THE MATHEMATICAL WELLBEING AND THINKING STYLES OF GIFTED PRIMARY SCHOOL STUDENTS

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Despite growing research on mathematical wellbeing (MWB), no studies have examined MWB among gifted students. We report on 261 gifted primary students' (Mage = 9.13) MWB and mathematical thinking styles during mathematics learning moments. Latent class analysis identified three thinking styles: integrated (n = 118), visual (n= 94), and analytic (n = 49). ANOVA revealed significant effects for thinking styles (η^2 = .162), with integrated thinkers generally reporting higher MWB than visual thinkers. No gender or grade-level differences emerged. Findings suggest flexible thinking supports gifted students' MWB, while visual thinkers experience lower MWB when instruction emphasises symbolic approaches, highlighting the need for differentiated instruction accommodating diverse thinking styles.

INTRODUCTION AND BACKGROUND

Despite growing international attention to student wellbeing in education, mathematics remains an affectively challenging domain characterised by high anxiety, engagement, and negative self-perceptions (Grootenboer & Marshman, 2015; Hill & Hunter, 2024). Mathematical wellbeing (MWB)—defined as students' fulfilment of core values through learning mathematics, accompanied by positive feelings and functioning within the discipline (Hill & Hunter, 2024)—offers a framework for understanding how students experience mathematics and what conditions enable them to thrive.

Gifted students present an important case for understanding MWB. While their advanced cognitive capacities suggest potential for deep mathematical engagement, research reveals a more complex picture. Gifted students frequently experience boredom and motivational decline when standard curricula fail to provide adequate cognitive challenge (Smedsrud et al., 2022). They demonstrate distinctive cognitive profiles—greater conceptual fluency, advanced abstract reasoning, and enhanced mathematical creativity (Leikin, 2021)—yet these strengths do not automatically translate into positive affective experiences. When instruction aligns with their capacities, gifted students can experience high engagement and deep learning (Smedsrud et al., 2022); when misaligned, they may disengage. This tension between cognitive potential and affective experience makes gifted learners particularly important for wellbeing research, yet no studies have systematically examined their MWB.

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We focus specifically on MWB during mathematics learning moments—students' immediate, context-specific experiences within particular lessons. Rather than measuring general dispositions toward mathematics, the learning moment approach captures affective states following instruction (Hill & Seah, 2023). This momentary perspective reveals how classroom experiences shape MWB across five dimensions: accomplishment, engagement, perseverance, positive emotions, and relationships. For gifted students, whose experiences may fluctuate dramatically based on task design and instructional approach, examining MWB at this micro-level provides insights unavailable through traditional, decontextualised measures.

Mathematical thinking styles—students' preferred approaches to representing, understanding, and processing mathematical information—represent an under-examined source of individual variation in MWB. These styles are typically classified as analytic (symbolic and formal), visual (pictorial representations), or integrated (flexibly combining both approaches) (Borromeo Ferri, 2015). For gifted students, misalignment between thinking style and instructional approach may be particularly consequential: visual thinkers may struggle when instruction emphasises symbolic manipulation, while flexible, integrated thinkers may sustain engagement across diverse problem types (Presmeg, 2006). Yet no research has examined how thinking styles relate to gifted students' MWB.

The current study addresses three interconnected gaps. First, despite extensive research on gifted students' cognitive characteristics (Leikin, 2021) and emerging research on MWB (e.g., Hill et al., 2021; Hill & Hunter, 2024), no empirical work examines how gifted students experience MWB during instruction. Moreover, while prior MWB research has examined demographic variations (gender, grade level, ethnicity), this study represents the first investigation of how individual learner characteristics—specifically cognitive/learning styles—relate to MWB, extending the framework beyond demographic categories to consider how students' preferred ways of thinking shape their wellbeing experiences. Second, existing research typically employs static measures of motivation or anxiety rather than capturing dynamic, context-dependent MWB as it unfolds in learning moments (Grootenboer & Marshman, 2015; Hill et al., 2021). Third, we lack understanding of how individual differences—particularly mathematical thinking styles, but also gender and developmental level—shape these momentary experiences.

1. Do gifted primary school students' MWB in learning moments differ significantly according to mathematical thinking style (integrated, analytic, visual)?

2. Do gifted primary school students' MWB in learning moments differ significantly according to gender?

3. Do gifted primary school students' MWB in learning moments differ significantly according to grade level (Grades 2–4)?

By examining how thinking styles and demographic characteristics relate to MWB experiences during instruction, this study provides empirical grounding for creating learning environments that support both cognitive and affective development among mathematically gifted learners.

METHOD

Study Context

Data were collected from Science and Art Centers (BİLSEM) in Türkiye, specialised institutions providing supplementary part-time education for gifted students alongside regular schooling. Students were identified as gifted through a multi-stage national examination system administered by the Ministry of National Education (MEB). These centres serve students from first grade onward, with teachers selected through rigorous national examinations.

Participants

The current cross-sectional study included 261 gifted students from Grade 2 (n = 64), Grade 3 (n = 105), and Grade 4 (n = 92) and aged 8-10 years (M = 9.13 years, SD = 0.77). All mathematics instruction was provided by three teachers. Each class accommodated 10-13 students, with a total of 24 classes.

Measures

Students completed two surveys, translated into Turkish, immediately following their mathematics lessons at BİLSEM: the MWB in the Learning Moment of Mathematics (MWB-LM) and the Mathematical Thinking Style (MTS) survey. The MWB-LM survey (Hill & Seah, 2023) comprises 20 items that ask students to identify learning moments associated with feeling good and functioning well when learning mathematics. For each item, students rated their responses on a 4-point Likert scale (1 = *not at all to* 4 = *very much*). Administered immediately following each mathematics lesson, the survey captures students' MWB across five dimensions: accomplishment, engagement, perseverance, positive emotions, and relationships. Example items include: “when your mathematics teacher praises you” (relationships) and “when you are given an interesting mathematics learning task” (engagement).

The MTS survey (Borromeo Ferri, 2015), adapted into Turkish by Akcakin and Kaya (2020), consists of 10 items rated on a 4-point Likert scale (1 = *strongly disagree* to 4 = *strongly agree*). The survey assesses students' preferred approaches to mathematical thinking: analytic (symbolic/formal reasoning), visual (pictorial representations), or integrated (flexibly combining approaches). Example items include: “visual images are helpful for me to understand mathematics” (visual). Students' thinking styles were identified using latent class analysis (LCA), which probabilistically classifies individuals based on response patterns rather than summing scale scores.

Analytic Strategy

Univariate normality was assessed through skewness (ranging from −0.438 to 1.082) and kurtosis values (ranging from −0.549 to −1.161), which fell within acceptable ranges (Hair et al., 2022). However, Mardia's test indicated significant departures from multivariate normality (multivariate skewness = 120.936, z = 36.616, p < .001; multivariate kurtosis = 580.316, z = 15.850, p < .001). To address non-normality, robust maximum likelihood estimation (MLR) with Satorra–Bentler scaled chi-square statistics was used in confirmatory factor analysis (Jöreskog et al., 2016). Students' mathematical thinking styles were identified using LCA. Competing models with increasing numbers of classes were compared, and the three-class solution was selected based on the Bayesian Information Criterion (BIC) and entropy values to assess classification accuracy. Group differences in mathematical wellbeing were examined using ANOVA with post hoc comparisons conducted using Gabriel's procedure when variances were homogeneous and Games–Howell when variances were unequal.

RESULTS

Preliminary analyses

Confirmatory factor analysis (CFA) was conducted to assess the construct validity of the MWB-LM questionnaire. The five-factor model (Relationships, Engagement, Accomplishment, Positive Emotions, and Perseverance) with all 20 items demonstrated acceptable fit indices: CMIN = 390.17, df = 160, CMIN/df = 2.44, CFI = .90, RMSEA = .074 (90% CI [.065, .084]), SRMR = .075. All factor loadings were statistically significant across the five dimensions (all ps < .01). Item–total correlations ranged from 0.21 to 0.52 (all ps < .01). Composite reliability was .85, indicating acceptable internal consistency (Hair et al., 2022).

Table 1 outlines the determination of students' mathematical thinking styles using LCA models compared via Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC), sample-size adjusted BIC (ABIC), entropy, Lo–Mendell–Rubin likelihood ratio test (LMR), adjusted LMR (ALMR), and bootstrap likelihood ratio test (BLR) p-values. The results indicate that the three-class model provides the best fit to the data, as evidenced by the lowest BIC and ABIC values. In addition, the LMR, ALMR, and BLR test results consistently support the three-class model. The entropy value for the three-class solution is .84, indicating high classification accuracy. Students show very high posterior probabilities of class membership: .94 for the integrated thinking style, .93 for the visual thinking style, and .91 for the analytic thinking style.

Table 1: Model fit indices and information criteria for mathematical thinking styles

Sequential model comparisons	1-class LCA	2-class LCA	3-class LCA	4-class LCA
AIC	2947.859	2682.229	2593.246	2591.748
BIC	2983.504	2757.083	2707.311	2745.022
ABIC	2951.8	2690.505	2605.857	2608.694
Entropy	NA	.83	.84	.84
LMR p value	NA	<0.01	<0.01	.248
ALMR p value	NA	<0.00	<0.00	.2551
BLR p value	NA	<0.01	<0.01	.6667

The three thinking styles showed different distributions across the sample: integrated (n = 118, 45.2%), visual (n = 94, 36.0%), and analytical (n = 49, 18.8%). Grade-level distributions indicated developmental patterns. The integrated style was most common in Grade 3 (42.4%), followed by Grade 4 (37.3%) and Grade 2 (20.3%). The analytical style increased with grade level, being most prevalent in Grade 4 (42.9%), suggesting the development of systematic reasoning. The visual style peaked in Grade 3 (43.6%), indicating the salience of visual representations during this transitional stage.

Primary analyses

Descriptive statistics are presented in Table 2. Mathematical thinking style comparisons revealed that integrated thinkers reported the highest wellbeing (M = 3.49, SD = 0.34), followed by analytical thinkers (M = 3.36, SD = 0.34) and visual thinkers (M = 3.14, SD = 0.38). Grade level and gender comparisons showed minimal variation across all dimensions. ANOVA results revealed significant differences by thinking style but not by grade level or gender. Mathematical thinking style showed significant effects on Overall MWB, $F(2, 258) = 24.95$, $p < .001$, $\eta^2 = .162$, Relationships, $F(2, 258) = 23.81$, $p < .001$, $\eta^2 = .156$, Accomplishment, $F(2, 258) = 17.43$, $p < .001$, $\eta^2 = .119$, Engagement, $F(2, 258) = 13.44$, $p < .001$, $\eta^2 = .094$, and Perseverance, $F(2, 258) = 5.39$, $p = .005$, $\eta^2 = .040$. These effect sizes ranged from small to large (Cohen, 1988), with the strongest effects observed for overall wellbeing and relationships. No significant difference emerged for Positive Emotions, $F(2, 258) = 1.31$, $p = .273$. Post hoc comparisons tests indicated that integrated thinkers scored significantly higher than visual thinkers across all dimensions except positive emotions (all ps < .01). Analytical thinkers also scored significantly higher than visual thinkers on most dimensions (ps < .05). No significant differences were found for grade level or gender across any dimension (all ps > .05).

Table 2: MWB during learning moments

	Overall MWB	Accomp.	Engage.	Persev.	Pos. Emot.	Relation.
Grade Level						
Grade 2	3.31(.31)	3.38(.43)	3.20(.49)	3.62(.49)	3.05(.71)	3.32(.53)
Grade 3	3.36(.41)	3.40(.48)	3.27(.55)	3.52(.62)	3.20(.77)	3.42(.49)
Grade 4	3.34(.42)	3.47(.42)	3.13(.56)	3.43(.63)	3.15(.75)	3.42(.57)
Gender						
Females	3.35(.37)	3.39(.45)	3.24(.49)	3.45(.58)	3.15(.73)	3.47(.46)
Males	3.34(.41)	3.44(.45)	3.18(.57)	3.56(.61)	3.14(.76)	3.34(.58)
Thinking Style						
Integrated	3.49(.34)	3.57(.39)	3.35(.50)	3.63(.55)	3.23(.74)	3.61(.45)
Analytical	3.36(.34)	3.42(.41)	3.27(.50)	3.54(.57)	3.10(.80)	3.39(.49)
Visual	3.14(.38)	3.23(.47)	2.99(.53)	3.36(.64)	3.07(.72)	3.14(.54)

Note. Standard deviations in parentheses.

DISCUSSION

This study examined gifted primary school students' MWB during learning moments, whilst also focusing on differences across gender, grade level, and mathematical thinking styles. Results showed that MWB differed significantly by thinking style but not by gender or grade level.

This study advances MWB research theoretically by demonstrating that individual learner characteristics—specifically, mathematical thinking styles—significantly predict MWB during learning moments. While prior MWB research has examined demographic variations such as gender, grade level, and ethnicity (e.g., Hill & Hunter, 2024; Hill et al., 2024), this is the first investigation to identify learning styles associated with MWB. This finding extends the MWB framework beyond demographic categories, suggesting that how students prefer to think about mathematics can shape their MWB.

Gifted primary students with integrated thinking styles scored significantly higher than visual thinkers on all MWB dimensions except positive emotions, suggesting that flexibility in mathematical thinking positively impacts the students' MWB. Integrated thinkers flexibly combine analytical and visual approaches (Borromeo Ferri, 2015), enabling effective adaptation to different problem situations. Lower MWB among visual thinkers may reflect challenges encountered when traditional mathematics instruction emphasises symbolic approaches (Presmeg, 2006), limiting opportunities to leverage visual strengths. Analytical thinkers exhibited intermediate MWB levels, similar to integrated thinkers, except for relationships. This likely reflects the continued dominance of analytical approaches in mathematics education. The absence of statistically significant differences in positive emotions across students' thinking styles

suggests that this dimension is influenced by different factors from those influencing other MWB dimensions. While other MWB dimensions depend on thinking style-instruction alignment, positive emotions may be more strongly shaped by immediate contextual factors—teacher interactions, classroom climate, and success experiences—that vary moment-to-moment (Hill et al., 2021).

In contrast to studies from Australia (Hill et al., 2024) and New Zealand (Hill & Hunter, 2024), we found no significant differences in MWB by gender or grade level. The absence of gender differences may suggest that BİLSEM settings are perceived as equitable by students, or that specialised gifted education contexts provide more consistent support across genders than mainstream classrooms. The absence of grade-level differences may reflect consistent instructional quality across grades or the limited age range studied (Grades 2 to 4). Future research should examine wider age ranges, particularly transitions to middle school where gifted students may experience increased boredom and motivational decline (Little, 2012).

Implications and limitations

Findings highlight the importance of differentiated instruction that accommodates gifted students' diverse thinking preferences. Visual thinkers may benefit from instructional approaches that emphasise visual representations. The positive association between integrated thinking and MWB underscores the value of fostering flexible thinking through tasks that encourage multiple solution pathways and representations. This cross-sectional study cannot establish causality between thinking styles and MWB; longitudinal research examining how thinking style-instruction alignment affects wellbeing development over time would be valuable. Future research should examine how thinking styles develop over time and what specific contextual factors most strongly influence positive emotions, providing insights for creating learning environments that support all dimensions of gifted students' MWB.

CONCLUSION

This study demonstrated that gifted primary school students' MWB during learning moments differs significantly by mathematical thinking style, with integrated thinkers showing the highest MWB across most dimensions. The absence of gender and grade-level differences suggests that supportive educational environments in gifted education might support the affective experiences of diverse learners. Findings highlight the importance of differentiated instruction that accommodates gifted students' diverse thinking styles, supporting their MWB across all five dimensions—engagement, accomplishment, perseverance, positive emotions, and relationships.

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