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Valuing Mathematics Links Prospective Elementary Teachers' Perceptions of Mathematics to Their Mathematics Well-Being

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Abstract

Prospective elementary school teachers often begin teacher education with ambivalent relationships with mathematics, yet little is known about the pathway through which their perceptions of mathematics relate to their well-being as learners of mathematics. Mathematical resilience is a plausible pathway, but its total score overlaps strongly with measures of mathematics well-being, which makes a single-mediator test difficult to interpret. This survey study of 204 prospective elementary school teachers from several universities in West Nusa Tenggara, Indonesia, therefore examined the dimensions of mathematical resilience separately. Discriminant validity analysis showed that the struggle dimension was empirically indistinguishable from well-being (HTMT = 1.00), so value, growth and culture were tested as parallel mediators using bootstrapped regression-based path analysis. Perception was associated with well-being (β = .62), and this association was fully accounted for by the three dimensions (total indirect β = .56, 95% CI [.43, .68]; direct β = .07, p = .367). Valuing mathematics carried most of the indirect association (β = .40, 95% CI [.27, .53]), family and cultural expectations a small part (β = .09, 95% CI [.04, .14]), and the belief that difficulty is normal (growth) no unique part (β = .07, 95% CI [− .01, .16]). The pattern was unchanged when 17 potentially careless respondents were excluded and when gender and year of study were controlled. Gender did not moderate the perception–well-being association. Teacher education programmes that aim to support prospective teachers' relationships with mathematics should help them see why mathematics matters to their own lives and future work, rather than focusing on perceptions alone.

INTRODUCTION

Prospective elementary school teachers occupy a distinctive position in mathematics education. Unlike specialist mathematics teachers, most of them did not choose mathematics as a field of study, many report negative school experiences with the subject, and they will nonetheless be responsible for children's first sustained encounters with it (Bekdemir, 2010; Brady & Bowd, 2005; Maulyda, Sugiman, et al., 2025). A substantial body of research has documented elevated mathematics anxiety in this group and its consequences for confidence to teach (Gresham, 2007; Hembree, 1990), and there is evidence that teachers' anxieties about mathematics can be transmitted to the children they teach (Beilock et al., 2010). Understanding how prospective elementary teachers' relationships with mathematics are organised during teacher education is therefore of direct relevance to mathematics education research.

Research on mathematics-related affect has moved beyond anxiety towards a more differentiated view in which beliefs, emotions and attitudes are treated as interrelated but distinguishable components (Di Martino & Zan, 2011; Hannula, 2012; Philipp, 2007). Two constructs have recently become prominent within this tradition. Mathematical resilience describes a positive adaptive stance towards mathematics that allows learners to persist when they encounter difficulty; it comprises valuing mathematics, accepting struggle as a normal part of learning and believing that mathematical ability can grow (Johnston-Wilder & Lee, 2010; Kooken et al., 2016; Lee & Johnston-Wilder, 2017). Mathematics well-being refers to feeling good and functioning well in mathematics, including positive emotions,

engagement, meaning, accomplishment and supportive relationships (Hill et al., 2021, 2024). Both constructs have been studied mainly with school students (Akkan & Horzum, 2024; Hill et al., 2024), and their application to prospective teachers remains limited (Apostolidu & Johnston-Wilder, 2023; Lee & Ward-Penny, 2022).

Measures of these constructs share considerable affective content. Items expressing enjoyment of, or positive feelings towards, mathematics appear in scales of perception, resilience and well-being alike, so a positive association among their total scores is to be expected on construction grounds alone, and a test of whether total resilience "mediates" the link between perception and well-being risks re-describing that overlap. Mathematical resilience, however, is not a single disposition. Its components differ in content: valuing mathematics concerns why mathematics is worth engaging with, growth concerns how difficulty and mistakes are interpreted, and the cultural component concerns the expectations of family and community (Atahan & Mert Uyangor, 2024; Kooken et al., 2016). Examining these components separately, after establishing which of them are empirically distinct from well-being, allows a more informative question to be asked: through which aspect of resilience, if any, are prospective teachers' perceptions of mathematics linked to how they fare in it? The answer matters for teacher education, because the components point to different kinds of support (Lee & Ward-Penny, 2022).

A second issue concerns gender. Female students, who form the large majority of elementary teacher education cohorts in many countries, have consistently been found to report higher mathematics anxiety than male students (Hembree, 1990), female elementary teachers' mathematics anxiety has been linked to their pupils' beliefs and achievement (Beilock et al., 2010), and gender differences in well-being during mathematics lessons have been reported among school students (Palsdottir et al., 2012). It is therefore plausible that the link between how prospective teachers perceive mathematics and how they fare in it differs between women and men, but this has not been examined.

Accordingly, this study examined perceptions of mathematics, the dimensions of mathematical resilience and mathematics well-being among prospective elementary school teachers in West Nusa Tenggara, Indonesia. In keeping with the measures used, all constructs refer to participants' experiences as learners of mathematics during teacher education, not to their experiences of teaching it. The study addressed the following research questions:

1. To what extent is prospective elementary school teachers' perception of mathematics associated with their mathematics well-being?
2. Do the empirically distinct dimensions of mathematical resilience account for this association and, if so, which dimension carries it and does a direct association remain?
3. Does gender moderate the association between perception of mathematics and mathematics well-being?

METHOD

Research Design

This study used a cross-sectional correlational survey design. Confirmatory factor analysis and discriminant validity analysis were used to establish which constructs could be distinguished empirically, and regression-based parallel mediation analysis was then used to estimate the total, direct and specific indirect associations between perception of mathematics and mathematics well-being (Hayes, 2022). The design allows the pattern of associations among the constructs to be described; it does not support causal inference, which is discussed as a limitation.

Participant

Participants were 204 students enrolled in elementary school teacher education (PGSD) programmes at several universities in West Nusa Tenggara, Indonesia. They were recruited by convenience sampling: a link to the online questionnaire was distributed to students in these programmes, and all students who completed it were included. Of the participants, 175 (85.8%) were female and 29 (14.2%) were male; 136 (66.7%) were in their first year of study, 39 (19.1%) in their second year and 29 (14.2%) in their third year. All participants had taken at least one mathematics course in their programme at the time of data collection. Before taking part, participants were informed of the purpose and procedures of the study, were told that participation was voluntary and that they could withdraw at any time without penalty, and gave their consent.

Instrument and Data Collection

Data were collected through an online questionnaire administered via Google Forms in January-February 2026. All three scales used a four-point Likert format ranging from 1 (strongly disagree) to 4 (strongly agree), and all items referred to participants' experiences as learners of mathematics during teacher education. Negatively worded items were reverse-scored before analysis. Scale and dimension scores were computed as item means, so all scores range from 1 to 4.

Mathematical Perception

Perception of mathematics was measured with 17 items adapted from Kasim and Muhamad Sukri (2022). The items form three dimensions (Table 1): student attitude (six items, e.g., "I feel happy when I find the correct solution to a math problem"), lecturer role (six items concerning how mathematics has been taught to participants) and student perspective (five negatively worded items concerning the perceived difficulty and nature of mathematics, e.g., "Mathematics is difficult to understand in a short time"). In this sample, Cronbach's $\alpha = .905$ and McDonald's $\omega = .921$.

Table 1

Outline of Mathematical Perception Instrument

No	Dimension	Sum	Example
1	Student Attitude	6	I feel happy when I find the correct solution to a math problem
2	Lecturer Role	6	The lecturer is very knowledgeable and prepares before starting the class
3	Student Perspective	5	Mathematics is difficult to understand in a short time
Total		17	

Mathematical Resilience

Mathematical resilience was measured with 14 items from the scale developed by Atahan and Mert Uyangor (2024), which builds on the value–struggle–growth model of Kooken et al. (2016). The items form four dimensions (Table 2): value (five items, e.g., “Mathematics is very important for my future”), struggle (three items), growth (three items, e.g., “Difficulty is a normal part of learning mathematics”) and culture (three items concerning family expectations about mathematics). For the full scale, α = .915 and ω = .952; dimension reliabilities are reported in Table 4. As explained in the Results, the struggle dimension was not distinguishable from mathematics well-being and was therefore not used as a mediator.

Table 2

Outline of Mathematical Resilience Instrument

No	Dimension	Sum	Example
1	Value	5	Mathematics will be encountered everywhere in my life
2	Struggle	3	Mathematics is one of my favorite subjects
3	Growth	3	Difficulty is a normal part of learning mathematics
4	Culture	3	My family has high expectations for my success in mathematics
Total		14	

Mathematics Well-Being

Mathematics well-being was measured with 22 items based on the conceptualisation of Hill et al. (2024). The items form seven dimensions (Table 3): accomplishment (four items) and cognitions, engagement, meaning, perseverance, positive emotions and relationships (three items each). In this sample, α = .957 and ω = .958. Consistent with the item wording, the scale measures well-being as a learner of mathematics, not well-being in teaching mathematics.

Table 3

Outline of Mathematics Well-Being Instrument

No	Dimension	Sum	Example
1	Accomplishment	4	I feel that I have achieved important goals I set for myself in mathematics
2	Cognitions	3	I understand what I have learned in mathematics
3	Engagement	3	When I study mathematics, I feel truly engaged
4	Meaning	3	I feel that my learning of mathematics has purpose and meaning to me
5	Perseverance	3	I feel it is important to keep working hard on my math tasks until I finish them
6	Positive Emotions	3	When I work on mathematics, I find it very enjoyable
7	Relationships	3	I feel I receive help and support from my math teacher when I need it
Total		22	

Data Screening

No data were missing. Because careless responding can distort the associations among self-report scales (Meade & Craig, 2012), two indicators were examined: the longest run of identical consecutive responses across the 53 items (longstring), and standardised scale totals beyond $|z| = 3.29$. Seventeen respondents (8.3%) had a longstring of 27 or more, that is, identical responses to at least half of the items, or an extreme total score; three of them gave the same response to all 53 items, including the reverse-scored items. These respondents were retained in the main analyses and excluded in a sensitivity analysis.

Data Analysis

Measurement quality was examined in three steps. First, a confirmatory factor analysis with maximum likelihood estimation was conducted for each scale in JASP, specifying the dimensions in Tables 1–3 as correlated factors. Model fit was evaluated with the comparative fit index (CFI), Tucker–Lewis index (TLI), root mean square error of approximation (RMSEA) and standardised root mean square residual (SRMR). Second, discriminant validity among perception, each resilience dimension and well-being was assessed with the item-level heterotrait–monotrait ratio (HTMT), using .85 as the threshold for distinct constructs (Henseler et al., 2015). Third, a joint measurement model with dimension-level parcels was used to compare a three-factor model (perception, resilience and well-being) with models that merged resilience and well-being, merged perception and resilience, or specified a single factor.

To address RQ1 and RQ2, a parallel mediation model was estimated with ordinary least squares regression, equivalent to PROCESS Model 4 (Hayes, 2022), using the statsmodels library in Python (Seabold & Perktold, 2010). Perception predicted each mediator (a paths); perception and the mediators jointly predicted well-being (direct association c' and b paths); and perception alone predicted well-being (total association c). Specific indirect associations (a × b for each mediator), the total indirect association and pairwise contrasts between specific indirect associations were tested with 95% percentile bootstrap confidence intervals based on 5,000 resamples. An indirect association was considered significant when its interval excluded zero (Zhao et al., 2010). Standardised coefficients are reported.

To address RQ3, a perception × gender interaction term was added to the regression of well-being on perception (Hayes, 2022, Model 1), to the model that also included the mediators, and to the regressions of each mediator on perception. A difference in the level of well-being between women and men was examined with an analysis of covariance controlling for perception and the mediators. Three sensitivity analyses were conducted: excluding the 17 potentially careless respondents, adding gender and year of study as covariates to the mediation model, and estimating the conventional single-mediator model with the total resilience score for comparison.

RESULT

Descriptive Statistics and Correlations

Table 4 presents the descriptive statistics, reliabilities and correlations. Mean scores lay above the scale midpoint of 2.5 for all constructs except culture (M = 2.58). Perception was strongly correlated with the value (r = .76) and growth (r = .71) dimensions and moderately with culture (r = .33). The struggle dimension correlated more strongly with well-being (r = .82) than any other construct did.

Table 4
Descriptive Statistics, Reliability and Pearson Correlations (N = 204)

Variable	M	SD	α	1	2	3	4	5
1. Perception	2.96	0.52	.91					
2. Value	3.23	0.71	.95	.76				
3. Growth	3.26	0.65	.82	.71	.66			
4. Culture	2.58	0.68	.73	.33	.47	.23		
5. Struggle	2.84	0.64	.70	.57	.69	.54	.47	
6. Well-being	2.92	0.53	.96	.62	.77	.55	.55	.82
Note. Scores are item means on a 1–4 scale. All correlations are significant at p < .01.								

Table 5 summarises the confirmatory factor analyses. The well-being scale showed acceptable fit, and the resilience scale showed acceptable CFI and SRMR but a high RMSEA. Fit for the perception scale was weaker (CFI = .878), mainly because the negatively worded student perspective dimension had low average variance extracted (AVE = .37); the item “Female students are better qualified to become mathematicians” had the lowest item–total correlation (r = .21). Reliability was high for all three scales.

Table 5
Confirmatory Factor Analysis of Each Scale

Scale	χ^2 (df)	CFI	TLI	RMSEA [90% CI]	SRMR	ω
Perception (3 factors)	367.17 (116)	.878	.857	.103 [.091, .115]	.092	.921
Resilience (4 factors)	245.36 (71)	.917	.894	.110 [.095, .125]	.073	.952
Well-being (7 factors)	430.67 (188)	.936	.921	.080 [.070, .089]	.051	.958
Note. Maximum likelihood estimation; N = 204. All χ^2 tests $p < .001$.						

Discriminant validity results confirmed the overlap that motivated the study (Table 6). The total resilience score was not clearly distinct from well-being (HTMT = .90) or from perception (HTMT = .87), and in a joint measurement model the latent correlation between resilience and well-being was .96. The source of this overlap was the struggle dimension, whose HTMT with well-being was 1.00; its items (for example, “Mathematics is one of my favourite subjects”) express affective content that the well-being scale also measures. The value, growth and culture dimensions, by contrast, were distinct from well-being (HTMT = .63–.81), from perception (HTMT = .45–.83) and from each other (HTMT = .32–.74). Although the three-factor joint model fitted better than models that merged resilience with well-being ($\Delta\chi^2(2) = 38.35$, $p < .001$) or used a single factor ($\Delta\chi^2(3) = 110.14$, $p < .001$), the struggle dimension was excluded from the mediation analysis, and value, growth and culture were entered as separate mediators.

Table 6
Heterotrait–Monotrait Ratios (HTMT) Among the Constructs

1. Perception	1	2	3	4	5
2. Value	.83				
3. Growth	.82	.74			
4. Culture	.45	.58	.32		
5. Struggle	.79	.85	.73	.67	
6. Well-being	.74	.81	.63	.66	1.00
Note. Values of .85 or above indicate insufficient discriminant validity (Henseler et al., 2015). For the total resilience score, HTMT = .87 with perception and .90 with well-being.					

Parallel Mediation Analysis (RQ1 and RQ2)

Table 7 presents the path estimates. Perception was significantly associated with well-being (total association c: β = .62, 95% CI [.52, .73], R^2 = .39), which answers RQ1. Perception was also associated with all three mediators, most strongly with value (β = .76) and growth (β = .71) and more weakly with culture (β = .33). When perception and the mediators were entered together (R^2 = .64), value (β = .53, p < .001) and culture (β = .26, p < .001) were uniquely associated with well-being, whereas growth was not (β = .10, p = .105). The direct association of perception with well-being was small and not significant (c': β = .07, 95% CI [− .08, .21], p = .367).

Table 7

Path Estimates for the Parallel Mediation Model (N = 204)

Path	β	SE	t	p	95% CI
c: Perception → Well-being (total)	.624	.055	11.35	< .001	[.516, .732]
a_1: Perception → Value	.760	.046	16.64	< .001	[.670, .851]
a_2: Perception → Growth	.708	.050	14.23	< .001	[.610, .806]
a_3: Perception → Culture	.334	.066	5.03	< .001	[.203, .464]
b_1: Value → Well-being	.527	.073	7.24	< .001	[.383, .670]
b_2: Growth → Well-being	.102	.062	1.63	.105	[− .021, .225]
b_3: Culture → Well-being	.259	.048	5.34	< .001	[.163, .354]
c': Perception → Well-being (direct)	.065	.072	0.90	.367	[− .077, .207]

Note. Standardised ordinary least squares estimates with t-based confidence intervals. b paths and c' are estimated in the same model (R^2 = .643).

The bootstrap results are shown in Table 8. The total indirect association was significant (β = .56, 95% CI [.43, .68]), so the three dimensions together fully accounted for the association between perception and well-being. Value carried the largest share (β = .40, 95% CI [.27, .53]), culture a small share (β = .09, 95% CI [.04, .14]), and growth no unique share (β = .07, 95% CI [− .01, .16]). The indirect association through value was significantly larger than those through growth (difference = .33, 95% CI [.15, .50]) and culture (difference = .31, 95% CI [.17, .45]), which did not differ from each other.

Table 8

Bootstrapped Indirect Associations and Contrasts, With Sensitivity Analyses

Effect	Main model (N = 204)	Careless excluded (N = 187)	Gender and year controlled (N = 204)
Total association (c)	.62 [.52, .73]	.43 [.30, .56]	.62 [.51, .73]
Direct association (c')	.07 [− .08, .20]	.01 [− .13, .15]	.05 [− .09, .19]
Total indirect	.56 [.43, .68]	.42 [.29, .55]	.57 [.44, .70]
Via value	.40 [.27, .53]	.32 [.19, .45]	.40 [.27, .54]
Via growth	.07 [− .01, .16]	.04 [− .02, .11]	.07 [− .01, .16]
Via culture	.09 [.04, .14]	.06 [.01, .12]	.10 [.05, .15]
Value − growth	.33 [.15, .50]	.28 [.12, .44]	.33 [.16, .51]
Value − culture	.31 [.17, .45]	.27 [.12, .41]	.31 [.16, .46]
Growth − culture	−.01 [− .10, .08]	−.01 [− .10, .07]	−.03 [− .12, .07]

Note. Standardised estimates with 95% percentile bootstrap confidence intervals (5,000 resamples); the total association is shown with its t-based interval. Intervals that exclude zero indicate significant associations.

The pattern was robust. Excluding the 17 potentially careless respondents reduced the size of the associations, as expected when extreme response patterns are removed, but left the conclusions unchanged: the direct association remained near zero (β = .01, p = .931), the indirect association through value remained the largest (β = .32, 95% CI [.19, .45]), the indirect association through culture remained small (β = .06, 95% CI [.01, .12]), and the indirect association through growth remained non-significant (β = .04, 95% CI [− .02, .11]). Adding gender and year of study as covariates changed no estimate by more than .01, and neither covariate was significant (Table 8). For comparison, the conventional single-mediator model with the total resilience score suggested an even larger indirect association (β = .67) with a direct association of β = −.04; given the HTMT of .90 between total resilience and well-being, this larger estimate partly reflects shared item content and is not interpreted further.

Gender and the Perception–Well-Being Association (RQ3)

Gender did not moderate the association between perception and well-being (Table 9). The perception × gender interaction was not significant for the total association (b = − .07, p = .641) or for the direct association once the mediators were included (b = .07, p = .520), and it was not significant for the a paths to value (p = .556), growth (p = .231) or culture (p = .071). Women and men also reported similar well-being (M = 2.93 and 2.89; Welch's t = 0.36, p = .722). After perception and the mediators were controlled, the difference in well-being between women and men was small and not significant, F(1, 198)

= 3.71, p = .056, partial η² = .02. Conclusions were the same when the potentially careless respondents were excluded (interaction p = .386).

Table 9
Tests of Gender as a Moderator (N = 204)

Outcome and model	b (perception × gender)	SE	p	95% CI
Well-being: total association	−.065	.140	.641	[− .342, .211]
Well-being: with mediators	.070	.108	.520	[− .144, .284]
Value	−.068	.116	.556	[− .298, .161]
Growth	−.152	.126	.231	[− .401, .098]
Culture	−.301	.166	.071	[− .627, .026]

Note. Gender coded 0 = male (n = 29), 1 = female (n = 175). Perception and outcomes standardised; coefficients are unstandardised interaction terms.

LITERATURE FRAMEWORK

Perceptions of Mathematics Among Prospective Elementary Teachers

In this study, perception of mathematics refers to prospective teachers' evaluative views of mathematics as a subject and of their own experiences of learning it, including their attitudes, their judgements about its difficulty and their appraisal of how it has been taught to them (Kasim & Muhamad Sukri, 2022). This usage is consistent with the broader construct of attitude towards mathematics, which Di Martino and Zan (2011) describe as linking learners' emotional dispositions, their views of mathematics and their perceived competence. For prospective elementary teachers, such perceptions are frequently rooted in their own schooling: negative classroom experiences, particularly those involving public embarrassment or an emphasis on speed and memorised procedures, have been identified as a major source of their mathematics anxiety (Bekdemir, 2010; Uusimaki & Nason, 2004).

Perceptions of mathematics are consequential because they shape how prospective teachers engage with mathematics during teacher education and how confident they feel about teaching it (Brady & Bowd, 2005; Gresham, 2007). Earlier Indonesian work with prospective elementary teachers reported a positive association between perception of mathematics and mathematics well-being (Wahyuningsih & Hidayati, 2025) but did not examine the pathway through which this association arises.

Mathematical Resilience and Its Dimensions

Mathematical resilience was introduced by Johnston-Wilder and Lee (2010) to describe the stance that enables learners to continue engaging with mathematics despite setbacks. Unlike general psychological resilience, it is domain-specific and grounded in learners' relationships with mathematics. Kooken et al. (2016) identified three components: value, the belief that mathematics is worthwhile; struggle, the recognition that difficulty is a normal part of learning mathematics and can be worked through; and growth, the belief that mathematical ability can be developed through effort. Atahan and Mert Uyangor (2024) added a cultural component capturing the expectations of family and community regarding mathematics. These components rest on different theoretical foundations. The value component corresponds closely to the utility and attainment values described in expectancy–value theory, which are among the strongest predictors of engagement and persistence in a domain (Wigfield & Eccles, 2000), whereas the growth component reflects learners' interpretations of difficulty and error.

Research with school students has linked mathematical resilience to problem-solving performance (Fitriani et al., 2023) and to reduced anxiety (Apostolidu & Johnston-Wilder, 2023), and a recent study of elementary students found that resilience mediated the association between self-efficacy and mathematics well-being (Maulyda, Rakhmawati, et al., 2025). Among teachers, Lee and Ward-Penny (2022) showed that primary teachers' efforts to develop resilience in their pupils depend on their own relationship with mathematics, and Tang (2025) documented the role of resilience in novice mathematics teachers' first year of teaching. These studies have treated resilience as a single construct. Whether its components play different roles in linking learners' views of mathematics to how they function in it has not been examined, with prospective elementary teachers or otherwise.

Mathematics Well-Being and Gender

Mathematics well-being is a domain-specific application of multidimensional models of well-being, notably the PERMA framework, which describes flourishing in terms of positive emotion, engagement, relationships, meaning and accomplishment (Kern et al., 2015; Seligman, 2011). Hill et al. (2021, 2024) adapted this framework to mathematics education, defining mathematics well-being as learners' sense of feeling good and functioning well when learning mathematics, and adding dimensions related to cognition and perseverance. Because this conceptualisation includes both affective and functional components, it is suited to examining how learners' perceptions of mathematics and their stance towards it relate to how they fare in it.

Gender is examined in this study on theoretical rather than incidental grounds. Gender differences in mathematics anxiety are among the most consistently reported findings in research on mathematical affect (Hembree, 1990), and in elementary teacher populations, which are predominantly female, female teachers' mathematics anxiety has been linked to their pupils' gender-stereotyped beliefs and achievement (Beilock et al., 2010). Gender differences in well-being during mathematics lessons have also been reported among school students (Palsdottir et al., 2012). If women and men in teacher education experience mathematics differently, the strength of the link between perception and well-being may also differ between them.

Conceptual Model

Drawing on this literature, the study tested a parallel mediation model in which the empirically distinct dimensions of mathematical resilience are the proposed pathways linking perception of mathematics to mathematics well-being, and in which gender is a potential moderator of the perception–well-being association (Fig. 1). Rather than presupposing mediation, the analysis estimated the total, direct and specific indirect associations. Three expectations followed from the literature:

1. Perception of mathematics will be positively associated with mathematics well-being (total association).
2. The dimensions of mathematical resilience will account for at least part of this association. Given its links to engagement and persistence in expectancy–value research, the value dimension was expected to carry a larger share than the growth and culture dimensions; whether a direct association remains was treated as an open question.
3. Because the literature points to gender differences in mathematical affect but not to a specific direction of moderation, the moderating role of gender was tested two-sided.

DISCUSSION

Valuing Mathematics Carries the Perception–Well-Being Association (RQ1 and RQ2)

The central finding of this study is that the association between prospective elementary teachers' perceptions of mathematics and their mathematics well-being was fully accounted for by the dimensions of mathematical resilience, and that it was carried mainly by one of them: valuing mathematics. Once value, growth and culture were considered, perception carried no unique association with well-being, and the indirect association through value was significantly larger than those through the other dimensions. This pattern held after potentially careless respondents were excluded and after gender and year of study were controlled.

The result also clarifies what a conventional analysis would have shown. A single-mediator model with the total resilience score produced an apparently stronger mediation, but the total score was not empirically distinct from well-being, and the struggle dimension in particular was indistinguishable from it. Had the analysis stopped there, it would largely have re-described overlap between the instruments, which is the concern that motivated this study. Separating the dimensions, and retaining only those that could be distinguished from well-being, turned a question that the instruments partly answered in advance into one that the data could answer.

Why should value, rather than growth, carry the link? Perceptions of mathematics, as measured here, are largely evaluative: they concern whether mathematics is liked, whether it is hard and whether it has been taught well. Expectancy–value theory holds that learners' engagement and persistence in a domain

depend substantially on the importance and usefulness they attach to it (Wigfield & Eccles, 2000). The present results are consistent with this account: a more favourable perception of mathematics went together with seeing mathematics as important for one's future, and it was this sense of value, rather than the perception itself, that was associated with feeling good and functioning well in mathematics. The growth dimension, by contrast, was strongly associated with perception but not uniquely with well-being. Believing that difficulty and mistakes are normal may be necessary for persistence (Johnston-Wilder & Lee, 2010; Kooken et al., 2016) without, on its own, making mathematics a more positive experience. The small but reliable indirect association through culture suggests that family expectations add a modest independent contribution, in line with the cultural component proposed by Atahan and Mert Uyangor (2024).

These findings extend earlier work in two ways. Maulyda, Rakhmawati, et al. (2025) found that resilience as a whole mediated the association between self-efficacy and mathematics well-being among elementary students; the present results suggest that, at least among prospective teachers, the mediating role of resilience is concentrated in its value component. They also extend Wahyuningsih and Hidayati (2025), who reported a positive perception–well-being association among Indonesian prospective teachers, by identifying the pathway through which that association arises.

Implications for Prospective Teachers' Relationships With Mathematics

The results have a direct implication for elementary teacher education. Programmes often seek to improve prospective teachers' attitudes towards mathematics, for example through enjoyable or low-stakes activities, or to normalise struggle and mistakes. The present findings suggest that the most promising lever is the value that prospective teachers attach to mathematics: helping them see why mathematics matters for their own lives, for their future work as teachers and for the children they will teach. Mathematics content courses in teacher education could make this explicit, for example by linking each topic to children's mathematical development and to everyday uses of mathematics, and by inviting prospective teachers to articulate the value of what they are learning. Approaches that build resilience more broadly, such as those described by Apostolidu and Johnston-Wilder (2023) and Lee and Ward-Penny (2022), remain relevant, but the present results suggest that their effect on well-being may depend on whether they also strengthen the perceived value of mathematics.

At the same time, the outcome measured in this study is well-being as a learner of mathematics. Whether prospective teachers' valuing of mathematics and their well-being as learners carry over to their well-being when teaching mathematics, and to the experiences of the children they teach, cannot be determined from these data (Beilock et al., 2010; Tang, 2025). This is an important question for future research.

Gender (RQ3)

Contrary to expectations derived from research on gender differences in mathematics anxiety (Hembree, 1990), gender did not moderate any path in the model, and women and men reported similar levels of mathematics well-being. One interpretation is that, among students who have chosen elementary teacher education, the processes linking perceptions of mathematics to well-being are similar for women and men. The finding should nonetheless be interpreted cautiously, because only 29 participants were male, which limits the power to detect moderation; the interaction for the culture path ($p = .071$) suggests that family expectations may be worth examining in larger and more balanced samples.

CONCLUSION

This study examined how perception of mathematics, the dimensions of mathematical resilience and mathematics well-being are related among prospective elementary school teachers. Perception was associated with well-being, but this association was fully accounted for by the resilience dimensions and was carried mainly by valuing mathematics, with a small contribution from family and cultural expectations and none from the belief that difficulty is normal. Gender did not moderate these associations.

The study contributes to research on prospective teachers' mathematical affect in two ways. Methodologically, it shows that the total score of a mathematical resilience scale may be empirically indistinguishable from mathematics well-being, so that single-mediator tests with total scores can largely re-describe instrument overlap; examining discriminant validity and the separate dimensions avoids this problem. Substantively, it identifies the value that prospective teachers attach to mathematics as the component through which their perceptions of mathematics relate to their well-being, which suggests that teacher education should help prospective teachers see why mathematics matters, rather than focus on perceptions alone.

Several limitations should be noted. First, the cross-sectional design does not permit causal conclusions, and the ordering of the variables in the mediation model rests on theory rather than on temporal precedence. Second, the struggle dimension had to be excluded because it could not be distinguished from well-being, and the perception scale showed only modest model fit, mainly because of its negatively worded dimension; future work should refine both instruments. Third, all data were self-reported in a single online session, which raises the possibility of common method variance (Podsakoff et al., 2003), and 8.3% of respondents showed signs of careless responding, although excluding them did not change the conclusions. Fourth, participants were recruited by convenience sampling from universities in a single Indonesian province, most were in their first year and few were male, which limits generalisation. Fifth, the measures concern well-being as a learner of mathematics. Longitudinal research following prospective teachers through teacher education and into their first years of teaching would clarify whether the value they attach to mathematics supports their well-being as teachers of mathematics.

Declarations

Ethics approval and consent to participate

Ethical approval was obtained from the institutional research ethics committee of Universitas Negeri Yogyakarta (approval number T/6.78/UN34.9/KP.06.07/2026) prior to data collection. The study was conducted in accordance with the ethical principles of the Declaration of Helsinki and with relevant institutional and national guidelines and regulations. Participation was voluntary. Participants received information about the study purpose, confidentiality, and their right to withdraw at any time without penalty, and informed consent was obtained from all participants before they completed the questionnaire.

Consent for publication

Not applicable. The manuscript contains no information that could identify individual participants.

Competing interests

The authors declare no competing interests.

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Author Contribution

A.F. conceptualized the study, developed the research framework, formulated the research questions, and led the study. B.Y.W. contributed to the development of the research instruments and data collection. H.R.P. contributed to data collection, data organization, and literature review. V.R.H. contributed to the development and validation of the research instruments and interpretation of the findings. M.A.M. contributed to the statistical analysis, and assisted in interpreting the quantitative results. Z.A. contributed to data collection, data curation, and manuscript preparation. Z.S. contributed to literature review, data curation, and manuscript preparation. A.F. wrote the main manuscript text, with contributions from all authors to the interpretation and discussion of the findings. All authors reviewed, revised, and approved the final version of the manuscript and agreed to be accountable for all aspects of the work.

Data Availability

All data supporting the findings of this study are available within the paper and its Supplementary Information.

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Figures

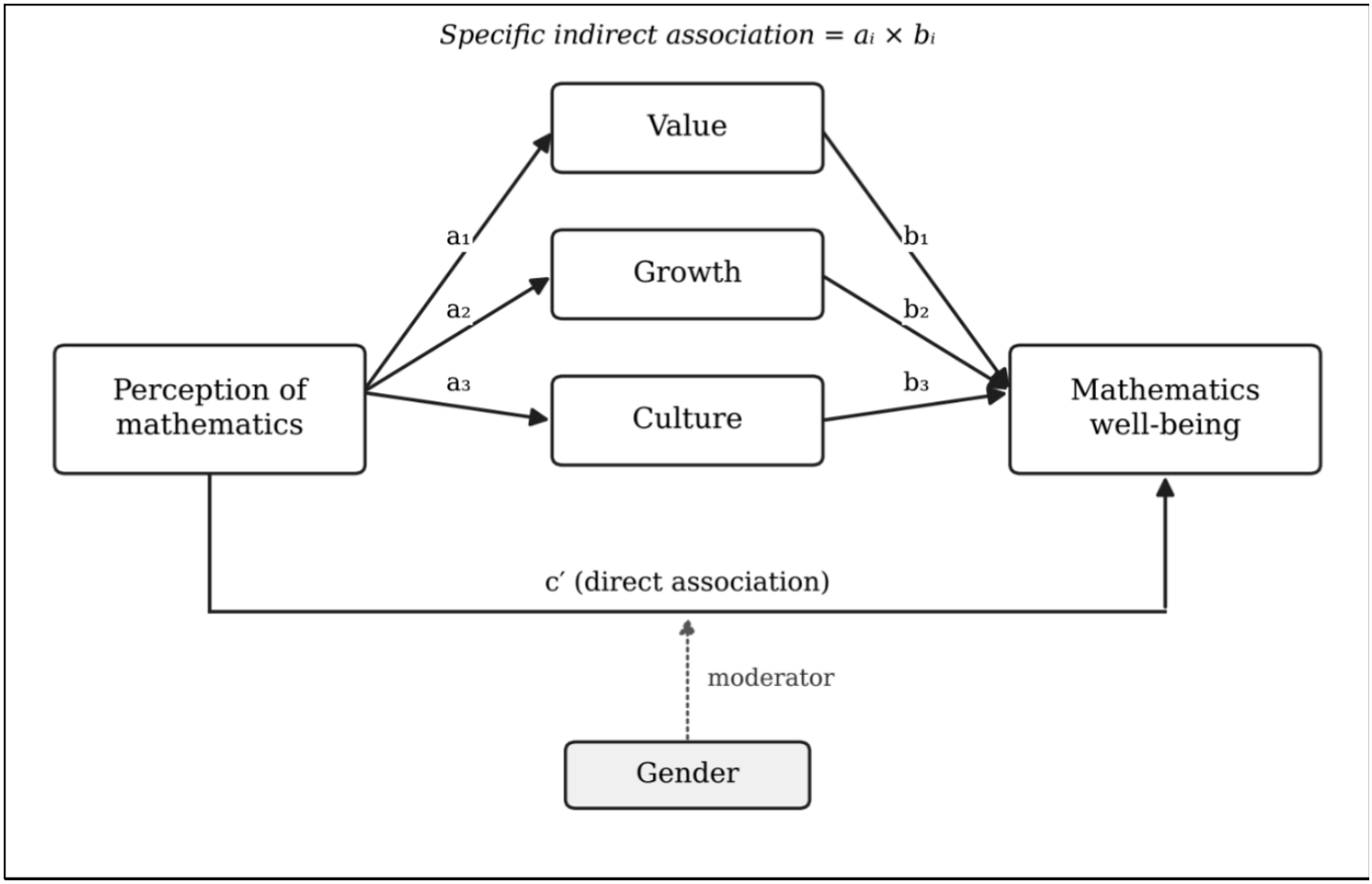


Figure 1

Figure 1 presents the conceptual model. Because the data are cross-sectional, the paths represent statistical associations consistent with the proposed ordering, not causal effects.

Conceptual Framework

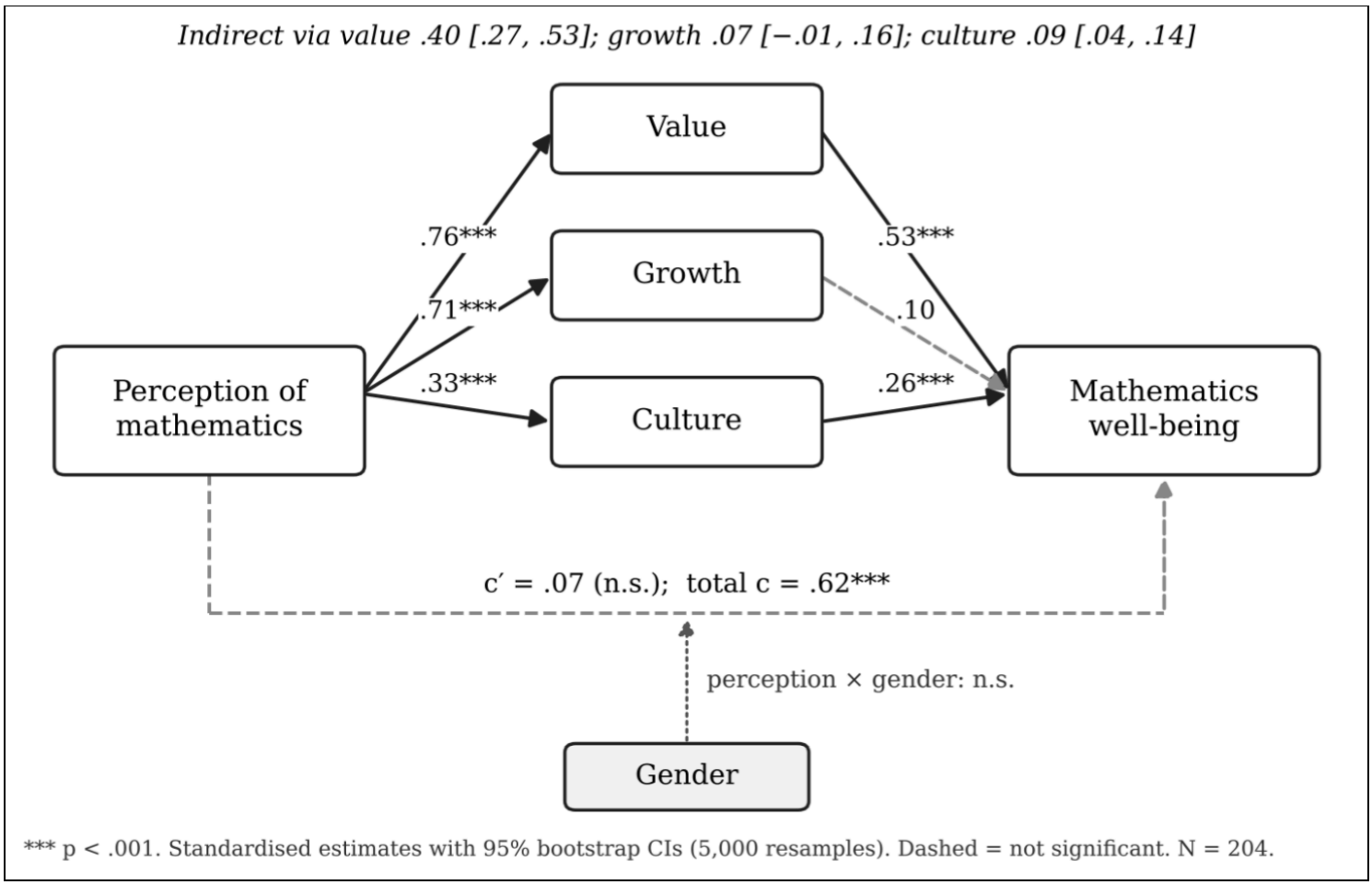


Figure 2

Figure 2 summarises the results of the parallel mediation analysis.

Results of the Parallel Mediation Model

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- DataSetPNBPMediasiModerasi.sav
- OutputPNBPMediasiModerasiVersi2.spv.zip