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Number Sense and Mathematical Attitudes of Middle School Students: A Correlational Study

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Abstract

This research examines the relationship between number sense competence and attitudes towards mathematics among middle school students in Şanlıurfa, Türkiye, during the 2021-2022 academic year. Using a mixed methods approach, the Number Sense Scale and the Mathematics Attitude Scale were used to collect data from a group of 39 students in grades 6, 7, and 8. Inferential analyses, including ANOVA, Pearson correlation, and linear regression, revealed that number sense was at a very low level ($M=3.46$) and that student solved problems using rule based, classical methods rather than number sense strategies. Male students exhibited significantly stronger number sense skills and positive attitudes compared to female students, while 8th grade students showed higher competence than 6th grade students. The most significant finding of the study was a strong positive correlation ($r=0.846$) between the two constructs, with number sense emerging as a powerful factor explaining 71.6% of the variance in mathematical attitudes. These findings highlight that cognitive problems in flexible numerical thinking can fundamentally restrict students' attitudes towards mathematics. Consequently, the study advocates for instructional frameworks that prioritize non routine problem solving and diverse strategic approaches to foster both conceptual understanding and sustainable positive attitudes in mathematics classrooms.

Keywords: Number Sense, Mathematics Attitude, Middle School, Gender, Grade Level

Introduction

Mathematics is often perceived as one of the most challenging subjects by students because it requires skills such as working with numbers, mathematical reasoning, and problem solving. This raises the question of whether this is due to student's mathematical attitudes or underlying cognitive processes. A review of the literature reveals that these difficulties are closely related to a mathematical perceptual ability called number sense, defined as the ability to intuitively understand the magnitude, meaning, and relationships of numbers and operations (Toll et al., 2016). This ability involves processes such as estimation, mental calculation, rounding, and interpreting numerical meaning and plays an indispensable role in solving everyday problems such as determining enough money for a purchase or dividing a cake equally (Bresser & Holtzman, 1999; Çekirdekçi, 2015). Similarly, mathematical attitude, defined as the totality of positive or negative feelings, beliefs, and behaviors towards the subject (Sezgin, 2013), is another important factor influencing academic motivation. Positive attitudes, such as enjoying mathematics, increase success, while negative attitudes, such as fear or boredom, generally lead to decreased performance (Neale, 1969). In a study examining postgraduate theses in Türkiye by Küçükay and Yenilmez (2024), it was observed that studies on number sense largely

focused on cognitive outcomes such as Mathematical Achievement (23.26%) and Number Sense Performance (20.93%). A recent systematic review conducted by [Güleç \(2024\)](#) also supports this trend, revealing that articles primarily concentrate on examining components (30%) and determining strategies (16%). However, the affective dimension, a cornerstone of the learning process, is neglected in this context. The fact that the proportion of studies addressing the relationship between number sense and mathematical attitude remains at only 6.6% to 6.98% demonstrates a critical gap in the literature at the intersection of cognitive and affective domains. Despite the 2018 curriculum update in Turkey, the predictive power of number sense on mathematical attitude is not sufficiently supported by current data. There is a noticeable lack of research on the interaction of these two variables, particularly in regions with unique socio-economic dynamics such as Şanlıurfa. This study demonstrates the capacity of number sense to explain 71.6% of the variance in mathematical attitudes, offering original evidence of how cognitive skills dominate a student's emotional world. Our article aims to fill this quantitative and qualitative gap in the literature and build the necessary theoretical framework for more integrated pedagogical strategies.

Theoretical Framework and Literature

Number sense appears in the literature as a multifaceted concept, defined in various ways, reflecting a broad conceptual framework. According to [McIntosh et al. \(1992\)](#), number sense is defined as “a general understanding of numbers and operations with the ability to develop flexible strategies for solving real-world problems.” Supporting this perspective on cognitive flexibility, [Howden \(1989\)](#) characterizes number sense as “the ability to make reasonable judgments without strictly adhering to formal rules,” while [Gersten and Chard \(1999\)](#) further elaborate on it as “competence in mental calculation, comparison, and numerical fluency.” More recently, this framework has been further functionalized as a multicomponent structure of interconnected elements: “number, number relations, and number operations.” [Jordan et al. \(2010\)](#) stated that competence in number sense is effective in restructuring students' cognitive

frameworks, thus forming a critical foundation for mastering advanced mathematical concepts.

These conceptual definitions are directly reflected in the strategic positioning of the concept of number sense within educational policies and curricula. The [National Council of Teachers of Mathematics \(2000\)](#) and the Ministry of National Education ([MEB, 2018](#)) position number sense as a fundamental component of the curriculum, emphasizing essential skills such as mental computation, estimation, and flexible thinking. In the context of Türkiye, [Acar and Peker \(2021\)](#) emphasize that number sense plays a critical role in mathematics curricula and highlight that teachers occupy a central position in developing this competence. An examination of the 2018 Middle School Mathematics Curriculum reveals that it includes specific learning outcomes to support the components of number sense; however, [Acar and Peker \(2021\)](#) also note that these objectives must be effectively implemented by teachers in classroom practices to reach their full potential.

The practical significance of integrating these skills into the curriculum is underscored by their direct impact on student performance and mathematical proficiency. Numerous studies ([Harç, 2010](#); [Singh, 2009](#); [Ak, 2019](#)) have demonstrated that students with well developed number sense are significantly more successful in understanding numerical magnitudes, producing strategic solutions, and performing mental calculations. Thus, the literature suggests a continuous link between the conceptual understanding of number sense, its curricular application and the resulting enhancement of students' mathematical thinking skills.

Purpose of the Study

This study aims to determine the number sense and mathematical attitudes of 6th, 7th and 8th grade middle school students, examine the relationship between these two variables, and investigate the effects of demographic factors such as gender and grade level on these variables. The research problem is formulated as follows: “Is there a significant relationship between the number sense and mathematical attitudes of 6th, 7th, and 8th grade middle school students?” Within this framework, the study seeks to address the following sub questions:

- What is the level of students' achievement on the number sense scale?

- Does students' number sense vary by gender?
- Does students' number sense vary by grade level?
- What is the level of students' mathematical attitude scores?
- Do students' mathematical attitude scores vary by gender?
- Do students' mathematical attitude scores vary by grade level?
- Is there a significant relationship between students' number sense and mathematical attitudes?
- Is students' number sense a significant predictor of their mathematical attitudes?

Limitations and Assumptions of the Study

The scope of this research is subject to several limitations regarding its sample, methodology, and instruments. Primarily, the study was conducted with 39 middle school students in the 6th, 7th, and 8th grades during the 2021-2022 academic year. This small sample size, selected via convenience sampling from a single middle school in Şanlıurfa, restricts the generalizability of the findings to broader student populations across Türkiye. Furthermore, the lack of detailed data regarding the school's specific socio-economic context, academic performance averages, and teacher qualifications limits the depth of contextual interpretation. From a methodological perspective, the research is constrained by its reliance on quantitative data collected solely through the "Number Sense Scale" and the "Mathematical Attitude Scale." Consequently, the results are framed within the specific psychometric properties and theoretical boundaries of these instruments, focusing strictly on the predictive role of number sense as a cognitive skill on mathematical attitude as an affective characteristic. The validity of the findings is also based on certain fundamental assumptions. It is assumed that the measurement instruments employed are theoretically and statistically reliable and valid for assessing the targeted constructs. Additionally, it is assumed that the participating students understood the scale items correctly, were free from external pressure or guidance during the application, and provided sincere, objective responses that accurately reflect their genuine thoughts and feelings.

Method

Research Design and Study Group

This study was designed using a mixed-methods approach to investigate the relationship between middle school students' number sense and their mathematical attitudes. The mixed methods approach combines qualitative and quantitative research methods to provide both in-depth understanding and statistical generalizations ([Creswell & Plano Clark, 2017](#)). The qualitative dimension involves a detailed examination of students' responses on the Number Sense Scale through content analysis, while the quantitative dimension analyzes the relationships between number sense and mathematical attitudes using a correlational survey model. The correlational survey model is a quantitative research method used to determine the existence and degree of relationships between two or more variables ([Karasar, 2011](#)).

The study was conducted with a participant group of 39 students from the 6th, 7th, and 8th grades attending a middle school affiliated with the Ministry of National Education in Şanlıurfa during the 2021-2022 academic year. The study group was selected using convenience sampling, a method that facilitates a practical and cost-effective data collection process ([Karagöz, 2017](#)). The study group consisted of 14 sixth grade students (9 girls, 5 boys), 15 seventh grade students (10 girls, 5 boys), and 10 eighth grade students (4 girls, 6 boys). In total, 23 female and 16 male students participated in the study.

Data Collection Tools and Procedure

Two data collection tools were used in this study: the Number Sense Scale, designed by [Kayhan Altay and Umay \(2013\)](#), and the Mathematical Attitude Scale, developed by the Directorate of Educational Research and Development (EARGED). The Number Sense Scale consists of 17 questions related to numbers and operations, including both open-ended and multiple choice items. The Cronbach's alpha reliability coefficient for this scale was reported as 0.86 ([Kayhan Altay & Umay, 2013](#)). Scoring was based on whether students solved the questions using number sense strategies: 1 point was awarded for correct responses using number sense, while 0 points were given for rule-based or incorrect responses. The possible score range for the scale is 0–17.

The Mathematical Attitude Scale, developed by EARGED in 2009 for 6th–8th grade students, is a 20-item, 5-point Likert-type scale. The Cronbach’s alpha reliability coefficient for this scale in the current study was 0.88. The scale includes 12 positive and 8 negative items, with positive items scored such that “Strongly agree” receives 5 points, and negative items (e.g., items 2, 6, 8, 10, 11, 13, 14, 15) scored such that “Strongly agree” receives 1 point. The possible score range for the scale is 20–100.

The data collection process was conducted by the researcher in a classroom setting. Students were informed about the purpose of the study, and the objectives and instructions for completing the scales were explained. One class period was allocated for the administration of the Number Sense Scale, followed by the administration of the Mathematical Attitude Scale. Students were asked to indicate their grade level and gender on the scales and to avoid leaving any questions requiring explanations blank.

Data Analysis

Prior to data analysis, the normality of the data obtained from the scales was examined. Normality was assessed by evaluating the proximity of the mean, median, and mode values, as well as the kurtosis and skewness coefficients within acceptable ranges. Kurtosis values below 7 and skewness values between -2 and +2 indicate that the data conform to a normal distribution ([West et al., 1995](#); [Byrne, 2010](#)). For the Number Sense Scale, the mode was 4.000, the median was 4.000, the mean was 3.462, the skewness was 0.064, and the kurtosis was -0.798. For the Mathematical Attitude Scale, the mode was 53.000, the median was 49.000, the mean was 52.615, the skewness was 0.327, and the kurtosis was -1.209. The mean, median, and mode values for both scales were found to be close to each other, and the kurtosis and skewness coefficients fell within acceptable ranges. Consequently, the data were determined to follow a normal distribution, and parametric tests were used for the analyses.

The data were analyzed using statistical software. Descriptive statistics, including frequency, standard deviation, and arithmetic mean were calculated to reveal the basic characteristics of the data. To evaluate whether number sense and mathematical

attitudes differed by gender, an independent samples t-test was conducted. To examine differences in number sense and mathematical attitudes by grade level, a one way analysis of variance (ANOVA) test was performed. In cases where significant differences were found, the Scheffe test was used to determine which groups differed. The Pearson product-moment correlation coefficient was calculated to determine the direction and strength of the relationship between number sense and mathematical attitudes, and regression analysis was employed to assess the extent to which number sense explains mathematical attitudes. For t-test and ANOVA results showing significant differences, Cohen’s *d* was applied to determine the effect size of the variables.

For the Number Sense Scale, students’ responses were evaluated on a question-by-question basis. One point was awarded for correct responses using number sense strategies, while zero points were given for rule based or incorrect responses or for responses lacking explanations ([Harç, 2010](#)). For the Mathematical Attitude Scale, positive items were scored as follows: “Strongly agree” received 5 points, “Agree” 4 points, “Undecided” 3 points, “Disagree” 2 points and “Strongly disagree” 1 point. Negative items were reverse scored. Higher scores indicate a more positive attitude toward mathematics.

Findings

Students’ Number Sense Achievement

The first sub question of the study investigates the achievement levels of middle school students on the Number Sense Scale. Analysis of the scores revealed that the 39 students’ scores ranged from 0 to 7, with a mean score of 3.462 (standard deviation = 1.847). Given that the maximum score on the scale is 17, it was observed that students’ number sense skills were low, and they generally preferred rule based, standard solution methods. No student answered all questions correctly using number sense strategies.

The 17 questions on the scale were evaluated through content analysis, examining the number of students who answered each question correctly using number sense strategies and their solution approaches. For example, in Question 1 (multiplying 0.25 by 16), 5 students used number sense by dividing 16 by 4, while others applied rule based

multiplication or left the question blank. In Question 2 (finding a fraction between two fractions), 4 students correctly answered by establishing a half whole relationship, while others equalized denominators to solve it. In Question 3 (multiplying a whole number by a decimal), 6 students used number sense for comparison, while others applied standard multiplication. In Question 4 (subtraction based on given information), 12 students produced flexible solutions using the provided information, while others opted for the classic subtraction method. In Question 5 (identifying a number on a number line), no student used number sense; most incorrectly assumed the midpoint of the number line was zero. In Question 6 (writing numbers in parentheses to achieve equality), 28 students answered correctly using number sense, marking the highest number sense usage rate (71%) for any question. Students combined addition and division to produce flexible solutions. In Question 7 (sum of decimals), 18 students chose a practical approach, while others used rule based addition or answered incorrectly. In Question 8 (combination of addition and subtraction), 8 students used shortcuts by considering place values, while others solved it conventionally by writing numbers vertically. In Question 9 (determining if the sum of fractions is greater than 1), 2 students compared fractions as greater or less than half, while others equalized denominators for calculation. In Question 10 (ordering decimals), only a student correctly ordered them using number sense, while others converted decimals to fractions for ordering. In Question 11 (coloring a fraction of squares), 18 student divided the shape into equal parts using number sense, while others used multiplication. In Question 12 (range of

a colored area), 12 students established a half whole relationship, while others divided into equal parts or answered incorrectly. In Question 13 (comparing multiplication and division by $\frac{1}{2}$), 12 students intuitively evaluated the effects of multiplication and division, while others calculated both operations for comparison. In Question 14 (fraction with a numerator greater than the denominator), only 1 student used the concept of an improper fraction, while others struggled to understand or left it blank. In Question 15 (placing a fraction on a number line), 3 students used reference distances, while others placed fractions without considering their magnitude. In Question 16 (multiplying 86,424 by 500), no student used number sense; most multiplied by 5 and added zeros or performed vertical multiplication. In Question 17 (finding the largest value from a fraction table), 4 students used a half whole relationship to answer correctly, while others equalized denominators for comparison.

In summary, Question 6 had the highest rate of number sense usage, while Questions 5 and 16 showed no number sense application. Students' tendency to rely on rule based methods rather than number sense indicates limited flexible thinking skills.

Differences in Number Sense and Mathematical Attitudes by Gender and Grade Level

The second and fifth sub questions examine whether students' number sense and mathematical attitudes differ by gender. The results of the independent samples t-test are presented in Table 1 and Table 2.

Table 1 Independent Samples t-Test Results for Number Sense Scores by Gender

Gender	n	Mean	SD	df	t	p	Cohen's d
Male	16	4.813	1.559	37	4.780	.001	1.56
Female	23	2.522	1.410				

According to Table 1, male students' number sense scores ($M=4.813, SD=1.559$) are significantly higher than those of female students ($M=2.522, SD$

$=1.410$). This difference is statistically significant ($t(37) = 4.780, p < .001$) and represents a very large effect size (Cohen's $d = 1.56$).

Table 2 t-Test Results for Mathematical Attitude Scores by Gender

Gender	n	Mean	SD	df	t	p	Cohen's d
Male	16	66.250	19.154	37	4.433	.001	1.35
Female	23	43.130	13.472				

Table 2 indicates that male student's mathematical attitude scores ($M = 66.250$, $SD = 19.154$) are significantly higher than those of female students ($M = 43.130$, $SD = 13.472$). This difference is statistically significant ($t(37) = 4.433$, $p < .001$) and represents a large effect size (Cohen's $d = 1.35$).

These findings suggest that male students exhibit

both stronger number sense competencies and more positive attitudes toward mathematics compared to female students

The third sub-question assesses whether number sense differs by grade level. The ANOVA test results for number sense scores are presented in Table 3.

Table 3 ANOVA Test Results for Number Sense Scores by Grade Level

Gender	n	Mean	SD	df	t	p
6th Grade	14	2.571	1.742	36	3.710	.034
7th Grade	15	3.600	1.957			
8th Grade	10	4.500	1.269			

According to Table 3, 8th grade students' number sense scores ($M = 4.500$) are higher than those of 7th grade ($M = 3.600$) and 6th grade ($M = 2.571$)

students. This difference is statistically significant ($F(2,36) = 3.710$, $p = .034$). The effect size for the difference across grade levels is large, with $\eta^2 = .17$

Table 4 Scheffe Test Results for Number Sense Scores by Grade Level

Comparison	Mean Difference	p (Scheffe)	Cohen's d
6th Grade - 7th Grade	-1.029	0.290	0.55
6th Grade - 8th Grade	-1.929	0.037	1.19
7th Grade - 8th Grade	-0.900	0.451	0.51

Table 4 (Scheffe Test Results) shows that the difference is significant between 6th and 8th grades ($p = .037$), representing a large effect size (Cohen's $d = 1.19$). The differences between 6th and 7th grades ($p = .290$, $d = 0.55$) or 7th and 8th grades ($p = .451$,

$d = 0.51$) were not statistically significant.

The sixth sub question assesses whether mathematical attitudes differ by grade level. The ANOVA test results are presented in Table 5.

Table 5 ANOVA Test Results for the Effect of Grade Level on Mathematical Attitude Scores

Grade Level	n	Mean	SD	df	t	p
6th Grade	14	45.286	19.621	36	2.886	.069
7th Grade	15	52.000	21.061			
8th Grade	10	63.800	12.090			

The results of the ANOVA conducted to determine whether mathematical attitude scores differ significantly by grade level are presented in Table 5. The analysis revealed that while 8th-grade students had higher attitude scores ($M = 63.80$, $SD = 12.09$) compared to 7th-grade ($M = 52.00$, $SD = 21.06$) and 6th-grade ($M = 45.29$, $SD = 19.62$) students, this upward trend across grade levels did

not reach statistical significance, $F(2, 36) = 2.886$, $p = .069$. On the other hand, the calculated effect size ($\eta^2 = .14$) indicates a large effect of grade level on attitude scores. This suggests that the lack of statistical significance may be attributed to the small sample size, and a significant difference might be observed with a larger participant pool.

General Distribution of Mathematical Attitude Scores

The fourth sub question examines the overall level of students' mathematical attitude scores. The distribution of scores is presented in Table 6.

Table 6 Distribution of Students' Mathematical Attitude Scale Scores

Total Data	Mean	SD	Minimum	Maximum
39	52.615	19.560	25.000	89.000

According to Table 6, mathematical attitude scores ranged from 25 to 89, with a mean of 52.615 (SD = 19.560). Considering the scale's range of 20–100 and that higher scores indicate positive attitudes, students' mathematical attitudes can be described as moderate.

Relationship Between Number Sense and Mathematical Attitudes

The seventh and eighth sub questions evaluate the relationship between number sense and mathematical attitudes and the predictive power of number sense.

Table 7 Correlation Between Number Sense and Mathematical Attitudes

Variables	n	Correlation Coefficient (r)	p
Mathematical Attitude	39	19.560	25.000
Number Sense	39		

Pearson correlation analysis (Table 7) indicated a strong, positive, and significant relationship between number sense and mathematical attitudes ($r = .846$, $p < .001$). A correlation coefficient in the range of .70–1.00 signifies a strong relationship ([Büyüköztürk, 2011](#)).

Table 8 Simple Linear Regression Analysis for Predicting Mathematical Attitudes

Variable	Standard Error	β	t	p
Sabit	3.132		16.798	.001
Sayı Hissi	3.629	0.846	5.952	.001

According to Table 8, number sense is a significant predictor of mathematical attitudes ($F(1,37) = 93.271$, $p < .01$), explaining 71% of the variance in mathematical attitudes ($R^2 = .716$). The regression coefficient ($\beta = 0.846$, $t = 5.952$, $p < .05$) confirms the strong effect of number sense.

Simple linear regression analysis (Table 8) confirmed that number sense is a significant predictor of mathematical attitudes ($F(1,37)=93.271$, $p < .001$). Number sense explains 71.6% of the variance in mathematical attitudes ($R^2 = .716$). The regression coefficient ($\beta=0.846$, $t = 5.952$, $p < .001$) further confirms the strong effect of number sense.

Discussion, Conclusion

The study examined the relationship between middle school students' number sense and mathematical attitudes. The mean score on the Number Sense Scale was 3.462 (out of 17), indicating low number sense skills. Students generally relied on rule based, rote methods to solve questions, demonstrating deficiencies in flexible thinking skills. Only 20% of the questions were answered correctly using number sense strategies. This rate is lower compared to studies by [Yang and Li \(2008; 34%\)](#), [Şengül and Gülbağcı \(2012; 42%\)](#), and [Harç \(2010; 11%\)](#). Students' focus on equalizing denominators in fraction questions, inability to establish half-whole relationships, and preference for lengthy methods over shortcuts in multiplication reflect a lack of flexible thinking ([Yang, 2003](#); [Singh, 2009](#); [Mohamed & Johnny, 2010](#); [İymen, 2012](#); [Şengül, 2013](#); [Takır, 2016](#)). Additionally, and relatedly, students' tendency to leave explanatory questions blank or provide only result-oriented answers highlights their difficulty in expressing their thought processes ([Işık & Kar, 2011](#)).

Regarding demographic variables, number sense scores varied significantly by gender, with male students ($M = 4.813$) significantly outperforming female students ($M = 2.522$) ($p < .05$). The calculated Cohen's d value of 1.56 indicates a very large effect size, emphasizing the substantial difference in number sense competency between genders. This result aligns with findings suggesting males think more practically and flexibly ([Yapıcı, 2013](#); [Ak, 2019](#); [Singh, 2009](#)). However, studies by

[Kayhan Altay \(2010\)](#), [Şengül and Gülbağcı \(2012\)](#), and [Harç \(2010\)](#) found no gender differences, while [Acar \(2019\)](#) and [Menon \(2004\)](#) reported higher performance among female students. Regarding grade level, 8th grade students ($M = 4.500$) showed higher number sense scores than 6th grade students ($M = 2.571$). The significant difference between the 6th and 8th grades ($p < .05$) had a large effect size (Cohen's $d = 1.19$), indicating that number sense improves substantially as students advance from the 6th to the 8th grade. This is consistent with studies by [Işık and Kar \(2011\)](#), [Caferoğlu \(2020\)](#), and [Şengül and Gülbağcı \(2012\)](#). However, [Kayhan Altay \(2010\)](#) reported that number sense decreases as grade level increases, with rote approaches becoming more dominant.

The mean score on the Mathematical Attitude Scale was 52.615 (range 20–100), indicating moderate mathematical attitudes. Consistent with the number sense findings, male students' attitude scores ($M = 66.250$) were significantly higher than those of female students ($M = 43.130$) ($p < .05$). The accompanying Cohen's d value of 1.35 represents a large effect size, suggesting that males possess a substantially more positive approach to mathematics ([Başer & Yavuz, 2003](#); [Pehlivan, 2012](#); [Saracoğlu, 2016](#)). However, [Güzel \(2004\)](#) and [Katrancı and Şengül \(2019\)](#) found higher attitudes among female students, while [Akdemir \(2006\)](#) and [Birgin and Demirkan \(2017\)](#) reported no gender differences. Regarding grade level, 8th grade students' attitude scores ($M = 63.800$) were higher than those of 7th grade ($M = 52.000$) and 6th grade ($M = 45.286$) students, but this difference was not significant ($p = .069$). This aligns with studies by [Kurbanoğlu and Takunyacı \(2012\)](#) and [Sezgin \(2013\)](#), while [Tan \(2015\)](#) and [Şimşek et al. \(2017\)](#) reported declining attitudes with increasing grade levels.

A strong, positive, and significant relationship was found between number sense and mathematical attitudes ($r = .846$, $p < .05$). Crucially, the regression analysis demonstrated that number sense is a significant predictor of mathematical attitudes, explaining 71.6% of the total variance in attitudes ($R^2 = .716$, $p < .001$). This highly significant finding (71.6% variance explained) strongly suggests that developing robust number sense skills may not only

enhance cognitive abilities but also directly foster positive attitudes toward mathematics, thereby influencing overall mathematical achievement ([Yang & Hsu, 2009](#)). Given the very large effect sizes observed in both number sense and attitude differences based on gender and the strong predictive power of number sense, educational interventions focused on this skill are critically important.

Suggestions

To enhance number sense skills and positive mathematical attitudes in mathematics education, classroom activities should actively encourage flexible thinking and equip students with problem-solving strategies that allow for multiple solution paths. Group discussions specifically focused on number sense can be organized to promote this flexibility, providing a platform where students share different strategies for tasks such as estimating numerical magnitudes or performing mental calculations. Furthermore, the integration of open-ended, real-life problems—such as calculating discounts during shopping or partitioning quantities equally—is essential to develop students' number sense in practical contexts. These practices are vital for reducing the observed reliance on rule-based methods and strengthening the intuitive thinking skills that are strongly linked to positive attitudes. For instance, in lessons involving fractions, students should be encouraged to use reference points like half or quarter when placing values on a number line. Additionally, integrating digital tools and interactive games, such as number sense-based mobile apps or online estimation games, can capture student interest and provide a more engaging environment for developing these competencies.

Teachers and school administrators play a central role in fostering these skills by emphasizing practical and efficient solution methods alongside traditional rule-based approaches. Educators should design engaging lessons that simultaneously develop number sense and mathematical attitudes, while administrators can support this process by organizing professional development programs focused on effective number sense instruction. Furthermore, establishing school-wide strategies, such as math clubs or mental calculation competitions, can boost

student motivation and interest in the subject. Stakeholders, including parents, should also be involved in this educational journey. Parents can support their children's attitudes by engaging in simple daily activities that involve mathematics, such as comparing prices at the grocery store or measuring ingredients for recipes. Making mathematics enjoyable through math-themed board games and praising positive experiences—while encouraging children not to fear mistakes—can strengthen the school-family collaboration necessary for sustainable student success.

Future research should build upon these findings by employing larger and more heterogeneous samples across different geographical regions and socio-economic backgrounds to enhance generalizability. Future studies should provide more detailed descriptions of demographic characteristics, such as family income and parental education levels, to examine their specific impact on number sense and attitudes. It is also recommended that these studies be replicated at different educational levels, including secondary education, and with various school types. Additionally, investigate the relationships between number sense, mathematical attitudes, and other critical variables such as academic achievement and motivation. Finally, researchers should employ experimental methods to evaluate the actual effectiveness of the specific classroom activities and interventions proposed in this study, thereby assessing their impact on both cognitive and affective domains in a controlled manner.

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