, New Zealand has an increasingly diverse population which is reflected in the composition of students within the classroom and schools. This includes Pakeha (New Zealand European) (70% of the total population), indigenous Māori (16.5%), Pāsifikā people (from the Pacific Islands) (8%), and those of Asian heritage (15%) (Stats NZ, 2018). Both Māori and Pacific cultures draw on collectivism as a key value with strong obligations to the wellbeing of a group (Hunter, 2021; Uehara et al., 2018), this contrasts with Pakeha culture which displays a low level of collectivist value orientation (Podsiadlowski & Fox, 2011). Interestingly, New Zealand has one of the widest levels of mathematics education achievement disparity amongst OECD nations (OECD, 2018) with a long tail of under-achievement for marginalized groups.

Earlier studies have highlighted that when students' learning values are fulfilled and are congruent with the values in their environment (e.g. teacher or pedagogical values), students are happier, more engaged, feel like they belong and are respected, and thus have greater levels of wellbeing in mathematics education (Hill, Kern, Seah, et al., 2021; Sirgy, 2021; Tiberius, 2018). In contrast, disengagement, dislike and illbeing occurs when student values are not being fulfilled or conflict with their values in their mathematics classroom. We argue that to achieve equity in schooling requires teachers to develop culturally sustaining pedagogy which draws upon the values and identity of students as a strength in teaching and learning. Given the significant equity issues in New Zealand, there needs to be greater attention to students' values to facilitate equitable outcomes and to address both students' experiences and wellbeing in the mathematics classroom.

In this study, we explore what students value as most important when learning mathematics. Specifically, we address the following research questions:

(1) What mathematics education values are rated as most and least important by a culturally diverse group of middle school students?
(2) How do fourteen mathematics education values differ in importance across student ethnicities, genders and grades?

## 2. Literature review

In this section, we explore the key mathematics values concepts, and secondly, review the research exploring student values in mathematics education across different countries and cultures, grade levels, and genders.

### 2.1. Defining values

Earlier definitions of values describe them as enduring beliefs that are linked to feelings (Clarkson et al., 2000; Debellis & Goldin, 2006; Rokeach, 1973). Values and beliefs are closely interconnected (Debellis & Goldin, 2006; Grootenboer & Marshman, 2015). For instance, someone can believe something is true (e.g. believing mathematics is about accuracy) and value it at the same time (e.g. accuracy is important in mathematics). Yet, there are also marked differences – beliefs are generally concerned with truths or correctness and are especially stable over time (Grootenboer & Marshman, 2015). Values are slightly less stable than beliefs and generally concern the degree of importance of some experience, object, or activity (Seah, 2019). Values are more motivational in nature generating reasons to respond in specific ways whilst assisting individuals to plan and evaluate how well their lives are going (Halstead, 1996; Tiberius, 2018). Values are also more strongly connected to culture than are beliefs, with culture being a value system organized formally and informally and serving to set norms and standards for people from different groups to aid decision making (McConatha & Schnell, 1995; Schwartz, 2012). The hierarchical nature of values also differentiates them from beliefs (Schwartz, 2012). At the highest level are 'ultimate values' (e.g. relationships, life meaning, accomplishments) valued for their own sake and most impactful on a person's subjective experiences (e.g. wellbeing, happiness). Underneath these are 'instrumental' values, being everything valued to achieve more ultimate values e.g. valuing respect, friendships, or family to fulfill the ultimate valuing of relationships (Tiberius, 2018).

In sum, we define values as the core of culture (McConatha & Schnell, 1995), and the hierarchy of things an individual cares about, an indication of what is important, and as the foundation from which individuals base, plan and judge their lives, consequently, values define wellbeing (Seah, 2019; Tiberius, 2018).

### 2.2. Values in the context of mathematics education

Within mathematics education, earlier theorizing classified values as part of an affective system (alongside mathematical beliefs, attitudes and emotions) (Bishop, 1996; Debellis & Goldin, 2006). More recently, values in mathematics have been conceptualized as motivational or conative, conation representing the striving component of motivation (Bishop, 1996; Emmons, 1986; Seah, 2019). Considering the high incidence of student disengagement (Attard, 2013) and lack of persistence (Sullivan et al., 2013) reported in many mathematics classrooms, the conative qualities of values are especially important. In our work we define values and valuing in mathematics education as conative, as 'an individual's embracing of convictions in mathematics pedagogy which are of importance and worth personally … [shaping] the individual's willpower to embody the convictions in the

choice of actions' (Seah, 2019, p. 107). Put simply, values in mathematics education concern important mathematical objects, experiences, or pedagogies that also drive students to behave in ways that are consistent with their values.

Values in mathematics education have been categorized into three broad subtypes: general education values (that is moral and ethical values aligned with purpose of education e.g. valuing justice); mathematical values (the values of mathematics as a discipline, i.e. rationalism, objectism, openness, mystery, control and progress); and mathematics education values (any value associated with teaching and learning mathematics e.g. clear teacher explanations or group work) (Bishop, 1996). These three value categories are not mutually exclusive. For example, students may value respect more broadly (i.e. a general education value) because mathematics supports understanding of equity and fairness. However, a student may also value respect specific to their learning in the mathematics classroom (i.e. a mathematics education value) because they desire friendships and support. Across Bishop's three value subtypes, mathematics education values are cited most often by students and teachers, they have the most influence on learning experiences, are most closely tied to cultural values, and subsequently have received the most research attention (Seah, 2019). For these reasons our study focuses on students' mathematics education values, rather than general or mathematics values.

Students' mathematics education values have been linked to various positive learning outcomes including learning preferences, positive classroom relationships, feeling respected, academic engagement and student wellbeing in mathematics (e.g. Averill, 2012; Guo et al., 2015; Hill, 2018; Hill, Kern, Seah, et al., 2021; Hunter, 2021; Kalogeropoulos & Bishop, 2019). For instance, improvements in student mathematical engagement were noted when teachers aligned pedagogical values to the values of their students (Kalogeropoulos & Bishop, 2019). Additionally, significant similarities were noted between students' descriptions of their values including mathematics education values and wellbeing in mathematics education indicating that addressing values can support wellbeing in the subject (Hill, Kern, Seah, et al., 2021). However, mathematics education values are subjective and vary from one student to the next, particularly across ethnicities, cultures and demographics. To achieve equitable learning outcomes for diverse groups of students, it is important to recognize these values differences.

### 2.3. Values in mathematics education across countries and cultures

Values in mathematics education vary across countries and cultures in part because of differences in cultural values or region-specific pedagogical practices (Hunter, 2021; Zhang, 2019). For example, across the WIFI in learning mathematics studies, differences have been noted in what students from different cultural contexts value as most important with consistency in specific locations (Davis et al., 2019; Österling et al., 2015; Österling & Andersson, 2013). For example, studies (e.g. Law et al., 2011; Lim, 2015; Zhang, 2019) with Chinese students found that they consistently emphasized accomplishments (e.g. smartness, achievement, memory), effort, practice and teacher led learning (e.g. teacher explanations, strictness, teacher board work). Another Australian study (with a predominantly immigrant sample) reported students most valued achievement, open-endedness, humanism, relevance and ICT, captured using the WIFI questionnaire (Seah & Barkatsas, 2014). Potentially, the emphasis on achievement may reflect the social inequities faced by

immigrant students. Other studies in New Zealand found similarities between collectivist Pāsifikā and Māori cultural values and students' mathematics education values, such as practice, family, peer support, respect and persistence (Anthony, 2013; Hill, 2018; Hunter, 2021).

To a lesser extent other research has examined the differences in values for students from different cultures. A comparative WIFI study with students from mainland China, Taiwan and Hong Kong found students across these regions shared the same six values (i.e. achievement, relevance, practice, communication, ICT and feedback). Yet, across regions the importance attributed to each value differed, for example, Chinese mainland students valued practice, achievement and relevance significantly more than the other regions, potentially because mainland China is more populous and has a greater emphasis on high stakes exams. Using interviews, Dede (2019) revealed both similarities and differences in values for German, Turkish and Turkish immigrant students. Utility, relevance and rationalism were common among the three groups, fun was valued only by the German and Turkish students. Germans valued consolidating knowledge, Turkish valued practice, and communication was valued only by immigrant students. Like the Seah and Barkatsas (2014) study, differences in social equalities and cultural values likely influenced students' values in mathematics.

It appears that there are limited studies that have specifically explored cultural diversities in students' mathematics education values within a single country or region (e.g. Aktaş et al., 2021; Anthony, 2013; Hill, 2018). Other cross-cultural values studies (e.g. Dede, 2019; Seah & Barkatsas, 2014) use the WIFI questionnaire, however, this does not address unique cultural values (e.g. family, respect, reciprocity) which potentially impacts on the responses of Indigenous or other groups of marginalized students. For example, Hill (2017, 2018) investigated ethnic differences in mathematics education values for Māori, Pāsifikā, Asian and European students within Auckland, New Zealand. She found all ethnicities mostly valued utility. Māori and Pāsifikā students rated collaborative and family values as most important, and interestingly, Asian, and European students rated these same values as least important, reflecting the intersection of cultural values and students' mathematics education values. Another New Zealand study noted students from low socio-economic schools (predominately Māori and Pāsifikā students) emphasized more collaborative values than students from high socio-economic schools (Anthony, 2013). Aktaş et al. (2021) explored the values of Turkish students in Islamic schools to other studies with non-religious Turkish students and concluded that students in Islamic schools espoused relevance to a lesser extent. The researchers argue that Islamic beliefs emphasize utility mathematics values to reveal hidden truths, thus relevance might be less salient than other values in mathematics education. The study reported in this article focuses on a single system (i.e. country) uncovering the rich cultural diversities in mathematics education values across classrooms in New Zealand.

### 2.4. Values in mathematics education across grade levels

As students develop and progress through school, both pedagogy and learning environments alongside students' priorities and values can change. A longitudinal study with American students highlighted that subjective mathematical task values (i.e. attainment, intrinsic and utility values) declined as students progressed from grades 1 through 12

(Jacobs et al., 2002). Similarly, a Ghanaian study (Davis et al., 2019) compared values across primary to secondary grades and found that valuing increased for achievement, fluency, authority, versatility, ICT and knowing multiple strategies as students became older. Additionally, senior secondary students valued relevance less than primary and junior secondary students and valued greater understanding and mastery potentially because high stakes exams were introduced in secondary grades. Zhang (2019) reported primary students in China attributed greater value to ability, effort, diligence, use of formulas and memory than secondary students. Also, secondary students were more likely to value knowledge and mathematical thinking. Another study by Tang et al. (2021) reported junior secondary school as a critical period of change in Chinese students' values, with values switching across the primary to secondary school transition. Specifically, primary students' memorization and control values shifted to emphasize understanding and objectism in the secondary years, whereas valuing ICT declined, and practice increased as students became older. Interestingly, there are notable differences across these studies in relation to increases and decreases in student valuing as they progress through school.

### 2.5. Gender and values in mathematics education

Across research studies which examine gender differences in relation to valuing in mathematics education, there are both similarities and differences. Here we define gender as the socially constructed characteristics of boys and girls (World Health Organization, n.d.) A study by Barkatsas et al. (2019) in Hong Kong found boys valued meaningfulness, problem-solving processes with mathematical understanding, and effort and practising (e.g. doing lots of examples). In contrast, girls valued the use of mathematical discourse, autonomy and greater opportunities for their voices to be heard. Similarly, Wong (1995) highlighted that girls valued collaboration in mathematics whilst males preferred competition and problems solving. However, in studies from Anglo-western cultures, American girls and boys showed similar values concerning the importance of performing well (e.g. Wigfield et al., 1997). German, Swedish and American girls perceived mathematics education as less valuable (i.e. task value) than boys and less useful for future professional aspirations (Gaspard et al., 2015; Hyde et al., 1990; Samuelsson & Samuelsson, 2016). In contrast with studies reporting higher social values amongst girls, girls in Sweden noted feeling less involved in the mathematics classroom and during group work compared to boys (Samuelsson & Samuelsson, 2016).

## 3. Research design and methods

### 3.1. Participants

Five schools throughout New Zealand were invited by email to participate in the study. In New Zealand, there is a strong intersection between ethnicity and socio-economic background particularly for Pāsifikā and Māori communities (Stats NZ, 2018). 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 while decile ten indicates that the school is in the highest socio-economic area. Overall, students from Pāsifikā and Māori backgrounds are more likely to attend low decile (and socio-economic) schools, whilst

**Table 1.** Student demographics.

| | Student ethnicities | | | | |
|---|---|---|---|---|---|
| | Asian | European | Māori | Pāsifika | Row totals |
| Males | 14 | 123 | 54 | 70 | 261 (46%) |
| Females | 9 | 157 | 55 | 81 | 302 (54%) |
| Tollmouth (Dec. 1) | 1 | 1 | 15 | 112 | 129 (23%) |
| Smith (Dec. 6) | 16 | 149 | 43 | 14 | 222 (39%) |
| Jersey (Dec. 3) | 4 | 99 | 18 | 4 | 125 (22%) |
| Totara (Dec. 5) | 0 | 28 | 15 | 0 | 43 (8%) |
| Ranginui (Dec. 1) | 2 | 4 | 19 | 22 | 47 (8%) |
| Grade 7 | 17 | 163 | 69 | 93 | 342 (60%) |
| Grade 8 | 6 | 118 | 41 | 59 | 224 (40%) |
| Column totals | 23 (4%) | 281 (50%) | 110 (19%) | 152 (27%) | |

Note: Deciles 1 and 3 = low sociodemographic schools, deciles 5 and 6 = medium demographic schools.

European Pakeha and Asian students tend to attend higher decile (and socio-economic) schools. Given a key focus in this study was on the values of culturally diverse students, all of the schools invited to participate were middle to low decile. The schools were also selected to cover a range of geographic locations and to include both urban and rural areas. All five schools consented to take part which included 566 middle school students (Years 7 and 8). Student demographics variables are summarized in Table 1. Three low decile and two medium decile schools are included here. The clustering of ethnicities by school decile is reflected in our study with most Pāsifikā and Māori students attending the low decile schools and European and Asian students attending the medium decile schools.

### *3.2. Data collection*

Students completed an online Qualtrics survey during schooltime at the beginning of 2019, recording the extent to which they valued 14 different mathematics educational values listed in Table 2. Mathematics education values were considered to be any objects, experiences, or pedagogies that students considered important for their learning of mathematics (Bishop, 1996; Seah, 2019). We developed the survey ourselves so that the cultural values of Māori and Pāsifikā students – which are often missing from existing mathematics values surveys (e.g. WIFI) could be included. Specifically, the survey included three culturally derived mathematics education values – family, respect and belonging – from earlier research studies in New Zealand with Māori and Pāsifikā learners (Anthony, 2013; Averill & Clark, 2012; Hill, 2018) and New Zealand policy documents (Ministry of Education, 2013). Also included were eleven mathematics education values derived from earlier surveys (e.g. WIFI) and considered important by teachers and students in other studies – accuracy, mathematical clarity, peer collaboration, persistence, practice, problem solving, recall, risk taking, communication/talking, teacher explanations and utility (Clarkson et al., 2000; Hill, 2017; Hunter, 2021; Seah et al., 2017; Seah & Wong, 2012).

As it can be challenging for children to relate directly to values, each value was incorporated into a statement. For example, 'maths when it is clear and makes sense to me' represented the value of mathematical clarity. Students rated the importance of each value by sliding a marker along a line from 0 on the far left ('not important to me') up to 10 on the far right ('very important to me'). Labels appeared only on the endpoints as anchors as

**Table 2.** The fourteen mathematics education values and their corresponding value statements.

| Mathematics education values | Value statement |
|---|---|
| Accuracy | To get the correct or right answer in mathematics |
| Belonging | Feeling like I belong, or I am connected to others in my mathematics class |
| Family | To have my family (whanau) help or support me with my mathematics |
| Mathematical clarity | Mathematics when it is clear and makes sense to me |
| Peer collaboration | Working together with other children in mathematics |
| Persistence | If I can't solve a difficult mathematics problem, I need to keep working at it |
| Practice | To practice my mathematics lots so that I can improve |
| Problem solving | Trying out different way to see what works to solve a mathematics problem |
| Recall | To be able to know my basic facts quickly |
| Respect | Having respect for my mathematics teacher, and my teacher respecting me |
| Risk taking | To have a go at answering a mathematics problem even if I think I might be wrong |
| Communication/talking | Talking about my ideas with a group or with a partner |
| Teacher explanations | My mathematics teacher needs to explain it to me properly so that I can understand |
| Utility | Doing mathematics that is useful for my life outside of school |

recommended by other surveys measuring affect and wellbeing constructs (Butler & Kern, 2016). A ten-point scale was selected because previous surveys (e.g. Andersson & Österling, 2019) exploring values in mathematics show ratings tend to skew to the upper end (i.e. important rather than not important). Greater scale options can minimize this skewness and provide greater variability in students' responses (Dawes, 2008).

### 3.3. Data analysis

All statistical tests were conducted using the Statistical Program for Social Sciences (SPSS21). To address the first research question, we ranked the value means from the highest to lowest one to determine which of the fourteen mathematics education values were rated as most and least important. To determine if the importance of each of these fourteen values differed significantly from one another, across the whole sample and by ethnicity, gender and grade, one-way repeated measure ANOVA (using Greenhouse-Geisser corrections) and post-hoc Bonferroni tests were used.

To explore if the individual mathematics educational values were significantly more or less important across student groups (research question two) fourteen one-way multifactorial ANOVA were conducted using the mathematical educational values as the dependent variable, and 4 x ethnicity, 2 x gender, 2 x grade and 5 x school as fixed factors. Levene tests confirmed homogeneity of variances across these groups for each dependent variable ($p > .069$). Main effects for ethnicity, gender and grade were explored. School main effects were not investigated because of the unequal proportions of ethnicities in schools. Two- and three-way interactions were also not explored because of low sample sizes in some groups. A limitation of this study is that the results for the Asian students may potentially reflect the lower sample size ($n = 24$) and subsequent lack of statistical power, rather than an absence of statistical significance for this group of students.

## 4. Findings

***Research Question One – What mathematics education values are rated most and least important by a culturally diverse group of middle school students?***

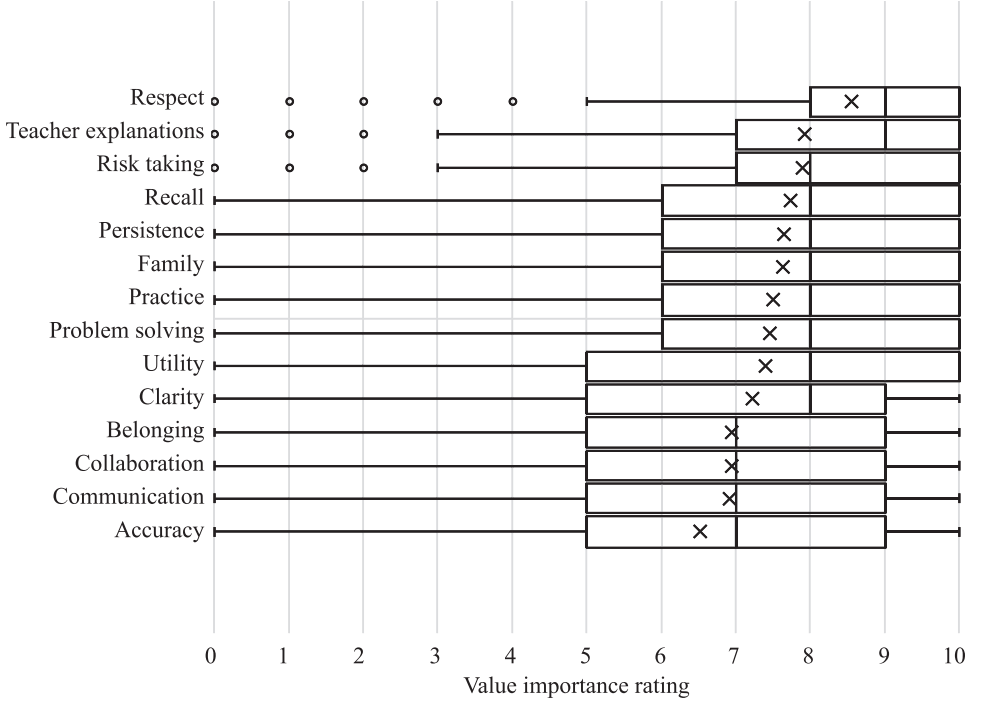


**Figure 1.** Mean value ratings from highest to lowest across all students.

Note: Value means are represented by the circle symbol and summarized on the far right. Values are ordered from the highest means at the top to the lowest means at the bottom.

Across all 566 students the highest rated (most important) value was respect ($M = 8.56, SD = 1.95$), followed by teacher explanations ($M = 7.94, SD = 2.33$), risk taking ($M = 7.91$, $SD = 2.13$), recall ($M = 7.74$, $SD = 2.50$) then persistence ($M = 7.66$, $SD = 2.29$) all displayed in Figure 1. Overall, the least important value was accuracy ($M = 6.52$, $SD = 2.75$). The range for respect, risk taking and teacher explanations were all skewed to the right indicating that students were more likely to rate these values as 'important' rather than 'not important'. Statistically significant differences were found across the fourteen values $F(10.73, 5673.67) = 6.30$, $p < .001$. Across the whole sample post hoc Bonferroni tests confirmed respect was rated significantly higher than all other values. The next seven highest rated values (i.e. teacher explanations, risk taking, recall, persistence, family, practice, problem solving) did not significantly differ from one another, however, they were each significantly higher than all the last seven values (i.e. utility, clarity, belonging, collaboration, communication and accuracy).

Group differences in value ratings were also investigated. Table 3 summarizes the fourteen value means and standard deviations across ethnicities, genders and grades with the superscripts 1–5 representing the top five and 14 the least important values. Overall, the mean ratings for the fourteen values differed significantly for each ethnicity (Asian, $F(5.57, 169.07) = 2.57$, $p = .25$; European, $F(9.91, 2885.78) = 22.87$, $p < .001$; Māori, $F(9.41, 1025.82) = 10.65$, $p < .001$; and Pāsifikā students, $F(10.42, 1699.10) = 8.13$, $p < .001$); gender (males, $F(10.19, 2766.1) = 15.22$, $p < .001$; females, $F(10.56, 3304.63) = 26.87$,

**Table 3.** Value means and standard deviations across all demographic groups.

| | Asian | Euro | Māori | Pāsifikā | M | F | Gr 7 | Gr 8 |
|---|---|---|---|---|---|---|---|---|
| Accuracy | 7.83 (2.10) | 6.34[14] (2.66) | 5.76[14] (2.69) | 7.22[14] (2.85) | 6.60 (2.72) | 6.46 (2.77) | 6.50[14] (2.86) | 6.55[14] (2.59) |
| Belonging | 7.09 (2.39) | 6.80 (2.60) | 6.47 (2.75) | 7.56 (2.41) | 6.87 (2.50) | 7.04 (2.66) | 6.78 (2.63) | 7.21 (2.53) |
| Clarity | 8.04 (1.64) | 7.21 (2.57) | 6.57 (2.68) | 7.64 (2.31) | 7.42 (2.47) | 7.08 (2.53) | 7.08 (2.57) | 7.47 (2.42) |
| Collaboration | 7.57 (1.93) | 6.68 (2.41) | 6.56 (2.42) | 7.63 (2.56) | 6.94 (2.40) | 6.99 (2.53) | 6.96 (2.57) | 6.94 (2.32) |
| Communication | 7.09 (2.17) | 6.70 (2.52) | 6.49 (2.79) | 7.64 (2.41) | 6.69 (2.55) | 7.15 (2.56) | 6.88 (2.65) | 7.00 (2.44) |
| Family | 7.04[14] (2.65) | 7.27 (2.54) | 7.50[4] (2.58) | 8.53[2] (2.20) | 7.22 (2.66) | 8.00[4] (2.34) | 7.63[4] (2.63) | 7.67 (2.34) |
| Persistence | 8.30[3] (1.72) | 7.55[5] (2.23) | 7.32[5] (2.20) | 8.03 (2.48) | 7.68[5] (2.23) | 7.66 (2.33) | 7.49 (2.40) | 7.93[4] (2.09) |
| Practice | 8.26[5] (1.91) | 7.17 (2.53) | 7.05 (2.43) | 8.34[4] (2.32) | 7.25 (2.64) | 7.74[5] (2.33) | 7.46 (2.53) | 7.57 (2.42) |
| Problem solving | 7.96 (2.27) | 7.14 (2.26) | 7.18 (2.06) | 8.19 (2.34) | 7.44 (2.23) | 7.49 (2.34) | 7.49 (2.32) | 7.43 (2.25) |
| Recall | 8.30[4] (2.42) | 7.61[4] (2.36) | 7.05 (2.72) | 8.39[3] (2.46) | 7.77[3] (2.47) | 7.72 (2.53) | 7.60[5] (2.63) | 7.96[3] (2.29) |
| Respect | 8.74[1] (1.60) | 8.47[1] (1.85) | 8.29[1] (2.13) | 8.89[1] (2.01) | 8.22[1] (2.14) | 8.85[1] (1.72) | 8.58[1] (1.94) | 8.53[1] (1.98) |
| Risk taking | 8.39[2] (1.85) | 7.91[2] (2.03) | 7.55[3] (2.14) | 8.12 (2.32) | 7.76[4] (2.11) | 8.07[2] (2.14) | 7.92[2] (2.13) | 7.91[5] (2.13) |
| Teacher explanations | 8.26[5] (2.30) | 7.88[3] (2.17) | 7.68[2] (2.28) | 8.19[5] (2.62) | 7.81[2] (2.25) | 8.06[3] (2.38) | 7.86[3] (2.46) | 8.06[2] (2.10) |
| Utility | 8.13 (1.79) | 7.38 (2.48) | 6.90 (2.57) | 7.74 (2.58) | 7.21 (2.59) | 7.59 (2.44) | 7.22 (2.61) | 7.71 (2.36) |

Note: *SD* in brackets, M = males, F = females, [1–5] top five values, [14] lowest value.

$p < .001$) and grade (Grade 7, $F(10.44, 3680.69) = 16.52$, $p < .001$; Grade 8, $F(10.47, 2458.81) = 16.52$, $p < .001$). Tukey tests confirmed respect was rated significantly more important than all the other values by the European, Māori and Pāsifikā students, also females and Grade 7 students. No significant differences were found for the Asian students across any of the fourteen values, which could be attributed to the lower sample size of the Asian students. For male students the top four values (i.e. respect, teacher explanations, recall, risk taking) did not differ significantly from each other, however these four values were each significantly higher than the last five values (i.e. collaboration, belonging, communication and accuracy). For females there were no significant differences between the second to the seventh most important values (i.e. risk taking, teacher explanations, family, practice, recall and persistence) whilst these seven each differed significantly to all the last four values (i.e. clarity, belonging, collaboration and accuracy). For Grade 7 students the second to the sixth most important values did not differ significantly (i.e. risk taking, teacher explanations, family, recall, persistence) however they each differed to the last three values (i.e. communication, belonging and accuracy). Grade 8 students' first three values (i.e. respect, teacher explanations and recall) also the third to tenth most important values did not differ significantly from each other. However, the first three values did significantly differ to the last five values (i.e. belonging, communication, collaboration and accuracy). All students rated accuracy as least important except the Asian students who rated family as least important.

***Research Question Two – How do fourteen mathematics education values differ in importance across student ethnicities, genders and grades?***

As summarized in Table 4, significant differences were discovered across different ethnicities for some values including accuracy, $F(3, 503) = 2.62$, $p = .051$; communication $F(3, 503) = 2.87$, $p = .042$; $p = .041$; family $F(3, 503) = 2.09$ $p = .024$; and recall $F(3, 503) = 2.81$, $p = .042$, and these were attributed to Pāsifikā students rating these values significantly higher than the other ethnicities.

Additionally, we noted differences in value ratings by gender. Female students rated family $F(1, 503) = 5.09$, $p = .023$; practice $F(1, 503) = 7.14$, $p = .014$; respect $F(1, 503) = 7.44$, $p = .011$; risk- taking $F(1, 503) = 10.49$, $p < .011$; and utility $F(1,$

**Table 4.** Statistically significant group differences across the values.

| | Values | Group 1 | Group 2 | Mean difference | *P* value |
|---|---|---|---|---|---|
| Ethnic differences | Accuracy | Pāsifika | European | .87 | .007 |
| | | Pāsifika | Māori | 1.41 | < .001 |
| | Communication | Pāsifika | European | .96 | .001 |
| | | Pāsifika | Māori | 1.17 | .002 |
| | Family | Pāsifika | Asian | 1.47 | .038 |
| | | Pāsifika | European | 1.25 | < .001 |
| | | Pāsifika | Māori | .99 | .008 |
| | Recall | Pāsifika | European | .79 | .008 |
| | | Pāsifika | Māori | 1.34 | < .001 |
| Gender differences | Family | females | males | .78 | .024 |
| | Practice | females | males | .49 | .008 |
| | Respect | females | males | .63 | .007 |
| | Risk taking | females | males | .31 | .001 |
| | Utility | females | males | .38 | .006 |

503) = 7.60, $p = .012$ significantly higher than males. No significant differences were observed across grades.

## 5. Discussion

In this article, we sought to examine what culturally diverse middle school students valued as most important when learning mathematics. We drew on a survey design incorporating value statements with a key focus on those mathematics education values that were rated as most and least important and how these values differed across ethnicity, gender and grade level. In the following sections we expand on the two research questions and discuss the key findings in greater detail.

### 5.1. The most and least important mathematics values overall

Our first research question explored the relative importance of fourteen mathematics education values. Earlier studies both in New Zealand and internationally indicate these fourteen mathematics education values are valued to some extent by students in other classrooms (e.g. Averill & Clark, 2012; Seah et al., 2017; Seah & Wong, 2012). In the study reported in this article, across the whole sample the values respect, teacher explanations and risk taking were rated most important and mathematical accuracy as least important. These three top rated values (i.e. respect, teacher explanation and risk-taking) all had less variability and were skewed to the higher end of the scale when compared to all other values, further supporting the importance of these values. The fourteen values in our survey can be interpreted as 'instrumental' values, that when fulfilled can serve higher 'ultimate' values (Tiberius, 2018). For instance, students' valuing of respect for and from their teacher; also having a safe classroom climate to support risk-taking, might each serve the ultimate valuing of positive relationships. Similarly, teacher explanations may serve the ultimate valuing of positive relationships (i.e. valuing support), and/or learning competency (i.e. explanations promote mathematical understanding). Typically, mathematics teaching has often been more focused on developing academic skills and competency rather than cultivating relationships. However, quality relationships are one of the strongest predictors of wellbeing, an important aspect of learning across the curriculum, given that quality relationships result in connections where individuals feel valued, respected and supported (Kern, 2021; Seligman, 2011).

Specific to mathematics education, previous research studies have highlighted that middle school students often cite positive classroom relationships as the highest contributor to their wellbeing in mathematics (Clarkson et al., 2010; Hill, Kern, van Driel, et al., 2021). Also, perceived teacher support, warmth, or enthusiasm predicts students' positive emotions (e.g. enjoyment) towards mathematics; higher mathematical engagement and effort; greater belongingness; self-efficacy; and lower feelings of hopelessness (Attard, 2013; Murray, 2011; Rimm-Kaufman et al., 2015; Sakiz et al., 2012; Winberg et al., 2014). Student beliefs, attitudes and values towards mathematics have been reported as most impacted by the relationships students have with their mathematics teachers (Grootenboer & Marshman, 2015; Riconscente, 2014). Students often equate 'good' mathematics teachers with those who provide clear, systemic and detailed explanations that specially address students' needs (Anthony, 2013; Österling et al., 2015; Seah & Peng, 2012). Our findings

highlight specific areas which can potentially improve students' experience in the mathematics classroom and can be built upon for responsive pedagogy. Given that the most highly rated values mapped with positive relationships, teachers might specifically target relational pedagogy or classroom practices which build on these student values as a strength.

In contrast, accuracy was rated the least important value overall. This does not negate the importance of accuracy in mathematics but instead may be related to the higher student ratings of risk-taking, practice and persistence which generally coincide with mathematical problem solving and learning from mistakes. The lower importance of accuracy aligns with findings from earlier studies also in New Zealand. For example, both Hill (2017) and Hunter (2021) reported New Zealand students valued learning from mistakes over accuracy, with one student noting 'it's getting stuff wrong the first time then the next time you get it right … You're actually helping yourself, and then you can get better at it' (Hunter, 2021, p. 14). For mathematics educators, identifying that students rated accuracy lower in their values related to mathematics learning is important as it then provides an opportunity to further investigate this area with students. For example, teachers may facilitate a discussion with students related to when accuracy is important within mathematics while still acknowledging the benefits of risk-taking, solving problems through trial and error, and learning from mistakes.

### 5.2. Group similarities and differences in students' mathematics education values

Our second research question explored similarities and differences across demographic groups for the fourteen mathematics educational values. Notably, respect was consistently rated as most important, and for most groups respect was significantly more important than all other values. Earlier studies (e.g. Averill & Clark, 2012; Hunter, 2021) have consistently shown respect, defined as reciprocal student-teacher respect between students and the teacher, as an important value to successfully learn mathematics for Māori and Pāsifikā students. However, it is interesting to also note the high rating of respect by European and Asian students as a previous study (e.g. Hill, 2017) found that European and Asian students ranked respect as a value of lower importance than their Pāsifikā and Māori peers. In this study the framing of respect in the value statement (see Table 2) indicated reciprocal respect, and interestingly, the findings indicate that the valuing of respect in the mathematics classroom transcended both cultural and demographic groups. In recent years, in New Zealand educational settings there has been increasing recognition of the importance of developing pedagogy both responsive and aligned with Māori and Pāsifikā cultural values (Berryman & Eley, 2017; MoE, 2013). Respect is one of the key values identified and this high rating by students may be related to greater recognition in both schooling and wider society of the importance of building on such values.

In terms of cultural differences, we found that Pāsifikā students rated family, communication, accuracy and recall as significantly more important than other ethnicities. All of these values have links to cultural values as well as social practices in family and community settings. Pāsifikā culture is founded on collectivism with familial obligations and support an integral part of everyday life and of central importance for Pacific people (MoE, 2018; Uehara et al., 2018). Similarly, communication and the process of *talanoa,* sharing ideas, telling stories and talking with others are important cultural practices (Johansson

Fua, 2014). The higher ratings of accuracy and recall are likely linked with family and community social practices related to attending church. Religious faith plays a significant role in Pāsifikā communities with close to 70% of Pāsifikā families in New Zealand identifying as Christian (Stats NZ, 2018). A common practice for children in church is to rote learn and orally present biblical readings where both accuracy and recall are highly valued (Dickie & McDonald, 2011). These findings align with earlier research (Hill, 2017; Hunter, 2021) which noted an intersection between cultural values and mathematics education values. All of these values have the potential for teachers to build upon them as strengths in relation to mathematics teaching and learning which is a means to address student wellbeing and issues of equity.

Interestingly, overall Pāsifikā students' ratings of values were particularly skewed towards being important rather than not important, more than the other ethnicities. For instance, the mean rating for accuracy (the least important value overall) was rated 7.22 out of 10 for the Pāsifikā students compared to a mean of 5.76 for the Māori students, 6.34 for European and 7.83 for Asian students. Other studies point to Pāsifikā and Asian New Zealand students reporting more positive attitudes towards mathematics than other ethnicities (Bonne, 2016). The higher rating of values by Pāsifikā students in this study potentially indicates higher positive affect towards mathematics learning. An area of further research could be the relationship between rating of values and disposition towards mathematics. We also noted differences in gender with females valuing family, practice, respect, risk-taking and utility significantly more than males. Female students emphasizing the pro-social and collaborative aspects of mathematics aligns with previous studies (Barkatsas et al., 2019; Wong, 1995). However, in contrast to our results, earlier studies found that female students often report mathematics as less useful than males (e.g. Gaspard et al., 2015) and males value problem-solving processes, effort and practising more than females in mathematics education (Barkatsas et al., 2019). Incongruencies between the pedagogical values in mathematics and STEM courses and the values of females may partly explain the under-representation of females in these disciplines. Conversely, considering and drawing on values that are important to females can potentially lead to more balanced gender representation in mathematics and STEM fields. We argue that the results from this study provide an indication of the type of values alignment that would potentially be productive to address ongoing engagement and participation in mathematics. Further longitudinal studies could be used to investigate these gender differences in mathematics education values and to investigate the potential of values alignment on participation in mathematics education.

## 6. Limitations and future directions

Our study highlights some interesting findings and also points to future directions for research while we note several limitations. Surveys provide an opportunity for consistency in their wording which reduces the potential for students to interpret the same items (or values) differently. Additionally, survey methods can reduce the complexity of ephemeral and subjective constructs (e.g. wellbeing, attitude, or values) into something tangible and measurable, however, a downside of this is that important aspects of one's experiences can be overlooked (Kern, 2021). Whilst qualitative methodologies provide greater richness of data than surveys, a core aim of this study was to explore cultural and ethnic differences

across similar values which have previously been shown to be important for students in other classrooms (e.g. Andersson & Österling, 2019; Hunter, 2021; Seah et al., 2017). Thus, we were more interested in the degree to which specific elements in mathematics learning were valued, and more importantly, how these same elements were valued differently across cultural groups. This has implications for culturally responsive teaching practices which can result in more equitable learning outcomes in mathematics. Values are inherently worthy and desirable to most people (Roccas et al., 2017) and students may perceive values as broadly important even if they do not relate the importance to themselves specifically (Gittelman et al., 2015). For instance, a student might value the utility of mathematics as a subject, yet not value mathematics as useful for their lives personally. Social desirability bias can be minimized by forcing students to rank rather than rate values (Roccas et al., 2017). Further studies in New Zealand and internationally might consider both students' ranking, and rating of their mathematics education values.

Whilst our sample size was relatively sizable, we cannot generalize our findings to students from other schools or countries. Most students were Māori or Pāsifikā thus the relative importance of the fourteen values (i.e. research question one) likely reflected the ratings of the students from these cultures. We grouped students from Southern (e.g. India), Southeastern (e.g. Cambodia) and Eastern Asia (e.g. China) together, however, students from these countries are not homogenous and often espouse diverse cultural values. Future investigations might include a larger Asian sample size and differentiate these students by country or jurisdiction.

## 7. Conclusions

In conclusion, this article has highlighted that while there are similarities, there are also significant differences in what culturally diverse middle school students value as most important when learning mathematics. We contend that in order to develop more equitable mathematics learning environments, greater understanding of students' mathematics education values is needed across different demographic groups. The challenge here for educators is that in many countries, including New Zealand, our classrooms are becoming increasingly diverse. Educators need to be cognisant that students in their mathematics classroom may have contrasting mathematics education values. Interestingly, we also noted differences in mathematics education values when analysing by gender.

Identifying students' mathematics education values provides opportunities for educators to develop responsive types of pedagogies and to address student wellbeing (Tiberius, 2018). For instance, a mathematics student who values personalized learning support and solving difficult problems will likely feel good and engage more when they experience one-to-one teacher support and are provided with challenging tasks. Whereas that student might disengage with and feel disheartened when they lack teacher support, and they perceive their mathematical tasks as easy. Conversely, in cases where mathematics education values may be important but not necessarily valued by students, or students may hold values that might be potentially disruptive in a learning environment, educators can surface these and then openly discuss when these values may (or may not) be useful or appropriate.

This article provides a contribution in relation to documenting the mathematics education values of a diverse group of students within New Zealand and analysing differences

in the mathematics education values according to different demographic aspects including ethnicity, gender and grade. We view this as an important element in moving towards both providing more equitable mathematics learning experiences for diverse students in New Zealand and in other countries, and also a way in which we can begin to address wellbeing in relation to mathematics teaching and learning.

## Disclosure statement

No potential conflict of interest was reported by the authors.

## Data availability statement

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

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