Validity and Reliability of Mathematics Motivation Questionnaire

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Abstract. *This study aims to examine the validity and reliability of a mathematics motivation instrument using Microsoft Excel and Winsteps. This study employed a quantitative approach using a survey method. The participants were 136 students from a high school in Jakarta (grade XI) and a high school in Tangerang (grade X). Data analysis was conducted using the Rasch model and Microsoft Excel. The results indicated that 65 respondents exhibited misfit, as they did not satisfy the Outfit Mean Square (MNSQ), Outfit Z-Standard (ZSTD), and Point Measure Correlation (PTMEA-CORR) criteria, based on responses to 19 items. Furthermore, 71 students (52.2%) met the recommended criteria, while 65 students (47.8%) needed to be excluded, Cronbach's alpha (KR-20) value is 0, 90, the person's confidence value is 0.86 and the item's confidence value is 0.93. Furthermore, Validity test results using Microsoft Excel show calculation results of question items showing $r_{count} > r_{table}$ where all question items are valid. Then the mathematical motivational instrument is said to be valid and has high reliability which has been verified and tested using the Winsteps and Microsoft Excel.*

Keyword: *Mathematics Motivation; Validity; Reliability.*

Abstrak. *Penelitian ini bertujuan untuk menguji validitas dan reliabilitas instrumen motivasi matematika dengan menggunakan Microsoft Excel dan Winsteps. Penelitian ini menggunakan pendekatan kuantitatif dengan metode survei. Partisipan dalam penelitian ini berjumlah 136 siswa yang berasal dari satu sekolah menengah atas di Jakarta (kelas XI) dan satu sekolah menengah atas di Tangerang (kelas X). Analisis data dilakukan dengan menggunakan model Rasch serta bantuan Microsoft Excel. Hasil penelitian menunjukkan bahwa sebanyak 65 responden teridentifikasi sebagai misfit karena tidak memenuhi kriteria Outfit Mean Square (MNSQ), Outfit Z-Standard (ZSTD), dan Point Measure Correlation (PTMEA-CORR) berdasarkan respons terhadap 19 butir instrumen. Selanjutnya, sebanyak 71 siswa (52,2%) memenuhi kriteria kesesuaian (fit) yang direkomendasikan, sedangkan 65 siswa (47,8%) dipertimbangkan untuk dikeluarkan dari analisis lanjutan. Nilai koefisien reliabilitas Cronbach's Alpha (KR-20) sebesar 0,90 menunjukkan tingkat reliabilitas yang tinggi, dengan estimasi reliabilitas person sebesar 0,86 dan reliabilitas item sebesar 0,93. Lebih lanjut, hasil uji validitas menggunakan Microsoft Excel menunjukkan bahwa seluruh butir soal memiliki nilai $r_{hitung} > r_{tabel}$ sehingga seluruh item dinyatakan valid. Dengan demikian, instrumen motivasi matematika yang dikembangkan dinyatakan valid dan memiliki reliabilitas tinggi, yang telah diverifikasi melalui analisis menggunakan Winsteps dan Microsoft Excel.*

Kata Kunci: *Motivasi Matematika, Validitas, Reliabilitas.*

INTRODUCTION

Mathematics is recognized as a very important subject, but the reality is that many students are reluctant to learn mathematics because they perceive it as a difficult subject to understand (Saragih, 2008; Guner, 2020; Rahmad & Wijaya, 2020). Many students complain, even fear, because they find math to be an uninteresting subject, which can reduce their motivation to learn math (Ilhamsyah et al., 2021; Dina et al., 2022). In addition, students often show low participation during learning activities and quickly forget newly learned material, which makes it difficult for them to understand subsequent topics. These conditions ultimately result in a decrease in students' motivation to learn mathematics (Ismail, 2015; Firdaus, 2023)

In relation to these issues, motivation is a key factor influencing learning effectiveness, as motivated students tend to be more engaged, persistent, and enthusiastic in the learning process (Fauziah et al., 2017; Ahmad, 2021) High learning motivation contributes to increased student participation and supports the achievement of optimal learning outcomes. Conversely, low motivation is associated with reduced engagement and weaker academic performance (Hanrahan, 1998; Kong, 2009; Fauziah et al., 2017; Nalevska & Kuzmanovska, 2020). In the context of mathematics learning, motivation plays an essential role in fostering important competencies such as creativity, initiative, and structured thinking. Therefore, strengthening students' motivation is a crucial aspect in supporting successful mathematics learning (Maryam, 2016; Nalevska & Kuzmanovska, 2020; Siregar & Scholar, 2025).

Given its importance, students' mathematics motivation needs to be measured using a valid and reliable instrument to ensure accurate data collection (Galindo-Domínguez et al., 2025). Questionnaires are commonly used for this purpose; however, their effectiveness depends on the extent to which they meet psychometric requirements, particularly validity and reliability (Dewi & Sudaryanto, 2020). However, the accuracy of the measurement depends on the quality of the instrument. Therefore, instruments must meet psychometric requirements, particularly validity and reliability, to ensure that they measure the intended construct appropriately (Matondang, 2009; Yusup, 2018; Dewi & Sudaryanto, 2020; Kane, 2024; Hlynsson et al., 2025). Therefore, careful evaluation of these aspects is essential to ensure that the instrument accurately measures the intended construct.

Previous studies indicate that students' mathematics motivation remains relatively low and is influenced by both internal and external factors. For instance, lack of curiosity and learning initiative, as well as environmental influences such as family and peers, have been identified as key contributors to low motivation. (Wahyuni & Netti 2021; Iqbal et al,. 2021; Iskandar, 2021)

Nevertheless, prior research has generally focused on describing students' motivation levels with limited emphasis on rigorous instrument validation. In addition, studies that integrate Microsoft Excel analysis with the Rasch model using Winsteps to examine both validity and reliability remain limited. Therefore, this study aims to analyze the validity and reliability of a mathematics motivation questionnaire using Microsoft Excel and the Rasch model. The findings are expected to contribute to the development of a more accurate and reliable instrument for measuring students' mathematics motivation.

METHOD

This study employed a quantitative research design using a survey method. The survey approach was used to collect data from respondents through a structured questionnaire (Zaluchu, 2020).

Data were collected using a non-test instrument consisting of a mathematics motivation questionnaire with 19 items (see Table 1). The instrument was developed based on five indicators: intrinsic value, self-regulation, self-efficacy, utility value, and test anxiety. Prior to data collection, the instrument was reviewed by two experts and revised accordingly to ensure its appropriateness. The participants of this study were 136 students from two senior high schools in Jakarta and Tangerang. The questionnaire employed a five-point Likert scale ranging from totally disagree (1) to totally agree (5).

Table 1. Indicators and Guidelines for Scoring on The Instrument

No	Indicators	Definition of Indicators	Statements
1.	*Intrinsic value*	Students feel that mathematics is very valuable for themselves	*I like to learn math* *I noticed learning math was interesting* *I prefer math that challenges me*
2.	*Self-regulation*	Students' propensity to have interaction in activity learning ways from personal experience.	*I put enough effort to learn math* *When I'm having a hard time learning math, I try to understand why* *I exploit strategies that guarantee I learn math well* *I prepared for math quizzes and tests*
3.	*Self-efficacy*	Student belief that they have the abilities and skills needed to succeed in math	*I'm certain it'll work for math projects* *I'm assured i will be able to act on math tests* *I feel I will acquire the knowledge and skills within the math courses* *I feel I can earn a grade of "A" in the math course*
4.	*Utility Value*	Students' perception that mathematics is in person concerning their future life and career	*I think regarding the way to apply the math I'm learning helps me* *I feel about however I will be able to use math I learn* *I feel about how learning math will*

			help me get an honest job *I feel about how learning math can help my career*
5.	*Test anxiety*	Student anxiety during math evaluation or when compared to others	*I'm worried when it's time to take a math test* *I'm nervous regarding however i'll do on the math tests.* *I worry about failing math test* *I'm involved that the opposite students are higher in math.*

The collected data were analyzed using the Rasch model with the assistance of Winsteps software and supported by Microsoft Excel. The Rasch analysis was used to transform ordinal data into interval (logit) values and to evaluate item fit, person fit, and measurement reliability (Sumintono et al., 2014; Hadi & Faradillah, 2019; Trimurti et al., 2024). In addition, Wright Map analysis was used to examine the distribution of item difficulty and respondent ability (Boone, 2016; Feng et al., 2025). Instrument reliability was assessed using Cronbach's alpha, person reliability, and item reliability indices obtained from Rasch analysis, while item validity was examined using correlation analysis with Microsoft Excel. The criteria for evaluating item fit in the Rasch model included Outfit Mean Square (MNSQ), Z-Standard (ZSTD), and Point Measure Correlation(Faradillah & Febriani, 2021; Khairuddin, 2021). The detailed indicators of the instrument, as well as the classification and interpretation of validity and reliability coefficients, are presented in Table 1 to Table 4.

Table 2. Reliability in *Rasch Model*

Statistics	Fit Indices	Interpretation
Cronbach's Alpha (KR-20)	< 0.5	Low
	0.5 – 0.6	Medium
	0.6 – 0.7	Good
	0.7 – 0.8	High
	>0.8	Too High
Item and Person Reliability	<0.67	Low
	0.67 – 0.80	Sufficient
	0.81 – 0.90	Good
	0.91 – 0.94	Very Good
	>0.94	Excellent
Item and Person Separation		A high cutoff worth indicates sensible instrumentality quality as a result of it will determine a bunch of objects and one person.

Table 3. Validity Coefficient (Guilford's Criteria)

Validity Coefficient	Criteria
$0{,}90 \leq r_{xy} \leq 1{,}00$	Very high
$0{,}70 \leq r_{xy} < 0{,}90$	High
$0{,}40 \leq r_{xy} < 0{,}70$	Currently
$0{,}20 \leq r_{xy} < 0{,}40$	Low
$0{,}00 \leq r_{xy} < 0{,}20$	Very low
$r_{xy} < 0{,}00$	Invalid

Table 4. Reliability Coefficient r_{11} (Guilford's Criteria)

Reliability Coefficient r_{11}	Criteria
$r_{11} < 0{,}20$	Very Low
$0{,}20 \leq r_{11} < 0{,}40$	Low
$0{,}40 \leq r_{11} < 0{,}70$	Currently
$0{,}70 \leq r_{11} < 0{,}90$	High
$0{,}90 \leq r_{11} \leq 1{,}00$	Very High

RESULTS AND DISCUSSION

Results

Item Fit

Table 5. Misfit Order of the Items

Item	Measure	Outfit MNSQ (0.5 – 1.5)	Outfit ZSTD (-2.0 - +2.0)	PTMEA-CORR (0.4 – 0.85)
$I15$	-0.36	1.33	2.3	0.62
$I4$	-1.20	1.25	1.6	0.51
$I14$	-0.35	1.18	1.3	0.63

$I3$	0.98	1.18	1.4	0.70
$I5$	-0.72	1.12	0.9	0.59
$I11$	0.06	1.07	0.6	0.66
$I6$	0.38	0.99	0.0	0.71
$I12$	0.36	0.95	-0.3	0.65
$I2$	0.40	0.96	-0.3	0.69
$I9$	0.13	0.88	-0.9	0.70
$I7$	0.28	0.89	-0.8	0.71
$I13$	0.19	0.83	-1.3	0.70
$I1$	0.42	0.81	-1.5	0.72
$I8$	-0.03	0.74	-2.2	0.71
$I10$	0.18	0.69	-2.6	0.75

The results of the Rasch model analysis for item fit are presented in Table 5. Three items (I15, I8, and I10) were identified as misfit based on ZSTD values outside the acceptable range. This finding indicates that most items function appropriately, although a small number of items do not fully conform to the measurement model.

Person Fit

Table 6. Summary of Misfit Order of the Person

School	Total Concern		Total Result		Measure	
A	35		$51-88$		$-0.48-2.90$	
B	30		$46-89$		$-0.20-3.41$	
School	**Outfit MNSQ**		**PTMEA-CORR**		**PTMEA-CORR**	
	Below 0.5	**Above 1.5**	**Below -2.0**	**Above +2.0**	**Below 0,4**	**Above 0.85**
A	22	13	21	18	12	5
B	17	10	24	15	10	8

The results of the person fit analysis are presented in Table 6. A total of 65 out of 136 respondents (47.8%) were identified as misfit, indicating a relatively high proportion of inconsistent response patterns. After excluding misfit data, 71 respondents (52.2%) remained and showed consistent response patterns.

Reliability Test by Winsteps

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SUMMARY OF 136 MEASURED (EXTREME AND NON-EXTREME) Person
-------------------------------------------------------------------------------
|          TOTAL                         MODEL         INFIT        OUTFIT    |
|          SCORE      COUNT    MEASURE   ERROR      MNSQ   ZSTD   MNSQ   ZSTD |
|-----------------------------------------------------------------------------|
| MEAN      68.9      19.0       .97      .34                                 |
| S.D.      11.3        .0      1.25      .29                                 |
| MAX.      95.0      19.0      5.75     1.82                                 |
| MIN.      45.0      19.0      -.88      .26       .12   -5.4    .13   -5.2 |
|-----------------------------------------------------------------------------|
| REAL RMSE    .48 TRUE SD    1.16  SEPARATION  2.43  Person RELIABILITY  .86 |
|MODEL RMSE    .45 TRUE SD    1.17  SEPARATION  2.59  Person RELIABILITY  .87 |
| S.E. OF Person MEAN = .11                                                   |
-------------------------------------------------------------------------------
 Person RAW SCORE-TO-MEASURE CORRELATION = .92
 CRONBACH ALPHA (KR-20) Person RAW SCORE "TEST" RELIABILITY = .90

SUMMARY OF 19 MEASURED (NON-EXTREME) Item
-------------------------------------------------------------------------------
|          TOTAL                         MODEL         INFIT        OUTFIT    |
|          SCORE      COUNT    MEASURE   ERROR      MNSQ   ZSTD   MNSQ   ZSTD |
|-----------------------------------------------------------------------------|
| MEAN     493.4     136.0       .00      .11      1.00    -.3   1.05    -.1 |
| S.D.      37.4        .0       .43      .00       .40    3.0    .52    3.4 |
| MAX.     560.0     136.0       .85      .11      1.93    6.2   2.31    7.5 |
| MIN.     415.0     136.0      -.79      .10       .60   -3.7    .59   -3.8 |
|-----------------------------------------------------------------------------|
| REAL RMSE    .12 TRUE SD     .41  SEPARATION  3.54  Item   RELIABILITY  .93 |
|MODEL RMSE    .11 TRUE SD     .41  SEPARATION  3.85  Item   RELIABILITY  .94 |
| S.E. OF Item MEAN = .10                                                     |
-------------------------------------------------------------------------------
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Picture 1. Output summary statistic pada Winstep

The summary statistics of the Rasch analysis are presented in Picture 1. The person reliability coefficient was 0.86, indicating good consistency of respondents' answers, while the item reliability coefficient reached 0.93, indicating very good item quality. In addition, the Cronbach's alpha (KR-20) value was 0.90, reflecting high internal consistency. The person separation index (2.43) and item separation index (3.54) indicate that the instrument is capable of distinguishing respondents and items into several levels..

Validity test by Microsoft Excel

Table 7. Item Validity Test Results Microsoft Excel

No	Correlation Coefficient	r_{count}	r_{table}	Explanation
1	0,689426	0,9095	0,168	VALID
2	0,638429	0,8372	0,168	VALID
3	0,616932	0,8072	0,168	VALID
4	0,554970	0,7221	0,168	VALID
5	0,609557	0,7969	0,168	VALID
6	0,670857	0,8830	0,168	VALID
7	0,692486	0,9140	0,168	VALID
8	0,710206	0,9396	0,168	VALID
9	0,693208	0,9150	0,168	VALID

10	0,708202	0,9367	0,168	VALID
11	0,649869	0,8532	0,168	VALID
12	0,662869	0,8716	0,168	VALID
13	0,699691	0,9244	0,168	VALID
14	0,728459	0,9664	0,168	VALID
15	0,729356	0,9677	0,168	VALID
16	0,217887	0,2790	0,168	VALID
17	0,275971	0,3539	0,168	VALID
18	0,379733	0,4888	0,168	VALID
19	0,458855	0,5931	0,168	VALID

Source: Primary Data Processed,2022

The results of the item validity test are presented in Table 7. All 19 items were declared valid, as each item had an r_count value greater than r_{table} (0.168). The correlation coefficients ranged from 0.2790 to 0.9677, indicating varying levels of item strength from low to very high.

Reliability Test by Microsoft Excel

Table 8. Microsoft Excel Reliability Test Results

Number of Variance	Total Variance	r_{11}	Explanation
19,24428	128,8622	0,897918	Reliabel

Source: Primary Data Processed, 2022

The results of the reliability test are presented in Table 8. The reliability coefficient (r_{11}) was 0.897918, indicating a high level of internal consistency.

Discussion

The presence of misfit items may be caused by ambiguous wording or overlapping indicators, which can lead to inconsistencies in respondents' interpretations. Similar findings have been reported by Sumintono et al. (2014) and Trimurti et al. (2024), who emphasize that item misfit reflects weaknesses in item construction. From a measurement perspective, misfit items may reduce the accuracy of the instrument. Therefore, these items need to be reviewed and refined to improve the validity of the instrument. This result highlights the importance of careful item development to ensure that each statement accurately represents the construct of mathematics motivation.

Furthermore, the person fit analysis revealed that a considerable proportion of respondents were classified as misfit, indicating inconsistent response patterns and potential deviations from the expected measurement model. This condition may be influenced by limited understanding of questionnaire items, lack of response consistency, or differences in interpreting the construct of mathematics motivation. As noted by Sumintono et al. (2014), person misfit reflects irregular response behavior that may affect data quality. In this regard, the exclusion of misfit data resulted in a more consistent dataset, emphasizing the importance of data screening in ensuring the validity of the analysis. These findings also suggest the need to improve item clarity and provide clearer instructions during data collection to minimize response inconsistency in future studies.

Moreover, These results demonstrate that the instrument has strong reliability and adequate discriminatory power. This finding is consistent with previous studies (Mohamad et al., 2015; Zayrin et al., 2025), which state that high reliability coefficients indicate stable and consistent measurement. However, the presence of misfit respondents suggests that reliability alone is not sufficient, and data quality must also be ensured through proper screening and instrument refinement.

In addition, this finding confirms that all items are capable of measuring the intended construct of mathematics motivation. These results are consistent with Dewi & Sudaryanto, 2020, , who state that items are considered valid when their correlation coefficients exceed the critical value. Despite all items being statistically valid, the variation in coefficient values suggests differences in item quality. Therefore, items with lower correlations may still require improvement to enhance the overall effectiveness of the instrument.

Building on these validity findings, the reliability analysis further indicates that the instrument produces stable and consistent measurements. This is in line with Ayunita (2018), who states that a reliability coefficient above 0.70 indicates a reliable instrument. From an analytical perspective, the high reliability also supports the findings from the Rasch analysis, demonstrating consistency across different analytical approaches.

Overall, the findings of this study demonstrate that the instrument produces stable and consistent measurements, as supported by high reliability coefficients across different analytical approaches. Therefore, the mathematics motivation questionnaire can be considered valid and reliable. However, the presence of misfit items and respondents indicates that continuous refinement remains necessary, particularly in improving item clarity and response consistency, to ensure higher measurement accuracy in future applications.

CONCLUSION

This study aimed to examine the validity and reliability of a mathematics motivation questionnaire using Rasch model analysis with Winsteps and statistical analysis with Microsoft Excel. The findings indicate that the instrument demonstrates acceptable psychometric properties, with several important considerations. The Rasch analysis showed that 65 out of 136 respondents (47.7%) were classified as misfit based on the Outfit Mean Square (MNSQ), Z-Standard (ZSTD), and Point Measure Correlation (PTMEA-CORR) criteria. It is important to emphasize that this result refers to respondents, not items. These misfit responses indicate inconsistencies in answering patterns, which may affect the accuracy of measurement. After excluding the misfit respondents, 71 respondents (52.2%) were identified as fitting the model, indicating that the remaining data are sufficiently consistent for analysis.

In terms of reliability, the instrument demonstrates high internal consistency. The Cronbach's alpha (KR-20) value obtained from the Rasch analysis is 0.90, while the reliability coefficient calculated using Microsoft Excel is 0.897918. Both values fall into the high to very high category, indicating that the instrument is stable and consistent in measuring students' mathematics motivation. Furthermore, the validity test results using Microsoft Excel indicate that all 19 items have correlation coefficients (r_{count}) greater than the critical value (r_{table} = 0.168), confirming that all items are valid and capable of measuring the intended construct.

In conclusion, the mathematics motivation questionnaire can be considered valid and reliable for measuring students' mathematics motivation. However, the presence of a substantial number of misfit respondents suggests that caution is needed in interpreting the results. Future studies are recommended to improve item clarity and strengthen data collection procedures in order to minimize inconsistent responses and enhance the overall quality of the instrument.

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