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CONSTRUCTION AND VALIDATION OF MATHEMATICAL SATISFACTION QUESTIONNAIRE: AN EXPLORATORY AND CONFIRMATORY FACTOR ANALYSIS

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Abstract

Mathematics satisfaction can drive students to work harder in math class. Thus, it is vital to assess the satisfaction of learners using an instrument to intervene in the teaching and learning process. There are research studies that have independently developed questionnaires to measure students' mathematics satisfaction, but most of them focused on students' satisfaction with mathematical resources and online mathematics courses. Thus, previously developed instruments had limitations. The purpose of this study was to develop and validate a mathematical satisfaction questionnaire for students. Face validation, content validation, exploratory factor analysis, confirmatory factor analysis, and reliability testing were used in the study to construct and validate the instrument. The initial draft of the mathematical satisfaction questionnaire has 44 items divided into five categories: skill, real-life, academic, praise, and task completion. The study's sample included 317 students from the Nueva Ecija University of Science and Technology – Gabaldon campus. The content validity of the test was assessed by ten instructors and professors using Aiken's V technique. The construct validity was examined using exploratory and confirmatory factor analysis. Aiken's V coefficient ranged from 0.73-0.87, which is adequate for the content validity index. Every construct has an acceptable reliability coefficient. Eight items were removed following EFA. Construct validation confirmed 36 items distributed among the five mathematical satisfaction constructs. The final instrument is reliable and can be used to assess students' mathematical satisfaction.
Keywords: *Item measurement, mathematical satisfaction, reliability test, validity test*

Introduction

Mathematical satisfaction is concerned with students' intrinsic and extrinsic satisfaction with mathematics, and it encompasses praise from others, skill satisfaction, task accomplishment, academic satisfaction, and real-life situations. Mathematical satisfaction may inspire students to study and strive for excellence in mathematics. It's frequently thought of satisfaction in mathematics as a desirable, good emotion during the learning process (Barnes, 2021). As a result, it is essential to assess the student's mathematical satisfaction to provide appropriate assistance in mathematics teaching. Identifying the characteristics that lead to student satisfaction in mathematics learning, on the other hand, is critical for educators. As a result, the current research work attempted to design a mathematical satisfaction instrument construct.

The purpose of a questionnaire is to collect information from the respondents about their attitudes, experiences, and opinions (Bhandari, 2021). The questionnaire must go through several testing methods to produce an accurate result based on the collected data. In general, a good questionnaire should be valid, reliable, clear, concise, and interesting (Jenn, 2006). According to Tsang et al. (2017), a validated questionnaire is a scale or questionnaire that has been designed to be used with the intended respondents and has undergone validation using a

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representative sample, proving sufficient reliability and validity. The questionnaire is validated by experts or panellists who have a thorough understanding of the subject matter. Similarly, the consistency or stability of scores over time or across raters is a characteristic of a reliable questionnaire, which yields the same findings on repeated attempts (Bolarinwa, 2015). There are four methods for establishing questionnaire reliability: inter-rater, test-retest, parallel forms, and internal consistency reliability tests (Sauro, 2015).

Currently, it is difficult to find a questionnaire that measures the mathematical satisfaction of the students in terms of a different construct such as praise from others, skill satisfaction, task accomplishment, academic satisfaction, and real-life situations. The research study conducted by González-Ramírez and García-Hernández (2021) was only developed to assess satisfaction with mathematics study materials, while Modu (1970) designed a questionnaire to measure students' persistence in college and satisfaction with their major fields such as mathematics and English. In addition, Ramos et al. (2022) and Davis (2014) focused on students' satisfaction with online mathematics course. Furthermore, Lee (2014) used a questionnaire to assess the satisfaction levels of graduate students of mathematics, but the questionnaire focused on human constructs such as professors, instructional associates (IA) or graduate assistants (GA), course structure and technical aspects, while Majeed et al. (2001) used mathematics satisfaction questionnaire that focused on the extent of enjoyment of class work. On the other hand, several studies focused on the different satisfaction scales, such as Wang et al. (2007) and Hwang and Kim (2022) who developed and validated an e-learning satisfaction scale, Rahmatpour et al. (2021) constructed and validated a postgraduate nursing student academic satisfaction scale, Franklin et al. (2014) focused on students' satisfaction and confidence on learning, and Courtney-Pratt et al. (2015) focused on the development of satisfaction with cultural simulation experience scale.

The researcher conducted this study based on similar studies to develop a questionnaire that may measure students' mathematics satisfaction such as praise satisfaction from others, skill satisfaction, task accomplishment, academic satisfaction, and real-life scenarios. To address a broader variety of mathematics problems related to education and to undertake essential interventions, mathematics education must need an instrument that comprehensively measures students' satisfaction. Educators and researchers can utilize the instrument developed to fill a gap in gauging mathematics satisfaction. Furthermore, researchers can utilize this questionnaire to learn about the various aspects of student satisfaction with mathematics learning.

The current research aimed to (a) design and develop a validated instrument to be used for measuring students' mathematical satisfaction; (b) test the reliability of each construct of mathematical satisfaction; and (c) test the validity of each construct of mathematical satisfaction.

Research Methodology

Research Design

This study was carried out to create a questionnaire that can assess students' mathematical satisfaction in five different dimensions. The following processes were used to develop the questionnaire: (a) conducting interviews with experts and face validity; (b) content validation; (c) exploratory factor analysis; (d) confirmatory factor analysis; and (e) reliability testing. The study aimed to develop and validate a mathematical satisfaction questionnaire. The respondents of the research study are the students of Nueva Ecija University of Science and Technology – Gabaldon campus. The research study was conducted from September 2022 to March 2023.

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Interviews with Experts and Face Validity

In this step, the researcher interviewed three mathematics teachers from the Department of Education, four instructors, and five mathematics professors from Nueva Ecija University of Science and Technology about relevant items on the various constructs of mathematical satisfaction. The researcher seeks the expertise of educators from different sectors of education in the Philippines to establish a more thorough and broad understanding of mathematical satisfaction. The interviews were recorded by the researcher so that expert insight could be kept. After evaluating and analyzing the interview, the researcher generated 44 items using face validation. Researchers' subjective assessments of a measuring instrument's presentation and applicability, including whether the items seem relevant, reasonable, simple, and clear, are referred to as face validity (Oluwatayo, 2012). The 44 items were classified into five constructs: seven for praise satisfaction from others, thirteen for skill satisfaction, seven for task accomplishment, eight for academic satisfaction, and nine for a real-life situation.

Content Validation

The level to which an instrument's elements accurately reflect its content domain is known as content validity (Zamanzadeh et al., 2015). The content validity of the questionnaire is determined by the researcher using Aiken's V technique, which was developed by Aiken (1980). Ten instructors and professors from the College of Education are enlisted by the researcher to rate each item in the questionnaire's five primary dimensions. Each item receives a score from the rater based on how relevant it is to the particular construct. For each item, the lowest and maximum scores are 1 and 4, respectively. The formula of Aiken's V is $V = \sum \{(r - lo) / [n (c - 1)]\}$, where r is the score that might be given by the faculty rater to an item, lo is the lowest possible score that might be given for each item, c is the maximum possible score that might be given for each item, and n is the number of raters. The critical value for 10 raters is 0.73.

Sample

The study utilized a sample size of 317 students from Nueva Ecija University of Science and Technology Gabaldon Campus. The respondents consist of 221 females (69.7%) and 96 males (30.3%). The sample size is based on the rule of 300. According to Garson (2008), there should be at least 300 sample-size cases in running factorial analysis (EFA and CFA). Furthermore, Bryant and Yarnold (1995) argued that one's sample should be at least five times the number of variables. The number of items analyzed in this study is 44, hence there should be at least 220 responses. As a result, 317 samples were sufficient for EFA and CFA. The Google forms are accompanied by a letter of consent for the respondent, which was signed by the campus director. It is not compulsory to respond to the Google forms. The researchers also secure the participants' identities, and the data supplied were kept confidential to protect and consider the respondents' privacy.

Data Collection

Google forms were used to obtain the data. It was distributed to 600 students at the Nueva Ecija University of Science and Technology - Gabaldon campus between January 2, 2023, and February 2, 2023. The researcher sends Google forms to all sections and courses at NEUST - Gabaldon. The researcher reminds each year and section about the survey with the assistance of class advisers. After a month, and after all sections and courses had been responded to, the Google form was closed. The survey got 317 responses.

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Data Analysis

The exploratory factor analysis was performed first in the analysis of the data. The author used the Kaiser-Meyer-Olkin (KMO) to assess the appropriateness of using factor analysis on the data set. The KMO values between 0.8 to 1.0 indicate the sampling is adequate (Shrestha, 2021). To test the null hypothesis that the correlation matrix is an identity matrix, Bartlett's test of Sphericity was performed. Bartlett's Test of Sphericity must be less than 0.05 for Factor Analysis to be suitable (Van Truong et al., 2016). In addition, the author used the varimax rotation method. At one level of factor analysis, the varimax rotation approach was utilized to clarify the relationship between the factors (Dilbeck, 2017). In this study, the requirements are an Eigenvalue > 1 and a minimum loading factor of 0.5. Confirmation factor analysis (CFA) was used to determine the scales' model fit, convergent validity, and discriminant validity. The scales model fit must have a comparative fit index (CFI) value of 0.90 or greater (Hu & Bentler, 1999), a Tucker-Lewis index (TLI) value of 0.95 (Hu & Bentler, 1998), a goodness of fit index (GFI) value of greater than 0.95 (Miles and Shevlin, 1998), and an acceptable root mean square of approximation (RMSEA) value between 0.05 and 0.08. (Fabrigar et al., 1999). Cronbach's alpha was used for internal consistency reliability testing of the scale and each factor. According to various studies, an alpha value of 0.7 is sufficient to measure an instrument's internal consistency (Taber, 2018). The Cronbach's alpha coefficient of $\alpha<0.5$ is unacceptable, $0.6> \alpha\geq0.5$ is poor, $0.7> \alpha\geq0.6$ is questionable, $0.8> \alpha\geq0.7$ is acceptable, $0.9> \alpha\geq0.8$ is good, and $\alpha\geq0.9$ is excellent (Glen, 2022).

Research Results

Content Validation

The content validity of each item is shown in Table 1. Each item's content validity value was equal to or greater than the critical value of 0.73, indicating that all items were acceptable and were all considered for factorial analysis.

Table 1.
Content Validity of each Item

	Praise satisfaction	Aiken's V	Interpretation
PS1	I was pleased when someone complimented my ability in maths.	.77	Valid
PS2	I am delighted with my teacher's compliments on my math performance.	.73	Valid
PS3	I am delighted with my parents' compliments on my mathematics ability.	.73	Valid
PS4	I'm happy to be acknowledged for my accomplishments in mathematics by others.	.83	Valid
PS5	I appreciate being addressed as Mr. or Mrs. Mathematician.	.83	Valid
PS6	The compliments my superiors have made regarding my mathematics abilities fill me with pride.	.87	Valid
PS7	The mathematics awards I received bring me joy.	.80	Valid
	Skill satisfaction		
SS1	I am fulfilled to derived equations algebraically.	.87	Valid
SS2	I am satisfied with my problem-solving skill.	.87	Valid
SS3	I am satisfied when I know what to do with a specific mathematical problem.	.73	Valid
SS4	I am fulfilled that I can use specific measuring tools to measure something.	.80	Valid

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SS5	I am fulfilled about my algebraic skills.	.80	Valid
SS6	I am fulfilled about my logical skills.	.87	Valid
SS7	I am fulfilled about my inductive reasoning skills	.87	Valid
SS8	I am fulfilled about my deductive reasoning skills.	.83	Valid
SS9	I am fulfilled about my derivation skills	.77	Valid
SS10	I am fulfilled about my integration skills	.77	Valid
SS11	I am fulfilled about my statistical skills.	.77	Valid
SS12	I am fulfilled about my critical thinking skill.	.80	Valid
SS13	I am fulfilled with my analytical thinking skill.	.80	Valid
	Task accomplishment		
TA1	I am pleased when I accomplished my activities, assignment, projects in mathematics.	.80	Valid
TA2	I loved to accomplish my activities, assignments, projects in mathematics before the deadline.	.80	Valid
TA3	I am fulfilled that I solve mathematics problems on time.	.77	Valid
TA4	I am fulfilled that I solved mathematics problems accurately.	.80	Valid
TA5	I am fulfilled with my mathematics output.	.73	Valid
TA6	I am fulfilled that I can accomplish mathematics tasks on time	.80	Valid
TA7	I am fulfilled that I can accomplish mathematics tasks with no constraints.	.73	Valid
	Academic satisfaction		Valid
AS1	Getting a high grade in mathematics was fulfilling.	.83	Valid
AS2	I loved to be top performing in mathematics class.	.73	Valid
AS3	I am so much fulfilled with the mathematics grade of 1.25 (90 and above).	.73	Valid
AS4	I am satisfied with my mathematics performance.	.83	Valid
AS5	I am satisfied with the results of my mathematics examination.	.80	Valid
AS6	I am satisfied with the results of my mathematics quizzes.	.80	Valid
AS7	I am satisfied with the results of my mathematics assignments and activities.	.80	Valid
AS8	I am satisfied with the results of my mathematics project.	.83	Valid
	Real-life situation		
RL1	I loved applying mathematics principles in real-life situations.	.83	Valid
RL2	Applying mathematics principles in selling or buying something was fulfilling.	.83	Valid
RL3	I am satisfied when I solved real-life problems using mathematics.	.87	Valid
RL4	Applying mathematics principles in work was fulfilling.	.87	Valid
RL5	Applying mathematics principles in my social life was fulfilling.	.80	Valid
RL6	Applying mathematics principles to my family was fulfilling.	.83	Valid
RL7	Applying mathematics principles in my spiritual life was fulfilling.	.83	Valid
RL8	Applying mathematics principles to my finances was fulfilling.	.77	Valid
RL9	Applying mathematics principles in planning something was fulfilling.	.77	Valid

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Exploratory Factor Analysis (EFA)

According to Table 2, the value of the Kaiser-Meyer-Olkin Measure of Sampling Adequacy is 0.963, which is excellent. In addition, the Bartlett's test of sphericity is significant. Both EFA assumptions are met, hence the factorial analysis is appropriate for the data.
Items TA5, TA7, AS1, AS2, AS3, SS3, PS2, and PS3 were deleted after applying EFA using Varimax rotation because their loading factor value was less than 0.5. Following the deletion of items that did not meet the loading factor of 0.5, the statistical analysis was re-run (Samuels, 2017). EFA confirmed the five factors for mathematical satisfaction and these are; skill satisfaction (12 items), real-life satisfaction (9 items), academic satisfaction (5 items), praise satisfaction (5 items), and task accomplishment (5 items).

Table 2
Kaiser-Meyer-Olkin and Bartlett's Test of Sphericity

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.963
Bartlett's Test of Sphericity	Approx. Chi-Square	10488.231
	df	630
	p	$p < .001$

Reliability of Each Factor

Table 3 shows the reliability coefficient for each factor. Cronbach's alpha was used to determine the internal consistency of the items. Each factor falls into the good and excellent categories. Furthermore, Griethuijsen et al. (2014) stated that a level greater than or equal to 0.70 was considered adequate or satisfactory. Thus, Cronbach's alpha for each factor is reliable for factor-based scales.

Table 3
Reliability Coefficients.

Factors	Cronbach's Alpha	Interpretation
Skills Satisfaction	.88	Good
Real Life	.95	Excellent
Academic Satisfaction	.95	Excellent
Praise Satisfaction	.88	Good
Task Accomplishment	.89	Good

Loading Factors

The factor loading of each factor is shown in Table 4. Each item has a loading factor greater than the reference value of 0.5. As a result, each item fits the criteria in factor analysis, confirming the five factors for mathematical satisfaction. Every item loads with the proper loading factor, demonstrating the significant construct validity of every item.

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Table 4
Loading Factor in EFA

Items	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
SS8. I am fulfilled about my deductive reasoning skills.	.826				
SS9. I am fulfilled about my derivation skills	.824				
SS7. I am fulfilled about my inductive reasoning skills	.798				
SS10. I am fulfilled about my integration skills	.788				
SS11. I am fulfilled about my statistical skills.	.747				
SS6. I am fulfilled about my logical skills.	.738				
SS13. I am fulfilled with my analytical thinking skill.	.737				
SS12. I am fulfilled about my critical thinking skill.	.718				
SS5. I am fulfilled about my algebraic skills.	.708				
SS1. I am fulfilled to derived equations algebraically.	.662				
SS2. I am satisfied with my problem-solving skill.	.605				
SS4. I am fulfilled that I can use specific measuring tools to measure something.	.550				
RL5. Applying mathematics principles in my social life was fulfilling.		.798			
RL6. Applying mathematics principles to my family was fulfilling.		.780			
RL7. Applying mathematics principles in my spiritual life was fulfilling.		.773			
RL4. Applying mathematics principles in work was fulfilling.		.745			
RL3. I am satisfied when I solved real-life problems using mathematics.		.729			
RL2. Applying mathematics principles in selling or buying something was fulfilling.		.682			
RL1. I loved applying mathematics principles in real-life situations.		.681			
RL8. Applying mathematics principles to my finances was fulfilling.		.625			
RL9. Applying mathematics principles in planning something was fulfilling.		.605			
AS7. I am satisfied with the results of my mathematics assignments and activities.			.773		
AS5. I am satisfied with the results of my mathematics examination.			.769		
AS6. I am satisfied with the results of my mathematics quizzes.			.766		
AS8. I am satisfied with the results of my mathematics project.			.763		
AS4. I am satisfied with my mathematics performance.			.728		
PS5. I appreciate being addressed as Mr. or Mrs. Mathematician.				.763	
PS6. The compliments my superiors have made regarding my mathematics abilities fill me with pride.				.761	

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PS4. I'm happy to be acknowledged for my accomplishments in mathematics by others.	.666	
PS1. I was pleased when someone complimented my ability in maths.	.629	
PS7. The mathematics awards I received bring me joy.	.624	
TA1. I am pleased when I accomplished my activities, assignment, projects in mathematics.		.689
TA3. I am fulfilled that I solve mathematics problems on time.		.656
TA2. I loved to accomplish my activities, assignments, projects in mathematics before the deadline.		.652
TA6. I am fulfilled that I can accomplish mathematics task on time.		.540
TA4. I am fulfilled that I solved mathematics problems accurately.		.525

Confirmatory Factor Analysis (CFA)

Following EFA, the test was continued with CFA. The loading factors for each item are shown in Table 5. All items have a loading factor greater than 0.5, indicating a strong correlation within the factor. Similarly, Chen and Tsai (2007) used 0.5 as a cutoff point for factor analysis.

Table 5
Loading Factor in CFA

Items	Factor Loading
SS8. I am fulfilled about my deductive reasoning skills.	.872
SS9. I am fulfilled about my derivation skills	.883
SS7. I am fulfilled about my inductive reasoning skills	.867
SS10. I am fulfilled about my integration skills	.848
SS11. I am fulfilled about my statistical skills.	.826
SS6. I am fulfilled about my logical skills.	.844
SS13. I am fulfilled with my analytical thinking skill.	.813
SS12. I am fulfilled about my critical thinking skill.	.785
SS5. I am fulfilled about my algebraic skills.	.777
SS1. I am fulfilled to derived equations algebraically.	.723
SS2. I am satisfied with my problem-solving skill.	.708
SS4. I am fulfilled that I can use specific measuring tools to measure something.	.696
RL5. Applying mathematics principles in my social life was fulfilling.	.852
RL6. Applying mathematics principles to my family was fulfilling.	.845
RL7. Applying mathematics principles in my spiritual life was fulfilling.	.825
RL4. Applying mathematics principles in work was fulfilling.	.857
RL3. I am satisfied when I solved real-life problems using mathematics.	.832
RL2. Applying mathematics principles in selling or buying something was fulfilling.	.767
RL1. I loved applying mathematics principles in real-life situations.	.777
RL8. Applying mathematics principles to my finances was fulfilling.	.763

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RL9. Applying mathematics principles in planning something was fulfilling.	.771
AS7. I am satisfied with the results of my mathematics assignments and activities.	.913
AS5. I am satisfied with the results of my mathematics examination.	.839
AS6. I am satisfied with the results of my mathematics quizzes.	.906
AS8. I am satisfied with the results of my mathematics project.	.914
AS4. I am satisfied with my mathematics performance.	.842
PS5. I appreciate being addressed as Mr. or Mrs. Mathematician.	.815
PS6. The compliments my superiors have made regarding my mathematics abilities fill me with pride.	.796
PS4. I'm happy to be acknowledged for my accomplishments in mathematics by others.	.743
PS1. I was pleased when someone complimented my ability in maths.	.752
PS7. The mathematics awards I received bring me joy.	.784
TA1. I am pleased when I accomplished my activities, assignment, projects in mathematics.	.659
TA3. I am fulfilled that I solve mathematics problems on time.	.863
TA2. I loved to accomplish my activities, assignments, projects in mathematics before the deadline.	.724
TA6. I am fulfilled that I can accomplish mathematics tasks on time.	.864
TA4. I am fulfilled that I solved mathematics problems accurately.	.822

Fit Indices and Validity

The fit indices' findings are shown in Table 6. The figures reveal that all of the necessary requirements for fit indices were met. The Normed Chi-squared CMIN/DF = 2.683 achieved the threshold of 3, the Comparative Fit Index (CFI) of 0.954 is greater than 0.95, the Tucker Lewis Index (TLI) of 0.952 is greater than 0.95, the Goodness of Fit Index (GFI) of 0.956 is greater than 0.95, and the Root Mean Square Error of Approximation (RMSEA) of 0.073 is between the acceptable range of 0.05-0.08. The p-value of 0.057 indicates that the model fits the individual subject's data.

Table 6
Results of Fit Indices.

Measure	Value	Threshold	Interpretation
CMIN	1566.862	-	-
DF	584	-	-
CMIN/DF	2.683	Between 1 and 3	Excellent
CFI	0.954	>0.95	Excellent
TLI	0.952	>0.95	Excellent
GFI	0.956	>0.95	Excellent
RMSEA	0.073	0.05 - 0.08	Acceptable
PClose	0.057	>0.05	Excellent

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Tables 6 and 7 indicate that all of the convergent validity indicators are satisfied. Table 7 further demonstrates that all of the square roots of the Average Variance Extracted are larger than the estimated correlation coefficient between components. As a result, the criteria for discriminant validity are also met.

Table 7
Convergent and Discriminant Validity

	CR	AVE	MSV	MaxR(H)	Skill	Real Life	Academic	Praise	Task
Skill	0.957	0.65	0.48	0.962	**(0.806)**				
Real Life	0.945	0.657	0.568	0.948	0.682	**(0.811)**			
Academic	0.947	0.781	0.541	0.951	0.667	0.691	**(0.884)**		
Praise	0.885	0.606	0.604	0.887	0.643	0.637	0.653	**(0.779)**	
Task	0.892	0.625	0.604	0.908	0.693	0.754	0.735	0.777	**(0.791)**

Discussion

Mathematical satisfaction is an essential component of learning mathematics; it may boost motivation to learn mathematics. Mathematics satisfaction is a positive emotional aspect of an individual, and positive emotions boost intrinsic motivation (Løvoll et al., 2017). Furthermore, Attard and Holmes (2020) demonstrate that student satisfaction levels influence mathematics performance. Thus, this research analyzes the 44-item mathematical satisfaction questionnaire, which included the following subscales: praise satisfaction (7 items), skill satisfaction (13 items), task accomplishment (7 items), academic satisfaction (8 items), and real-life situation (9 items). These 44 items were derived from an analysis of interviews with various mathematics teachers and professors. Following face validity, the researcher conducts content validity using Aiken's V approach, with the participation of ten faculty members. The validity of each item to measure a construct is examined by the 10 faculty raters. The 44 items have a validity coefficient greater than the threshold value of 0.73, indicating that each item in the five constructs is valid.

EFA analysis was done after the content validation. Each factor has an Eigenvalue greater than one, implying that the factors should be retained (Goodwyn, 2012). Each item on each component had a loading factor larger than 0.5, and those that did not meet the requirements were deleted. To eliminate measurement errors, it is necessary to drop observed variables with loading factors below 0.5 (Ramasamy & Krishnan, 2011). The EFA analysis yields a five-factor instrument with new item counts in some components. The EFA specifically revealed the five factors that make up the scales for measuring mathematical satisfaction as follows: (a) skill satisfaction has 12 items; (b) real-life satisfaction has 9 items; (c) academic satisfaction has 5 items; (d) praise satisfaction has 5 items; and (e) task accomplishment has 5 items. The CFA was carried out after the exploratory factor analysis. The CFA analysis demonstrates that all of the fit indices criteria were met, confirming the convergent and discriminant validity of each factor.

The findings of the study confirmed the construct validity of the questionnaires. This is in accordance with Mohajan's (2017) assertion that reliability refers to the degree to which any measuring tool controls for random error, while validity refers to what an instrument measures and how well it does so. Thus, results show that the research study effectively established a mathematical satisfaction questionnaire for students in a distinct and broader dimension. Several studies have focused on mathematical satisfaction, but not in a broader sense. For example,

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Settle and Settle (2005) used solely student assessments of the course and the instructor to determine student satisfaction in mathematics. Ramos et al. (2022), Davis (2014), and Zhu (2012) concentrated on mathematics satisfaction in an online course. Furthermore, González Ramírez and García Hernández (2021), Mahir et al. (2021), and García-Hernández and González-Ramírez (2018) focused on students' satisfaction with mathematics study resources.

Conclusions

This study provided another powerful tool for measuring students' mathematics satisfaction in five categories. The study's primary analysis is exploratory factor analysis, which is followed by confirmatory factor analysis and a validity test. The EFA and CFA analyses yielded five mathematical satisfaction scale constructs. These five factors are as follows: (a) skill satisfaction has 12 items; (b) real-life satisfaction contains 9 items; (c) academic satisfaction contains 5 items; (d) praise satisfaction contains 5 items; and (e) task accomplishment contains 5 items. Students' satisfaction with their skills in various fields of mathematics can be measured using a skill satisfaction scale. The real-life-situation satisfaction questionnaire can assess student satisfaction when they apply mathematics principles in their daily lives. The academic satisfaction scale will measure how satisfied students are with their mathematical achievement. The praise-satisfaction scale can assess students' sense of satisfaction when they are complimented on their mathematical performance. Finally, the task accomplishment scale can provide the degree of satisfaction of students once they have completed a task in mathematics. To the best of his knowledge, the researcher concluded that the instruments were valid and reliable.

Recommendations

School teachers can use the validated instrument to determine students' levels of mathematics satisfaction and utilize it as baseline data for designing interventions. Various researchers interested in mathematics learning may utilize the questionnaire. Future researchers may re-evaluate or modify the items in this study for future research purposes.

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