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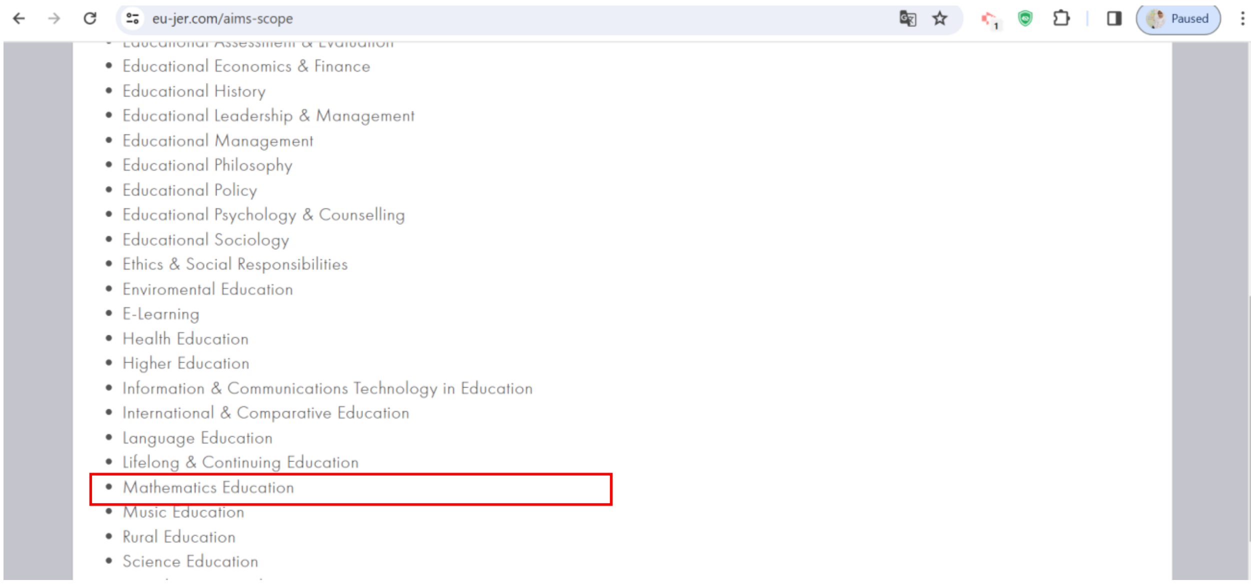

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Samsul Maarif <samsul_maarif@uhamka.ac.id> Jul 21, 2023, 8:11 AM

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We hope that this article can be considered for entry into the next stage.

Kind Regard
Dr. Samsul Maarif, M.Pd.
Lecturer-Mathematics Education
Faculty of Teacher Training and Education
University of Muhammadiyah Prof. DR. HAMKA, Indonesia
telephone: 0856 7141 763
e-mail: samsul_maarif@uhamka.ac.id
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Congratulations! Your paper has passed the test of plagiarism. We have completed the preliminary review for your manuscript entitled "A Psychometric Validation of the Sociomathematical Norm Scale for Senior High School Students in Mathematics Learning" (Manuscript EU-JER ID#23062603062941). It is suitable for our journal's scope. We have sent your paper to the referees to evaluate.

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Editor - European Journal of Educational Research · Thu, Aug 24, 6:06 PM (1 day ago)

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Dear Dr. Samsul Maarif,
Congratulations! After a thorough double-blind review, I am pleased to inform you that your manuscript entitled "A Psychometric Validation of the Sociomathematical Norm Scale for Senior High School Students in Mathematics Learning" (Manuscript EU-JER ID#23062603062941) can be published on condition that corrections are made.
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telephone: 0856 7141 763
e-mail: samsul_maarif@uhamka.ac.id
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Kind Regard

Dr. Samsul Maarif, M.Pd.
Lecturer-Mathematics Education
Faculty of Teacher Training and Education
University of Muhammadiyah Prof. DR. HAMKA, Indonesia
telephone: 0856 7141 763
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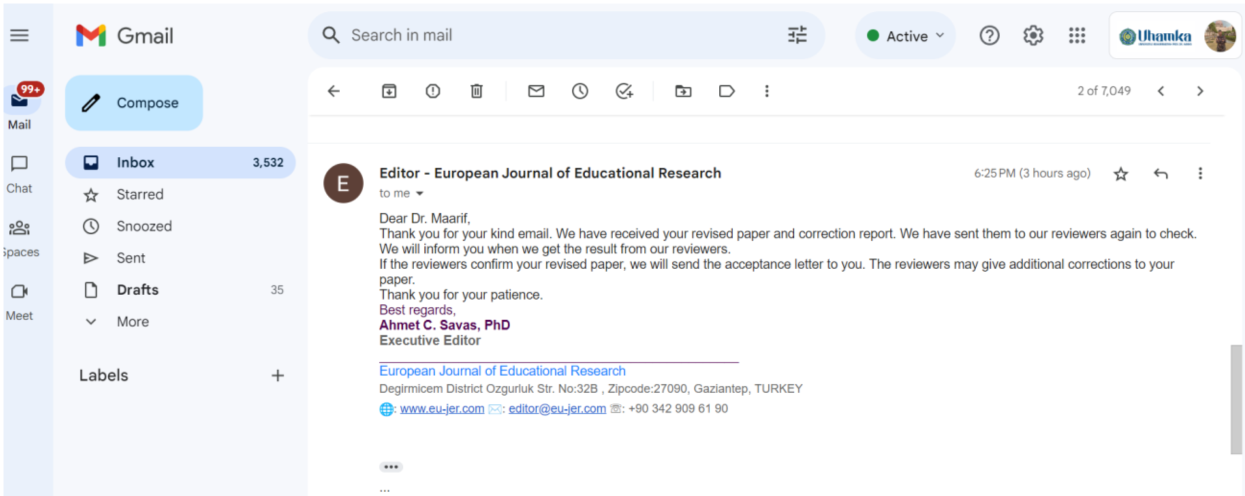

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HASIL REVIU DARI REVIEWER I

A Psychometric Validation of the Sociomathematical Norm Scale for Senior High School Students in Mathematics Learning

Abstract: The importance of sociomathematical norms in learning mathematics must be developed in all elements. One of the essential elements to be developed is an instrument to measure sociomathematical norms in learning mathematics. This study aims to create and verify the psychometric validity of the sociomathematical norm scale. This research used a survey method with 505 senior high school students from Jakarta and West Java as respondents. The results showed that 25 items had convergent validity, with a loading factor value of > 0.700, meaning they could be declared valid. Concurrent validity indicates that each socio-mathematical norm indicator is valid as a whole. Discriminant validity shows that the AVE value on the diagonal is higher than the other values, so each item is declared valid. It was concluded that each item of socio-mathematical instrument norms has accuracy in its measurement function. The reliability test shows that each socio-mathematical norm item is declared reliable. The reliability value of the sociomathematical norm item is 0.99, and the person's reliability is 0.86. Thus, the instruments developed can measure socio-mathematical norms in learning mathematics.

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Keywords: *Developments Scale; learning of mathematics; RASCH Model; sociomathematical norms*

Introduction

Learning mathematics is an activity that does involve not only the process of thinking individually but also a collective action in social interaction (Dickes et al., 2020; Güven & Dede, 2017; McClain & Cobb, 2001; Yackel & Rasmussen, 2003). Social interaction in teaching and learning mathematics determines cognitive development through a group communication process that goes hand in hand (Widodo et al., 2019, 2023). Therefore, it is necessary to develop an in-depth study of the importance of social interaction norms in mathematics learning, known as sociomathematical norms (Maarif et al., 2022; Yackel & Cobb, 1996). Sociomathematical norms are normative understandings in the learning process of differences and the effectiveness of mathematical thinking to build mathematical knowledge (Denton, 2017; Lim et al., 2023). Others revealed that sociomathematical norms as an attitude to consider explanations for different mathematical answers received by students (Code et al., 2016; Kang & Kim, 2016; Savuran & Akkoç, 2021). Sociomathematical norms will appear when there are differences in perceptions, ways, mindsets, arguments, expectations, and obligations that are in discussion. However, they can be neutralized through negotiations to share (Baki & Kilicoglu, 2023). This sharing process makes students effective in understanding math problems so that each student can take information from one another. The practical discussion will find a middle point in the differences in perceptions to understand a mathematical problem. Accuracy, efficiency, and motivation in solving mathematical problems can occur in learning (Arroyo et al., 2014).

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Sociomathematical norms in learning mathematics are an essential part to be developed to discipline students in complying with the rules of the learning interaction process by respecting each other's opinions (Biza et al., 2015; Kang & Kim, 2016; Stephan, 2020; Widodo et al., 2020). Furthermore, sociomathematical norms can train cooperation between students in solving mathematical problems through sharing ideas (Fukawa-Connelly, 2012). In addition, with strong sociomathematical norms, students can explain, justify, and argue for solutions obtained in solving math problems (Francisco, 2013).

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Sociomathematical norms result from forming self-confidence, attitude values, and individual arguments related to mathematics as a learning activity process (Apsari et al., 2020; Putri et al., 2015; Yun & Kim, 2015). In addition, sociomathematical norms can be developed through various mathematics learning activities that are interactive between individuals by emphasizing active collaboration (Levenson et al., 2009; Morrison et al., 2021). The teacher's role in developing sociomathematical norms includes being a facilitator and directing students to develop the ability to represent values, accuracy, and thoroughness in determining answers, efficiency, and writing solutions with confidence (Maarif et al., 2022; Pang, 2000).

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Sociomathematical norms are mathematical activities in learning which are characterized by: experience of mathematics, explanation of the mathematics, mathematical difference, mathematical communication, mathematical effectiveness, and mathematical insight (Heyd-Metzuyanim, 2015; Ningsih & Maarif, 2021; Widodo et al., 2020; Zembat & Yasa, 2015). In the process of learning mathematics, activity experience is needed. The intended mathematics experience is students' experience in understanding written mathematical ideas, which can then be explained systematically (Kang & Kim, 2016). Knowledge of mathematics can train students to construct beliefs about the arguments expressed when solving mathematical problems (Thompson, 2013; Zhou et al., 2021). Explaining the material being studied in mathematics learning activities is very much needed. That is necessary for developing sociomathematical norms, namely the explanation of mathematics (Matranga & Silverman, 2022). Description of mathematics is urgently required when learning activities are taking place to foster students' confidence in their understanding of the mathematical concepts they are learning (Maarif et al., 2020). Explanation of mathematics can provide inferences about descriptions of mathematical operations and provide a valid way of specifying a mathematical sentence needed in compiling ideas to a conclusion (Baker, 2009; Wylie & Chi, 2014).

There are often differences in thinking between students in learning mathematics. To bridge these differences in thinking, a method is needed to find common ground between the ideas expressed. Sociomathematical norms allow students to learn how to deal with differences in thinking in mathematical problems (Lim et al., 2023). We can view mathematical differences as a positive side for developing students' thinking so that the analysis of mathematical problems becomes more profound and comprehensive (Fukawa-Connelly, 2012). Mathematical differences can be analyzed by examining the similarities and differences in ideas from several alternative solutions, which are then compared to find the best solution (Zembat & Yasa, 2015).

Sociomathematical norms can be seen in how students develop mathematical communication of mathematical concepts both orally and in writing (Gearing & Hart, 2019; Kang & Kim, 2016). In learning mathematics, mathematical communication can be seen in how students express mathematical ideas, represent mathematical problems in images, discuss concepts coherently, and understand ideas in a language that is easy to understand (Lomibao et al., 2016). In addition, mathematical communication is also intended to see student explanations in acting to validate procedures or steps for solving mathematics systematically, both orally and in writing (Brendefur & Frykholm, 2000).

In learning mathematics, effective action is needed to understand and solve the mathematical problems being studied. For this reason, one of the values developed in the sociomathematical norm includes mathematical effectiveness (Ningsih & Maarif, 2021). When students encounter learning obstacles, practical steps are needed to solve problems with the right ideas (Maarif et al., 2019). The value of mathematics effectiveness will lead students to determine practical actions from several alternative solutions in solving a mathematical problem (Svensson & Wester, 2022).

Commented [A6]: In the introduction, the authors introduced several concepts, but they did not clarify the research problem. What are the shortcomings of previous studies, and what was the need for conducting this research?

Solving problems in learning mathematics requires the maturity of knowledge based on a thorough understanding of the material being studied (Abramovich et al., 2019). Therefore, to solve a mathematical problem, mathematical insight is needed in developing sociomathematical norms (Maarif et al., 2022; Widodo et al., 2019, 2020). Students need various sources of information to construct and explain ideas in a discussion process (Kwon et al., 2011). Sources of information are not only obtained from their knowledge of other people's opinions to be used as material for mathematical analysis (McNamara, 2017). Thus, the process of forming sociomathematical norms can be appropriately embedded.

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Several different studies have focused on research on sociomathematical norms and how they are implemented in classroom learning by teachers and students (McClain & Cobb, 2001; Sánchez & García, 2014), identification of the elements forming sociomathematical norms (Maarif et al., 2022); and observation of sociomathematical norm indicators (Widodo et al., 2020). Referring to the several research perspectives carried out as a hierarchical research framework, the researchers have provided some information that the importance of sociomathematical norms in learning mathematics needs to be developed in all elements. One crucial element to create is an instrument in the form of a questionnaire to measure sociomathematical norms in learning mathematics.

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From the description above, this study aims to develop and verify the psychometric validity of the sociomathematical norm scale. Sociomathematical norm instruments are adapted from aspects that have been developed by previous research, which include elements of the experience of mathematics (MEx), explanation of mathematics (MMEp), the mathematical difference (MD), mathematical communication (MC), mathematical effectiveness (MEf), and mathematical insight (MI) (Kang & Kim, 2016; Widodo et al., 2020; Yackel & Cobb, 1996). This instrument can be used to strengthen the process of student competency in determining norms in learning mathematics. In addition, the instrument can be used as a reference for further research on developing sociomathematical norms in mathematics learning.

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Methodology

Research Design

This research develops sociomathematical norm instruments by adapting aspects produced by Kang & Kim (2016), Widodo et al. (2020), and Yackel & Cobb (1996), including parts of MEx, MEp, MD, MC, MEf, and MI. Items are developed concerning these aspects. Furthermore, the instrument was validated and tested for reliability with a survey method of senior high school students.

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Participant and Data Collection

Participants in this study were senior high school students who voluntarily filled out the sociomathematical norm questionnaire. The questionnaire instrument was distributed via Google form, complete with a consent letter to participate as a respondent. This research involved 505 high school students spread across the provinces of DKI Jakarta (80.4%) and West Java (19.4%). This follows the minimum sampling requirement to validate the instrument with at least 150 to 200 respondents (Kim, 2023). Data was collected using a survey of 505 respondents who voluntarily filled out a questionnaire using the Google form platform from 20 December 2022 to 20 January 2023.

Instrument

The sociomathematical norm instrument was developed adapting by Kang & Kim (2016), Widodo et al. (2020), and Yackel & Cobb (1996), which includes Indicator Instrument indicators: MEx, MEp, MD, MC, MEf, and MI. MEx is defined as students being able to contribute to careful discussion activities in learning mathematics. MEp means that students can understand and explain ideas systematically in problem-solving. Furthermore, MD can be interpreted as students being able to compare the similarities and differences of several alternative problem-solving solutions to get the best solution. The next indicator is MC defines students' ability to understand and express a statement by using language that is straightforward to understand. MEf can be interpreted as constructing the most effective alternative solutions and explaining them in plain language. The latter MI broadly refers to various sources of information and interaction in discussing mathematical problems.

The questionnaire consisted of 28 items using a Likert scale of 4 items. The score of each indicator is obtained by finding the average value of each question representing the dimension. Items are developed by referring to the operational definition of these aspects. Furthermore, the item items are validated by experts with academic positions as associate

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professors and doctoral degrees covering grammar, vocabulary, and content validity of the specified indicators and some input from experts as material for consideration for revising the developed instrument. The distribution of items based on each hand can be seen in Table 1.

Table 1. Indicators and Coding (Total Items=28)

Indicators	**Statement Item Numbers**	**Statement Item Codes**	**Sum of Items**
Mathematical Experience (MEx)	1,2,3,4,5,6	MEx1, MEx2, MEx3, MEx4, MEx5, MEx6	6
Mathematical Explanation (MEp)	7,8,9,10	MEp1, MEp2, MEp, MEp3, MEp4	4
Mathematical Difference (MD)	11,12,13,14	MD1, MD2, MD3, MD4	4
Mathematical Communication (MC)	15,16,17,18,19,20	MC1, MC2, MC3, MC4, MC5, MC6	6
Mathematics Effectiveness (MEf)	21,22,23,24	MEf1, MEf2, MEf3, MEf4	4
Mathematical Insight (MI)	25,26,27,28	MI1, MI2, MI3, MI4	4

Statistical Data Analysis

Statistical data analysis was performed using IBM SPSS Statistics 25, WINSTEPS Version 5.1.4.0, AMOS 22.0, and SmartPLS 4 software. Descriptive statistical analysis was performed to see an overview of the data's characteristics, including percentage, average and standard deviation. To analyze construct validity, convergent validity, discriminant, and concurrent validity. Furthermore, to test the reliability of sociomathematical norm instruments, RASH analysis, confirmatory factor analysis, and consistent internal analysis were used.

RASCH model analysis was performed using WINSTEPS Version 5.1.4.0 software. Much analysis of the RASCH model was carried out to analyze the construct validity of a questionnaire (Tabatabaee-Yazdi et al., 2018). An instrument is said to be valid if the research data that has been collected follows the model with constructs based on the covariance between items and the causes of item responses (Atmoko et al., 2022; Kim, 2023). RASCH model analysis was conducted on sociomathematical norm instruments to determine RASCH model analysis, construct validity, item difficulty parameters, separator index, and reliability index. Calculation of the mean square value (MNSQ) is performed to show the suitability of the model fit and determine an item according to the assumption of unidimensionality. Suppose the average infit MNSQ value is between 0.5 and 2.0 (Kandel et al., 2020; Matheny & Clanton, 2020; Muslihin et al., 2022), and the point-measure correlation value is more than 0.4 (Ghazali et al., 2019; Khamis et al., 2014; Kim, 2023). The instrument is considered a model assessed at the appropriate level and productive for measuring rating scales (Fan et al., 2022; Kim, 2023; Muniandy et al., 2023; Muslihin et al., 2022). To indicate the instrument item difficulty parameter, it can be shown that a higher logit value is interpreted as having an item difficulty level, and a low logic value indicates it is easier. The item response curve verifies the goodness of fit value of the category response with a Likert scale of 4. If the SI value is more than 2.0, then the unidimensionality of the item is appropriate, and RI is more than equal to 0.80, indicating internal scale consistency (Kim, 2023).

Confirmatory factor analysis was performed using IBM SPSS Statistics 25 and AMOS 22.0 software. Confirmatory factor analysis was carried out by constructing the equation model structure. Model fit was analyzed according to the criteria if $\chi 2/df \leq 3.0$, comparative fit index (CFI) ≥ 0.90, Tucker–Lewis index (TLI) ≥ 0.90, incremental fit index (IFI) ≥ 0.90, adjusted fit index (AGFI) ≥ 0.80, and the root mean square error of approximation (RMSEA) ≤ 0.08 criteria are met, the model is considered suitable (Widodo et al., 2020).

Convergent validity analyses were conducted using SartPLS 4 software with criteria if the loading factor values of > 0.7 (Cheah et al., 2018; Purnomo et al., 2020; Webb et al., 2017; Wigert, 2013). Concurrent validity was carried out using SmartPLS with the Average Variance Extracted (AVE) criterion value > 0.5 (Cheah et al., 2018; Hermanda et al., 2019; Wong, 2013). Furthermore, the Discriminant Validity test is carried out by looking at the Fornell & Larcker Criterion value by assessing the AVE value on the diagonal with higher values below (Ab Hamid et al., 2017; Karakus et al., 2021; Purwanto et al., 2021).

Analysis of the reliability of the sociomathematical norm instrument items was carried out using SmartPLS 4 software. To see the level of reliability, it was carried out using the RASCH model analysis. Reliability testing is carried out by looking at Cronbach's Alpha and Composite Reliability values with the criteria if the Cronbach's Alpha values are > 0.7 and Composite Reliability > 0.7, then the instrument items are said to be reliable (Kaur et al., 2012).

Results

General Characteristics of Participant

This research involved 505 senior high school students spread across the provinces of DKI Jakarta (80.4%) and West Java (19.4%). All study participants were divided by gender and school level, which included grades X and XI as shown in Table 2.

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Table 2. Participant Demographics

Respondent		frequency	Percent (%)
Gender	Male	259	51.3
	Female	246	48.7
	Total	505	100
Province	DKI Jakarta	406	80.4
	West Java	99	19.6
	Total	505	100
Grade	10th	350	69.3
	11th Science	85	16.8
	11th Social Science	70	13.9
	Total	505	100

Construct Validity Base on Rasch Model

The results of the analysis of the RASCH model of the sociomathematical norm instrument involving 505 respondents are shown in Table 3.

Table 3. Item Difficulty Measures and Statistical Fit Sociomathematical Norms Applied in the RASCH Model Analysis

Items Number	Items Statement	Items Code	Measure	Infit MNSQ	Outfit MNSQ	PT-Measure Corr.

Items Number	Items Statement	Items Code	Measure	Infit MNSQ	Outfit MNSQ	PT-Measure Corr.
1	I paid attention to the teacher while explaining the material	MEx1	-1.54	0.74	0.73	0.51
2	I can show enthusiasm when learning mathematics with an active attitude during learning	MEx2	-0.45	0.79	0.78	0.57
3	I can solve math problems correctly during learning	MEx3	0.25	0.86	0.86	0.59
4	I never paid attention to the teacher while explaining the material	MEx4	-1.03	1.46	1.46	0.35
5	I am passive and do not show enthusiasm during learning	MEx5	0.08	1.36	1.39	0.47
6	I could not solve math problems correctly during the lesson	MEx6	0.64	0.99	1.02	0.60
7	I can understand ideas/arguments from solutions given by teachers of math problems	MEp1	-0.48	0.72	0.70	0.58
8	I accept ideas/arguments expressed by other students	MEp2	-0.98	0.71	0.71	0.45
9	I have no difficulty expressing ideas/arguments to solve mathematical problems in a structured way	MEp3	0.71	0.76	0.77	0.57
10	I have difficulty understanding the ideas/arguments given by the teacher or other students in solving math problems	MEp4	0.91	0.93	0.95	0.55
11	I work on every problem given by the teacher using the solution from myself	MD1	0.40	0.93	0.94	0.44
12	I am happy when there are differences of opinion conveyed by other students in the class	MD2	-0.55	0.95	0.97	0.58
13	I am unable to accept the diversity of ideas/arguments from other students	MD3	-0.39	1.04	1.03	0.41
14	I am waiting for solutions from other students in working on the questions given by the teacher	MD4	1.16	1.09	1.13	0.48

Items Number	Items Statement	Items Code	Measure	Infit MNSQ	Outfit MNSQ	PT-Measure Corr.
15	I can understand the material presented by the teacher with one explanation	MC1	0.87	1.10	1.14	0.47
16	When the teacher asks me a question, I can respond or answer with the right answer	MC2	0.61	0.78	0.79	0.58
17	I ask questions when I don't understand the material presented by the teacher	MC3	-0.55	1.11	1.10	0.48
18	I find it difficult to understand the material delivered by the teacher even though the explanation is repeated	MC4	-0.85	1.27	1.35	0.18
19	I am not able to give responses or answers appropriately when the teacher asks me questions	MC5	0.93	0.78	0.78	0.57
20	I don't ask questions when I don't understand the material presented by the teacher	MC6	0.12	1.12	1.13	0.54
21	can find an easier solution to solving math problems	MEf1	0.40	0.95	0.95	0.51
22	I can explain the problem-solving solutions I find to other students appropriately	MEf2	0.39	0.79	0.77	0.56
23	I am not able to explain the solution to the problem solving that I find to other students appropriately	MEf3	0.92	0.73	0.75	0.57
24	I have no interest in finding solutions to math problems	MEf4	0.66	1.07	1.09	0.62
25	I tried to find various solutions from different sources during the discussion	MI1	-1.05	0.98	0.97	0.43
26	I feel happy when learning mathematics applies the discussion system because I will get various solutions	MI2	-1.00	1.19	1.17	0.43
27	I help other students who have difficulty doing math problems	MI3	0.07	1.03	1.03	0.54

Items Number	Items Statement	Items Code	Measure	Infit MNSQ	Outfit MNSQ	PT-Measure Corr.
28	I am not happy if my group mates do not accept my opinion	MI4	0.13	1.66	1.66	0.24

Note: MNSQ = Mean Squared; PT-Measure CORR. = Point-Measure Correlation

Table 3 shows that the MNSQ infit value for each item lies between 0.71 to 1.66 (with the criteria for an average MNSQ infit value being from 0.5 to 2.0), so 28 items are suitable for measuring the sociomathematical norm scale. Furthermore, table 2 shows the correlation value of the 24 items indicating more than 0.4, which means that the items can be used to measure the sociomathematical norm scale. At the same time, items with MEx4, MC4, and MI4 codes have a correlation value of less than 0.4. Nevertheless, the four items have MNSQ values following the criteria. So, overall, 28 items are considered to fulfill the model assessed at an appropriate and productive level for measuring the sociomathematical norm scale.

Furthermore, it shows each item's parameter difficulty by analyzing the logit value, as shown in Figure 1.

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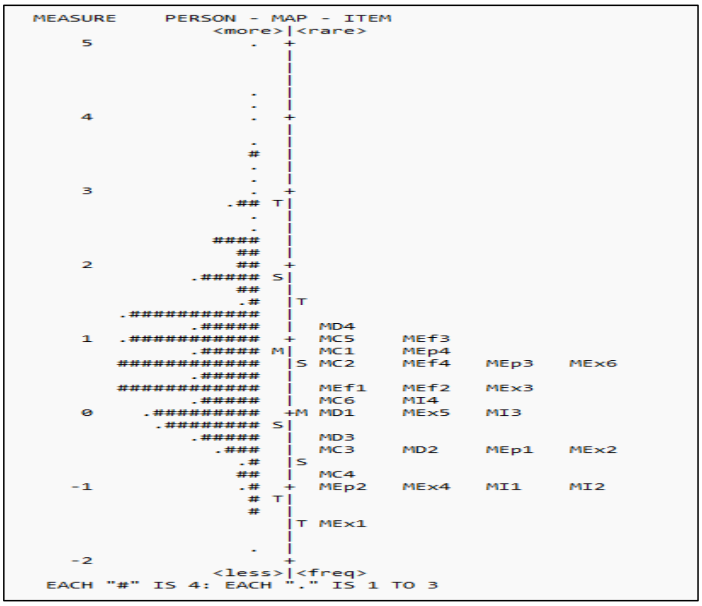

Figure 1. Person Item Map Sociomathematical Norm

Figure 1 shows the logit value of each item of the sociomathematical norm instrument. Items with code MEx1 with the editorial "I have paid attention to the teacher while explaining the material" are the lowest items so they have a low difficulty level or are easy for respondents to answer. The item with the MD4 code with the editorial "I am waiting for solutions from other students in working on the questions given by the teacher" has the highest logit value, meaning that the respondent has difficulty being answered. Overall, Figure 1 shows the logit value of each item, which is equally distributed in terms of the problem.

To verify the goodness of fit value of the category response, it is shown through the item response curve, as shown in Figure 2.

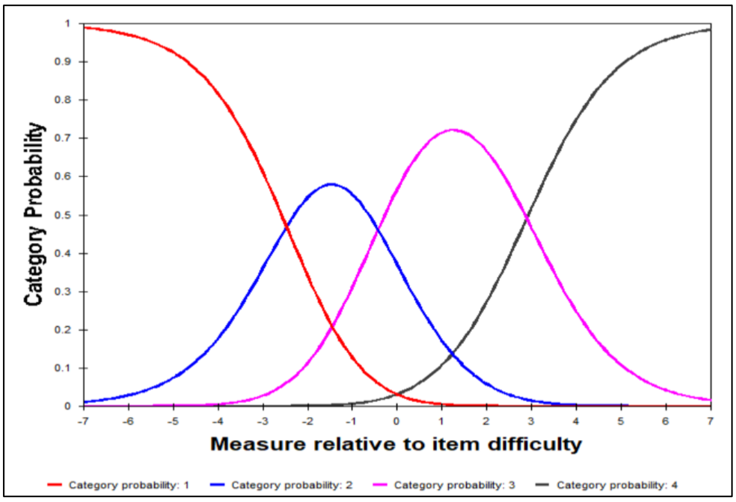

Figure 2. Response Item Category Curve

Figure 2 shows the sociomathematical norm curve's value, consisting of a Likert scale with four answers on the appropriate item response category curve. It can be seen that the rating scale looks different in each category, and there is an interaction between the scales, which indicates a relatively consistent interval scale.

Confirmatory Factor Analysis

The confirmation model for the sociomathematical norm factor can be seen in the following Figure 3. The results of the analysis of the norm sociomathematical factor confirmation model show $\chi 2/df = 0.971 \leq 3.0$, CFI = $0.935 \geq 0.90$, TLI = $0.912 \geq 0.90$, IFI = $0.905 \geq 0.90$, AGFI = $0.914 \geq 0.80$, and RMSEA) = $0.0036 \leq 0,08$. These results show that the model is at a suitable validation level.

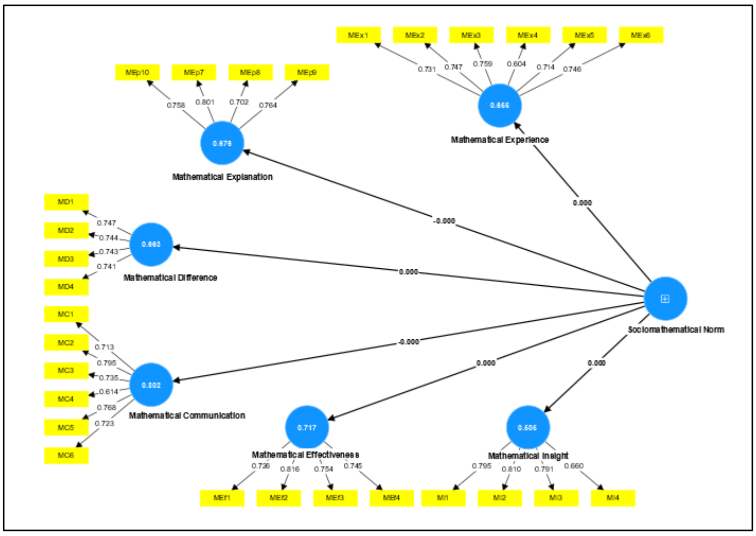

Figure 3. The confirmatory Factor Analysis of the Sociomathematical Norm Model with SmartPLS

Test of Validity: Convergent, Discriminant, and Concurrent

To analyze the convergent validity of the sociomathematical norm items is carried out by analyzing the factor loading of each item. Table 4 shows the results of the factor loading analysis for each item.

Table 4. Results of Convergent Validity Analysis of Sociomathematical Norm Instruments

Numbers Item	Items Code	Outer Loading	Explana tion	Numbers Item	Items Code	Outer Loading	Explanation
1	MEx1	0.731	V	15	MC1	0.713	V
2	MEx2	0.747	V	16	MC2	0.795	V
3	MEx3	0.759	V	17	MC3	0.735	V
4	MEx4	0.604	NV	18	MC4	0.614	NV
5	MEx5	0.714	V	19	MC5	0.768	V
6	MEx6	0.748	V	20	MC6	0.723	V
7	MEp1	0.758	V	21	MEf1	0.720	V
8	MEp2	0.801	V	22	MEf2	0.816	V
9	MEp3	0.702	V	23	MEf3	0.754	V
10	MEp4	0.764	V	24	MEf4	0.745	V
11	MD1	0.747	V	25	MI1	0.795	V
12	MD2	0.744	V	26	MI2	0.810	V
13	MD3	0.743	V	27	MI3	0.791	V
14	MD4	0.741	V	28	MI4	0.660	NV

Note: V= Valid and NV=Not Valid

Table 4 shows that of the 28 items of the sociomathematical norm instrument, 25 items have a loading factor value > 0.700, which means they can be declared valid. While the three items, which include MEx4, MC4, and MI4, have a factor loading value of <0.700 even though each factor loading value is more than 0.600, which means that the three items are not valid. Furthermore, to show the validity for each item by showing AVE, as shown in Table 5.

Table 5. Concurrent Validity Analysis with Average Variance Extracted (AVE)

Indicators	**AVE**	**Rule of thumb**	**Explanation**
MEx	0.571	> 0.500	V
MEp	0.573	> 0.500	V
MD	0.553	> 0.500	V
MC	0.574	> 0.500	V
MEf	0.579	> 0.500	V
MI	0.678	> 0.500	V

Note: V=Valid

Table 5 shows the AVE value for each indicator of the socio-mathematical norm > 0.500, which means that each indicator can be considered valid. Thus, the instrument is supported by each item that can measure each indicator. Furthermore, discriminant validity analysis is carried out to ensure that each concept from each latent model is different from the other variables. Validity testing is conducted to determine how precisely a measuring instrument performs its measurement function. The discriminant validity results using the Fornell & Larcker criterion values can be seen in Table 6.

Table 6. Discriminant validity: Fornell & Larcker criterion

	MC	**MD**	**MEf**	**MEx**	**MEp**	**MI**
MC	0.727					
MD	0.692	0.744				
MEf	0.721	0.672	0.761			
MEx	0.642	0.560	0.603	0.719		
MEp	0.675	0.611	0.664	0.640	0.757	
MI	0.581	0.559	0.558	0.444	0.461	0.767

Table 6 shows the Fornell & Larcker Criterion values on the diagonal with higher values below so that it can be concluded that each item of the sociomathematical norm instrument has accuracy in its measurement function. In addition, table 7 shows the correlation between sociomathematical norm indicators showing a significant correlation.

Table 7. Correlation Between Sociomathematical Norm Indicators

Correlation Between Indicators	**r**	**p-value**	**Interpretation**
MEx <=> MEp	0.640	<0.000	Sig
MEx <=>MD	0.560	<0.001	Sig
MEx <=>MC	0.642	<0.000	Sig
MEx <=> MEf	0.603	<0.000	Sig
MEx <=> MI	0.444	<0.001	Sig
MEp <=> MD	0.611	<0.001	Sig
MEp <=> MC	0.675	<0.000	Sig
MEp <=> MEf	0.684	<0.000	Sig
MEp <=> MI	0.641	<0.000	Sig
MD <=> MC	0.692	<0.000	Sig
MD <=> MEf	0.627	<0.000	Sig
MD < => MI	0.559	<0.001	Sig
MC <=> MEf	0.721	<0.000	Sig
MC <=> MI	0.581	<0.001	Sig
MEf <=> MI	0.558	<0.001	Sig

Note: Sig = Significant

Table 7 above shows that each sociomathematical norm indicator has a positive correlation. This shows that each indicator contributes positively to the sociomathematical norm. Thus, the developed indicators can be used to measure sociomathematical norms.

Test of Reliability

Instrument reliability testing was conducted by looking at Cronbach's Alpha and Composite Reliability values. The results of reliability testing can be seen in Table 8.

Table 8. Result of Reliability Test

Indicators	**Cα**	**CR**	**Rule of thumb**	**Explanation**
MEx	0.750	0.752	> 0.700	Rel.
MEp	0.752	0.756	> 0.700	Rel.
MD	0.731	0.731	> 0.700	Rel.
MC	0.814	0.818	> 0.700	Rel.
MEf	0.756	0.759	> 0.700	Rel.
MI	0.764	0.765	> 0.700	Rel.

Note: Cα = Cronbach's alpha, CR = Composite Reliability, Rel. = Reliabel

Table 8 shows that Cα for each indicator is > 0.7, and the CR for each indicator is > 0.7. This can be interpreted that each item of socio-mathematical norms is declared reliable.

Furthermore, by analyzing the RASCH model, overall, the reliability of the socio-mathematical norm instrument can be seen in Figure 4.

PERSON	493 INPUT		493 MEASURED		INFIT		OUTFIT	
	TOTAL	COUNT	MEASURE	REALSE	IMNSQ	ZSTD	OMNSQ	ZSTD
MEAN	79.0	28.0	.77	.37	1.00	-.4	1.00	-.4
P.SD	9.0	.0	1.03	.10	.78	2.3	.79	2.3
REAL RMSE	.38	TRUE SD	.96	SEPARATION	2.52	PERSON RELIABILITY		.86
ITEM	28 INPUT		28 MEASURED		INFIT		OUTFIT	
	TOTAL	COUNT	MEASURE	REALSE	IMNSQ	ZSTD	OMNSQ	ZSTD
MEAN	1390.6	493.0	.00	.08	1.00	-.3	1.00	-.2
P.SD	117.3	.0	.73	.01	.23	3.4	.24	3.5
REAL RMSE	.08	TRUE SD	.72	SEPARATION	8.83	ITEM	RELIABILITY	.99

Figure 4. Result of Reliability Test with RASCH Model Analysis

Figure 4 shows the reliability value of the sociomathematical norm item of 0.99 and the person's reliability of 0.86. Thus, the sociomathematical norm instrument is identified as a scale with very high reliability.

Discussion

A culture of thinking in mathematics is needed through an activity between the teacher and students (Svensson & Wester, 2022). Therefore, norms in learning mathematics must be developed by directing activities that lead to mathematical thinking processes called sociomathematical norms (Dickes et al., 2020; Gülburnu & Gürbüz, 2022; Widodo et al., 2019). In its development, sociomathematical norms are carried out by observing or observing mathematics learning activities in class with an instrument developed by several researchers (Güven & Dede, 2017; Putri et al., 2015). For this reason, it is necessary to continue to create sociomathematical norm instruments, including how students perceive themselves against sociomathematical norms in learning mathematics.

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The research that has been carried out seeks to develop and validate the sociomathematical norm instrument in the form of a questionnaire. The sociomathematical norm questionnaire was developed by adapting the indicators developed by Yackel & Cobb (1996) and Kang & Kim (2016), including Instruments Indicators MEx, MEp, MD, MC, MEf, and MI. This is in line with research that confirms the factor analysis of the sociomathematical norm observation instrument (Widodo et al., 2020).

Research on developing the sociomathematical norm scale has not been studied much. Previous research studies focused on how to create sociomathematical norms in the form of (Dickes et al., 2020; Fukawa-Connelly, 2012; Güven & Dede, 2017; Kang & Kim, 2016; Maarif et al., 2022; Partanen & Kaasila, 2015; Putri et al., 2015; Sánchez & García, 2014; Widodo et al., 2019). One study by (Widodo et al., 2020) tried to validate the sociomathematical norm instrument as an observational instrument conducted ~~by (Widodo et al., 2020)~~ with indicators developed including MEx, MEp, MD, and MI. Therefore, the results of this study try to build a nom sociomathematical instrument scale to strengthen the results of previous research findings.

The study results show that the item coded MEx1 with the editorial "I have paid attention to the teacher while explaining the material" is the lowest item. Hence, it has a low difficulty level, or in other words, it is easy for the respondent to answer. Such conditions naturally occur because the questions asked are necessary for every lesson, especially in learning mathematics. Students in the learning process in the classroom are required to always pay attention to what is being taught by the teacher so that when faced with these statements' students are easy to answer. These findings align with the previous study, which revealed teacher variations in teaching would attract students' attention and encourage students to provide quick responses in each mathematics lesson (Lan et al., 2009). In addition, the results of the previous study revealed that developing sociomathematical norms on aspects of mathematical experience shows that students' attention to most students can focus when the teacher is explaining math material in class (Ningsih & Maarif, 2021).

Items with the MD4 code with the editor "I am waiting for solutions from other students in working on the questions given by the teacher" have the highest logit value and mean that the

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respondent has difficulty answering the item. These conditions indicate that making decisions on statements to wait for solutions to problem solving from other people need consideration. In learning mathematics, it is not uncommon for students to wait for confirmation of their classmates' ideas. This is in line with the results of previous research, which revealed that only 7% of the respondents could accept other friends' solutions while solving mathematical problems (Ningsih & Maarif, 2021). In line with this research, the different results show that in the process of mathematical representation, students experience a tendency to wait for the opinions of other participants to be compared with the results of the solutions that have been constructed (Renaldy & Maarif, 2022). Overall, Figure 1 shows the logit value of each item, which is equally distributed in terms of difficulty. These conditions indicate that the instrument is good at estimating the answers from respondents. This follows what previous researchers said: a measurement scale with an even difficulty level suggests that the instrument can differentiate solutions from respondents (Kim, 2023).

Furthermore, the convergent validity test shows that of the 28 items of the sociomathematical norm instrument, 25 items are said to be valid with a loading factor > 0.700. Whereas three items include MEx4 (I never paid attention to the teacher while explaining the material), MC4 (I find it challenging to understand the material delivered by the teacher even though the explanation is repeated), and MI4 (I am not happy if my group mates do not accept my opinion) has a loading factor value < 0.700. Even so, each factor loading value of more than 0.600 is valid. An instrument item can still be accepted if the loading factor is between 0.500 and 0.69 (Ghozali & Fuad, 2014).

Concurrent validity shows that each sociomathematical norm indicator validates with an AVE > 0.500, so the instrument can measure sociomathematical norms. These results align with the previous research who have validated sociomathematical norm indicators, including MEx, MEp, MD, and MC (Widodo et al., 2020). Furthermore, the discriminant validity results show

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the Fornell & Larcker Criterion values on the diagonal with higher values below, so it can be concluded that each item of the sociomathematical norm instrument has accuracy in its measurement function. Thus, the sociomathematical norm instrument that has been developed has been verified to have accuracy in its assessment. This aligns with research conducted by several previous studies (Kang & Kim, 2016; Ningsih & Maarif, 2021; Widodo et al., 2020).

The reliability test results showed that Cα for each indicator is > 0.7 and CR for each indicator is > 0.7. This can be interpreted that each item of the socio-mathematical norm is declared reliable. Furthermore, the RASCH model analysis shows that Cα for item reliability is 0.99 and person reliability is 0.86. Thus, the sociomathematical norm instrument is identified as a scale with very high reliability. This aligns with a previous study that confirmed sociomathematical norm indicators with reliable results (Widodo et al., 2020).

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Conclusion

This research measured sociomathematical norms in learning mathematics by testing the validity and reliability of senior high school students in DKI Jakarta and West Java provinces. This study provides findings that can be useful for the development of mathematics learning, especially sociomathematical norms, due to the compatibility of the analysis results using the model RASCH, Smart PLS, and AMOS. Improvement and development of learning mathematics in various ways, exceedingly soft skill competencies. Therefore, we hope that the findings of the sociomathematical norm instrument can be used and further developed to contribute to improving mathematics learning.

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Recommendations

This research produces a socio-mathematics norm instrument that can improve mathematics learning in the classroom. The study results obtained that the socio-mathematics norm instrument consisted of 25 valid and reliable items. Based on the results of this study, we recommend teachers use the socio-mathematics norm instrument to measure social abilities (student affective aspects) in learning and mathematics classrooms. In addition, this instrument can be used as an alternative to measuring socio-mathematical norms for researchers in the field of socio-mathematical norms.

Limitations

Several research limitations have been carried out in developing sociomathematical norm instruments. First, the research that has been done uses a sample of high school students, so it is limited in generalization. Therefore, in further study, we recommend validating the sociomathematical norm instrument with a more extensive and varied sample for all levels of education. Second, there are three sociomathematical norm items with a loading factor value of < 0.700, so these three items need to be re-analyzed regarding the editorial to be more easily understood by respondents. Third, the analysis of validity and reliability using the RASCH, Smart PLS, and Amos models that have been carried out still has weaknesses, so it is necessary to verify the reliability of the test-retest. Fourth, research on validating sociomathematical norm instruments has not examined comparisons between gender and educational levels. So that further analysis can be carried out to compare sociomathematical norms based on gender and status of education.

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Conflict of Interest

The authors have no conflict of interest to declare.

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Review Form

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ABOUT MANUSCRIPT (Mark with "X" one of the options)	Accept	Weak	Refuse	Not Available
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A reasonable discussion of the results is presented		X		
Conclusions are clearly stated		X		
Recommendations are clearly stated	X			

GENERAL REMARKS AND RECOMMENDATIONS TO THE AUTHOR

This paper is a well-written article. However, it has some flaws. I listed them below.

The authors introduced several concepts in the introduction but did not clarify the research problem. What are the shortcomings of previous studies, and what was the need for conducting this research?

As a researcher, I struggled to comprehend how the authors decided their goals. It would be helpful if the authors could provide more detailed explanations of the research problem.

The introduction lacks a clear explanation of the results from previous studies, and the weaknesses of these studies are not highlighted.

What are the results of the previous research? No information was given about the results of earlier studies.

The method is detailed, but some information is missing. For example, how was the adaptation conducted? How were the items developed?

The discussion does not provide possible explanations for the obtained results. Also, the differences and similarities between previous studies and this research are not discussed.

It is important to discuss the study's contribution to the existing knowledge. My other suggestions are in balloons in the paper.

Overall, major revisions are necessary.

THE DECISION (Mark with "X" one of the options)	
Accepted: Correction not required	
Accepted: Minor correction required	
Conditionally Accepted: Major Correction Required **(Need the second review after corrections)**	X
Refused	

Reviewer Code: R2612 (The name of the referee is hidden because of blind review)

HASIL REVIU UNTUK REVIUWER II

A Psychometric Validation of the Sociomathematical Norm Scale for Senior High School Students in Mathematics Learning

Abstract: The importance of sociomathematical norms in learning mathematics must be developed in all elements. One of the essential elements to be developed is an instrument to measure sociomathematical norms in learning mathematics. This study aims to create and verify the psychometric validity of the sociomathematical norm scale. This research used a survey method with 505 senior high school students from Jakarta and West Java as respondents. The results showed that 25 items had convergent validity, with a loading factor value of > 0.700, meaning they could be declared valid. Concurrent validity indicates that each socio-mathematical norm indicator is valid as a whole. Discriminant validity shows that the AVE value on the diagonal is higher than the other values, so each item is declared valid. It was concluded that each item of socio-mathematical instrument norms has accuracy in its measurement function. The reliability test shows that each socio-mathematical norm item is declared reliable. The reliability value of the sociomathematical norm item is 0.99, and the person's reliability is 0.86. Thus, the instruments developed can measure socio-mathematical norms in learning mathematics.

Keywords: *Developments Scale; learning of mathematics; RASCH Model; sociomathematical norms*

Commented [iD1]: keywords are one of the basic pillars of a study. but these words are not used elsewhere in this paper. for example learning mathematic is more suitable.

Introduction

Learning mathematics is an activity that does involve not only the process of thinking individually but also a collective action in social interaction (Dickes et al., 2020; Güven & Dede, 2017; McClain & Cobb, 2001; Yackel & Rasmussen, 2003). Social interaction in teaching and learning mathematics determines cognitive development through a group communication process that goes hand in hand (Widodo et al., 2019, 2023). Therefore, it is necessary to develop an in-depth study of the importance of social interaction norms in mathematics learning, known as sociomathematical norms (Maarif et al., 2022; Yackel & Cobb, 1996). Sociomathematical norms are normative understandings in the learning process of differences and the effectiveness of mathematical thinking to build mathematical knowledge (Denton, 2017; Lim et al., 2023). Others revealed that sociomathematical norms as an attitude to consider explanations for different mathematical answers received by students (Code et al., 2016; Kang & Kim, 2016; Savuran & Akkoç, 2021). Sociomathematical norms will appear when there are differences in perceptions, ways, mindsets, arguments, expectations, and obligations that are in discussion. However, they can be neutralized through negotiations to share (Baki & Kilicoglu, 2023). This sharing process makes students effective in understanding math problems so that each student can take information from one another. The practical discussion will find a middle point in the differences in perceptions to understand a mathematical problem. Accuracy, efficiency, and motivation in solving mathematical problems can occur in learning (Arroyo et al., 2014).

Sociomathematical norms in learning mathematics are an essential part to be developed to discipline students in complying with the rules of the learning interaction process by respecting each other's opinions (Biza et al., 2015; Kang & Kim, 2016; Stephan, 2020; Widodo et al., 2020). Furthermore, sociomathematical norms can train cooperation between students in solving mathematical problems through sharing ideas (Fukawa-Connelly, 2012). In addition, with strong sociomathematical norms, students can explain, justify, and argue for solutions obtained in solving math problems (Francisco, 2013).

Sociomathematical norms result from forming self-confidence, attitude values, and individual arguments related to mathematics as a learning activity process (Apsari et al., 2020; Putri et al., 2015; Yun & Kim, 2015). In addition, sociomathematical norms can be developed through various mathematics learning activities that are interactive between individuals by emphasizing active collaboration (Levenson et al., 2009; Morrison et al., 2021). The teacher's role in developing sociomathematical norms includes being a facilitator and directing students to develop the ability to represent values, accuracy, and thoroughness in determining answers, efficiency, and writing solutions with confidence (Maarif et al., 2022; Pang, 2000).

Sociomathematical norms are mathematical activities in learning which are characterized by: experience of mathematics, explanation of the mathematics, mathematical difference, mathematical communication, mathematical effectiveness, and mathematical insight (Heyd-Metzuyanim, 2015; Ningsih & Maarif, 2021; Widodo et al., 2020; Zembat & Yasa, 2015). In the process of learning mathematics, activity experience is needed. The intended mathematics experience is students' experience in understanding written mathematical ideas, which can then be explained systematically (Kang & Kim, 2016). Knowledge of mathematics can train students to construct beliefs about the arguments expressed when solving mathematical problems (Thompson, 2013; Zhou et al., 2021). Explaining the material being studied in mathematics learning activities is very much needed. That is necessary for developing sociomathematical norms, namely the explanation of mathematics (Matranga & Silverman, 2022). Description of mathematics is urgently required when learning activities are taking place to foster students' confidence in their understanding of the mathematical concepts they are learning (Maarif et al., 2020). Explanation of mathematics can provide inferences about descriptions of mathematical operations and provide a valid way of specifying a mathematical sentence needed in compiling ideas to a conclusion (Baker, 2009; Wylie & Chi, 2014).

There are often differences in thinking between students in learning mathematics. To bridge these differences in thinking, a method is needed to find common ground between the ideas expressed. Sociomathematical norms allow students to learn how to deal with differences in thinking in mathematical problems (Lim et al., 2023). We can view mathematical differences as a positive side for developing students' thinking so that the analysis of mathematical problems becomes more profound and comprehensive (Fukawa-Connelly, 2012). Mathematical differences can be analyzed by examining the similarities and differences in ideas from several alternative solutions, which are then compared to find the best solution (Zembat & Yasa, 2015).

Sociomathematical norms can be seen in how students develop mathematical communication of mathematical concepts both orally and in writing (Gearing & Hart, 2019; Kang & Kim, 2016). In learning mathematics, mathematical communication can be seen in how students express mathematical ideas, represent mathematical problems in images, discuss concepts coherently, and understand ideas in a language that is easy to understand (Lomibao et al., 2016). In addition, mathematical communication is also intended to see student explanations in acting to validate procedures or steps for solving mathematics systematically, both orally and in writing (Brendefur & Frykholm, 2000).

In learning mathematics, effective action is needed to understand and solve the mathematical problems being studied. For this reason, one of the values developed in the sociomathematical norm includes mathematical effectiveness (Ningsih & Maarif, 2021). When students encounter learning obstacles, practical steps are needed to solve problems with the right ideas (Maarif et al., 2019). The value of mathematics effectiveness will lead students to determine practical actions from several alternative solutions in solving a mathematical problem (Svensson & Wester, 2022).

Solving problems in learning mathematics requires the maturity of knowledge based on a thorough understanding of the material being studied (Abramovich et al., 2019). Therefore, to solve a mathematical problem, mathematical insight is needed in developing sociomathematical norms (Maarif et al., 2022; Widodo et al., 2019, 2020). Students need various sources of information to construct and explain ideas in a discussion process (Kwon et al., 2011). Sources of information are not only obtained from their knowledge of other people's opinions to be used as material for mathematical analysis (McNamara, 2017). Thus, the process of forming sociomathematical norms can be appropriately embedded.

Several different studies have focused on research on sociomathematical norms and how they are implemented in classroom learning by teachers and students (McClain & Cobb, 2001; Sánchez & García, 2014), identification of the elements forming sociomathematical norms (Maarif et al., 2022); and observation of sociomathematical norm indicators (Widodo et al., 2020). Referring to the several research perspectives carried out as a hierarchical research framework, the researchers have provided some information that the importance of sociomathematical norms in learning mathematics needs to be developed in all elements. One crucial element to create is an instrument in the form of a questionnaire to measure sociomathematical norms in learning mathematics.

From the description above, this study aims to develop and verify the psychometric validity of the sociomathematical norm scale. Sociomathematical norm instruments are adapted from aspects that have been developed by previous research, which include elements of the experience of mathematics (MEx), explanation of mathematics (MMEp), the mathematical difference (MD), mathematical communication (MC), mathematical effectiveness (MEf), and mathematical insight (MI) (Kang & Kim, 2016; Widodo et al., 2020; Yackel & Cobb, 1996). This instrument can be used to strengthen the process of student competency in determining norms in learning mathematics. In addition, the instrument can be used as a reference for further research on developing sociomathematical norms in mathematics learning.

Methodology

Research Design

This research develops sociomathematical norm instruments by adapting aspects produced by Kang & Kim (2016), Widodo et al. (2020), and Yackel & Cobb (1996), including parts of MEx, MEp, MD, MC, MEf, and MI. Items are developed concerning these aspects. Furthermore, the instrument was validated and tested for reliability with a survey method of senior high school students.

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Participant and Data Collection

Participants in this study were senior high school students who voluntarily filled out the sociomathematical norm questionnaire. The questionnaire instrument was distributed via Google form, complete with a consent letter to participate as a respondent. This research involved 505 high school students spread across the provinces of DKI Jakarta (80.4%) and West Java (19.4%). This follows the minimum sampling requirement to validate the instrument with at least 150 to 200 respondents (Kim, 2023). Data was collected using a survey of 505 respondents who voluntarily filled out a questionnaire using the Google form platform from 20 December 2022 to 20 January 2023.

Instrument

The sociomathematical norm instrument was developed adapting by Kang & Kim (2016), Widodo et al. (2020), and Yackel & Cobb (1996), which includes Indicator Instrument indicators: MEx, MEp, MD, MC, MEf, and MI. MEx is defined as students being able to contribute to careful discussion activities in learning mathematics. MEp means that students can understand and explain ideas systematically in problem-solving. Furthermore, MD can be interpreted as students being able to compare the similarities and differences of several alternative problem-solving solutions to get the best solution. The next indicator is MC defines students' ability to understand and express a statement by using language that is straightforward to understand. MEf can be interpreted as constructing the most effective alternative solutions and explaining them in plain language. The latter MI broadly refers to various sources of information and interaction in discussing mathematical problems.

The questionnaire consisted of 28 items using a Likert scale of 4 items. The score of each indicator is obtained by finding the average value of each question representing the dimension. Items are developed by referring to the operational definition of these aspects. Furthermore, the item items are validated by experts with academic positions as associate

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Commented [İD7]: Are all items suitable for your scale. Did anayone check before factor analysis professors and doctoral degrees covering grammar, vocabulary, and content validity of the specified indicators and some input from experts as material for consideration for revising the developed instrument. The distribution of items based on each hand can be seen in Table 1.

Table 1. Indicators and Coding (Total Items=28)

Indicators	**Statement Item Numbers**	**Statement Item Codes**	**Sum of Items**
Mathematical Experience (MEx)	1,2,3,4,5,6	MEx1, MEx2, MEx3, MEx4, MEx5, MEx6	6
Mathematical Explanation (MEp)	7,8,9,10	MEp1, MEp2, MEp, MEp3, MEp4	4
Mathematical Difference (MD)	11,12,13,14	MD1, MD2, MD3, MD4	4
Mathematical Communication (MC)	15,16,17,18,19,20	MC1, MC2, MC3, MC4, MC5, MC6	6
Mathematics Effectiveness (MEf)	21,22,23,24	MEf1, MEf2, MEf3, MEf4	4
Mathematical Insight (MI)	25,26,27,28	MI1, MI2, MI3, MI4	4

Statistical Data Analysis

Statistical data analysis was performed using IBM SPSS Statistics 25, WINSTEPS Version 5.1.4.0, AMOS 22.0, and SmartPLS 4 software. Descriptive statistical analysis was performed to see an overview of the data's characteristics, including percentage, average and standard deviation. To analyze construct validity, convergent validity, discriminant, and concurrent validity. Furthermore, to test the reliability of sociomathematical norm instruments, RASH analysis, confirmatory factor analysis, and consistent internal analysis were used.

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RASCH model analysis was performed using WINSTEPS Version 5.1.4.0 software. Much analysis of the RASCH model was carried out to analyze the construct validity of a questionnaire (Tabatabaee-Yazdi et al., 2018). An instrument is said to be valid if the research data that has been collected follows the model with constructs based on the covariance between items and the causes of item responses (Atmoko et al., 2022; Kim, 2023). RASCH model analysis was conducted on sociomathematical norm instruments to determine RASCH model analysis, construct validity, item difficulty parameters, separator index, and reliability index. Calculation of the mean square value (MNSQ) is performed to show the suitability of the model fit and determine an item according to the assumption of unidimensionality. Suppose the average infit MNSQ value is between 0.5 and 2.0 (Kandel et al., 2020; Matheny & Clanton, 2020; Muslihin et al., 2022), and the point-measure correlation value is more than 0.4 (Ghazali et al., 2019; Khamis et al., 2014; Kim, 2023). The instrument is considered a model assessed at the appropriate level and productive for measuring rating scales (Fan et al., 2022; Kim, 2023; Muniandy et al., 2023; Muslihin et al., 2022). To indicate the instrument item difficulty parameter, it can be shown that a higher logit value is interpreted as having an item difficulty level, and a low logic value indicates it is easier. The item response curve verifies the goodness of fit value of the category response with a Likert scale of 4. If the SI value is more than 2.0, then the unidimensionality of the item is appropriate, and RI is more than equal to 0.80, indicating internal scale consistency (Kim, 2023).

Confirmatory factor analysis was performed using IBM SPSS Statistics 25 and AMOS 22.0 software. Confirmatory factor analysis was carried out by constructing the equation model structure. Model fit was analyzed according to the criteria if $\chi 2/df \leq 3.0$, comparative fit index (CFI) ≥ 0.90, Tucker–Lewis index (TLI) ≥ 0.90, incremental fit index (IFI) ≥ 0.90, adjusted fit index (AGFI) ≥ 0.80, and the root mean square error of approximation (RMSEA) ≤ 0.08 criteria are met, the model is considered suitable (Widodo et al., 2020).

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Convergent validity analyses were conducted using SartPLS 4 software with criteria if the loading factor values of > 0.7 (Cheah et al., 2018; Purnomo et al., 2020; Webb et al., 2017; Wigert, 2013). Concurrent validity was carried out using SmartPLS with the Average Variance Extracted (AVE) criterion value > 0.5 (Cheah et al., 2018; Hermanda et al., 2019; Wong, 2013). Furthermore, the Discriminant Validity test is carried out by looking at the Fornell & Larcker Criterion value by assessing the AVE value on the diagonal with higher values below (Ab Hamid et al., 2017; Karakus et al., 2021; Purwanto et al., 2021).

Analysis of the reliability of the sociomathematical norm instrument items was carried out using SmartPLS 4 software. To see the level of reliability, it was carried out using the RASCH model analysis. Reliability testing is carried out by looking at Cronbach's Alpha and Composite Reliability values with the criteria if the Cronbach's Alpha values are > 0.7 and Composite Reliability > 0.7, then the instrument items are said to be reliable (Kaur et al., 2012).

Results

General Characteristics of Participant

This research involved 505 senior high school students spread across the provinces of DKI Jakarta (80.4%) and West Java (19.4%). All study participants were divided by gender and school level, which included grades X and XI as shown in Table 2.

Table 2. Participant Demographics

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Respondent		frequency	Percent (%)
Gender	Male	259	51.3
	Female	246	48.7
	Total	505	100
Province	DKI Jakarta	406	80.4
	West Java	99	19.6
	Total	505	100
Grade	10th	350	69.3
	11th Science	85	16.8
	11th Social Science	70	13.9
	Total	505	100

Construct Validity Base on Rasch Model

The results of the analysis of the RASCH model of the sociomathematical norm instrument involving 505 respondents are shown in Table 3.

Table 3. Item Difficulty Measures and Statistical Fit Sociomathematical Norms Applied in the RASCH Model Analysis

Items Number	Items Statement	Items Code	Measure	Infit MNSQ	Outfit MNSQ	PT-Measure Corr.

Items Number	Items Statement	Items Code	Measure	Infit MNSQ	Outfit MNSQ	PT-Measure Corr.
1	I paid attention to the teacher while explaining the material	MEx1	-1.54	0.74	0.73	0.51
2	I can show enthusiasm when learning mathematics with an active attitude during learning	MEx2	-0.45	0.79	0.78	0.57
3	I can solve math problems correctly during learning	MEx3	0.25	0.86	0.86	0.59
4	I never paid attention to the teacher while explaining the material	MEx4	-1.03	1.46	1.46	0.35
5	I am passive and do not show enthusiasm during learning	MEx5	0.08	1.36	1.39	0.47
6	I could not solve math problems correctly during the lesson	MEx6	0.64	0.99	1.02	0.60
7	I can understand ideas/arguments from solutions given by teachers of math problems	MEp1	-0.48	0.72	0.70	0.58
8	I accept ideas/arguments expressed by other students	MEp2	-0.98	0.71	0.71	0.45
9	I have no difficulty expressing ideas/arguments to solve mathematical problems in a structured way	MEp3	0.71	0.76	0.77	0.57
10	I have difficulty understanding the ideas/arguments given by the teacher or other students in solving math problems	MEp4	0.91	0.93	0.95	0.55
11	I work on every problem given by the teacher using the solution from myself	MD1	0.40	0.93	0.94	0.44
12	I am happy when there are differences of opinion conveyed by other students in the class	MD2	-0.55	0.95	0.97	0.58
13	I am unable to accept the diversity of ideas/arguments from other students	MD3	-0.39	1.04	1.03	0.41
14	I am waiting for solutions from other students in working on the questions given by the teacher	MD4	1.16	1.09	1.13	0.48

Items Number	Items Statement	Items Code	Measure	Infit MNSQ	Outfit MNSQ	PT-Measure Corr.
15	I can understand the material presented by the teacher with one explanation	MC1	0.87	1.10	1.14	0.47
16	When the teacher asks me a question, I can respond or answer with the right answer	MC2	0.61	0.78	0.79	0.58
17	I ask questions when I don't understand the material presented by the teacher	MC3	-0.55	1.11	1.10	0.48
18	I find it difficult to understand the material delivered by the teacher even though the explanation is repeated	MC4	-0.85	1.27	1.35	0.18
19	I am not able to give responses or answers appropriately when the teacher asks me questions	MC5	0.93	0.78	0.78	0.57
20	I don't ask questions when I don't understand the material presented by the teacher	MC6	0.12	1.12	1.13	0.54
21	can find an easier solution to solving math problems	MEf1	0.40	0.95	0.95	0.51
22	I can explain the problem-solving solutions I find to other students appropriately	MEf2	0.39	0.79	0.77	0.56
23	I am not able to explain the solution to the problem solving that I find to other students appropriately	MEf3	0.92	0.73	0.75	0.57
24	I have no interest in finding solutions to math problems	MEf4	0.66	1.07	1.09	0.62
25	I tried to find various solutions from different sources during the discussion	MI1	-1.05	0.98	0.97	0.43
26	I feel happy when learning mathematics applies the discussion system because I will get various solutions	MI2	-1.00	1.19	1.17	0.43
27	I help other students who have difficulty doing math problems	MI3	0.07	1.03	1.03	0.54

Items Number	Items Statement	Items Code	Measure	Infit MNSQ	Outfit MNSQ	PT-Measure Corr.
28	I am not happy if my group mates do not accept my opinion	MI4	0.13	1.66	1.66	0.24

Note: MNSQ = Mean Squared; PT-Measure CORR. = Point-Measure Correlation

Table 3 shows that the MNSQ infit value for each item lies between 0.71 to 1.66 (with the criteria for an average MNSQ infit value being from 0.5 to 2.0), so 28 items are suitable for measuring the sociomathematical norm scale. Furthermore, table 2 shows the correlation value of the 24 items indicating more than 0.4, which means that the items can be used to measure the sociomathematical norm scale. At the same time, items with MEx4, MC4, and MI4 codes have a correlation value of less than 0.4. Nevertheless, the four items have MNSQ values following the criteria. So, overall, 28 items are considered to fulfill the model assessed at an appropriate and productive level for measuring the sociomathematical norm scale.

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Furthermore, it shows each item's parameter difficulty by analyzing the logit value, as shown in Figure 1.

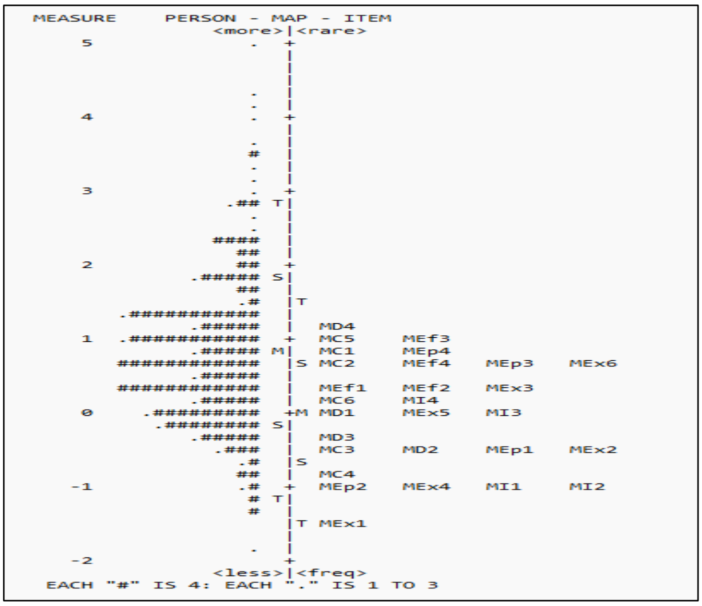

Figure 1. Person Item Map Sociomathematical Norm

Figure 1 shows the logit value of each item of the sociomathematical norm instrument. Items with code MEx1 with the editorial "I have paid attention to the teacher while explaining the material" are the lowest items so they have a low difficulty level or are easy for respondents to answer. The item with the MD4 code with the editorial "I am waiting for solutions from other students in working on the questions given by the teacher" has the highest logit value, meaning that the respondent has difficulty being answered. Overall, Figure 1 shows the logit value of each item, which is equally distributed in terms of the problem.

To verify the goodness of fit value of the category response, it is shown through the item response curve, as shown in Figure 2.

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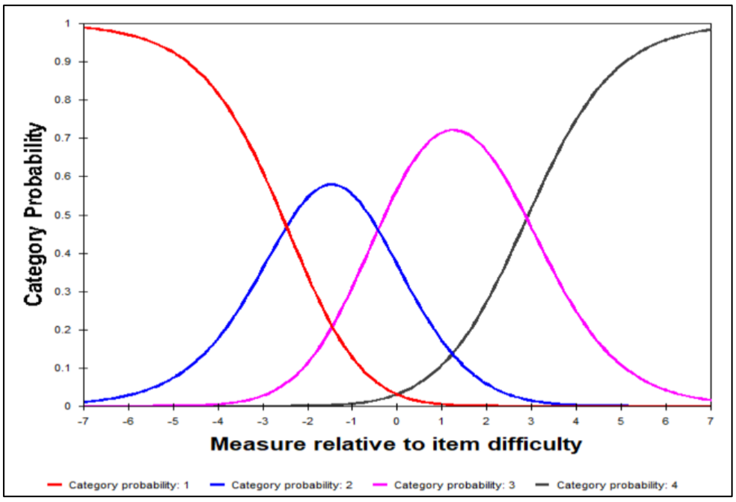

Figure 2. Response Item Category Curve

Figure 2 shows the sociomathematical norm curve's value, consisting of a Likert scale with four answers on the appropriate item response category curve. It can be seen that the rating scale looks different in each category, and there is an interaction between the scales, which indicates a relatively consistent interval scale.

Confirmatory Factor Analysis

The confirmation model for the sociomathematical norm factor can be seen in the following Figure 3. The results of the analysis of the norm sociomathematical factor confirmation model show $\chi 2/df = 0.971 \leq 3.0$, CFI = $0.935 \geq 0.90$, TLI = $0.912 \geq 0.90$, IFI = $0.905 \geq 0.90$, AGFI = $0.914 \geq 0.80$, and RMSEA) = $0.0036 \leq 0,08$. These results show that the model is at a suitable validation level.

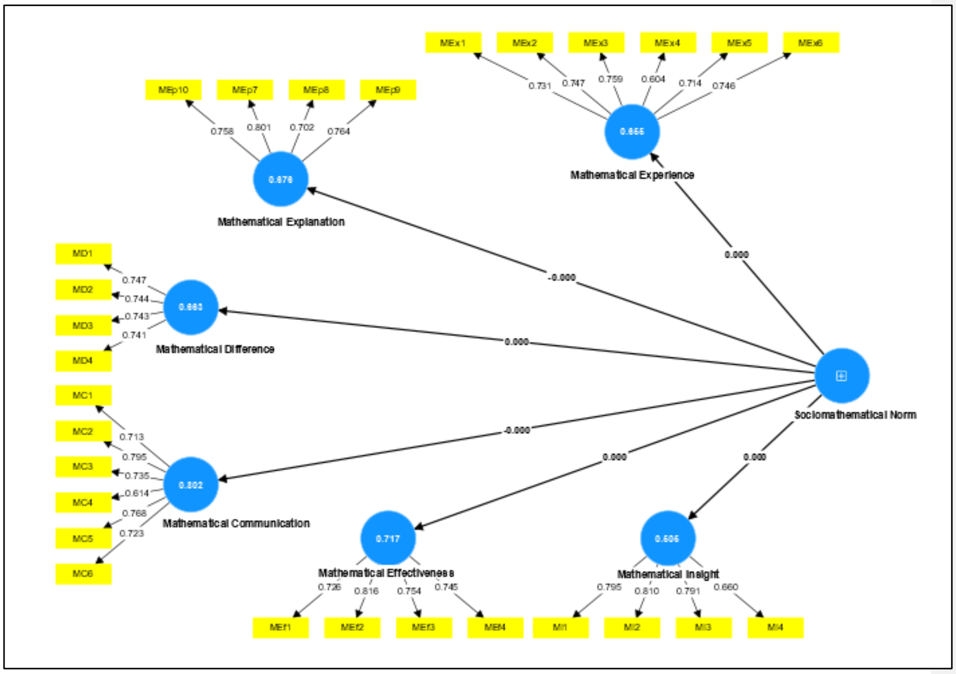

Figure 3. The Ceonfirmatory Factor Analysis of the Sociomathematical Norm Model wWith SmartPLS

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Test of Validity: Convergent, Discriminant, and Concurrent

To analyze the convergent validity of the sociomathematical norm items is carried out by analyzing the factor loading of each item. Table 4 shows the results of the factor loading analysis for each item.

Table 4. Results of Convergent Validity Analysis of Sociomathematical Norm Instruments

Numbers Item	Items Code	Outer Loading	Explana tion	Numbers Item	Items Code	Outer Loading	Explanation
1	MEx1	0.731	V	15	MC1	0.713	V
2	MEx2	0.747	V	16	MC2	0.795	V
3	MEx3	0.759	V	17	MC3	0.735	V
4	MEx4	0.604	NV	18	MC4	0.614	NV
5	MEx5	0.714	V	19	MC5	0.768	V
6	MEx6	0.748	V	20	MC6	0.723	V
7	MEp1	0.758	V	21	MEf1	0.720	V
8	MEp2	0.801	V	22	MEf2	0.816	V
9	MEp3	0.702	V	23	MEf3	0.754	V
10	MEp4	0.764	V	24	MEf4	0.745	V

Numbers Item	Items Code	Outer Loading	Explanation	Numbers Item	Items Code	Outer Loading	Explanation
11	MD1	0.747	V	25	MI1	0.795	V
12	MD2	0.744	V	26	MI2	0.810	V
13	MD3	0.743	V	27	MI3	0.791	V
14	MD4	0.741	V	28	MI4	0.660	NV

Note: V= Valid and NV=Not Valid

Table 4 shows that of the 28 items of the sociomathematical norm instrument, 25 items have a loading factor value > 0.700, which means they can be declared valid. While the three items, which include MEx4, MC4, and MI4, have a factor loading value of <0.700 even though each factor loading value is more than 0.600, which means that the three items are not valid. Furthermore, to show the validity for each item by showing AVE, as shown in Table 5.

Table 5. Concurrent Validity Analysis ~~w~~With Average Variance Extracted (AVE)

Indicators	AVE	Rule of thumb	Explanation
MEx	0.571	> 0.500	V
MEp	0.573	> 0.500	V
MD	0.553	> 0.500	V
MC	0.574	> 0.500	V
MEf	0.579	> 0.500	V
MI	0.678	> 0.500	V

Note: V=Valid

Table 5 shows the AVE value for each indicator of the socio-mathematical norm > 0.500, which means that each indicator can be considered valid. Thus, the instrument is supported by each item that can measure each indicator. Furthermore, discriminant validity analysis is carried out to ensure that each concept from each latent model is different from the other variables. Validity testing is conducted to determine how precisely a measuring instrument performs its measurement function. The discriminant validity results using the Fornell & Larcker criterion values can be seen in Table 6.

Table 6. Discriminant ~~v~~Validity: Fornell & Larcker C~~c~~riterion

	MC	MD	MEf	MEx	MEp	MI
MC	0.727					
MD	0.692	0.744				
MEf	0.721	0.672	0.761			
MEx	0.642	0.560	0.603	0.719		
MEp	0.675	0.611	0.664	0.640	0.757	
MI	0.581	0.559	0.558	0.444	0.461	0.767

Table 6 shows the Fornell & Larcker Criterion values on the diagonal with higher values below so that it can be concluded that each item of the sociomathematical norm instrument has accuracy in its measurement function. In addition, table 7 shows the correlation between sociomathematical norm indicators showing a significant correlation.

Table 7. Correlation Between Sociomathematical Norm Indicators

Correlation Between Indicators	**r**	**p-value**	**Interpretation**
MEx <=> MEp	0.640	<0.000	Sig
MEx <=>MD	0.560	<0.001	Sig
MEx <=>MC	0.642	<0.000	Sig
MEx <=> MEf	0.603	<0.000	Sig
MEx <=> MI	0.444	<0.001	Sig
MEp <=> MD	0.611	<0.001	Sig
MEp <=> MC	0.675	<0.000	Sig
MEp <=> MEf	0.684	<0.000	Sig
MEp <=> MI	0.641	<0.000	Sig
MD <=> MC	0.692	<0.000	Sig
MD <=> MEf	0.627	<0.000	Sig
MD < => MI	0.559	<0.001	Sig
MC <=> MEf	0.721	<0.000	Sig
MC <=> MI	0.581	<0.001	Sig
MEf <=> MI	0.558	<0.001	Sig

Note: Sig = Significant

Table 7 above shows that each sociomathematical norm indicator has a positive correlation. This shows that each indicator contributes positively to the sociomathematical norm. Thus, the developed indicators can be used to measure sociomathematical norms.

Test of Reliability

Instrument reliability testing was conducted by looking at Cronbach's Alpha and Composite Reliability values. The results of reliability testing can be seen in Table 8.

Table 8. Result of Reliability Test

Indicators	**Cα**	**CR**	**Rule of thumb**	**Explanation**
MEx	0.750	0.752	> 0.700	Rel.
MEp	0.752	0.756	> 0.700	Rel.
MD	0.731	0.731	> 0.700	Rel.
MC	0.814	0.818	> 0.700	Rel.
MEf	0.756	0.759	> 0.700	Rel.
MI	0.764	0.765	> 0.700	Rel.

Note: Cα = Cronbach's alpha, CR = Composite Reliability, Rel. = Reliabel

Table 8 shows that C$\boldsymbol{\alpha}$ for each indicator is > 0.7, and the CR for each indicator is > 0.7. This can be interpreted that each item of socio-mathematical norms is declared reliable. Furthermore, by analyzing the RASCH model, overall, the reliability of the socio-mathematical norm instrument can be seen in Figure 4.

PERSON	493 INPUT	493 MEASURED			INFIT		OUTFIT	
	TOTAL	COUNT	MEASURE	REALSE	IMNSQ	ZSTD	OMNSQ	ZSTD
MEAN	79.0	28.0	.77	.37	1.00	-.4	1.00	-.4
P.SD	9.0	.0	1.03	.10	.78	2.3	.79	2.3
REAL RMSE	.38 TRUE SD	.96	SEPARATION	2.52	PERSON RELIABILITY			.86

ITEM	28 INPUT	28 MEASURED			INFIT		OUTFIT	
	TOTAL	COUNT	MEASURE	REALSE	IMNSQ	ZSTD	OMNSQ	ZSTD
MEAN	1390.6	493.0	.00	.08	1.00	-.3	1.00	-.2
P.SD	117.3	.0	.73	.01	.23	3.4	.24	3.5
REAL RMSE	.08 TRUE SD	.72	SEPARATION	8.83	ITEM RELIABILITY			.99

Figure 4. Result of Reliability Test with RASCH Model Analysis

Figure 4 shows the reliability value of the sociomathematical norm item of 0.99 and the person's reliability of 0.86. Thus, the sociomathematical norm instrument is identified as a scale with very high reliability.

Discussion

A culture of thinking in mathematics is needed through an activity between the teacher and students (Svensson & Wester, 2022). Therefore, norms in learning mathematics must be developed by directing activities that lead to mathematical thinking processes called sociomathematical norms (Dickes et al., 2020; Gülburnu & Gürbüz, 2022; Widodo et al., 2019). In its development, sociomathematical norms are carried out by observing or observing mathematics learning activities in class with an instrument developed by several researchers (Güven & Dede, 2017; Putri et al., 2015). For this reason, it is necessary to continue to create sociomathematical norm instruments, including how students perceive themselves against sociomathematical norms in learning mathematics.

The research that has been carried out seeks to develop and validate the sociomathematical norm instrument in the form of a questionnaire. The sociomathematical norm questionnaire was developed by adapting the indicators developed by Yackel & Cobb (1996) and Kang & Kim (2016), including Instruments Indicators MEx, MEp, MD, MC, MEf, and MI. This is in line with research that confirms the factor analysis of the sociomathematical norm observation instrument (Widodo et al., 2020).

Research on developing the sociomathematical norm scale has not been studied much. Previous research studies focused on how to create sociomathematical norms in the form of (Dickes et al., 2020; Fukawa-Connelly, 2012; Güven & Dede, 2017; Kang & Kim, 2016; Maarif et al., 2022; Partanen & Kaasila, 2015; Putri et al., 2015; Sánchez & García, 2014; Widodo et al., 2019). One study tried to validate the sociomathematical norm instrument as an observational instrument conducted by (Widodo et al., 2020) with indicators developed including MEx, MEp, MD, and MI. Therefore, the results of this study try to build a nom sociomathematical instrument scale to strengthen the results of previous research findings.

The study results show that the item coded MEx1 with the editorial "I have paid attention to the teacher while explaining the material" is the lowest item. Hence, it has a low difficulty level, or in other words, it is easy for the respondent to answer. Such conditions naturally occur because the questions asked are necessary for every lesson, especially in learning mathematics. Students in the learning process in the classroom are required to always pay attention to what is being taught by the teacher so that when faced with these statements' students are easy to answer. These findings align with the previous study, which revealed teacher variations in teaching would attract students' attention and encourage students to provide quick responses in each mathematics lesson (Lan et al., 2009). In addition, the results of the previous study revealed that developing sociomathematical norms on aspects of mathematical experience shows that students' attention to most students can focus when the teacher is explaining math material in class (Ningsih & Maarif, 2021).

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Items with the MD4 code with the editor "I am waiting for solutions from other students in working on the questions given by the teacher" have the highest logit value and mean that the respondent has difficulty answering the item. These conditions indicate that making decisions on statements to wait for solutions to problem solving from other people need consideration. In learning mathematics, it is not uncommon for students to wait for confirmation of their classmates' ideas. This is in line with the results of previous research, which revealed that only 7% of the respondents could accept other friends' solutions while solving mathematical problems (Ningsih & Maarif, 2021). In line with this research, the different results show that in the process of mathematical representation, students experience a tendency to wait for the opinions of other participants to be compared with the results of the solutions that have been constructed (Renaldy & Maarif, 2022). Overall, Figure 1 shows the logit value of each item, which is equally distributed in terms of difficulty. These conditions indicate that the instrument is good at estimating the answers from respondents. This follows what previous researchers said: a measurement scale with an even difficulty level suggests that the instrument can differentiate solutions from respondents (Kim, 2023).

Furthermore, the convergent validity test shows that of the 28 items of the sociomathematical norm instrument, 25 items are said to be valid with a loading factor > 0.700. Whereas three items include MEx4 (I never paid attention to the teacher while explaining the material), MC4 (I find it challenging to understand the material delivered by the teacher even though the explanation is repeated), and MI4 (I am not happy if my group mates do not accept my opinion) has a loading factor value < 0.700. Even so, each factor loading value of more than 0.600 is valid. An instrument item can still be accepted if the loading factor is between 0.500 and 0.69 (Ghozali & Fuad, 2014).

Concurrent validity shows that each sociomathematical norm indicator validates with an AVE > 0.500, so the instrument can measure sociomathematical norms. These results align with the previous research who have validated sociomathematical norm indicators, including MEx, MEp, MD, and MC (Widodo et al., 2020). Furthermore, the discriminant validity results show the Fornell & Larcker Criterion values on the diagonal with higher values below, so it can be concluded that each item of the sociomathematical norm instrument has accuracy in its measurement function. Thus, the sociomathematical norm instrument that has been developed has been verified to have accuracy in its assessment. This aligns with research conducted by several previous studies (Kang & Kim, 2016; Ningsih & Maarif, 2021; Widodo et al., 2020).

The reliability test results showed that $C\alpha$ for each indicator is > 0.7 and CR for each indicator is > 0.7. This can be interpreted that each item of the socio-mathematical norm is declared reliable. Furthermore, the RASCH model analysis shows that $C\alpha$ for item reliability is 0.99 and person reliability is 0.86. Thus, the sociomathematical norm instrument is identified as a scale with very high reliability. This aligns with a previous study that confirmed sociomathematical norm indicators with reliable results (Widodo et al., 2020).

Conclusion

This research measured sociomathematical norms in learning mathematics by testing the validity and reliability of senior high school students in DKI Jakarta and West Java provinces. This study provides findings that can be useful for the development of mathematics learning, especially sociomathematical norms, due to the compatibility of the analysis results using the model RASCH, Smart PLS, and AMOS. Improvement and development of learning mathematics in various ways, exceedingly soft skill competencies. Therefore, we hope that the findings of the sociomathematical norm instrument can be used and further developed to contribute to improving mathematics learning.

Recommendations

This research produces a socio-mathematics norm instrument that can improve mathematics learning in the classroom. The study results obtained that the socio-mathematics norm instrument consisted of 25 valid and reliable items. Based on the results of this study, we recommend teachers use the socio-mathematics norm instrument to measure social abilities (student affective aspects) in learning and mathematics classrooms. In addition, this instrument can be used as an alternative to measuring socio-mathematical norms for researchers in the field of socio-mathematical norms.

Limitations

Several research limitations have been carried out in developing sociomathematical norm instruments. First, the research that has been done uses a sample of high school students, so it is limited in generalization. Therefore, in further study, we recommend validating the sociomathematical norm instrument with a more extensive and varied sample for all levels of education. Second, there are three sociomathematical norm items with a loading factor value of < 0.700, so these three items need to be re-analyzed regarding the editorial to be more easily understood by respondents. Third, the analysis of validity and reliability using the RASCH, Smart PLS, and Amos models that have been carried out still has weaknesses, so it is necessary to verify the reliability of the test-retest. Fourth, research on validating sociomathematical norm instruments has not examined comparisons between gender and educational levels. So that further analysis can be carried out to compare sociomathematical norms based on gender and status of education.

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Conflict of Interest

The authors have no conflict of interest to declare.

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GENERAL REMARKS AND RECOMMENDATIONS TO THE AUTHOR

Author should give more information of developing questionnaire. Who did select items from other scales and how many. Which parts was selected from those scales and why? Which part of your questionaire was developed by researcher. Some scale is not authors native language so how did he execute this process?

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CORRECTION REPORT			
No	**Reviewer Code**	**Reviews**	**Corrections made by the author**
1.	R2612	The word "All elements" in abstract is given a comment "What are these elements ?"	Students in mathematics classes do not understand the importance of sociomathematical norm in learning mathematics. This causes sociomathematical norm not to be teachers' focus when learning mathematics. Besides, there is no standardized instrument for assessing this norm, so developing this instrument is necessary to measure socio-mathematical norms in learning mathematics.
2.	R2614	The reviewer is comment " keywords are one of the basic pillars of a study. but these words are not used elsewhere in this paper. for example learning mathematic is more suitable."	*Developments Scale; Learning Mathematics;* Psychometric *Validation; RASCH Model; Sociomathematical Norms*
3.	R2612	The setences "Others revealed that sociomathematical norms as an attitude to consider explanations for different mathematical answers received by students" in introduction (page 2) is given a comment "who, and nor understandable"	Other researchers reveal that sociomathematical norms are an attitude to explaining different answers to students' math problems "other" refers to Code et al. (2016), Kang & Kim (2016), Savuran & Akkoç (2021) as in the quote
4.	R2612	Paragraph 2 in page 2, reviewer is comment "First define the sociomathematical norms"	Adding sentences In connection with the opinions of these experts, the sociomathematical norms is an activity that does not only involve individual thought processes but also social interaction in the mathematics class. This norm implies the need for negotiation between students and exchanges with teachers. If there are differences in math answers and differences in mathematical explanations, they need an agreement so that the math problems faced by students are relatively easy to solve.
5.	R2612	I paragraph 2 reviewer is comment "First define the sociomathematical norms"	Adding sentences In connection with the opinions of these experts, the sociomathematical norms is an activity that does not only involve individual thought processes but also social interaction in the mathematics class. This norm implies the need for negotiation between students and exchanges with teachers. If there are differences in math answers and differences in mathematical explanations, they need an agreement so that the math problems faced by students are relatively easy to solve.
6.	R2612	The reviewer comments "I do not think this paper is related to teachers." in sentences "The teacher's role in developing sociomathematical norms includes being a facilitator and directing students to develop the ability to represent values, accuracy, and thoroughness in determining answers, efficiency, and writing solutions with confidence	deleted

CORRECTION REPORT			
No	**Reviewer Code**	**Reviews**	**Corrections made by the author**
7.	R2612	In page 4, reviewer is comment "In the introduction, the authors introduced several concepts, but they did not clarify the research problem. What are the shortcomings of previous studies, and what was the need for conducting this research?"	Adding sentences In learning mathematics, effective action is needed to understand and solve the mathematical problems being studied. For this reason, one of the values developed in the sociomathematical norm includes mathematical effectiveness (Ningsih & Maarif, 2021). The value of mathematics effectiveness will lead students to determine practical actions from several alternative solutions in solving a mathematical problem (Svensson & Wester, 2022). In previous research conducted by Ningsih & Maarif (2021) with class VII-A students at SMP 113 Jakarta learning mathematics in class, it was found that sociomathematical norms affect the learning outcomes of students learning mathematics. Students with high sociomathematical norms have good learning outcomes; if students have low sociomathematical norms, students also have expected learning outcomes. These results align with research conducted by Rahmah & Khusna (2023), which found a positive relationship between the ability to solve problems and the sociomathematical norms possessed by students. In other words, students with high problem-solving abilities have high sociomathematical norms, and students with low problem-solving abilities have standard sociomathematical norms. When students encounter learning obstacles, practical steps are needed to solve problems with the right ideas (Maarif et al., 2019). This requires students to have the ability to think creatively in solving problems. The level of creativity students possess causes the arguments presented by students to vary, thus requiring negotiation so that the differences in opinions get a way out or a solution (Widodo, 2020). Although the results of this study are different from research conducted by Saskiya & Khusna (2023), which states that every individual who has high mathematical creative thinking abilities has high sociomathematical norms, every individual who has moderate mathematical creative thinking abilities also has sociomathematical norms. Students with low mathematical creative thinking abilities have soft aspects of sociomathematical norms.

CORRECTION REPORT			
No	**Reviewer Code**	**Reviews**	**Corrections made by the author**
8.	R2612	In page 4, reviewer is comment "In the introduction, the authors introduced several concepts, but they did not clarify the research problem. What are the shortcomings of previous studies, and what was the need for conducting this research?"	McClain & Cobb (2001), in their research to understand how mathematics teachers can proactively support their students' mathematics learning by documenting the role of a first-grade teacher in guiding the development of sociomathematical norms in their classrooms, found that it is essential for teachers to drive the emergence of social norms proactively—sociomathematical norms when teaching mathematics for understanding so that learning mathematics becomes more effective. Sanchez & Garcia (2014), who investigated whether or not there was a relationship between sociomathematical norms and mathematics at different academic levels, showed that sometimes there are cognitive conflicts when students work in small groups, the impact of which can lead to an incomplete understanding of mathematical concepts, for that conflict This cognitive function must be completed by students in their groups so that knowledge of concepts becomes better and learning mathematics becomes more effective. Both of these studies have used the sociomathematical norms instrument, but the level of validity of the instrument used has not been reported. The results of research conducted by Ningsih & Maarif (2021), Rahmah & Khusna (2023), and Saskiya & Khusna (2023) have used instruments on sociomathematical norms to study sociomathematical norms based on their mathematical abilities such as critical and creative thinking skills. The instruments used in these three studies have used indicators of sociomathematical norms. Still, only the level of validity of these instruments has not been measured because they only use expert judgment in measuring the sociomathematical norms used. In contrast, the research conducted by Widodo et al. (2020) used a sociomathematical norms instrument which was developed from 4 aspects, namely (1) the experience of mathematics, (2) the explanation of the mathematics, (3) mathematical differences, (4) mathematical communication the indicators developed were analyzed using confirmatory analysis, and it was concluded that the four indicators are valid and fit
9.	R2612	The last paragraph in page 4, the reviewer comments "This is a different concept and the existing of too many concepts makes the text hard to understand."	The last paragraph in page 4 is deleted
10.	R2612	The reviewer comment "Indirect writing", in sentences "Referring to the several research perspectives carried out as a hierarchical research framework,"	as well as the hierarchical viewpoint related to research on sociomathematical norms

CORRECTION REPORT			
No	**Reviewer Code**	**Reviews**	**Corrections made by the author**
11.	R2612	The reviewer comment “need citation” in setences “the researchers have provided some information that the importance of sociomathematical norms in learning mathematics needs to be developed in all elements”	The researchers have provided some information that the importance of sociomathematical norms in learning mathematics needs to be developed in all elements (Guven & Dede, 2017; Stephand, 2020),
12.	R2612	reviewer comment “The authors should make an emphasize on the weaknesses of earlier studies.” In setences One crucial element to create is an instrument in the form of a questionnaire to measure sociomathematical norms in learning mathematics	An instrument used for research should be validated and standardized (Mojan, 2017; Martin et al., 2022). as was done by Widodo et al. (2020), who developed an observation sheet to measure sociomathematical norms. However, research on developing sociomathematical norm questionnaires to obtain standardized and measurable questionnaire instruments has never been carried out.
13.	R2612	The reviewer comment “As a researcher, I am struggling to comprehend how the authors decided their goal. It would be helpful if the authors could provide more detailed explanations of the research problem.” In setences “this study aims to develop and verify the psychometric validity of the sociomathematical norm scale”	So, this study focused on creating an instrument as a standardized and quantifiable sociomathematics norm questionnaire. This is what distinguishes current research from research that several researchers have carried out, e.g. McClain & Cobb (2001), Sánchez & García (2014), Maarif et al. (2022), Ningsih & Maarif (2021), Rahmah & Khusna (2023), dan Saskiya & Khusna (2023). In addition, the difference between this study and the research conducted by Widodo et al. (2020) lies in (1) the type of instrument being developed, which in the current research uses a questionnaire, while previous research is in the form of observation sheets, (2) the indicators used to develop sociomathematical norms , in the current research include elements of mathematical experience (MEx), explanation of mathematics (MMEp), the mathematical difference (MD), mathematical communication (MC), mathematical effectiveness (MEf), and mathematical insight (MI) (Kang & Kim, 2016; Yackel & Cobb, 1996). At the same time, previous research included elements of (1) the experience of mathematics, (2) the explanation of mathematics, (3) mathematical differences, and (4) mathematical communication. The last difference lies in the analysis used to test the development of the instrument. The current study used SmartPLS 4 and RASCH, whereas previous studies used Confirmatory Factor Analysis with LISRELL. For this reason, this study aimed to establish and verify the psychometric validity of the sociomathematical norms scale.
14.	R2612	The reviewer comment “What are results of the previous research? No information was given about the results of earlier studies.”	Several paragraphs have been added, such as paragraphs 7-10

<table>
<tr><th colspan="4">CORRECTION REPORT</th></tr>
<tr><th>No</th><th>Reviewer Code</th><th>Reviews</th><th>Corrections made by the author</th></tr>
<tr><td>15.</td><td>R2612</td><td>The reviewer comment “The method should be in the past tense.” İn setencers This research develops sociomathematical norm instruments by adapting aspects produced by Kang & Kim (2016), Widodo et al. (2020), and Yackel & Cobb (1996)</td><td>This research develops an instrument of sociomathematical norm adapted from the aspects produced by Kang & Kim (2016), Widodo et al. (2020), and Yackel & Cobb (1996),</td></tr>
<tr><td>16.</td><td>R2164</td><td>the reviewer is comment “You should give more information of this process. Who did select items from these scale and how many. Which parts was selected from these scales and why? Which part of your questionaire was developed by researcher. Are the scales you used while developing your scale in your native language?”</td><td>including parts of MEx, MEp, MD, MC, MEf, and MI. The items developed were derived from these six (6) aspects. Before testing the validity and reliability using the survey method of senior high school students, the instrument was first translated in forward and back translation (English to Indonesian, then Indonesian to English) by linguists’ expert and native speakers. This was done because the subjects used as trials used Indonesian as their mother language.</td></tr>
<tr><td>17.</td><td>R2612</td><td>The reviewer comment “??”</td><td>The items developed were derived from these six (6) aspects.</td></tr>
<tr><td>18.</td><td>R2612</td><td>The reviewer comment “demographic information is missed” in setences “505 high school”</td><td rowspan="2">All study participants were divided by gender and school level, which included grades X and XI, as shown in Table 1.
Table 1. Participant Demographics
<table>
<tr><th>Respondent</th><th></th><th>frequency</th><th>Percent (%)</th></tr>
<tr><td rowspan="3">Gender</td><td>Male</td><td>259</td><td>51.3</td></tr>
<tr><td>Female</td><td>246</td><td>48.7</td></tr>
<tr><td>Total</td><td>505</td><td>100</td></tr>
<tr><td rowspan="3">Province</td><td>DKI Jakarta</td><td>406</td><td>80.4</td></tr>
<tr><td>West Java</td><td>99</td><td>19.6</td></tr>
<tr><td>Total</td><td>505</td><td>100</td></tr>
<tr><td rowspan="4">Grade</td><td>10th</td><td>350</td><td>69.3</td></tr>
<tr><td>11th Science</td><td>85</td><td>16.8</td></tr>
<tr><td>11th Social Science</td><td>70</td><td>13.9</td></tr>
<tr><td>Total</td><td>505</td><td>100</td></tr>
</table></td></tr>
<tr><td>19.</td><td>R2614</td><td>The reviewer comment “ Gender and other identifying information ??”, “The minimum sampling is related with your number of questionnaire's item. Hoew many items does your questionaire have?”, and “Are all surveys you sent returned complete and truely complete?”</td></tr>
<tr><td>20.</td><td>R2612</td><td>In instrument, reviewer is comment “How was the adaptation conducted? How were the items developed?”</td><td>The steps for adjusting the sociomathematical norms instrument consist of five (5) stages. First, First, synthesize the indicators of sociomathematical norms reported by the three research teams. This stage is carried out to define the variables owned by sociomathematical norms. Second, it describes the variables the researchers agreed upon in more detailed indicators. Third, arrange items corresponding to the agreed variables to obtain a prototype instrument of sociomathematical norms . Fourth, try out sociomathematical norms instruments. Fifth, Analyzing the validity and reliability.</td></tr>
</table>

CORRECTION REPORT			
No	**Reviewer Code**	**Reviews**	**Corrections made by the author**
21.	R2612	In setencens “The questionnaire consisted of 28 items using a Likert scale of 4 items”, reviewer comment “How were the items and they adapted?” and “Items or indicators? What are difference?”	The questionnaire consists of 28 items that refer to 6 predetermined indicators: MEx, MEp, MD, MC, MEf, and MI. Each item has four answer choices using a Likert scale.
22.	R2164	The reviewer comments “ Are all items suitable for your scale. Did anayone check before factor analysis”	Furthermore, the item items are validated by experts with academic positions as associate professors and doctoral degrees covering grammar, vocabulary, and content validity of the specified indicators and some input from experts as material for consideration for revising the developed instrument
23.	R2612	In setencens “score of each indicator is obtained by finding the average value of each question representing the dimension”, reviewer comment “ not clear “	Delete
24.	R2612	In setencens “Items are developed by referring to the operational definition of these aspects”, reviewer comment “who develope “	Items on an instrument of sociomathematical norms were developed by referring to the operational definitions of variables (indicators) set.
25.	R2612	In setences “table 2 shows the correlation value of the 24 items indicating more than 0.4”, the reviewer is comment “wrong info”	Furthermore, Table 3 shows the correlation

CORRECTION REPORT			
No	**Reviewer Code**	**Reviews**	**Corrections made by the author**
26.	R2612	In discussion reviewer comment “these are not discussion and vague to discuss the results. Write firstly the aims of the study.”	This study aims to establish and verify psychometric validity on a sociomathematics norm scale. Following the phrase, Sociomathematical norms are social norms that exist in mathematics class (Widodo et al., 2019; Widodo et al., 2023), so that this norm leads more to the process of mathematical thinking (Dickes et al., 2020; Gülburnu & Gürbüz, 2022). This norm is an activity that does not only involve individual thought processes but also social interactions in the mathematics class. This norm implies the need for negotiation if there are differences in mathematical answers and differences in mathematical explanations. In addition, sociomathematical norms in learning mathematics can discipline students to obey mathematical rules, follow the interactions of learning mathematics and respect each other's opinions (Biza et al., 2015; Kang & Kim, 2016; Stephan, 2020; Widodo et al., 2020). This is what underlies the need to develop a sociomathematical norms instrument. By acquiring or adapting a measuring tool for sociomathematical norms, it is hoped that it will make it easier to observe sociomathematical norms that exist in students in mathematics classes and make it easier for students to perceive themselves about social norms in learning mathematics.
27.	R2612	The reviewer comment “Not clear. Needs to be rewritten.” İn the setences This is in line with research that confirms the factor analysis of the sociomathematical norm observation instrument	This study's results align with previous research, which justifies the factor analysis of sociomathematical norm observation instruments
28.	R2612	İn discussionn in paragraph 3 reviewer comment “What are your references?”, “The authors did not mention about the results of previous research?”, “What form?”, “Use another word.”, and “The results are not clearly given in the intro”	Research related to sociomathematical norms focuses more on analyzing sociomathematical norms in learning mathematics (Dickes et al., 2020; Fukawa-Connelly, 2012; Güven & Dede, 2017; Kang & Kim, 2016; Maarif et al., 2022; McClain & Cobb, 2001; Partanen & Kaasila, 2015; Putri et al., 2015; Sánchez & García, 2014; Widodo et al., 2019). Besides that, the analysis of sociomathematical norms on mathematical skills was also mainly carried out in previous studies (Ningsih & Maarif, 2021; Rahmah & Khusna, 2023; Saskiya & Khusna, 2023). It was found that only one study focused on developing a sociomathematical norms measurement, namely research conducted by Widodo et al. (2020). Previous measuring instrument studies used sociomathematical norms observation sheets, differentiating this research from current research. Besides that, in the study conducted by Widodo, the variables: experience of mathematics, explanation of the mathematics, mathematical differences, and mathematical communication were used to form sociomathematical norms, in contrast to the current research, which developed sociomathematical norms derived from Mathematical Experience (MEx), Mathematical Explanation (MEp), Mathematical Difference (MD), Mathematical Communication (MC), Mathematics Effectiveness (MEf), Mathematical Insight (MI).

CORRECTION REPORT			
No	**Reviewer Code**	**Reviews**	**Corrections made by the author**
29.	R2612	Reviewer comment “Do not repeat the statistical results in the discussion. “ in setences “loading factor > 0.700”	deleted
30.	R2612	Reviewer comment “Explain possible reasons of this finding”	This condition can occur if one of the following conditions is met. First, items have meanings that have multiple linguistic interpretations or ambiguity. Ambiguity is the double meaning of a sentence uttered by someone so that it is doubtful, or completely not understood by another person . Ambiguity can occur because the structure of phrases and sentences is inappropriate, changes in the formation of words used in a sentence are not appropriate. This condition makes the subject (student) confused because there is more than one sentence, the effect is that the student is confused in determining the appropriate answer to the subject's condition. For this reason, in preparing the items of a research instrument, it is hoped that there will be no ambiguity. Second, all students' answers lead to one answer. This is in line with research conducted by Satrio (2008), that in social research involving questionnaires in the form of closed questions with answer choices provided, respondents are often "forced" to choose the answers that have been provided, because they do not have other answer choices. This forced condition results in the possibility that all students' answers refer to the same choice
31.	R2612	Reviewer comment “I am not convinced.”	Item Code Mex1, the subject has a tendency to answer according to the facts on the ground, and according to the existing learning culture. This condition causes all students to give answers that lead to one answer. context pays attention to the context of understanding different material. The context of paying attention does not necessarily mean that students understand. It's different if students understand, students are more likely to pay attention to the material taught by the teacher in mathematics class. Students in the learning process in the classroom are required to always pay attention and understand the concept being taught by the teacher so that when faced with these statements’ students are easy to answer.
32.	R2612	The reviewer comment “Readers need to read the items in the discussion” in setences “I never paid attention to the teacher while explaining the material), MC4 (I find it challenging to understand the material delivered by the teacher even though the explanation is repeated”	Three items include (1) I never paid attention to the teacher while explaining the material, which is contained in the indicator of MEx or Mathematical Experience; (2) I find it challenging to understand the material delivered by the teacher even though the explanation is repeated, which is contained in the indicator MC or Mathematical Communication, and (3) I am not happy if my group mates do not accept my opinion, which is contained in the indicator MC or Mathematical Insight
33.	R2612	The reviewer is comment “Statistical result!” in setences > 0.500	in the AVE analysis

CORRECTION REPORT			
No	**Reviewer Code**	**Reviews**	**Corrections made by the author**
34.	R2612	The reviewer comment "This does not serve for a well written discussion" in setences "Thus, the sociomathematical norm instrument is identified as a scale with very high reliability."	if this sentence is omitted, then in this paragraph it cannot be concluded that "the developed sociomathematical norms instrument has high reliability, so that it can be used to measure students' sociomathematical norms ". for that I decided to stick with this sentence
35.	R2612	İn conclusion, the reviewer is comment "Only? So the development of instrument"	This study developed a measure for sociomathematical norms in learning mathematics by testing its validity and reliability. The research results show that the instrument of sociomathematical norm has been obtained and comes from 6 variables: mathematical experience, mathematical explanation, mathematical difference, mathematical communication, mathematical effectiveness, and mathematical insight
36.	R2612	İn conclusion, the reviewer is comment "missing verb" in setences ". Improvement and development of learning mathematics in various ways, exceedingly soft skill competencies"	Delete
37.	R2612	İn conclusion, the reviewer is comment "The new knowledge revealed from this research is not explained. How this study contributed to the literature. This is not clarified. "	In addition, knowledge of sociomathematical norms formed from these six variables can be used as an alternative to studying sociomathematical norms.
38.	R2614	Reference	Ab Hamid, M. R., Sami, W., & Mohmad Sidek, M. H. (2017). Discriminant validity assessment: use of Fornell & Larcker criterion versus HTMT criterion. *Journal of Physics: Conference Series*, *890*, Article. 012163 . https://doi.org/10.1088/1742-6596/890/1/012163
39.	R2614	Reference	Apsari, R. A., Sripatmi, S., Putri, R. I. I., Hayati, L., & Sariyasa, S. (2020). From less to more sophisticated solutions: a sociomathematical norms to develop students' self-efficacy. In G Gunawan et al., (Ed), *Proceeding of the 1st annual conference on education and social sciences*, Mataram, Indonesia, *465*, pp 268-290. https://doi.org/10.2991/assehr.k.200827.072

CORRECTION REPORT			
No	**Reviewer Code**	**Reviews**	**Corrections made by the author**
40.	R2614	Reference	Güven, N. D., & Dede, Y. (2017). Examining social and sociomathematical norms in different classroom microcultures: Mathematics teacher education perspective. *Kuram ve Uygulamada Egitim Bilimleri*, *17*(1), 265-292. https://doi.org/10.12738/estp.2017.1.0383
41.	R2614	Reference	Kang, S. M., & Kim, M. K. (2016). Sociomathematical norms and the teacher's mathematical belief: A case study from a Korean in-service elementary teacher. *Eurasia Journal of Mathematics, Science and Technology Education*, *12*(10), 2733-2751. https://doi.org/10.12973/eurasia.2016.1308a
42.	R2614	Reference	Matranga, A., & Silverman, J. (2022). Documenting two emerging sociomathematical norms for examining functions in mathematics teachers' online asynchronous discussions. *Journal of Mathematics Teacher Education*, *25*, 1–30. https://doi.org/10.1007/s10857-022-09563-2
43.	R2614	Reference	Morrison, S., Venkat, H., & Askew, M. (2021). Journeys towards sociomathematical norms in the Foundation Phase. *South African Journal of Childhood Education*, *11*(1), Article a927. https://doi.org/10.4102/sajce.v11i1.927
44.	R2614	Reference	Savuran, R., & Akkoç, H. (2021). Examining pre-service mathematics teachers' use of technology from a sociomathematical norm perspective. *International Journal of Mathematical Education in Science and Technology*, 54, 1–25. https://doi.org/10.1080/0020739X.2021.1966529
45.	R2614	Reference	Svensson, C., & Wester, R. (2022). Socio-mathematical norms regulate whole-class discussion. In J. Hodgen et al. (Eds), Proceedings of the *Twelfth Congress of the European Society for Research in Mathematics Education (CERME12)*, Bolzano, Italy, hal-03745691. Retrieved from https://hal.science/hal-03745691/document

CORRECTION REPORT			
No	**Reviewer Code**	**Reviews**	**Corrections made by the author**
46.	R2614	Reference	Widodo, S. A., Turmudi, T., & Dahlan, J. A. (2019). Can sociomathematical norms be developed with learning media? *Journal of Physics: Conference Series*, *1315*, Article 012005. https://doi.org/10.1088/1742-6596/1315/1/012005

A Psychometric Validation of the Sociomathematical Norm Scale for Senior High School Students in Mathematics Learning

Abstract: Students in mathematics classes do not understand the importance of sociomathematical norms in learning mathematics. This causes sociomathematical norms not to be teachers' focus when learning mathematics. Besides, there is no standardized instrument for assessing this norm, so developing this instrument is necessary to measure socio-mathematical norms in learning mathematics. This study aims to create and verify the psychometric validity of the sociomathematical norm scale. This research used a survey method with 505 senior high school students from Jakarta and West Java as respondents. The results showed that 25 items had convergent validity, with a loading factor value of > 0.700, meaning they could be declared valid. Concurrent validity indicates that each sociomathematical norms indicator is valid as a whole. Discriminant validity shows that the AVE value on the diagonal is higher than the other values, so each item is declared valid. It was concluded that each item of the sociomathematical norms instrument has accuracy in its measurement function. The reliability test shows that each sociomathematical norms item is declared reliable. The reliability value of the sociomathematical norm item is 0.99, and the person's reliability is 0.86. Thus, the instruments developed can measure sociomathematical norms in learning mathematics.

Keywords: *Developments Scale; Learning Mathematics; Psychometric Validation; RASCH Model; Sociomathematical Norms*

Introduction

Learning mathematics is an activity that involves not only the process of thinking individually but also a collective action in social interaction (Dickes et al., 2020; Güven & Dede, 2017; McClain & Cobb, 2001; Yackel & Rasmussen, 2003). Social interaction in teaching and learning mathematics determines cognitive development through a group communication process that goes hand in hand (Widodo et al., 2019, 2023). Therefore, it is necessary to develop an in-depth study of the importance of social interaction norms in mathematics learning, known as sociomathematical norms (Maarif et al., 2022; Yackel & Cobb, 1996).

Sociomathematical norms are normative understandings in the learning process of differences and the effectiveness of mathematical thinking to build mathematical knowledge (Denton, 2017; Lim et al., 2023). Other researchers reveal that sociomathematical norms are an attitude to explaining different answers to students' math problems (Code et al., 2016; Kang & Kim, 2016; Savuran & Akkoç, 2021). Sociomathematical norms will appear when there are differences in perceptions, ways, mindsets, arguments, expectations, and obligations that are in discussion. However, they can be neutralized through negotiations to share (Baki & Kilicoglu, 2023). This sharing process makes students effective in understanding math problems so that each student can take information from one another. The practical discussion will find a middle point in the differences in perceptions to understand a mathematical problem. Accuracy, efficiency, and motivation in solving mathematical problems can occur in learning (Arroyo et al., 2014).

In connection with the opinions of these experts, the sociomathematics norm is an activity that involves not only individual thought processes but also social interaction in the mathematics class. This norm implies the need for negotiation between students and exchanges with teachers. If there are differences in math answers and differences in mathematical explanations, they need an agreement so that the math problems faced by students are relatively easy to solve. Sociomathematical norms in learning mathematics are an essential part to be developed to discipline students in complying with the rules of the learning interaction process by respecting each other's opinions (Biza et al., 2015; Kang & Kim, 2016; Stephan, 2020; Widodo et al., 2020). Furthermore, sociomathematical norms can train cooperation between students in solving mathematical problems through sharing ideas (Fukawa-Connelly, 2012). In addition, with strong sociomathematical norms, students can explain, justify, and argue for solutions obtained in solving math problems (Francisco, 2013).

Sociomathematical norms result from forming self-confidence, attitude values, and individual arguments related to mathematics as a learning activity process (Apsari et al., 2020; Putri et al., 2015; Yun & Kim, 2015). In addition, sociomathematical norms can be developed through various mathematics learning activities that are interactive between individuals by emphasizing active collaboration (Levenson et al., 2009; Morrison et al., 2021).

Sociomathematical norms are mathematical activities in learning that is characterized by experience of mathematics, explanation of the mathematics, mathematical difference, mathematical communication, mathematical effectiveness, and mathematical insight (Heyd-Metzuyanim, 2015; Ningsih & Maarif, 2021; Widodo et al., 2020; Zembat & Yasa, 2015). In the process of learning mathematics, activity experience is needed. The intended mathematics experience is students' experience in understanding written mathematical ideas, which can then be explained systematically (Kang & Kim, 2016). Knowledge of mathematics can train students to construct beliefs about the arguments expressed when solving mathematical problems (Thompson, 2013; Zhou et al., 2021). Explaining the material being studied in mathematics learning activities is very much needed. That is necessary for developing sociomathematical norms, namely the explanation of mathematics (Matranga & Silverman, 2022). Description of mathematics is urgently required when learning activities are taking place to foster students' confidence in their understanding of the mathematical concepts they are learning (Maarif et al., 2020). Explanation of mathematics can provide inferences about descriptions of mathematical operations and provide a valid way of specifying a mathematical sentence needed in compiling ideas to a conclusion (Baker, 2009; Wylie & Chi, 2014).

There are often differences in thinking between students in learning mathematics. To bridge these differences in thinking, a method is needed to find common ground between the ideas expressed. Sociomathematical norms allow students to learn how to deal with differences in thinking in mathematical problems (Lim et al., 2023). We can view mathematical differences as a positive side for developing students' thinking so that the analysis of mathematical problems becomes more profound and comprehensive (Fukawa-Connelly, 2012). Mathematical differences can be analyzed by examining the similarities and differences in ideas from several alternative solutions, which are then compared to find the best solution (Zembat & Yasa, 2015).

Sociomathematical norms can be seen in how students develop mathematical communication of mathematical concepts both orally and in writing (Gearing & Hart, 2019; Kang & Kim, 2016). In learning mathematics, mathematical communication can be seen in how students express mathematical ideas, represent mathematical problems in images, discuss concepts coherently, and understand ideas in a language that is easy to understand (Lomibao et al., 2016). In addition, mathematical communication is also intended to see student explanations in acting to validate procedures or steps for solving mathematics systematically, both orally and in writing (Brendefur & Frykholm, 2000).

In learning mathematics, effective action is needed to understand and solve the mathematical problems being studied. For this reason, one of the values developed in the sociomathematical norm includes mathematical effectiveness (Ningsih & Maarif, 2021). The value of mathematics effectiveness will lead students to determine practical actions from several alternative solutions in solving a mathematical problem (Svensson & Wester, 2022). In previous research conducted by Ningsih & Maarif (2021) with class VII-A students at SMP 113 Jakarta learning mathematics in class, it was found that sociomathematical norms affect the learning outcomes of students learning mathematics. Students with high sociomathematical norms have good learning outcomes; if students have low sociomathematical norms, students also have expected learning outcomes. These results align with research conducted by Rahmah & Khusna (2023), which found a positive relationship between the ability to solve problems and the sociomathematical norms possessed by students. In other words, students with high problem-solving abilities have high sociomathematical norms, and students with low problem-solving abilities have standard sociomathematical norms.

When students encounter learning obstacles, practical steps are needed to solve problems with the right ideas (Maarif et al., 2019). This requires students to have the ability to think creatively in solving problems. The level of creativity students possess causes the arguments presented by students to vary, thus requiring negotiation so that the differences in opinions get a way out or a solution (Widodo, 2020). Although the results of this study are different from research conducted by Saskiya & Khusna (2023), which states that every individual who has high mathematical creative thinking abilities has high sociomathematical norms, every individual who has moderate mathematical creative thinking abilities also has sociomathematical norms. Students with low mathematical creative thinking abilities have soft aspects of sociomathematic norms.

Several different studies have focused on research on sociomathematical norms and how they are implemented in classroom learning by teachers and students (McClain & Cobb, 2001; Sánchez & García, 2014), identification of the elements forming sociomathematical norms (Maarif et al., 2022), observation of sociomathematical norm indicators (Widodo et al., 2020), and the relationship between sociomathematical norms on mathematical ability (Ningsih & Maarif, 2021; Rahmah & Khusna, 2023; Saskiya & Khusna, 2023). McClain & Cobb (2001), in their research to understand how mathematics teachers can proactively support their students' mathematics learning by documenting the role of a first-grade teacher in guiding the development of sociomathematical norms in their classrooms, found that it is essential for teachers to drive the emergence of social norms proactively—sociomathematical norms when teaching mathematics for understanding so that learning mathematics becomes more effective. Sanchez & Garcia (2014), who investigated whether or not there was a relationship between sociomathematical norms and mathematics at different academic levels, showed that sometimes there are cognitive conflicts when students work in small groups, the impact of which can lead to an incomplete understanding of mathematical concepts, for that conflict This cognitive function must be completed by students in their groups so that knowledge of concepts becomes better and learning mathematics becomes more effective. Both of these studies have used the sociomathematical norm instrument, but the level of validity of the instrument used has not been reported.

The results of research conducted by Ningsih & Maarif (2021), Rahmah & Khusna (2023), and Saskiya & Khusna (2023) have used instruments on sociomathematical norms to study sociomathematical norms based on their mathematical abilities such as critical and creative thinking skills. The instruments used in these three studies have used indicators of sociomathematical norms. Still, only the level of validity of these instruments has not been measured because they only use expert judgment in measuring the sociomathematical norms used. In contrast, the research conducted by Widodo et al. (2020) used a sociomathematical norm instrument which was developed from 4 aspects, namely (1) the experience of mathematics, (2) the explanation of the mathematics, (3) mathematical differences, (4) mathematical communication the indicators developed were analyzed using confirmatory analysis, and it was concluded that the four indicators are valid and fit

The researchers have provided some information that the importance of sociomathematical norms in learning mathematics needs to be developed in all elements (Guven & Dede, 2017; Stephand, 2020), as well as the hierarchical viewpoint related to research on sociomathematical norms. One crucial element to create is an instrument in the form of a questionnaire to measure sociomathematical norms in learning mathematics. An instrument used for research should be validated and standardized (Mojan, 2017; Martin et al., 2022). as was done by Widodo et al. (2020), who developed an observation sheet to measure sociomathematical norms. However, research on developing sociomathematical norm questionnaires to obtain standardized and measurable questionnaire instruments has never been carried out. So, this study focused on creating an instrument as a standardized and quantifiable sociomathematics norm questionnaire. This is what distinguishes current research from research that several researchers have carried out, e.g. McClain & Cobb (2001), Sánchez & García (2014), Maarif et al. (2022), Ningsih & Maarif (2021), Rahmah & Khusna (2023), dan Saskiya & Khusna (2023).

In addition, the difference between this study and the research conducted by Widodo et al. (2020) lies in (1) the type of instrument being developed, which in the current research uses a questionnaire, while previous research is in the form of observation sheets, (2) the indicators used to develop sociomathematical norms, in the current research include elements of mathematical experience (MEx), explanation of mathematics (MMEp), the mathematical difference (MD), mathematical communication (MC), mathematical effectiveness (MEf), and mathematical insight (MI) (Kang & Kim, 2016; Yackel & Cobb, 1996). At the same time, previous research included elements of (1) the experience of mathematics, (2) the explanation of mathematics, (3) mathematical differences, and (4) mathematical communication. The last difference lies in the analysis used to test the development of the instrument. The current study used SmartPLS 4 and RASCH, whereas previous studies used Confirmatory Factor Analysis with LISRELL. For this reason, this study aimed to establish and verify the psychometric validity of the sociomathematics norm scale. This instrument can be used to strengthen the process of student competency in determining norms in learning mathematics. In addition, the instrument can be used as a reference for further research on developing sociomathematical norms in mathematics learning.

Methodology

Research Design

This research develops an instrument of sociomathematical norm adapted from the aspects produced by Kang & Kim (2016), Widodo et al. (2020), and Yackel & Cobb (1996), including parts of MEx, MEp, MD, MC, MEf, and MI. The items developed were derived from these six (6) aspects. Before testing the validity and reliability using the survey method of senior high school students, the instrument was first translated in forward and back translation (English to Indonesian, then Indonesian to English) by linguists' expert and native speakers. This was done because the subjects used as trials used Indonesian as their mother language.

Participant and Data Collection

Participants in this study were senior high school students who voluntarily filled out the sociomathematical norm questionnaire. The questionnaire instrument was distributed via Google form, complete with a consent letter to participate as a respondent. This research involved 505 high school students spread across the provinces of DKI Jakarta (80.4%) and West Java (19.4%). This follows the minimum sampling requirement to validate the instrument with at least 150 to 200 respondents (Kim, 2023). Data was collected using a survey of 505 respondents who voluntarily filled out a questionnaire using the Google form platform from 20 December 2022 to 20 January 2023. All study participants were divided by gender and school level, which included grades X and XI, as shown in Table 1.

Table 1. Participant Demographics

Respondent		**frequency**	**Percent (%)**
Gender	Male	259	51.3
	Female	246	48.7
	Total	505	100
Province	DKI Jakarta	406	80.4
	West Java	99	19.6
	Total	505	100
Grade	10th	350	69.3
	11th Science	85	16.8
	11th Social Science	70	13.9
	Total	505	100

Instrument

The sociomathematical norm instrument was developed and adapted by Kang & Kim (2016), Widodo et al. (2020), and Yackel & Cobb (1996). The steps for adjusting the sociomathematics norm instrument consist of five (5) stages. First, First, synthesize the indicators of sociomathematical norms reported by the three research teams. This stage is carried out to define the variables owned by sociomathematical norms. Second, it describes the variables the researchers agreed upon in more detailed indicators. Third, arrange items corresponding to the agreed variables to obtain a prototype instrument of sociomathematics norms. Fourth, try out sociomathematical norms instruments. Fifth, Analyzing the validity and reliability. From the analysis and synthesis results derived from the study report by Kang & Kim (2016), Widodo et al. (2020), and Yackel & Cobb (1996) obtained six (6) indicators or variables related to sociomathematical norms, which include indicator: MEx, MEp, MD, MC, MEf, and MI. MEx is defined as students being able to contribute to careful discussion activities in learning mathematics. MEp means that students can understand and explain ideas systematically in problem-solving.

Furthermore, MD can be interpreted as students being able to compare the similarities and differences of several alternative problem-solving solutions to get the best solution. The next indicator is MC, which defines students' ability to understand and express a statement using straightforward language. MEf can be interpreted as constructing the most effective alternative solutions and explaining them in plain language. The latter MI broadly refers to various sources of information and interaction in discussing mathematical problems.

The questionnaire consists of 28 items that refer to 6 predetermined indicators: MEx, MEp, MD, MC, MEf, and MI. Each item has four answer choices using a Likert scale. Items on an instrument of sociomathematical norms were developed by referring to the operational definitions of variables (indicators) set. Furthermore, the item items are validated by experts with academic positions as associate professors and doctoral degrees covering grammar, vocabulary, and content validity of the specified indicators and some input from experts as material for consideration for revising the developed instrument. The distribution of items based on each hand can be seen in Table 2.

Table 2. Indicators and Coding (Total Items=28)

Indicators	**Statement Item Numbers**	**Statement Item Codes**	**Sum of Items**
Mathematical Experience (MEx)	1,2,3,4,5,6	MEx1, MEx2, MEx3, MEx4, MEx5, MEx6	6
Mathematical Explanation (MEp)	7,8,9,10	MEp1, MEp2, MEp, MEp3, MEp4	4
Mathematical Difference (MD)	11,12,13,14	MD1, MD2, MD3, MD4	4
Mathematical Communication (MC)	15,16,17,18,19,20	MC1, MC2, MC3, MC4, MC5, MC6	6
Mathematics Effectiveness (MEf)	21,22,23,24	MEf1, MEf2, MEf3, MEf4	4
Mathematical Insight (MI)	25,26,27,28	MI1, MI2, MI3, MI4	4

Statistical Data Analysis

Statistical data analysis was performed using IBM SPSS Statistics 25, WINSTEPS Version 5.1.4.0, AMOS 22.0, and SmartPLS 4 software. Descriptive statistical analysis was performed to see an overview of the data's characteristics, including percentage, average and standard deviation. To analyze construct validity, convergent validity, discriminant, and concurrent validity. Furthermore, to test the reliability of sociomathematical norm instruments, RASH analysis, confirmatory factor analysis, and consistent internal analysis were used.

RASCH model analysis was performed using WINSTEPS Version 5.1.4.0 software. Much analysis of the RASCH model was carried out to analyze the construct validity of a questionnaire (Tabatabaee-Yazdi et al., 2018). An instrument is said to be valid if the research data that has been collected follows the model with constructs based on the covariance between items and the causes of item responses (Atmoko et al., 2022; Kim, 2023). RASCH model analysis was conducted on sociomathematical norm instruments to determine RASCH model analysis, construct validity, item difficulty parameters, separator index, and reliability index. Calculation of the mean square value (MNSQ) is performed to show the suitability of the model fit and determine an item according to the assumption of unidimensionality. Suppose the average infit MNSQ value is between 0.5 and 2.0 (Kandel et al., 2020; Matheny & Clanton, 2020; Muslihin et al., 2022), and the point-measure correlation value is more than 0.4 (Ghazali et al., 2019; Khamis et al., 2014; Kim, 2023). The instrument was considered a model assessed at the appropriate level and productive for measuring rating scales (Fan et al., 2022; Kim, 2023; Muniandy et al., 2023; Muslihin et al., 2022). To indicate the instrument item difficulty parameter, it can be shown that a higher logit value is interpreted as having an item difficulty level, and a low logic value indicates it is easier. The item response curve verifies the goodness of fit value of the category response with a Likert scale of 4. If the SI value is more than 2.0, then the unidimensionality of the item is appropriate, and RI is more than equal to 0.80, indicating internal scale consistency (Kim, 2023).

Confirmatory factor analysis was performed using IBM SPSS Statistics 25 and AMOS 22.0 software. Confirmatory factor analysis was carried out by constructing the equation model structure. Model fit was analyzed according to the criteria if $\chi 2/df \leq 3.0$, comparative fit index (CFI) ≥ 0.90, Tucker–Lewis index (TLI) ≥ 0.90, incremental fit index (IFI) ≥ 0.90, adjusted fit index (AGFI) ≥ 0.80, and the root mean square error of approximation (RMSEA) ≤ 0.08 criteria are met, the model is considered suitable (Widodo et al., 2020).

Convergent validity analyses were conducted using SartPLS 4 software with criteria if the loading factor values of > 0.7 (Cheah et al., 2018; Purnomo et al., 2020; Webb et al., 2017; Wigert, 2013). Concurrent validity was carried out using SmartPLS with the Average Variance Extracted (AVE) criterion value > 0.5 (Cheah et al., 2018; Hermanda et al., 2019; Wong, 2013). Furthermore, the Discriminant Validity test is carried out by looking at the

Fornell & Larcker Criterion value by assessing the AVE value on the diagonal with higher values below (Ab Hamid et al., 2017; Karakus et al., 2021; Purwanto et al., 2021).

Analysis of the reliability of the sociomathematical norm instrument items was carried out using SmartPLS 4 software. To see the level of reliability, it was carried out using the RASCH model analysis. Reliability testing is carried out by looking at Cronbach's Alpha and Composite Reliability values with the criteria if the Cronbach's Alpha values are > 0.7 and Composite Reliability > 0.7, then the instrument items are said to be reliable (Kaur et al., 2012).

Results

Construct Validity Base on Rasch Model

The results of the analysis of the RASCH model of the sociomathematical norm instrument involving 505 respondents are shown in Table 3.

Table 3. Item Difficulty Measures and Statistical Fit Sociomathematical Norms Applied in the RASCH Model Analysis

Items Number	**Items Statement**	**Items Code**	**Measure**	**Infit MNSQ**	**Outfit MNSQ**	**PT-Measure Corr.**
1	I paid attention to the teacher while explaining the material	MEx1	-1.54	0.74	0.73	0.51
2	I can show enthusiasm when learning mathematics with an active attitude during learning	MEx2	-0.45	0.79	0.78	0.57
3	I can solve math problems correctly while learning	MEx3	0.25	0.86	0.86	0.59
4	I never paid attention to the teacher while explaining the material	MEx4	-1.03	1.46	1.46	0.35
5	I am passive and do not show enthusiasm during learning	MEx5	0.08	1.36	1.39	0.47
6	I could not solve math problems correctly during the lesson	MEx6	0.64	0.99	1.02	0.60

Items Number	Items Statement	Items Code	Measure	Infit MNSQ	Outfit MNSQ	PT-Measure Corr.
7	I can understand ideas/arguments from solutions given by teachers of math problems	MEp1	-0.48	0.72	0.70	0.58
8	I accept ideas/arguments expressed by other students	MEp2	-0.98	0.71	0.71	0.45
9	I have no difficulty expressing ideas/arguments to solve mathematical problems in a structured way	MEp3	0.71	0.76	0.77	0.57
10	I have difficulty understanding the ideas/arguments given by the teacher or other students in solving math problems	MEp4	0.91	0.93	0.95	0.55
11	I work on every problem given by the teacher using the solution myself	MD1	0.40	0.93	0.94	0.44
12	I am happy when there are differences of opinion conveyed by other students in the class	MD2	-0.55	0.95	0.97	0.58
13	I am unable to accept the diversity of ideas/arguments from other students	MD3	-0.39	1.04	1.03	0.41
14	I am waiting for solutions from other students in working on the questions given by the teacher	MD4	1.16	1.09	1.13	0.48
15	I can understand the material presented by the teacher with one explanation	MC1	0.87	1.10	1.14	0.47
16	When the teacher asks me a question, I can respond or answer with the right answer	MC2	0.61	0.78	0.79	0.58
17	I ask questions when I don't understand the material presented by the teacher	MC3	-0.55	1.11	1.10	0.48
18	I find it difficult to understand the material delivered by the teacher even though the explanation is repeated	MC4	-0.85	1.27	1.35	0.18

Items Number	Items Statement	Items Code	Measure	Infit MNSQ	Outfit MNSQ	PT-Measure Corr.
19	I am not able to give responses or answers appropriately when the teacher asks me questions	MC5	0.93	0.78	0.78	0.57
20	I don't ask questions when I don't understand the material presented by the teacher	MC6	0.12	1.12	1.13	0.54
21	can find an easier solution to solving math problems	MEf1	0.40	0.95	0.95	0.51
22	I can explain the problem-solving solutions I find to other students appropriately	MEf2	0.39	0.79	0.77	0.56
23	I am not able to explain the solution to the problem solving that I find to other students appropriately	MEf3	0.92	0.73	0.75	0.57
24	I have no interest in finding solutions to math problems	MEf4	0.66	1.07	1.09	0.62
25	I tried to find various solutions from different sources during the discussion	MI1	-1.05	0.98	0.97	0.43
26	I feel happy when learning mathematics applies the discussion system because I will get various solutions	MI2	-1.00	1.19	1.17	0.43
27	I help other students who have difficulty doing math problems	MI3	0.07	1.03	1.03	0.54
28	I am not happy if my group mates do not accept my opinion	MI4	0.13	1.66	1.66	0.24

Note: MNSQ = Mean Squared; PT-Measure CORR. = Point-Measure Correlation

Table 3 shows that the MNSQ infit value for each item lies between 0.71 and 1.66 (with the criteria for an average MNSQ infit value being from 0.5 to 2.0), so 28 items are suitable for measuring the sociomathematical norm scale. Furthermore, Table 3 shows the correlation value of the 24 items, indicating more than 0.4, which means that the items can be used to measure the sociomathematical norm scale. At the same time, things with MEx4, MC4, and

MI4 codes have a correlation value of less than 0.4. Nevertheless, the four items have MNSQ values following the criteria. So, overall, 28 items are considered to fulfil the model assessed at an appropriate and productive level for measuring the sociomathematical norm scale.

Furthermore, it shows each item's parameter difficulty by analyzing the logit value, as shown in Figure 1.

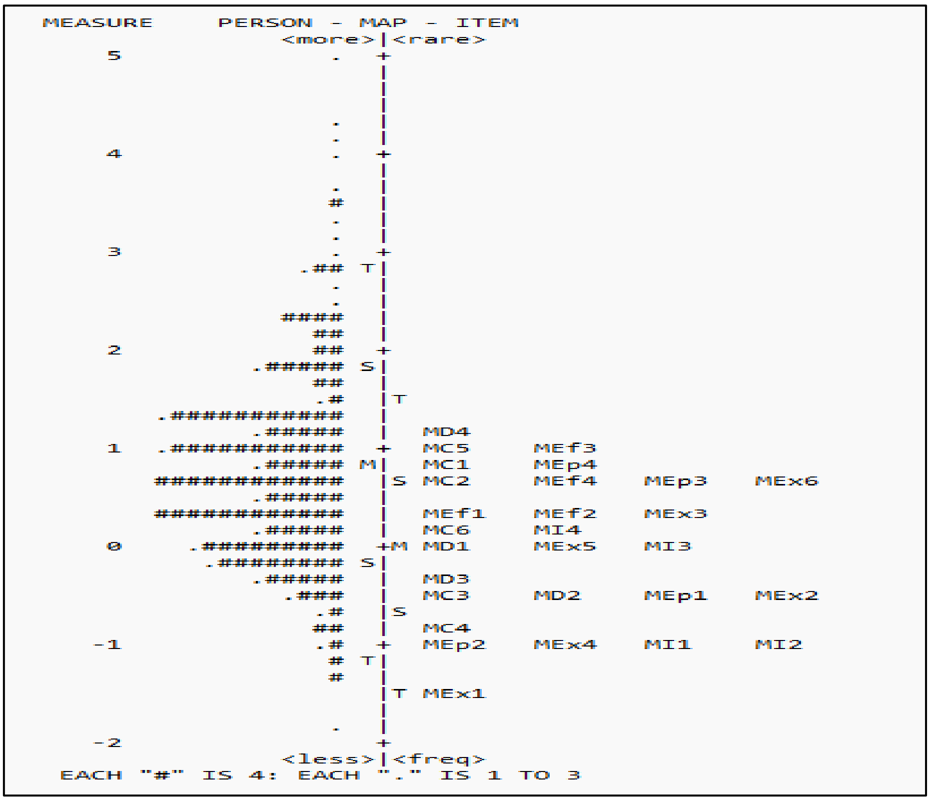

Figure 1. Person Item Map Sociomathematical Norm

Figure 1 shows the logit value of each item of the sociomathematical norm instrument. Items with code MEx1 with the editorial "I have paid attention to the teacher while explaining the material" are the lowest items, so they have a low difficulty level or are easy for respondents to answer. The item with the MD4 code with the editorial "I am waiting for solutions from other students in working on the questions given by the teacher" has the highest logit value, meaning that the respondent has difficulty being answered. Overall, Figure 1 shows the logit value of each item, which is equally distributed in terms of the problem.

To verify the goodness of fit value of the category response, it is shown through the item response curve, as shown in Figure 2.

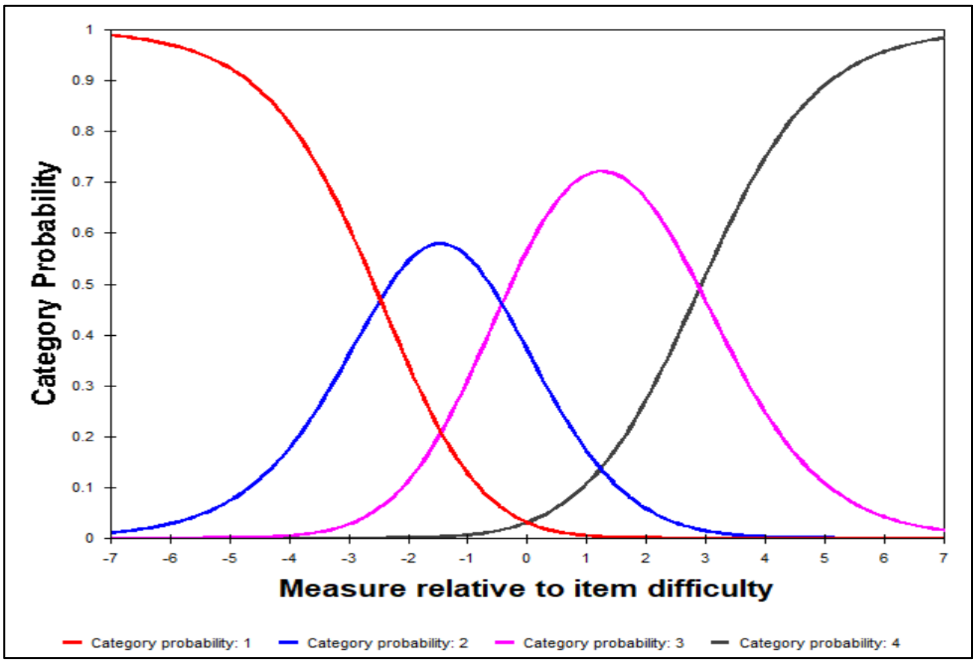

Figure 2. Response Item Category Curve

Figure 2 shows the sociomathematical norm curve's value, consisting of a Likert scale with four answers on the appropriate item response category curve. It can be seen that the rating scale looks different in each category, and there is an interaction between the scales, which indicates a relatively consistent interval scale.

Confirmatory Factor Analysis

The confirmation model for the sociomathematical norm factor can be seen in the following Figure 3. The results of the analysis of the norm sociomathematical factor confirmation model show $\chi 2/df = 0.971 \leq 3.0$, CFI = $0.935 \geq 0.90$, TLI = $0.912 \geq 0.90$, IFI = $0.905 \geq 0.90$, AGFI = $0.914 \geq 0.80$, and RMSEA) = $0.0036 \leq 0,08$. These results show that the model is at a suitable validation level.

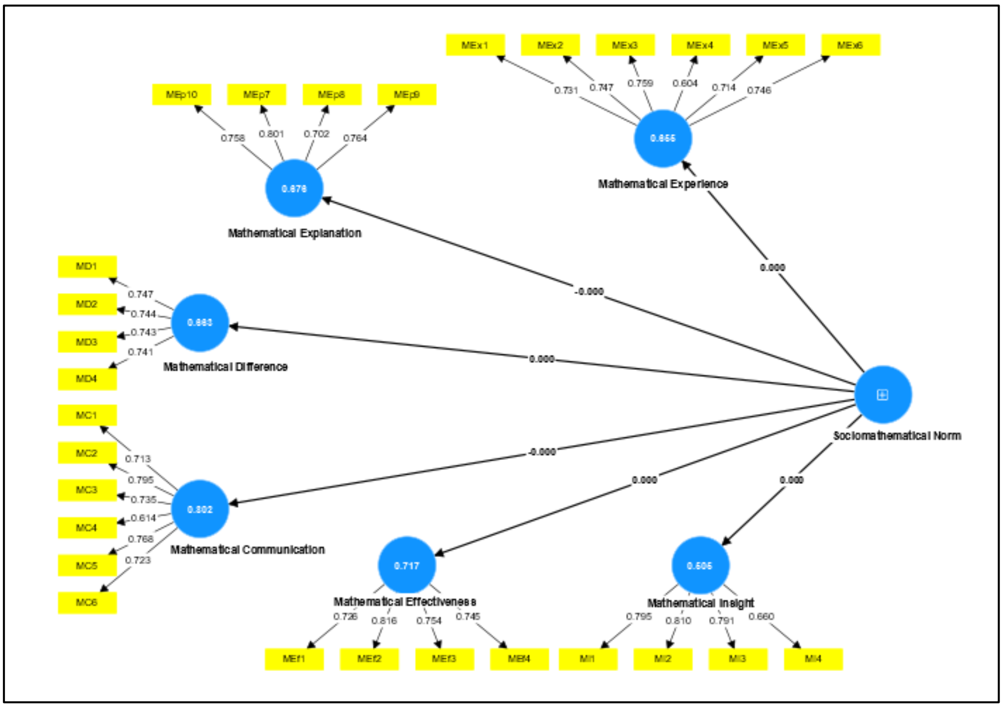

Figure 3. The Confirmatory Factor Analysis of the Sociomathematical Norm Model With SmartPLS

Test of Validity: Convergent, Discriminant, and Concurrent

Analysis of the convergent validity of the sociomathematical norm items is carried out by analyzing the factor loading of each item. Table 4 shows the results of the factor loading analysis for each item.

Table 4. Results of Convergent Validity Analysis of Sociomathematical Norm Instruments

Numbers Item	**Items Code**	**Outer Loading**	**Explanation**	**Numbers Item**	**Items Code**	**Outer Loading**	**Explanation**
1	MEx1	0.731	V	15	MC1	0.713	V
2	MEx2	0.747	V	16	MC2	0.795	V
3	MEx3	0.759	V	17	MC3	0.735	V
4	MEx4	0.604	NV	18	MC4	0.614	NV
5	MEx5	0.714	V	19	MC5	0.768	V
6	MEx6	0.748	V	20	MC6	0.723	V
7	MEp1	0.758	V	21	MEf1	0.720	V
8	MEp2	0.801	V	22	MEf2	0.816	V
9	MEp3	0.702	V	23	MEf3	0.754	V
10	MEp4	0.764	V	24	MEf4	0.745	V
11	MD1	0.747	V	25	MI1	0.795	V
12	MD2	0.744	V	26	MI2	0.810	V
13	MD3	0.743	V	27	MI3	0.791	V
14	MD4	0.741	V	28	MI4	0.660	NV

Note: V= Valid and NV=Not Valid

Table 4 shows that of the 28 items of the sociomathematical norm instrument, 25 items have a loading factor value > 0.700, which means they can be declared valid. The three items, which include MEx4, MC4, and MI4, have a factor loading value of <0.700 even though each is more than 0.600, which means the three items are invalid. Furthermore, to show the validity for each item by showing AVE, as shown in Table 5.

Table 5. Concurrent Validity Analysis with Average Variance Extracted (AVE)

Indicators	**AVE**	**Rule of thumb**	**Explanation**
MEx	0.571	> 0.500	V
MEp	0.573	> 0.500	V
MD	0.553	> 0.500	V
MC	0.574	> 0.500	V
MEf	0.579	> 0.500	V
MI	0.678	> 0.500	V

Note: V=Valid

Table 5 shows the AVE value for each indicator of the sociomathematical norm > 0.500, meaning each indicator can be considered valid. Thus, the instrument is supported by each item that can measure each indicator. Furthermore, discriminant validity analysis is carried out to ensure that each concept from each latent model is different from the other variables. Validity testing is conducted to determine how precisely a measuring instrument performs its measurement function. The discriminant validity results using the Fornell & Larcker criterion values can be seen in Table 6.

Table 6. Discriminant Validity: Fornell & Larcker Criterion

	MC	**MD**	**MEf**	**MEx**	**MEp**	**MI**
MC	0.727					
MD	0.692	0.744				
MEf	0.721	0.672	0.761			
MEx	0.642	0.560	0.603	0.719		
MEp	0.675	0.611	0.664	0.640	0.757	
MI	0.581	0.559	0.558	0.444	0.461	0.767

Table 6 shows the Fornell & Larcker Criterion values on the diagonal with higher values below so that it can be concluded that each item of the sociomathematical norm instrument has accuracy in its measurement function. In addition, Table 7 shows the correlation between sociomathematical norm indicators showing a significant correlation.

Table 7. Correlation Between Sociomathematical Norm Indicators

Correlation Between Indicators	**r**	**p-value**	**Interpretation**
MEx <=> MEp	0.640	<0.000	Sig
MEx <=>MD	0.560	<0.001	Sig
MEx <=>MC	0.642	<0.000	Sig
MEx <=> MEf	0.603	<0.000	Sig
MEx <=> MI	0.444	<0.001	Sig
MEp <=> MD	0.611	<0.001	Sig
MEp <=> MC	0.675	<0.000	Sig
MEp <=> MEf	0.684	<0.000	Sig
MEp <=> MI	0.641	<0.000	Sig
MD <=> MC	0.692	<0.000	Sig
MD <=> MEf	0.627	<0.000	Sig
MD < => MI	0.559	<0.001	Sig
MC <=> MEf	0.721	<0.000	Sig
MC <=> MI	0.581	<0.001	Sig
MEf <=> MI	0.558	<0.001	Sig

Note: Sig = Significant

Table 7 above shows that each sociomathematical norm indicator has a positive correlation. This shows that each indicator contributes positively to the sociomathematical norm. Thus, the developed indicators can be used to measure sociomathematical norms.

Test of Reliability

Instrument reliability testing was conducted by looking at Cronbach's Alpha and Composite Reliability values. The results of reliability testing can be seen in Table 8.

Table 8. Result of Reliability Test

Indicators	**C$\boldsymbol{\alpha}$**	**CR**	**Rule of thumb**	**Explanation**
MEx	0.750	0.752	> 0.700	Rel.
MEp	0.752	0.756	> 0.700	Rel.
MD	0.731	0.731	> 0.700	Rel.
MC	0.814	0.818	> 0.700	Rel.
MEf	0.756	0.759	> 0.700	Rel.
MI	0.764	0.765	> 0.700	Rel.

Note: C$\boldsymbol{\alpha}$ = Cronbach's alpha, CR = Composite Reliability, Rel. = Reliabel

Table 8 shows that C$\boldsymbol{\alpha}$ for each indicator is > 0.7, and the CR for each indicator is > 0.7. This can be interpreted that each item of sociomathematical norms is declared reliable.

Furthermore, by analyzing the RASCH model, overall, the reliability of the sociomathematical norm instrument can be seen in Figure 4.

```
---------------------------------------------------------------------------------
| PERSON      493 INPUT      493 MEASURED               INFIT          OUTFIT    |
|            TOTAL       COUNT      MEASURE   REALSE     IMNSQ   ZSTD  OMNSQ   ZSTD|
| MEAN        79.0        28.0          .77      .37      1.00    -.4   1.00    -.4|
| P.SD         9.0          .0         1.03      .10       .78    2.3    .79    2.3|
| REAL RMSE    .38 TRUE SD      .96  SEPARATION  2.52  PERSON RELIABILITY  .86|
|-------------------------------------------------------------------------------|
| ITEM        28 INPUT       28 MEASURED                INFIT          OUTFIT    |
|            TOTAL       COUNT      MEASURE   REALSE     IMNSQ   ZSTD  OMNSQ   ZSTD|
| MEAN      1390.6       493.0          .00      .08      1.00    -.3   1.00    -.2|
| P.SD       117.3          .0          .73      .01       .23    3.4    .24    3.5|
| REAL RMSE    .08 TRUE SD      .72  SEPARATION  8.83  ITEM   RELIABILITY  .99|
---------------------------------------------------------------------------------
```

Figure 4. Result of Reliability Test With RASCH Model Analysis

Figure 4 shows the reliability value of the sociomathematical norm item of 0.99 and the person's reliability of 0.86. Thus, the sociomathematical norm instrument is identified as a scale with very high reliability.

Discussion

This study aims to establish and verify psychometric validity on a sociomathematical norms scale. Following the phrase, Sociomathematical norms are social norms that exist in mathematics class (Widodo et al., 2019; Widodo et al., 2023), so that this norm leads more to the process of mathematical thinking (Dickes et al., 2020; Gülburnu & Gürbüz, 2022). This norm is an activity that does not only involve individual thought processes but also social interactions in the mathematics class. This norm implies the need for negotiation if there are differences in mathematical answers and differences in mathematical explanations. In addition, sociomathematical norms in learning mathematics can discipline students to obey mathematical rules, follow the interactions of learning mathematics and respect each other's opinions (Biza et al., 2015; Kang & Kim, 2016; Stephan, 2020; Widodo et al., 2020). This is what underlies the need to develop a sociomathematical norms instrument. By acquiring or adapting a measuring tool for sociomathematical norms, it is hoped that it will make it easier to observe sociomathematical norms that exist in students in mathematics classes and make it easier for students to perceive themselves about social norms in learning mathematics.

The research that has been carried out seeks to develop and validate the sociomathematical norm instrument in the form of a questionnaire. The sociomathematical norm questionnaire was developed by adapting the indicators developed by Yackel & Cobb (1996) and Kang & Kim (2016), including Instruments Indicators MEx, MEp, MD, MC, MEf, and MI. This study's results align with previous research, which justifies the factor analysis of sociomathematical norm observation instruments (Widodo et al., 2020).

Research related to sociomathematical norms focuses more on analyzing sociomathematical norms in learning mathematics (Dickes et al., 2020; Fukawa-Connelly, 2012; Güven & Dede, 2017; Kang & Kim, 2016; Maarif et al., 2022; McClain & Cobb, 2001; Partanen & Kaasila, 2015; Putri et al., 2015; Sánchez & García, 2014; Widodo et al., 2019). Besides that, the analysis of sociomathematical norms on mathematical skills was also mainly carried out in previous studies (Ningsih & Maarif, 2021; Rahmah & Khusna, 2023; Saskiya & Khusna, 2023). It was found that only one study focused on developing a sociomathematical norms measurement, namely research conducted by Widodo et al. (2020). Previous measuring instrument studies used sociomathematical norms observation sheets, differentiating this research from current research. Besides that, in the study conducted by Widodo, the variables: experience of mathematics, explanation of the mathematics, mathematical differences, and mathematical communication were used to form sociomathematical norms, in contrast to the current research, which developed sociomathematical norms derived from Mathematical Experience (MEx), Mathematical Explanation (MEp), Mathematical Difference (MD), Mathematical Communication (MC), Mathematics Effectiveness (MEf), Mathematical Insight (MI).

The study results show that the item coded MEx1 with the editorial "I have paid attention to the teacher while explaining the material" is the lowest item. Hence, it has a low difficulty level, or in other words, it is easy for the respondent to answer. This condition can occur if one of the following conditions is met. First, items have meanings that have multiple linguistic interpretations or ambiguity. Ambiguity is the double meaning of a sentence uttered by someone so that it is doubtful (Bialystok & Shapero, 2005; Truestwell & Tanenhaus, 2015) or completely not understood by another person (Veale, 2014). Ambiguity can occur because the structure of phrases and sentences is inappropriate, and changes in the formation of words used in a sentence are not appropriate (Truestwell & Tanenhaus, 2015). This condition makes the subject confused because there is more than one sentence. The effect is that the student is confused in determining the appropriate answer to the subject's condition (Just & Carpenter, 2013; Slattery et al., 2013).

For this reason, in preparing the items of a research instrument, it is hoped that there will be no ambiguity. Second, all students' answers lead to one solution. This is in line with research conducted by Satrio (2008) that in social research involving questionnaires in the form of closed questions with answer choices provided, respondents are often "forced" to choose the answers provided because they do not have other answer choices. This forced condition results in the possibility that all students' responses refer to the same choice.

Item Code Mex1, the subject tends to answer according to the facts on the ground and the existing learning culture. This condition causes all students to give answers that lead to one solution. Context pays attention to the context of understanding different material. The context of paying attention does not necessarily mean that students understand. It's different if students understand. Students are more likely to pay attention to the material taught by the teacher in mathematics class. Students in the classroom learning process are always required to pay attention and understand the concept being conducted by the teacher so that when faced with these statements, students are easy to answer. These findings align with the previous study, which revealed teacher variations in teaching would attract students' attention and encourage students to provide quick responses in each mathematics lesson (Lan et al., 2009). In addition, the results of the previous study revealed that developing sociomathematical norms on aspects of mathematical experience shows that students' attention to most students can focus when the teacher is explaining math material in class (Ningsih & Maarif, 2021).

Items with the MD4 code with the editor "I am waiting for solutions from other students in working on the questions given by the teacher" have the highest logit value and mean that the respondent has difficulty answering the item. These conditions indicate that making decisions on statements to wait for solutions to problem solving from other people needs consideration. In learning mathematics, it is not uncommon for students to wait for confirmation of their classmates' ideas. This is in line with the results of previous research, which revealed that only 7% of the respondents could accept other friends' solutions while solving mathematical problems (Ningsih & Maarif, 2021). In line with this research, the different results show that in the process of mathematical representation, students experience a tendency to wait for the opinions of other participants to be compared with the results of the solutions that have been constructed (Renaldy & Maarif, 2022). Overall, Figure 1 shows the logit value of each item, which is equally distributed in terms of difficulty. These conditions indicate that the instrument is good at estimating the answers from respondents. This follows what previous researchers said: a measurement scale with an even difficulty level suggests that the instrument can differentiate solutions from respondents (Kim, 2023).

Furthermore, the concurrent validity test shows that of the 28 items of the sociomathematical norm instrument, 25 items are said to be valid. Three items include (1) I never paid attention to the teacher while explaining the material, which is contained in the indicator of MEx or Mathematical Experience; (2) I find it challenging to understand the material delivered by the teacher even though the explanation is repeated, which is contained in the indicator MC or

Mathematical Communication, and (3) I am not happy if my group mates do not accept my opinion, which is contained in the indicator MC or Mathematical Insight has a loading factor value < 0.700. Even so, each factor loading value of more than 0.600 is valid. An instrument item can still be accepted if the loading factor is between 0.500 and 0.69 (Ghozali & Fuad, 2014).

Concurrent validity shows that each sociomathematical norm indicator is validated in the AVE analysis so that the instrument can measure sociomathematical norms. These results align with the previous research that validated sociomathematical norm indicators, including MEx, MEp, MD, and MC (Widodo et al., 2020). Furthermore, the discriminant validity results show the Fornell & Larcker Criterion values on the diagonal with higher values below, so it can be concluded that each item of the sociomathematical norm instrument has accuracy in its measurement function. Thus, the sociomathematical norm instrument that has been developed has been verified to have accuracy in its assessment. This aligns with research conducted by several previous studies (Kang & Kim, 2016; Ningsih & Maarif, 2021; Widodo et al., 2020).

The reliability test results showed that Cα for each indicator is > 0.7 and CR for each indicator is > 0.7. This can be interpreted that each item of the sociomathematical norms is declared reliable. Furthermore, the RASCH model analysis shows that Cα for item reliability is 0.99 and person reliability is 0.86. Thus, the sociomathematical norm instrument is identified as a very high-reliability scale, so it can be used to measure students' sociomathematical norms. This aligns with a previous study that confirmed sociomathematical norm indicators with reliable results (Widodo et al., 2020).

Conclusion

This study developed a measure for sociomathematical norms in learning mathematics by testing its validity and reliability. The research results show that the instrument of sociomathematical norm has been obtained and comes from 6 variables: mathematical experience, mathematical explanation, mathematical difference, mathematical communication, mathematical effectiveness, and mathematical insight. This study provides findings that can be useful for the development of mathematics learning, especially sociomathematical norms, due to the compatibility of the analysis results using the model RASCH, Smart PLS, and AMOS. However, this study only involved students in two provinces, namely DKI Jakarta and West Java. Therefore, we hope that the findings of the sociomathematical norm instrument can be used and further developed to contribute to improving mathematics learning. In addition, knowledge of sociomathematical norms formed from these six variables can be used as an alternative to studying sociomathematical norms.

Recommendations

This research produces a sociomathematical norms instrument that can improve mathematics learning in the classroom. The study results showed that the sociomathematical norms instrument consisted of 25 valid and reliable items. Based on the results of this study, we recommend teachers use the sociomathematical norms instrument to measure social abilities (student affective aspects) in learning and mathematics classrooms. In addition, this instrument can be used as an alternative to measuring sociomathematical norms for researchers in sociomathematical norms.

Limitations

Several research limitations have been carried out in developing sociomathematical norm instruments. First, the research that has been done uses a sample of high school students, so it is limited in generalization. Therefore, in further study, we recommend validating the sociomathematical norm instrument with a more extensive and varied sample for all levels of education. Second, there are three sociomathematical norm items with a loading factor value of < 0.700, so these three items need to be re-analyzed regarding the editorial to be more easily understood by respondents. Third, the analysis of validity and reliability using the RASCH, Smart PLS, and Amos models that have been carried out still has weaknesses, so it is necessary to verify the reliability of the test-retest. Fourth, research on validating sociomathematical norm instruments has not examined comparisons between gender and educational levels. So that further analysis can be carried out to compare sociomathematical norms based on gender and status of education.

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Conflict of Interest

The authors have no conflict of interest to declare.

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