Psychology, Evaluation, and Technology in Educational Research
8 (2), 2026, 97-106

Available Online: http://petier.org/index.php/PETIER

PET ER
Psychology, Evaluation, and Technology in Educational Research

WISC-V cognitive indicators of mathematical learning disabilities in elementary school students: A case-control study

Wang Fangping [1, a], Nuraeni Ratna Sari [2, b]*, Bingli Wang [3, c]

[1] Jiangsu University of Technology, Changzhou, Jiangsu, 213001, China
[2] West Java Provincial Education Office. West Java Province Indonesia, 40115, Indonesia
[3] Northwest Normal University. Lanzhou City, Gansu Province, China
[a] wfp@jsut.edu.cn; [b] nuraeniratna@jabarprov.go.id; [c] wangbinli8@126.com
* Corresponding Author.

Received: 14 January 2026; Revised: 25 March 2026; Accepted: 30 April 2026

Abstract: Mathematical learning disabilities (MLD) involve persistent and heterogeneous difficulties in acquiring age-appropriate mathematical skills, requiring assessment through both cognitive and classroom-based indicators. This study examined whether WISC-V profiles differentiate elementary students with MLD from typically developing peers and support an integrated classification model. A case-control design involved 120 students aged 8–12 years, comprising 60 students formally identified with MLD and 60 age-matched controls. Participants completed the WISC-V Chinese Edition and a Mathematical Achievement Test, while teachers completed the Teacher Questionnaire on Mathematical Performance. Data were analyzed using *t* tests, effect sizes, correlations, discriminant analysis, and ROC analysis. Students with MLD scored significantly lower on all WISC-V primary indices, particularly Working Memory (d = 2.10) and Processing Speed (d = 1.60). Quantitative Reasoning showed the strongest ancillary-index separation (d = 3.03). Arithmetic, Digit Span, and Figure Weights were the most discriminating subtests. MAT deficits were greatest in word problems (d = 3.29) and mental computation (d = 3.03). QRI correlated most strongly with MAT total score (r = .84, p < .001), and the combined model achieved 89.2% accuracy and AUC = .986. QRI, WMI, Arithmetic, Digit Span, word problems, and mental computation are promising screening indicators for MLD, pending external validation.

Keywords: WISC-V; mathematical learning disabilities; dyscalculia; diagnostic indicators; working memory; elementary school; assessment

How to Cite: Wang, F., Sari, N. R., & Wang, B. (2026). WISC-V cognitive indicators of mathematical learning disabilities in elementary school students: A case-control study. *Psychology, Evaluation, and Technology in Educational Research*, *8*(2), 97-106. https://doi.org/10.33292/petier.v8i2.317

INTRODUCTION

Mathematical learning disabilities (MLD), often discussed in relation to developmental dyscalculia or specific learning disorder with impairment in mathematics, refer to persistent difficulties in learning and using numerical and mathematical skills that cannot be explained solely by inadequate instruction, sensory impairment, or broad intellectual disability. Estimates vary by definition and assessment method, but population-based and clinical sources generally indicate that a substantial minority of school-age children experience persistent mathematics-related learning difficulties (American Psychiatric Association, 2022; Morsanyi et al., 2018). These difficulties have consequences beyond classroom performance because mathematical

10.33292/petier.v8i2.317

competence is associated with everyday functioning, educational attainment, and later occupational opportunities (Butterworth et al., 2011; Kucian & von Aster, 2015).

MLD is cognitively heterogeneous. Some students show primary weaknesses in numerical magnitude processing or number sense, whereas others show broader weaknesses in working memory, processing speed, language comprehension, executive control, or combinations of these domains (Geary, 2004, 2013; Soares et al., 2018). This heterogeneity complicates identification because a single achievement score may confirm low performance but may not explain the cognitive mechanisms that should guide intervention.

The WISC-V is one of the most widely used standardized instruments for assessing children's cognitive functioning. Its five primary index scores - Verbal Comprehension, Visual Spatial, Fluid Reasoning, Working Memory, and Processing Speed - allow a more differentiated profile than a global IQ score alone. The WISC-V also yields ancillary indices, including the Quantitative Reasoning Index (QRI), Auditory Working Memory Index (AWMI), General Ability Index (GAI), and Cognitive Proficiency Index (CPI), which may be clinically informative for students with specific learning needs (Wechsler, 2014). For mathematics assessment, QRI is particularly relevant because it reflects quantitative reasoning and numerical problem-solving; WMI and CPI may be relevant because they represent cognitive efficiency and the ability to hold and manipulate information during calculation.

Prior work has repeatedly linked working memory to mathematics achievement. Longitudinal and meta-analytic evidence indicates that working memory is associated with later mathematical performance, especially when tasks require multi-step calculation, mental computation, or problem representation (De Smedt et al., 2009; Peng et al., 2016; Raghubar et al., 2010). Studies using earlier Wechsler editions also suggest that students with learning disorders often show weaknesses in Arithmetic, Digit Span, Coding, or related cognitive-efficiency measures (Schuchardt et al., 2008; Watkins et al., 1997). However, evidence focused specifically on WISC-V profiles in elementary students with MLD remains limited. Existing WISC-V studies have more often examined mixed specific learning disorder groups or comorbid conditions such as ADHD rather than mathematics-specific profiles (Becker et al., 2021).

To address this gap, the present study examined WISC-V performance patterns among elementary school students with MLD and typically developing peers. The study had four aims: (1) to identify WISC-V indices and subtests that distinguish students with MLD from controls; (2) to describe mathematical achievement profiles across number sense, calculation, word problems, geometry/measurement, and mental computation; (3) to examine the ecological consistency of teacher-rated classroom mathematics performance; and (4) to evaluate a multi-source classification model combining cognitive, achievement, and teacher-observation indicators.

METHOD

Research design and setting

This study used a case-control design. Participants were recruited from five elementary schools in metropolitan areas. The MLD group consisted of students formally identified by school records and teacher nomination as having persistent mathematics learning difficulties. The control group consisted of age-matched typically developing students whose mathematics achievement was within the normal school range and who had no identified learning disability.

Participants

A total of 120 students aged 8-12 years participated. The MLD group included 60 students in Grades 2-5 (32 boys and 28 girls; mean age = 10.2 years, SD = 1.4). Inclusion criteria were formal identification with MLD, Full Scale IQ (FSIQ) of 80 or above, and absence of other diagnosed disabilities. The control group included 60 age-matched students (30 boys and 30 girls; mean age = 10.3 years, SD = 1.3) with no identified learning disabilities and mathematics achievement within the normal range. Written informed consent was obtained from parents or guardians, and assent was obtained from students.

Table 1. Participant characteristics

Characteristic	MLD group (n = 60)	Control group (n = 60)
Age, years, M (SD)	10.2 (1.4)	10.3 (1.3)
Age range, years	8-12	8-12
Gender, boys/girls	32/28	30/30
School grade	Grades 2-5	Age-matched elementary grades
Learning status	Formally identified with MLD	No identified learning disability
FSIQ inclusion criterion	FSIQ >= 80	No disability; normal mathematics achievement

Note. MLD = mathematical learning disabilities; FSIQ = Full Scale IQ.

Instruments

WISC-V Chinese Edition

All students were individually administered the complete WISC-V Chinese Edition by certified school psychologists. The assessment included the primary subtests Similarities, Vocabulary, Block Design, Visual Puzzles, Matrix Reasoning, Figure Weights, Digit Span, Picture Span, Coding, and Symbol Search, as well as supplemental subtests including Information, Comprehension, Letter-Number Sequencing, Cancellation, and Arithmetic. The primary indices were FSIQ, VCI, VSI, FRI, WMI, and PSI; ancillary indices included QRI, AWMI, NVI, GAI, and CPI.

Mathematical Achievement Test

A 100-point Mathematical Achievement Test (MAT) was developed for this study to capture five domains of elementary mathematics: number sense (20 points), calculation skills (25 points), word problems (25 points), geometry and measurement (15 points), and mental computation (15 points). The test was administered in a quiet classroom setting with a 60-minute time limit, except for the mental computation section, which was timed for 2 minutes. The internal consistency reliability of the MAT was high (Cronbach's alpha = .91).

Teacher Questionnaire on Mathematical Performance

The Teacher Questionnaire on Mathematical Performance (TQMP) contained 30 items rated on a five-point Likert scale from 1 (never) to 5 (always). The questionnaire covered calculation accuracy, problem-solving skills, mathematical concepts, and working habits/attitudes. Mathematics teachers who had known the students for at least three months completed the questionnaire. The TQMP showed high internal consistency (Cronbach's alpha = .94) and acceptable inter-rater reliability when two teachers rated the same students (r = .87).

Procedure

Data collection occurred in five phases. First, school records were reviewed and teacher nominations were used to screen eligible participants. Second, WISC-V assessments were administered individually in school assessment rooms; each session lasted approximately 90 minutes. Third, MAT data were collected through standardized group administration supervised by trained research assistants. Fourth, mathematics teachers completed the TQMP. Fifth, data were checked for completeness and analyzed statistically.

Data analysis

Analyses were conducted using SPSS 27.0. Descriptive statistics were calculated for all measures. Independent-samples t tests compared the MLD and control groups, and Cohen's d was used to estimate effect size. Pearson correlations examined associations between WISC-V indices and MAT domains. Discriminant function analysis was used to develop a classification model, and receiver operating characteristic (ROC) analysis was used to estimate diagnostic accuracy. Statistical significance was set at $p < .05$. Because multiple outcomes were tested, interpretation emphasized the magnitude and consistency of effects rather than p values alone.

Ethical considerations

The study was approved by the relevant institutional review board. Participation was voluntary. Parents or guardians provided written informed consent, and students provided assent. Student data were analyzed anonymously and reported only in aggregate form.

RESULTS AND DISCUSSION

Results

WISC-V primary and ancillary indices

The MLD group scored significantly lower than the control group across all WISC-V primary and ancillary indices. Among primary indices, the largest effect was observed for WMI ($d = 2.10$), followed by FSIQ ($d = 1.78$), FRI ($d = 1.70$), and PSI ($d = 1.60$). Among ancillary indices, QRI produced the largest separation between groups ($d = 3.03$), followed by CPI ($d = 2.48$) and AWMI ($d = 2.47$). Although all MLD participants met the FSIQ inclusion threshold, the control group had higher overall cognitive scores. Therefore, broad-index comparisons should be interpreted as case-control differences and not as evidence that MLD is independent of general ability in this sample.

Table 2. WISC-V primary and ancillary index scores by group

Index	Description	MLD M (SD)	Control M (SD)	t	p	d
FSIQ	Full Scale IQ	87.3 (8.6)	104.2 (10.4)	-9.71	< .001	1.78
VCI	Verbal Comprehension Index	89.4 (9.8)	103.8 (11.2)	-7.52	< .001	1.38
VSI	Visual Spatial Index	94.6 (10.5)	102.4 (9.8)	-4.23	< .001	0.77
FRI	Fluid Reasoning Index	88.7 (9.4)	105.3 (10.1)	-9.27	< .001	1.70
WMI	Working Memory Index	82.4 (8.9)	101.7 (9.6)	-11.47	< .001	2.10
PSI	Processing Speed Index	84.1 (10.2)	100.9 (10.8)	-8.76	< .001	1.60
QRI	Quantitative Reasoning Index	78.6 (8.2)	105.4 (9.8)	-16.54	< .001	3.03
AWMI	Auditory Working Memory Index	80.3 (8.7)	102.1 (9.4)	-13.49	< .001	2.47
NVI	Nonverbal Index	90.2 (9.6)	104.7 (10.2)	-8.14	< .001	1.49
GAI	General Ability Index	89.8 (9.1)	105.6 (10.5)	-8.93	< .001	1.64
CPI	Cognitive Proficiency Index	79.4 (8.5)	101.3 (9.7)	-13.52	< .001	2.48

Note. d = Cohen's d. Larger d values indicate greater separation between groups.

WISC-V subtest performance

Subtest-level analysis showed that Arithmetic was the single most discriminating WISC-V subtest (d = 2.32). Digit Span, Figure Weights, Picture Span, Coding, Information, Similarities, and Symbol Search also showed medium-to-large or very large group differences. Visual-spatial subtests, particularly Visual Puzzles and Block Design, showed the smallest differences, although both remained statistically significant.

Table 3. WISC-V subtest scaled scores by group

Subtest	MLD M (SD)	Control M (SD)	t	p	d
Similarities	8.2 (2.1)	10.4 (2.3)	-5.51	< .001	1.01
Vocabulary	8.5 (2.4)	10.2 (2.2)	-4.08	< .001	0.75
Information	7.9 (2.2)	10.1 (2.1)	-5.58	< .001	1.02
Block Design	9.1 (2.3)	10.3 (2.0)	-3.08	.003	0.56
Visual Puzzles	9.3 (2.5)	10.5 (2.1)	-2.87	.005	0.52
Matrix Reasoning	8.6 (2.2)	10.6 (2.3)	-4.89	< .001	0.89
Figure Weights	7.4 (2.0)	10.8 (2.2)	-8.91	< .001	1.63
Digit Span	6.8 (1.9)	10.2 (2.1)	-9.42	< .001	1.73
Picture Span	7.2 (2.1)	10.0 (2.0)	-7.56	< .001	1.38
Coding	7.5 (2.3)	10.1 (2.4)	-6.15	< .001	1.13
Symbol Search	7.8 (2.2)	9.9 (2.3)	-5.15	< .001	0.94
Arithmetic	6.2 (1.8)	10.5 (2.0)	-12.64	< .001	2.32

Note. Scaled scores have a normative mean of 10 and standard deviation of 3.

Mathematical achievement

The MLD group performed substantially below controls on every MAT domain. The largest domain-level deficit was observed for word problems (d = 3.29), followed by mental computation (d = 3.03), calculation skills (d = 2.53), number sense (d = 2.28), and geometry/measurement (d = 2.08). Only 3.3% of students with MLD scored above 70 on the MAT, whereas 76.7% of controls scored above 80.

Table 4. Mathematical Achievement Test performance by domain

Domain	Max	MLD M (SD)	Control M (SD)	t	p	d
Number Sense	20	11.3 (3.2)	17.4 (2.1)	-12.47	< .001	2.28
Calculation Skills	25	12.8 (4.1)	21.6 (2.8)	-13.79	< .001	2.53
Word Problems	25	8.4 (3.8)	19.8 (3.2)	-17.96	< .001	3.29
Geometry/Measurement	15	7.6 (2.6)	12.4 (2.1)	-11.37	< .001	2.08
Mental Computation	15	6.9 (2.4)	13.1 (1.8)	-16.55	< .001	3.03
Total Score	100	47.0 (12.6)	84.3 (8.4)	-19.38	< .001	3.55

Note. MAT = Mathematical Achievement Test.

Teacher-rated classroom mathematics performance

Teacher ratings were consistent with the objective test results. The MLD group received substantially lower ratings across calculation accuracy, problem-solving, mathematical concepts, and working habits/attitudes. The largest group difference appeared in problem-solving (d = 3.48), followed by calculation accuracy (d = 3.42) and mathematical concepts (d = 3.09). Teachers also reported more frequent mathematics anxiety, task avoidance, and dependence on external support among students with MLD.

Table 5. Teacher Questionnaire on Mathematical Performance scores

Section	Items	Max	MLD M (SD)	Control M (SD)	t	p	d
Calculation Accuracy	8	40	18.4 (4.8)	33.6 (4.2)	-18.68	< .001	3.42
Problem-Solving	8	40	16.2 (5.1)	32.8 (4.6)	-18.98	< .001	3.48
Mathematical Concepts	6	30	13.7 (3.9)	24.6 (3.2)	-16.87	< .001	3.09
Work Habits/Attitudes	8	40	19.8 (5.6)	31.4 (5.2)	-12.01	< .001	2.20
Total Score	30	150	68.1 (16.8)	122.4 (14.6)	-19.18	< .001	3.51

Note. Higher scores indicate better performance and more positive mathematics-related behavior after reverse scoring of negatively worded items.

Associations between cognitive indices and mathematical achievement

Across the total sample, WISC-V indices were positively correlated with MAT performance. QRI had the strongest association with MAT total score ($r = .84$), followed by FSIQ ($r = .82$), CPI ($r = .79$), WMI ($r = .78$), AWMI ($r = .76$), PSI ($r = .72$), and FRI ($r = .71$). Domain-specific patterns were also theoretically coherent: VCI was most strongly associated with word problems, VSI was most strongly associated with geometry, and WMI and CPI were strongly associated with mental computation.

Table 6. Correlations between WISC-V indices and MAT domains (N = 120)

Index	MAT total	Number sense	Calculation	Word problems	Geometry	Mental computation
FSIQ	.82	.71	.76	.79	.68	.73
VCI	.68	.58	.62	.74	.56	.59
VSI	.54	.52	.51	.48	.63	.49
FRI	.71	.67	.69	.72	.65	.66
WMI	.78	.69	.73	.76	.64	.79
PSI	.72	.66	.71	.67	.62	.75
QRI	.84	.76	.81	.82	.71	.78
AWMI	.76	.68	.72	.75	.63	.77
CPI	.79	.71	.76	.74	.67	.80

Note. All correlations are significant at $p < .001$.

Classification and ROC analysis

Table 7. Classification model and ROC accuracy indicators

Measure	Std. coeff.	Structure coeff.	AUC	95% CI	Optimal cut-off
QRI	.42	.87	.962	.931-.993	<= 85
Arithmetic	.31	.76	.951	.917-.985	<= 7
WMI	.26	.68	.934	.895-.973	<= 88
Digit Span	.19	.58	-	-	<= 7
MAT Word Problems	.18	.81	-	-	-
MAT Mental Computation	.15	.77	-	-	-
MAT Total	-	-	.978	.955-.999	<= 60
Combined model	-	-	.986	.969-.999	-

Note. Overall classification accuracy = 89.2%; sensitivity = 88.3%; specificity = 90.0%; positive predictive value = 89.8%; negative predictive value = 88.5%. AUC = area under the curve; CI = confidence interval.

Discriminant function analysis indicated that QRI was the strongest WISC-V predictor in the classification model. Arithmetic, WMI, Digit Span, MAT word problems, and MAT mental computation also contributed to classification. The model correctly classified 89.2% of students, with 88.3% sensitivity and 90.0% specificity. ROC analysis showed excellent discrimination for the combined model (AUC = .986), while individual measures also showed strong performance, especially MAT total score, QRI, Arithmetic, and WMI.

Cognitive weakness patterns within the MLD group

Profile analysis confirmed heterogeneity within the MLD group. Low QRI was the most common weakness (95.0%), followed by low WMI (90.0%), low Arithmetic (86.7%), low Digit Span (81.7%), and low PSI (80.0%). Four broad profiles were observed: low WMI and QRI with relatively average visual-spatial/fluid reasoning abilities; low WMI, PSI, and QRI; globally low performance across indices; and low QRI only.

Table 8. Common weakness patterns among students with MLD (n = 60)

Weakness pattern	n	%
Low QRI (< 85)	57	95.0
Low WMI (< 85)	54	90.0
Low Arithmetic (<= 7)	52	86.7
Low Digit Span (<= 7)	49	81.7
Low PSI (< 85)	48	80.0
Low Figure Weights (<= 7)	46	76.7
QRI as lowest index	43	71.7
WMI < PSI by >= 10 points	28	46.7

Note. Cut-offs are exploratory and should be validated in independent samples before clinical use.

Discussion

This study examined WISC-V cognitive indicators of MLD in elementary school students by integrating cognitive assessment, mathematics achievement testing, and teacher observation. The findings support three main conclusions. First, quantitative reasoning and working memory were the most salient WISC-V domains associated with MLD. Second, the strongest mathematics achievement deficits appeared in word problems and mental computation, suggesting that students with MLD experienced particular difficulty when mathematical knowledge had to be integrated with language comprehension, working memory, and rapid retrieval. Third, a combined model using WISC-V indicators and achievement data showed high internal classification accuracy, although external validation is required before the model can be used as a diagnostic protocol.

WISC-V indicators of MLD

QRI emerged as the strongest WISC-V indicator of MLD. This finding is theoretically consistent because QRI is designed to capture quantitative reasoning and numerical problem-solving. The very large effect size for QRI suggests that students with MLD in this sample had marked difficulty with tasks requiring the interpretation and manipulation of quantitative relations. Arithmetic was the most discriminating individual subtest, which is also expected because it requires numerical knowledge, verbal comprehension of orally presented problems, sustained attention, and working memory. These findings indicate that QRI and Arithmetic should receive careful interpretive attention when MLD is suspected.

WMI and AWMI also showed very large group differences. This result aligns with the broader literature showing that working memory supports mental computation, multi-step procedures, fact retrieval, and word-problem solving. Digit Span was particularly discriminating, indicating that auditory-verbal working memory may be a key bottleneck for many students with MLD. PSI and CPI were also lower in the MLD group, suggesting that cognitive efficiency and speeded visual-motor processing may contribute to mathematics performance, particularly under timed or high-load conditions.

Mathematical achievement and classroom performance

The MAT results showed that MLD was not limited to simple calculation errors. The largest deficit appeared in word problems, followed by mental computation. Word problems require students to parse language, identify relevant information, select operations, construct a solution plan, and monitor intermediate results. Mental computation places heavy demands on fact retrieval and working memory. The convergence of WISC-V and MAT results therefore suggests that cognitive load, rather than procedural knowledge alone, may explain a substantial part of mathematics difficulty in this sample.

Teacher ratings added ecological validity. Teachers observed lower calculation accuracy, weaker problem-solving, poorer conceptual understanding, more mathematics anxiety, and greater task avoidance among students with MLD. These observations are important because classroom behavior often reflects the cumulative impact of cognitive difficulty, repeated failure, reduced self-efficacy, and anxiety. Thus, assessment should not stop at cognitive and achievement scores; intervention planning should also consider students' emotional responses and learning behaviors in mathematics classrooms.

Heterogeneity and implications for assessment

The profile analysis indicated that MLD is not a single cognitive profile. Most students showed low QRI and WMI, but some had broader cognitive-efficiency weaknesses, while a smaller subgroup had low QRI with otherwise average indices. This supports a multiple-deficit view of MLD, in which mathematical difficulties may arise through different combinations of weaknesses in quantitative reasoning, working memory, processing speed, language-mediated reasoning, and cognitive efficiency. A practical implication is that clinicians and school psychologists should avoid relying only on global IQ or total mathematics scores. Instead, they should examine the pattern of strengths and weaknesses across WISC-V indices, subtests, mathematical domains, and teacher observations.

Implications for intervention

The results suggest several directions for educational intervention. Students with low WMI may benefit from worked examples, step-by-step scaffolding, external memory aids, reduced cognitive load, and explicit strategy instruction. Students with low PSI may require additional time, reduced task density, and gradual practice to build automaticity. Students with low QRI or weak word-problem performance may need explicit instruction in quantitative reasoning, visual representation, semantic problem schemas, and operation selection. Because anxiety and task avoidance were also elevated, intervention should include feedback practices that support persistence and reduce repeated failure experiences.

Limitations

This study has several limitations that should be acknowledged. First, the case-control design allowed meaningful comparison between students with MLD and typically developing peers, but it did not permit causal inference regarding the relationship between cognitive indices and mathematical learning disabilities. Second, although the sample size was adequate for the reported statistical analyses, it was not sufficient for more fine-grained subgroup modeling or for cross-validating the classification model. Third, while all students with MLD had FSIQ scores of 80 or above, the control group showed higher FSIQ scores; therefore, future studies should employ IQ-matched control groups or apply statistical controls using raw data. Fourth, students with comorbid conditions, such as ADHD or reading disorder, were excluded, which may limit the generalizability of the findings to real-world school settings where comorbidity is common. Fifth, the Mathematical Achievement Test and Teacher Questionnaire on Mathematical Performance were developed specifically for this study. Although both instruments demonstrated high internal reliability, further validation across different regions, grade levels, and curriculum systems is necessary. Finally, the cut-off scores derived from the present sample should be regarded as exploratory and should not be used as definitive diagnostic thresholds until replicated through independent and preferably longitudinal validation studies.

CONCLUSIONS

This study identified a coherent set of WISC-V and mathematics achievement indicators associated with elementary school MLD. QRI was the strongest single WISC-V indicator, while WMI, AWMI, CPI, Arithmetic, Digit Span, and Figure Weights also showed substantial group differences. Achievement weaknesses were most pronounced in word problems and mental computation, and teacher observations confirmed difficulties in calculation accuracy, problem-solving, mathematical concepts, work habits, and mathematics-related anxiety. A combined model showed high internal classification accuracy, but its cut-offs should be used cautiously until validated in independent samples. Overall, the findings support a multi-source assessment approach in which WISC-V profiles are interpreted alongside mathematics achievement and classroom evidence to guide early identification and individualized intervention planning.

ACKNOWLEDGEMENTS

We thank all students, parents, and teachers who participated in this study. Special thanks to some Primary School of Gansu and Sichuan. the Humanities and Social Sciences Project of the Min-istry of Education of China, "Research on the Impact of Metacognitive Teaching Strategies under the Background of AI on the Learning Effect of Mathematics Learning Difficulties in Compulsory Education Stage", Project No.: 23YJA880047".

REFERENCES

American Psychiatric Association. (2022). Diagnostic and statistical manual of mental disorders (5th ed., text rev.). American Psychiatric Association Publishing. https://doi.org/10.1176/appi.books.9780890425787

Becker, A., Daseking, M., & Kerner auch Koerner, J. (2021). Cognitive profiles in the WISC-V of children with ADHD and specific learning disorders. Sustainability, 13(17), 9948. https://doi.org/10.3390/su13179948

Butterworth, B., Varma, S., & Laurillard, D. (2011). Dyscalculia: From brain to education. Science, 332(6033), 1049-1053. https://doi.org/10.1126/science.1201536

De Smedt, B., Janssen, R., Bouwens, K., Verschaffel, L., Boets, B., & Ghesquiere, P. (2009). Working memory and individual differences in mathematics achievement: A longitudinal study from first grade to second grade. Journal of Experimental Child Psychology, 103(2), 186-201. https://doi.org/10.1016/j.jecp.2009.01.004

Ding, Y., Xiao, F., Fan, Z. H., & Zhang, D. K. (2016). A brief introduction to the performance of the Wechsler Intelligence Scale for Children-Fifth Edition in the United States. Chinese Journal of Special Education, 7, 18-25.

Geary, D. C. (2004). Mathematics and learning disabilities. Journal of Learning Disabilities, 37(1), 4-15. https://doi.org/10.1177/00222194040370010201

Geary, D. C. (2011). Cognitive predictors of achievement growth in mathematics: A five-year longitudinal study. Developmental Psychology, 47(6), 1539-1552. https://doi.org/10.1037/a0025510

Geary, D. C. (2013). Early foundations for mathematics learning and their relations to learning disabilities. Current Directions in Psychological Science, 22(1), 23-27. https://doi.org/10.1177/0963721412469398

Kucian, K., & von Aster, M. (2015). Developmental dyscalculia. European Journal of Pediatrics, 174, 1-13. https://doi.org/10.1007/s00431-014-2455-7

McLean, J. F., & Hitch, G. J. (1999). Working memory impairments in children with specific arithmetic learning difficulties. Journal of Experimental Child Psychology, 74(3), 240-260. https://doi.org/10.1006/jecp.1999.2516

Morsanyi, K., van Bers, B. M. C. W., McCormack, T., & McGourty, J. (2018). The prevalence of specific learning disorder in mathematics and comorbidity with other developmental disorders in primary school-age children. British Journal of Psychology, 109(4), 917-940. https://doi.org/10.1111/bjop.12322

Peng, P., Namkung, J., Barnes, M., & Sun, C. (2016). A meta-analysis of mathematics and working memory: Moderating effects of working memory domain, type of mathematics skill, and sample characteristics. Journal of Educational Psychology, 108(4), 455-473. https://doi.org/10.1037/edu0000079

Raghubar, K. P., Barnes, M. A., & Hecht, S. A. (2010). Working memory and mathematics: A review of developmental, individual difference, and cognitive approaches. Learning and Individual Differences, 20(2), 110-122. https://doi.org/10.1016/j.lindif.2009.10.005

Schuchardt, K., Maehler, C., & Hasselhorn, M. (2008). Working memory deficits in children with specific learning disorders. Journal of Learning Disabilities, 41(6), 514-523. https://doi.org/10.1177/0022219408317856

Soares, N., Evans, T., & Patel, D. R. (2018). Specific learning disability in mathematics: A comprehensive review. Translational Pediatrics, 7(1), 48-62. https://doi.org/10.21037/tp.2017.08.03

Szucs, D., Devine, A., Soltesz, F., Nobes, A., & Gabriel, F. (2013). Developmental dyscalculia is related to visuo-spatial memory and inhibition impairment. Cortex, 49(10), 2674-2688. https://doi.org/10.1016/j.cortex.2013.06.007

Watkins, M. W., Kush, J. C., & Glutting, J. J. (1997). Discriminant and predictive validity of the WISC-III ACID profile among children with learning disabilities. Psychology in the Schools, 34(4), 309-319. https://doi.org/10.1002/(SICI)1520-6807(199710)34:4<309::AID-PITS2>3.0.CO;2-G

Wechsler, D. (2014). Wechsler Intelligence Scale for Children-Fifth Edition: Technical and interpretive manual. Pearson.