A Non-Parametric Analysis of Interrelationships Among Mathematics Learning Interest Indicators: Kendall's Tau-b and Kendall's W Approaches Among Junior High School Students

Christina Eva Nuryani[1*], Kintoko[2], Kristina Warniasih[3]
1,2,3 Mathematics Education Study Program, PGRI Yogyakarta University*, Indonesia*
**Corresponding author. Email: evanuryani@upy.ac.id*

Abstrak

Sebagian besar penelitian memperlakukan minat belajar matematika sebagai satu konstruk tunggal yang dihubungkan dengan hasil belajar, tanpa lebih dahulu menguji apakah indikator-indikator pembentuknya (perasaan senang, ketertarikan, perhatian, dan keterlibatan) benar-benar saling berkaitan secara statistik. Penelitian ini bertujuan mengisi kekosongan tersebut dengan menganalisis kekuatan hubungan antar-indikator dan tingkat keselarasannya secara keseluruhan. Desain penelitian bersifat kuantitatif korelasional cross-sectional, menggunakan data 53 siswa kelas VII SMP Negeri 7 Yogyakarta yang dipilih melalui simple random sampling. Karena uji normalitas Kolmogorov-Smirnov menunjukkan tiga dari empat indikator tidak berdistribusi normal, analisis dilakukan dengan uji non-parametrik Kendall's tau-b untuk korelasi berpasangan dan Kendall's W untuk konkordansi keseluruhan. Hasil menunjukkan hanya tiga dari enam pasangan indikator yang berhubungan signifikan dengan kekuatan cukup, yaitu perasaan senang-ketertarikan ($\tau b = 0{,}463$), ketertarikan-perhatian ($\tau b = 0{,}281$), dan ketertarikan-keterlibatan ($\tau b = 0{,}258$), sedangkan tiga pasangan lainnya menunjukkan hubungan sangat lemah dan tidak signifikan. Koefisien Kendall's W sebesar 0,264 (signifikan secara statistik) mengindikasikan bahwa keempat indikator memiliki keselarasan yang nyata namun tidak besar. Temuan ini memberikan kontribusi metodologis dan praktis: skor minat belajar yang diagregasi dapat menyamarkan heterogenitas profil siswa, sehingga diagnosis dan intervensi pembelajaran sebaiknya diarahkan pada indikator spesifik, dengan ketertarikan sebagai dimensi penghubung yang paling sentral, bukan pada konstruk minat belajar secara homogen.

Kata Kunci: Kendall's tau-b; Kendall's W; Minat Belajar Matematika; Statistika Non parametrik; Siswa SMP

Abstract

Most studies treat mathematics learning interest as a single composite construct linked to learning outcomes, without first testing whether its constituent indicators, namely enjoyment, attraction, attention, and engagement, are themselves statistically interrelated. This study addresses that gap by examining the strength of pairwise associations among these indicators and their overall concordance. A quantitative, cross-sectional correlational design was employed using data from 53 seventh-grade students at a junior high school in Yogyakarta, selected through simple random sampling. Because the Kolmogorov-Smirnov normality test indicated that three of the four indicators departed from normality, non-parametric tests were applied: Kendall's tau-b for pairwise correlation and Kendall's W for overall concordance. The results show that only three of six indicator pairs were significantly and fairly associated, enjoyment-attraction ($\tau b = 0.463$), attraction-attention ($\tau b = 0.281$), and attraction-engagement ($\tau b = 0.258$), while the remaining three pairs showed very weak, non-significant associations. Kendall's W of 0.264 (statistically significant) indicates that the four indicators exhibit real but modest overall concordance. These findings offer both methodological and practical contributions: aggregated interest scores may obscure heterogeneous student profiles, so diagnosis and instructional intervention should target specific indicators, with attraction serving as the most central connective dimension, rather than treating learning interest as a homogeneous construct.

Keywords: Kendall's tau-b; Kendall's W; Mathematics Learning Interest; Non-parametric_Statistics; Junior High School Students

INTRODUCTION

Mathematical competence does not emerge solely from cognitive capacity; it is shaped jointly by prior knowledge and a constellation of affective and motivational conditions that surround the learning process. Students entering a mathematics lesson with strong prior achievement tend to commit errors mainly at the computational and notational stage, whereas students with moderate to low prior achievement more often falter earlier, in comprehending, interpreting, and translating a problem before they ever reach a procedure, a pattern usually attributed to haste, inattention, and incomplete mastery of the material (Upu et al., 2022). Beyond this cognitive starting point, internal conditions such as motivation, attention, and engagement, together with external conditions such as instructional variety, the social environment, and the psychological climate of the classroom, jointly determine whether a student's mathematical potential is realized (Hasibuan & Faisal, 2025). Family support, the availability of learning resources, and the broader school and community environment add a further external layer that interacts with these internal dispositions (Putri et al., 2025).

Among these internal factors, learning interest occupies a central position because it is both a precursor to engagement and a frequently used diagnostic for explaining uneven achievement across classrooms. A substantial body of research has linked mathematics learning interest to learning outcomes (Andriyani et al., 2025; Tegarwati et al., 2024) and to problem-solving ability (Baiq & Arfini, 2025). When interest is reported as low, the literature consistently associates it with weaker conceptual understanding (Artikel, 2025) and weaker mastery of mathematical concepts more specifically (Fikri, 2025; Putri & Firmansyah, n.d.). These associations recur across grade levels and instructional contexts, which suggests that learning interest functions less as an isolated trait and more as a proxy for several co-occurring affective states.

What constitutes "learning interest," however, is rarely treated as a single, unidimensional quantity in the instruments used to measure it. Sarah et al. (2021) identify curiosity toward engaging material, clarity of teacher explanation, and subject preference as antecedents of interest, alongside motivational drivers such as the desire to demonstrate competence, physical readiness, family attention, household atmosphere, the school environment, teaching strategy, peer influence, and exposure through mass media. Complementary explanations for persistently low interest point to disengagement from the subject matter, weak conceptual grounding, and textbooks that fail to connect mathematics to everyday contexts (Putri, 2023). Instructional choices compound these conditions: interactive media has been shown to raise interest (Wulandari, 2020), and the deliberate selection of varied teaching methods is frequently recommended as a lever for sustaining it (Dewi & Lestari, 2021). Taken together, this literature treats learning interest as a outcome of many converging forces, yet it offers comparatively little evidence on how the indicators that are used to operationalize interest relate to one another internally.

This gap matters because the standard operationalization of mathematics learning interest, following Papendang (2025), decomposes the construct into four indicators, namely a sense of enjoyment, attraction toward the subject, attention during instruction, and behavioral engagement, and instruments built on this structure implicitly assume that the four indicators move together as expressions of one coherent affective state. Most prior studies that employ such instruments proceed directly to relating an aggregate interest score to an external outcome (achievement, problem-solving, conceptual understanding) without first establishing whether the four indicators are themselves statistically associated, and at what strength. Studies examining the internal coherence and pairwise concordance of affective-construct indicators using rank-based, distribution-free methods remain comparatively scarce in the mathematics education literature, even though the ordinal, Likert-type data typical of interest questionnaires are precisely the data type for which such methods were designed. Without this internal check, an aggregate interest score may mask considerable heterogeneity: two students with the same total score could have markedly different profiles across

enjoyment, attraction, attention, and engagement, with consequences for how teachers and schools should design interventions.

The present study addresses this gap directly. Using survey data on mathematics learning interest collected from junior high school students by Tegarwati et al. (2024), this study asks two related questions. First, are the four indicators of mathematics learning interest, namely enjoyment, attraction, attention, and engagement, pairwise associated with one another, and how strong is each association? Second, taken together, how concordant are the four indicators as a set, that is, to what extent do they behave as a single coherent construct rather than as four loosely related dimensions? Because preliminary normality testing indicated that several indicators depart from a normal distribution, both questions are addressed using non-parametric, rank-based statistics, specifically Kendall's tau-b for pairwise association and Kendall's coefficient of concordance (Kendall's W) for overall agreement among the four indicators. This dual non-parametric strategy is methodologically appropriate for ordinal Likert-scale data and, more importantly, yields evidence that is directly actionable: it identifies which indicator pairs are tightly linked and which are practically independent, information that can guide both the refinement of mathematics learning interest instruments and the targeting of classroom interventions toward the specific dimension that is weakest in a given context.

METHOD

This study used a quantitative, cross-sectional correlational design to examine the interrelationship among indicators of mathematics learning interest. The data analyzed were drawn from a mathematics learning interest survey administered to seventh-grade students at SMP Negeri 7 Yogyakarta in 2024 (Tegarwati et al., 2024). A simple random sampling technique was applied within the target classes, yielding a total sample of 53 students from classes VII B and VII C.

Mathematics learning interest was operationalized through four indicators following Papendang (2025): a sense of enjoyment, attraction toward the subject, attention during instruction, and behavioral engagement. These four indicators were measured using a closed-ended questionnaire comprising 21 statements, encompassing both positively and negatively worded items, that had previously been tested for validity by expert judgment and statistical computation. Responses were recorded on a five-point ordinal scale ranging from strongly agree to strongly disagree, and indicator scores were computed as the mean of the relevant items for each respondent.

Prior to hypothesis testing, the assumption of normality was evaluated using the Kolmogorov-Smirnov test for each of the four indicators. Because three of the four indicators (enjoyment, attraction, and attention) did not satisfy the normality assumption, a non-parametric analytical strategy was adopted for all subsequent inferential testing, consistent with recommendations to apply rank-based methods when normality is violated (Roflin & Zulvia, 2021).

Two complementary non-parametric statistics were used to answer the study's two research questions. First, Kendall's tau-b correlation coefficient was computed for each of the six possible pairs among the four indicators to assess the strength and significance of pairwise association, with significance evaluated at $\alpha = 0.05$ (two-tailed). The resulting coefficients were interpreted using the strength-of-association benchmark proposed by Sarwono (2015), in which a coefficient between 0.00 and 0.25 indicates a very weak relationship, between 0.25 and 0.50 a fair relationship, between 0.50 and 0.75 (read here as the conventional 0.50–0.75 band) a strong relationship, between 0.75 and 0.99 a very strong relationship, and a coefficient of 1 a perfect relationship. Second, Kendall's coefficient of concordance (Kendall's W) was computed across all four indicators simultaneously to determine the overall degree of agreement among them as a set, accompanied by a chi-square test of significance with degrees of freedom equal to the number of indicators

minus one. Kendall's W ranges from 0 (no concordance) to 1 (perfect concordance). All statistical computations were performed using IBM SPSS Statistics version 25.

RESULTS AND DISCUSSION

1. Results

Descriptive statistics for the four mathematics learning interest indicators are presented in Table 1. Across the 53 respondents, attention recorded the highest mean score (M = 3.84, SD = 0.46), while attraction recorded the lowest (M = 3.29, SD = 0.49). Enjoyment showed the greatest dispersion among the four indicators (SD = 0.56), indicating that students' self-reported enjoyment of mathematics varied more widely than their attention, attraction, or engagement.

Table 1. Descriptive Statistics of Mathematics Learning Interest Indicators

Indicator	Mean	SD	Min	Max
Enjoyment	3.3396	0.56236	1.75	4.50
Attraction	3.2893	0.48608	1.83	4.67
Attention	3.8428	0.45575	2.67	5.00
Engagement	3.3986	0.37021	2.63	4.38

Before proceeding to correlation analysis, the normality of each indicator's distribution was tested using the Kolmogorov-Smirnov test (Table 2 and Table 3). Enjoyment (p = 0.003), attraction (p = 0.039), and attention (p = 0.008) each yielded a significance value below the 0.05 threshold, indicating departure from normality, whereas engagement (p = 0.200) did not depart significantly from a normal distribution. Because three of the four indicators violated the normality assumption, a non-parametric approach was adopted for all subsequent hypothesis testing, in line with standard practice when this assumption is not met (Roflin & Zulvia, 2021).

Table 2. Kolmogorov-Smirnov Normality Test Output

	Enjoyment	Attraction	Attention	Engagement
N	53	53	53	53
Mean	3.3396	3.2893	3.8428	3.3986
Std. Deviation	0.56136	0.48608	0.45575	0.37021
Test Statistic	0.154	0.125	0.144	0.088
Asymp. Sig. (2-tailed)	0.003	0.039	0.008	0.200

Table 3. Summary of Normality Test Results

No.	Indicator	p-value	Compared to α = 0.05	Conclusion
1	Enjoyment	0.003	Smaller	Not normally distributed
2	Attraction	0.039	Smaller	Not normally distributed
3	Attention	0.008	Smaller	Not normally distributed
4	Engagement	0.200	Larger	Normally distributed

Kendall's tau-b correlation coefficients for each pair of indicators are reported in Table 4, with the corresponding significance decisions summarized in Table 5. Three of the six indicator pairs showed a statistically significant association at $\alpha = 0.05$: enjoyment with attraction ($\tau b = 0.463$, $p < 0.001$), attraction with attention ($\tau b = 0.281$, $p = 0.009$), and attraction with engagement ($\tau b = 0.258$, $p = 0.012$). The remaining three pairs, enjoyment with attention ($\tau b = 0.129$, $p = 0.236$), enjoyment with engagement ($\tau b = 0.153$, $p = 0.139$), and attention with engagement ($\tau b = 0.134$, $p = 0.211$), did not reach statistical significance.

Table 4. Kendall's Tau-b Correlation Matrix Among Indicators

	Enjoyment	Attraction	Attention	Engagement
Enjoyment	1.000	0.463**	0.129	0.153
Attraction	0.463**	1.000	0.281**	0.258*
Attention	0.129	0.281**	1.000	0.134
Engagement	0.153	0.258*	0.134	1.000

*Note: ** Correlation is significant at the 0.01 level (2-tailed). * Correlation is significant at the 0.05 level (2-tailed).*

Table 5. Significance Decisions for Each Indicator Pair

Indicator Pair	p-value	Compared to $\alpha = 0.05$	Decision
Enjoyment - Attraction	0.000	Smaller	Significant
Enjoyment - Attention	0.236	Larger	Not significant
Enjoyment - Engagement	0.139	Larger	Not significant
Attraction - Attention	0.009	Smaller	Significant
Attraction - Engagement	0.012	Smaller	Significant
Attention - Engagement	0.211	Larger	Not significant

Applying Sarwono's (2015) benchmark to the three significant coefficients (Table 6) classifies all of them as fair associations, since each falls within the 0.25-0.50 band: enjoyment-attraction (0.463), attraction-attention (0.281), and attraction-engagement (0.258). The three non-significant pairs all fall below 0.25 and are accordingly classified as very weak. Notably, every coefficient in the matrix is positive, indicating that, to whatever degree two indicators are associated, they move in the same direction; no pair exhibited an inverse relationship.

Table 6. Strength of Association Among Indicator Pairs

Indicator Pair	τb Coefficient	Strength (Sarwono, 2015)
Enjoyment - Attraction	0.463	Fair
Enjoyment - Attention	0.129	Very weak
Enjoyment - Engagement	0.153	Very weak
Attraction - Attention	0.281	Fair
Attraction - Engagement	0.258	Fair
Attention - Engagement	0.134	Very weak

Finally, Kendall's W was computed to evaluate the overall concordance among all four indicators simultaneously (Table 7). The coefficient of concordance was W = 0.264 (χ^2 = 42.023, df = 3, p < 0.001). The associated chi-square test is significant, which formally indicates that the rankings produced by the four indicators are not independent of one another; some degree of shared ordering exists across the 53 respondents. However, the magnitude of W itself, 0.264 on a 0-to-1 scale, indicates that this shared ordering is modest rather than strong.

Table 7. Kendall's W: Mean Ranks and Test Statistics

Indicator	Mean Rank
Enjoyment	2.25
Attraction	1.98
Attention	3.45
Engagement	2.32

Statistic	Value
N	53
Kendall's W	0.264
Chi-Square	42.023
df	3
Asymp. Sig.	0.000

2. Discussion

The pattern of pairwise associations reveals a structure that does not match the implicit assumption behind a single aggregate interest score. Attraction toward mathematics functions as the indicator most consistently linked to the other three: it is significantly and at least fairly associated with enjoyment, attention, and engagement alike. By contrast, enjoyment, attention, and engagement show comparatively little direct association with one another once attraction is set aside, since none of the remaining three pairs reached significance. This positions attraction less as one indicator among four equals and more as a connective dimension through which the other facets of interest appear to relate to each other.

The fair-strength association between enjoyment and attraction (τb = 0.463) is consistent with prior conceptualizations of interest in which curiosity about engaging material and a favorable disposition toward the subject reinforce one another (Sarah et al., 2021); a student who finds mathematics enjoyable is also more likely to report being drawn to it, and the reverse plausibly holds as well. The associations linking attraction to attention and to engagement, though weaker, point in the same direction and are broadly compatible with accounts in which attraction-driven curiosity translates into sustained attention and active participation during instruction (Wulandari, 2020). What the data do not support, however, is an assumption that enjoyment automatically carries over into attention or into engagement, or that attention and engagement co-occur independently of attraction. A student may report enjoying mathematics without necessarily attending closely during lessons, and attentive behavior in class does not, in this sample, reliably predict active engagement, and vice versa. This dissociation is plausible given that enjoyment and attention can be shaped by largely separate proximate causes, classroom atmosphere and teacher delivery for the former (Hanipah et al., 2022), task design and lesson pacing for the latter, even when both ultimately fall under the umbrella label of "learning interest."

The modest Kendall's W (0.264) reinforces this reading at the level of the construct as a whole. A statistically significant but numerically modest concordance means that the four indicators are not interchangeable proxies for one another; ranking students by enjoyment would not reproduce the same ordering as ranking them by engagement, even though some shared tendency exists. This has a direct implication for instrument design and use: composite or average interest scores, by collapsing four indicators with this degree of internal divergence into a single number, may obscure more than they reveal about which

facet of interest is actually weak in a given classroom. Two students with an identical mean interest score could differ substantially in their underlying profile, one strong in enjoyment but weak in engagement, the other the reverse, a distinction that an aggregate score cannot recover.

These findings extend, rather than contradict, the broader literature connecting mathematics learning interest to outcomes such as achievement (Andriyani et al., 2025; Tegarwati et al., 2024) and problem-solving ability (Baiq & Arfini, 2025). That literature has generally treated interest as a single explanatory variable; the present results suggest a more granular reading is warranted; because the four constituent indicators are only partially and unevenly associated, the mechanism by which "interest" influences outcomes may run disproportionately through whichever indicator is dominant in a particular context, for instance attraction, given its centrality in the present correlation structure, rather than through interest as an undifferentiated whole. This is consistent with findings that the antecedents of low interest are themselves heterogeneous, ranging from disengagement with subject matter to textbook design (Putri, 2023), since different antecedents would be expected to act on different indicators rather than uniformly depressing all four at once.

For classroom practice, the implication is that interventions calibrated to a single aggregate interest score may be inefficient. Where attention is identified as the weak indicator, instructional adjustments such as varied teaching methods (Dewi & Lestari, 2021) or interactive media (Wulandari, 2020) target that dimension directly; where attraction is weak, given its connective role in this dataset, interventions aimed at attraction may carry disproportionate benefit for the construct as a whole, since attraction is the indicator most tightly linked to the others. Diagnosing which indicator is weakest before selecting an intervention, rather than relying on a single composite score, is therefore a more defensible basis for instructional decision-making than the literature's prevailing practice would suggest.

A limitation of this study is that the sample was confined to two classes at one junior high school, which constrains the generalizability of the specific coefficients reported here, although the broader methodological point, that indicator-level concordance should be checked before aggregation, does not depend on sample-specific values and is likely to generalize across other operationalizations of multidimensional affective constructs in mathematics education.

CONCLUSION

This study examined whether the four indicators commonly used to operationalize mathematics learning interest, namely enjoyment, attraction, attention, and engagement, are themselves statistically interrelated, using non-parametric tests appropriate for the ordinal, non-normally distributed data typical of interest questionnaires. Kendall's tau-b analysis showed that only three of the six possible indicator pairs were significantly and fairly associated, enjoyment with attraction, attraction with attention, and attraction with engagement, while the remaining three pairs showed only very weak, non-significant associations. Kendall's W confirmed that the four indicators, taken together, exhibit statistically significant but modest concordance ($W = 0.264$), indicating that they behave as related but clearly distinguishable facets rather than as interchangeable expressions of a single underlying state.

These results indicate that mathematics learning interest, as commonly measured, is internally heterogeneous: attraction functions as the indicator most consistently connected to the others, while enjoyment, attention, and engagement are comparatively independent of one another. Practically, this suggests that teachers and schools should examine indicator-level profiles, rather than relying solely on an aggregate interest score, when diagnosing which facet of student interest most needs intervention, and that instrument developers should treat the four indicators as components requiring separate validation rather than as a single homogeneous scale. Future research with larger and more diverse samples, across grade levels and school contexts, would help establish whether the indicator structure observed here, with attraction as the

connective dimension, holds more broadly, and would support the development of a more diagnostically precise instrument for measuring mathematics learning interest.

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