

Development of Instruments to Measure Mathematical Anxiety of Elementary School Students

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Abstract. To generate high-quality research, a reliable instrument is required. This study aims to develop an instrument that can measure mathematical dimensions of elementary school students appropriately, for use in mathematics learning on spatial geometry. Each statement item in Mathematical Anxiety Instrument was developed based on 3 learning aspects, namely Attitudinal, Cognitive, Somatic. This study uses Research and Development (R&D) method with a quasi-experimental design on geometry topic. The sample is 100 sixth grade students in an elementary school located in Karawang Regency. The instrument developed in this study is in the form of a questionnaire with closed-ended questions. The validity test analysis implies that 23 out of 30 items on the instrument are valid. This data is supported by Cronbach's Alpha test results, where all item has reliability value higher than 0.80 indicating that the instrument being tested has a very high-test reliability. Therefore, 23 items out of 30 items were developed into instruments for measuring mathematics anxiety that applicable in Mathematics learning activities. Thus, it leads to the conclusion that this mathematics anxiety questionnaire can be utilized as an instrument for future research.

Keywords: mathematical anxiety instrument; validity; reliability

1. Introduction

It is well known that mathematics is fundamental to children development and communication in future life. Basic numeracy skills assist children to have satisfactory achievement and further becoming a competent adult. A broader acknowledgment of this would lead to more parity with literacy. However, developing a strong foundation of early math skills is vital for children's later educational success as well as economic, health, and employment outcomes.

Children entering school with strong mathematics skills have a greater likelihood of success in mathematics during kindergarten and in later grades. In Indonesia, Mathematics is formally taught at kindergarten until university. Currently, many teachers still teach mathematical topics using a teacher-centered approach, making the learning process seems to be rigid and boring. On the other side, deficient teaching of mathematics in kindergarten hinders the consolidation of basic mathematical knowledge, which is useful to children during their following school course. The absence of which, according to many researchers, is responsible to the extent of failure in mathematics (Papadakis et al., 2017).

Moreover, such instructions make students perceive mathematics as a subject that is difficult to understand and frightening. This condition is contrary to the expected competencies in mathematics subjects for elementary school levels (grades 1 to 4), which includes: (1) Conceptual understanding, which refers to understanding connected and operational mathematical concepts. Students with conceptual understanding able to understand mathematical facts and methods in depth. Understand the function of and how to use a mathematical concept; (2) Procedural fluency, namely procedural knowledge, knowledge of when and how to use them appropriately, and skills in doing so flexibly, accurately, and efficiently; (3) Strategic competence, which refers to the ability to formulate, describe and solve mathematical problems. Strategic competence plays an important role in every stage of procedural fluency development related to calculation. Strategic competence involves learning to replace complicated procedures with a more concise and efficient way; (4) Adaptive reasoning competence. It is interpreted as the ability to think logically about the relationship between concepts and situations; and (5) Productive disposition or the ability to be aware of the value of mathematics. It includes awareness that mathematics is useful and beneficial and believing that a great effort in learning mathematics will lead to excellent results and to see oneself as an effective learner and mathematician (National Research Council, 2001). If students want to develop conceptual understanding, procedural fluency, strategic competence, and adaptive reasoning abilities, they must believe that with diligent effort mathematics can be understood and can be used to overcome problems in daily life. These competencies can be developed well if students are comfortable and enjoy learning mathematics, instead of feeling afraid or anxious. Anxiety is included in the realm of attitude in mathematics that must be well developed. In line with this, one of the four objectives of the Mathematics learning is currently used curriculum is related to attitude development (Yuliyanto et al., 2019).

Students' are afraid of mathematics because the way they understand the material is not appropriate, especially at the beginning of the lesson. This fear might lead to difficulties in understanding mathematics and difficulties to focus on learning. Unfocused behavior is one of the mathematical anxiety indicators that include into cognitive aspect at a medium level (Putri, Muqodas, et al., 2019). There are many obstacles experienced by students in learning mathematics, one of which is mathematics anxiety (Afrianti & Prabawanto, 2020). The significance of understanding mathematical anxiety lies in its potentially limiting effect on self-esteem and performance (Cropp, 2017). Therefore, students' mathematical anxiety can be defined as students' fear of mathematics. Anxiety appears when someone

is in a particularly threatening situation. The same thing applies to children, where students might have high mathematical anxiety due to their prior experiences on the mathematics subject (Suarjana et al., 2017).

Mathematical anxiety also can affect students' daily life, academic performance, and even contribute to increasing students' stress, and if this condition continues, various problems might eventually happen (Shishigu, 2018). Math anxiety impacts students as early as the first grade by affecting their working memory (Aosi et al., 2019). Similarly, a study explains that mathematical anxiety is a problem that might give a negative effect on learning achievement and job prospects in the future. As compared to others with no or little mathematical anxiety, students with higher mathematical anxiety were lower in the following aspects: Socioeconomic-status, teacher-student relationship, self-efficacy, and mathematical problem-solving ability (Zhou et al., 2020). There are consequences for the students' anxiety in mathematics, and this interferes with their academic achievement. Students who experience mathematics anxiety typically refuse to enroll in mathematics courses or attending courses with important mathematical components that will influence their future career options (Alves et al., 2016). Furthermore, the negative relationship among mathematical anxiety and learning achievement in mathematics are possible because mathematical anxiety leads students to avoid Mathematics subject and might disrupt students' performance in solving particular mathematical problems (Ramirez et al., 2016). In this condition, it is assumed that there is a particular barrier that prevents knowledge transfer thus making students difficult to understand the materials being learned. One of the biggest constraints in mathematics learning is when students cannot understand the materials that are presented abstractly. In line with that, the word "abstract" in a question may also have encouraged slightly higher anxiety scores (Leveré & Kahlon, 2019). Handling student's anxiety is one of the mental health rehabilitation efforts that can overcome various obstacles in learning (Ardi et al., 2019).

High mathematical anxiety has an impact on mathematics learning achievement. Longitudinal research indicates that low attainment in mathematics can have significant long-term consequences, affecting later school achievement, employment, criminality, mental health, and future earnings. In many countries, underachievement in mathematics is strongly associated with social, cultural, and economic disadvantages. Yet, if the issue is settled it will lead to the opposite effect. Prior studies examining the longitudinal relations between number sense skills (e.g., counting, number knowledge, and number transformation) and later mathematics learning has shown promising results about the effect of mathematical anxiety on elementary and middle school mathematics achievement (Papadakis et al., 2018). Ashcraft and Kirk also said that individuals with high mathematics anxiety demonstrate smaller working memory spans, especially when assessed with a computation-based span task (Sevindir et al., 2014).

Mathematical anxiety includes fear, tension, and discomfort emotions felt by several individuals regarding mathematics and might interfere with one's performance in doing mathematics (Ashcraft & Moore, 2009). Higher-level

mathematics probably relies even more heavily on working memory, so may show a far greater impact of mathematics anxiety. As students dealing with challenging mathematical problems, then we can distinguish clearly the effects of high mathematics anxiety and low mathematics competence (Sevindir et al., 2014). Similarly, Tobias and Weissbrod (1980) describe mathematical anxiety as panic, helplessness, paralysis, and mental disorders that arise when solving mathematical problems. In line with that, mathematical anxiety can be defined as uncomfortable feelings arising from unstable emotional conditions that are characterized by fear, worry, anxiety, panic, etc. when someone is facing an unwanted task (Annisa & Ifdil, 2016)

Moreover, particular physiological symptoms are somehow related to students' anxiety, which includes cardiovascular system (heart palpitations), breathing (shortness of breath, and a sense of strangulation), neuromuscular system (insomnia, and taut face), gastrointestinal system (loss of appetite, and diarrhea), urinary tract (cannot hold pee), and skin (facial blushing, and feeling chills on the skin) (Sunardi et al., 2019). It was also found that mathematics anxiety could affect the capacity of pre-service teachers to develop inclusive learning environments in their classrooms (Mizala et al., 2015).

A study done by Cavanagh and Sparrow (2010) divide mathematics anxiety into 3 domains, those are: 1) somatic; 2) cognitive and 3) attitude. Each domain was further broken down into three levels of mathematical anxiety (high, medium, and low) as seen on Table 1:

Table 1: Aspects, levels, and indicators of mathematical anxiety

Aspect	Level of mathematical anxiety	Indicator
Attitudinal	High	Afraid of what being done
	Medium	Has no intention to do things that should be done
	Low	Expecting difficulties in doing particular thing
Cognitive	High	Worry of being judged by others that she/he cannot do things well
	Medium	Has an empty mind
	Low	Feeling confused
Somatic	High	Difficult to breath
	Medium	Heart beats rapidly
	Low	Feeling uncomfortable

According to TIMSS results for Indonesian fourth grader, it is found that there are only 23% of students have a high confidence level in mathematics (TIMSS & PIRLS Study Center, 2016). The average performance of these students is 440 placings in Indonesia in the bottom 8 out of 49 countries. The improper method in mathematics learning could make students difficult to understand the materials being learned, has negative experience during learning math, develop negative perspective toward mathematical things, and eventually resulting in mathematical anxiety (Kristanti & Widyawati, 2009).

One of the mathematical anxiety contributing factors is the type of instructional method used by teachers. Appropriate application of the teaching method can be in the form of an instructional approach that promotes mathematical problem solving and decrease students' mathematical anxiety. Students prefer mathematics teachers who enable them to exploit their misunderstanding of particular mathematics concepts. Teacher's patience and connection with students will greatly affect students' success in learning mathematics (Sofiatun et al., 2018). Therefore, mathematics instructions should change its image from mechanistic learning into enjoyable humanistic learning (Hendriana, 2012). Fun and enjoyable learning could make the learning process more effective. However, before lesson implementation, it is important to arrange instruments that will be used in learning activities.

The success of mathematical abilities enhancement and students' negative attitudes reduction towards Mathematics begins with the success of the researcher in making and analyzing instruments that will be given during the research takes place. The lack of consistency in prevailing mathematics anxiety theory is rectifiable by using modern measurement theory for measure construction (Sevindir et al., 2014). One way to do measurement is by questionnaires filled by a number of required samples. Questionnaires may be administered individually or in a group, and typically include a series of items reflecting the research aims (Ponto, 2015). A questionnaire is a tool that can be used in many measurements in any type of research. Questionnaires should always have a definite purpose that is related to the objectives of the research, and it needs to be clear from the outset how the findings will be used (Roopa & Rani, 2012). The main indicator of measurement is the feasibility of its validity and reliability (Mohajan, 2017). In this case, the validity and reliability of an instrument are important. An instrument is said to be valid if the instruments are used to measure the corresponding object to be measured. The instrument is said to be reliable if the results are relatively similar even though it is used repeatedly (Ghofur et al., 2016). Validity and reliability can enhance transparency and reduce the bias possibility of qualitative research (Singh, 2014). Valid instruments indicate that it can be used to measure behavior that is meant to be measured (Haryeni & Yendra, 2019). Instruments that have reliability can be used many times but produce similar data (Pramono et al., 2016). Instruments have a high reliability if the source of the error in the measurement can be minimized (Fiangga & Sari, 2017).

Good quality instruments should be valid, reliable, standard, economical, and practical (Azwar, 2011). The instrument should be able to reveal particular facts and transformed them into data. Thus, the instrument that will be used should have good quality. Conversely, invalid, and unreliable examination results often failed to meet the purpose of examination and mislead decision making (Oluwatayo & Fajobi, 2015). If the obtained data is not valid or is not appropriate with the facts, it might lead to the wrong conclusion (Arifin, 2017). The quality of research can be identified from the quality of arranged and developed instruments, in which it should be valid and reliable (Manongko, 2016). Other studies describe good instrument requirements as instruments that have high validity and reliability or meet psychometric requirements (Kartowagiran, 2018). An instrument has validity if the drawn conclusion is meaningful and inferences

are valid based on the scores on the instrument (Creswell, 2009). Apart from the validity and reliability, an instrument also needs to meet the ability to measure samples in a large population and cost-effective (Rahman et al., 2019). Therefore, to support optimum research findings, before mathematics lesson implementation, the researcher has carefully analyzed the feasibility of instruments that have been developed. If the assumptions can be proven empirically, the instruments developed in a study have good predictive validity (Laliyo et al., 2019).

2. Methods

This research taken place from November 2018 to April 2019. Since this is developmental research, the method used in this study is Research and Development (R&D). R&D as a systematic process to develop, improve, and assess education programs and materials (Gall et al., 2010). This definition implies that research and development method in education is actually a process of developing research product, and eventually validate the product. All sixth-grade students in elementary schools in West Java were the population in this study. Participants included in the sample were 100 elementary school sixth-graders in Karawang Regency.

In this research, the product that will be developed and validated is learning materials, which are designed in such a way according to the CPA approach. The learning materials will then be used to measure the mathematical anxiety of elementary school students. There are three methods used in R&D implementations which include descriptive, evaluative, and experiment (Sugiyono, 2016). In this study, the descriptive method is used to gather data that is required in arranging research instruments to measure the mathematical anxiety of elementary school students. The questionnaire given to students is in the form of a mathematical anxiety questionnaire using a Likert scale. Four responses can be chosen for each statement in the questionnaire which includes strongly agree (SA), agree (A), disagree (D), strongly disagree (SD). The mathematical anxiety instrument that is used is the modification of the mathematical anxiety instrument indicator developed by Cavanagh and Sparrow (2010), and it is combined with the learning using the CPA approach. As the next step, the evaluative method is used to evaluate the trial process of mathematical anxiety instrument development which is arranged according to the CPA approach to reduce the mathematical anxiety of elementary students. On the other hand, in this study, the experimental method is used to test the feasibility of research products by using instrument validity and reliability test. The product refers to the instrument that has been developed and run through the trial process using a quasi-experimental method. Obtained data is processed by using Microsoft Excel 2013 and SPSS Version 25. Microsoft Excel 2013 is used to calculate instrument validity, while SPSS version 25 is used to calculate instrument reliability using Cronbach's Alpha method. As the next step, the calculation result is analyzed based on a particular category. Validity value is interpreted based on the validity coefficient classification by Guilford (Putri, Isrokatun, et al., 2019) as shown in table 2.

Table 2: Guilford's Validity Coefficient Classification

r^{xy} value	Interpret
$0,90 < r^{xy} \leq 1,00$	Very high
$0,70 < r^{xy} \leq 0,90$	High
$0,40 < r^{xy} \leq 0,70$	Moderate (sufficient)
$0,20 < r^{xy} \leq 0,40$	Low
$0,00 < r^{xy} \leq 0,20$	Very low
$r^{xy} \leq 0,00$	Not valid

Reliability value is interpreted based on Guilford's reliability classification (Putri, Isrokatun, et al., 2019) in table 3:

Table 3: Guilford's Reliability Coefficient Classification

r^{11} value	Interpretation
$r^{11} \leq 0,20$	Very low
$0,20 < r^{11} \leq 0,40$	Low
$0,40 < r^{11} \leq 0,60$	Intermediate
$0,60 < r^{11} \leq 0,80$	High
$0,80 < r^{11} \leq 1,00$	Very high

The research participant involved in this research is as much as 100 elementary school students throughout Purwakarta, Subang, and Karawang, West Java, Indonesia. The sampling was done through a purposive sampling technique. The selected sample should fulfill a particular requirement, in which samples must be a sixth-grader. Such sampling is done because the research will be implemented in grade 5 elementary school. Thus, the sample for instrument development should be those who have learned the topic. 100 participants were selected from three different areas. A greater number of samples will give more power and strength to the validation process (Lima-Rodríguez et al., 2015). The analysis technique used in this research is descriptive analysis in the form of a validity test and inferential analysis in the form of a reliability test using Cronbach's Alpha.

The development of students' mathematical anxiety instruments is carried out through several stages including, a preliminary study that is analyzing the definitions, factors, problems, and findings in mathematical anxiety of elementary school students through a literature review. The next stage of the instrument development is to analyze aspects, indicators, and items of mathematical anxiety based on the level of success in the form of a questionnaire blueprint. The last stage is the testing phase that is done by verifying the blueprint which is compiled to become a questionnaire. Lecturers of elementary school teacher education, and

elementary school teachers whose focus on mathematics were asked to become expert assessors in determining the questionnaire feasibility and giving suggestions for its improvement. Then a readability test was conducted by asking some students randomly to fill in the questionnaire.

Several changes and improvements were taken by considering suggestions for experts and readability test results. Furthermore, empirical validation through validity and reliability tests were performed to ensure that it really can measure mathematical anxiety and can produce similar results even though being used repeatedly. As Wright et al (2019) said, the development of instruments was based on a process of theoretical review and empirical validation.

3. Results

The quality of mathematical anxiety instruments can be measured using validity and reliability test. The validity of an instrument indicates measurement results illustrating a particular aspect that is measured. On the other hand, reliability is related to the consistency of measurement. A reliable instrument provided a consistent measure of important characteristics despite background fluctuations. It reflects the true score-one that is free from random errors (Tsisiga et al., 2018). Therefore, it is undebatable that validity and reliability is a significant research instrument (Taherdoost, 2018). The first step is done before the instrument validity and reliability test was developing indicators into statement items in the questionnaire with regard to the literature review. As explained earlier, the indicator of the mathematical anxiety questionnaire in this research referred to (Cavanagh & Sparrow, 2010) Table 1.

As seen in Table 1, three elements can influence the level of students' mathematical anxiety. Each element is further broken into three levels (low, medium, high). Based on Table 1, researchers developed the instrument by analyzing each element and identifying its indicators as the basis for developing a questionnaire item blueprint. It is in line with Sabri et al. (2019) who imply that to construct instruments with proper content validity it is necessary to do the following activities: (1) document analysis or pre-survey; (2) making the specification table (lattice); (3) consultation with experts (mentors); (4) writing the instrument. Each element and level have an indicator and become the basis for developing statement items that were used in the research. Those statements can be seen on the table of instrument blueprint (Table 4):

Table 4: Blueprint of Mathematical Anxiety Questionnaire Instrument

Element	Indicator	Statement	Level
Attitudinal	Fear of what he/she is doing	1. I often skip school when there is mathematics subject, especially when the learning is about geometry that has a lot of calculations.	High
		2. I always present in Mathematics subject because in my opinion Mathematics is a challenging subject, especially when	High

		discussing geometry with many calculations.	
		3. In every Math lesson, I prefer to sit at the very back row, because the back seat is not visible to the teacher so I am sure I will not be appointed to come forward.	High
		4. I always want to sit in the front row so that I can listen to the geometry material taught by my teacher.	High
		5. I always ask my teacher, if there is geometry material that I do not understand.	High
	Do not want to do something that should be done	6. I never answer questions about geometry, which is difficult for me.	Medium
		7. No matter how difficult the question about geometry is, I always try to do it.	Medium
	The expectation of difficulties in doing something	8. Every time I get a question about geometrical volume, it always difficult to solve because there are many numbers that I have to calculate.	Low
		9. I have no difficulty in doing questions about geometrical volume because I always careful in calculating the numbers.	Low
Cognitive	Worry to be judged by others that she/he cannot do things well	10. I always refuse every time the teacher appoints me to go forward to answer questions about geometry in front of the class because I am afraid my friends will laugh at me if my answer is wrong.	High
		11. I answered the question in front of the class with confidence even though my answer was wrong. By doing so, I came to understand how to do it correctly.	High
		12. I always hide question papers from friends and parents when the score is below 70.	High
		13. I am aware of my failure in the previous Mathematics test and I will try to get better score in the future.	High
	Empty mind	14. When working on geometry test, I remember another thing that, making the time runs out.	Medium
		15. Mathematics is a difficult subject, so the geometry formula is hard to remember.	Medium
		16. I always remember the things that I have to do even though the learning material is difficult to understand.	Medium
		17. I cannot focus working on the geometry problems that I do not understand.	Medium
		18. I always focus when working on all questions about geometry.	Medium
		19. I am not sure with my answers to geometry question.	Low

		20. I am sure that my answer to geometry questions are correct.	Low
	Feeling confuse	21. My chest feels tight when I get a math score below 70.	High
		22. My chest feels tight when a friend teases me because of the mistake I made when answering Math problems.	High
Somatic	Difficult to breath	23. My heart beats rapidly every time the teacher distribute marked test papers.	Medium
		24. My heart beats rapidly every time the teacher asks me to explain my answers to geometry questions in front of the class.	Medium
		25. I feel calm every time the teacher asks me to explain the answers to geometry questions in front of the class.	Medium
	Heartbeats fast	26. My feet tremble every time the teacher asks me to clarify the answers to geometry questions in front of the class.	Low
		27. I do not feel nervous when teacher appoint me to answer geometry question.	Low
		28. If there is a geometry test tomorrow, then tonight I will be difficult to sleep because I will be thinking about the questions that will come out on the test tomorrow.	Low
	Uncomfort able feeling	29. I will sleep well even though tomorrow there will be geometry test.	Low
		30. I often go back and forth to the toilet to pee because I am worried that I will not be able solve geometry problems in the test tomorrow.	Low

Statements that meet the requirements were further included in test trials. A sample of students' responses to the mathematical anxiety instrument developed in this study can be seen in Appendix 1. Students' responses in the form of ordinal data were converted into nominal data. The ordinal data in question is a collection of student responses for each item. Further processes to determine the score described by Azwar (2010) are: 1) classify items according to their nature (favorable/unfavorable); 2) if the item is favorable, then SD response category is placed at the leftmost side and the SA response category is placed at the rightmost side; 3) classify the number of students according to their choice of responses. The frequency of students' response in each item should be the same; 4) Find the proportion value with $p=f/N$ where p is proportion, f is frequency, and N is the number of respondents; 5) determine the p_k score (cumulative proportion) that is the proportion in a category plus the proportion of all categories to the left; 6) determine T_{pk} score (Midpoint of cumulative proportion) by adding half proportion in the relevant category to the cumulative proportion in the category to the left. It can be formulated by $T_{pk} = 1/2 p + p_{kb}$ where T_{pk} is the midpoint of cumulative proportion, p is the proportion of its category, and p_{kb} is the cumulative proportion in the category to the left; 7) determine z deviation value obtained by considering z value for each T_{pk} . In this study, to determine the value for z normal deviation table can be used or use the formula $' = \text{NORMSINV}$

(probability)' when using Microsoft Excel 2013 software. Probability in the formula can be filled with cells that show Tpk values; 8) shift the response category with the smallest value close to 0 (zero), i.e. make the price of z for the leftmost category equal to 0. This is done to determine the price of $z + z^*$ and can be found by adding the absolute z value at the most left category on all existing z values so that z values in the other response categories will be positive. See table 5 and 6 for a more detailed scheme:

Table 5: The example of Mathematical Anxiety Scale Calculation for Positive Statement Item

Statement Item	Response choices	f	p	pk	Tpk	Z	$z+z^*$	Rounding
2	SD	2	0.020	0.020	0.010	-2.326	0.000	0
	D	2	0.020	0.040	0.030	-1.881	0.445	0
	A	43	0.430	0.470	0.255	-0.659	1.667	2
	SA	53	0.530	1.000	0.735	0.628	2.954	3

Table 6: The example of Mathematical Anxiety Scale Calculation for Negative Statement

Statement Item	Response choices	f	p	pk	Tpk	Z	$z+z^*$	Rounding
30	SD	5	0.050	0.050	0.025	-1.960	0.000	0
	D	11	0.110	0.160	0.105	-1.254	0.706	1
	A	51	0.510	0.670	0.415	-0.215	1.745	2
	SA	33	0.330	1.000	0.835	0.974	2.934	3

Table 5 clearly illustrates that item number 2 of mathematical anxiety questionnaire has a positives scale and the score to be used can be seen in the rounding columns for SD, D, A, and SA categories. Those are 0, 0, 2, and 3 respectively. Meanwhile, Table 6 shows a mathematical anxiety scale questionnaire for negative items which is represented by item statement number 30. The score to be used can be seen in the rounding column as much as 0, 1, 2, and 3 for SA, A, D, and SD respectively. The data obtained is used for calculating the validity and reliability of students' mathematical anxiety scale instruments. Once the student answers collected, we convert them into nominal figures.

3.1. Validity Test Analysis

After mathematical anxiety instruments constructed, sixth-grade elementary school students filled it in for trial. Results obtained from the trial are further be used in the validity test. Table 7 presents the validity test results.

Table 7: Recapitulation of Validity Test Results for Mathematical Anxiety Instrument

Correlation between	Correlation Value (r)	r value count	r table value (k=n-2, $\alpha=5\%$)	Note	Conclusion
Number 1 with Total	0,57	6,81	0,198	r positive, $r_{\text{count}} > r_{\text{table}}$	Valid
Number 2 with Total	0,52	6,07	0,198	r positive, $r_{\text{count}} > r_{\text{table}}$	Valid
Number 3 with Total	0,43	4,65	0,198	r positive, $r_{\text{count}} > r_{\text{table}}$	Valid
Number 4 with Total	0,31	3,25	0,198	r positive, $r_{\text{count}} < r_{\text{table}}$	Valid
Number 5 with Total	0,29	3,03	0,198	positive, $r_{\text{count}} < r_{\text{table}}$	Valid
Number 6 with Total	0,46	5,11	0,198	r positive, $r_{\text{count}} > r_{\text{table}}$	Valid
Number 7 with Total	0,52	6,03	0,198	r positive, $r_{\text{count}} > r_{\text{table}}$	Valid
Number 8 with Total	0,50	5,73	0,198	r positive, $r_{\text{count}} > r_{\text{table}}$	Valid
Number 9 with Total	0,60	7,38	0,198	r positive, $r_{\text{count}} > r_{\text{table}}$	Valid
Number 10 with Total	0,58	7,02	0,198	r positive, $r_{\text{count}} > r_{\text{table}}$	Valid
Number 11 with Total	0,64	8,31	0,198	r positive, $r_{\text{count}} > r_{\text{table}}$	Valid
Number 12 with Total	0,48	5,45	0,198	r positive, $r_{\text{count}} > r_{\text{table}}$	Valid
Number 13 with Total	0,48	5,36	0,198	r positive, $r_{\text{count}} > r_{\text{table}}$	Valid
Number 14 with Total	0,39	4,15	0,198	positive, $r_{\text{count}} < r_{\text{table}}$	Valid
Number 15 with Total	0,48	5,35	0,198	r positive, $r_{\text{count}} > r_{\text{table}}$	Valid
Number 16 with Total	0,48	5,37	0,198	r positive, $r_{\text{count}} > r_{\text{table}}$	Valid
Number 17 with Total	0,42	4,60	0,198	r positive, $r_{\text{count}} > r_{\text{table}}$	Valid
Number 18 with Total	0,56	6,62	0,198	r positive, $r_{\text{count}} > r_{\text{table}}$	Valid
Number 19 with Total	0,41	4,50	0,198	r positive, $r_{\text{count}} > r_{\text{table}}$	Valid
Number 20 with Total	0,46	5,08	0,198	r positive, $r_{\text{count}} > r_{\text{table}}$	Valid
Number 21 with Total	0,31	3,25	0,198	positive, $r_{\text{count}} < r_{\text{table}}$	Valid
Number 22 with Total	0,37	3,90	0,198	positive, $r_{\text{count}} < r_{\text{table}}$	Valid
Number 23 with Total	0,44	4,85	0,198	r positive, $r_{\text{count}} > r_{\text{table}}$	Valid

Number 24 with Total	0,53	6,15	0,198	r positive, $r_{\text{count}} > r_{\text{table}}$	Valid
Number 25 with Total	0,63	7,94	0,198	r positive, $r_{\text{count}} > r_{\text{table}}$	Valid
Number 26 with Total	0,56	6,74	0,198	r positive, $r_{\text{count}} > r_{\text{table}}$	Valid
Number 27 with Total	0,22	2,25	0,198	positive, $r_{\text{count}} < r_{\text{table}}$	Valid
Number 28 with Total	0,52	6,05	0,198	r positive, $r_{\text{count}} > r_{\text{table}}$	Valid
Number 29 with Total	0,32	3,35	0,198	positive, $r_{\text{count}} < r_{\text{table}}$	Valid
Number 30 with Total	0,57	6,87	0,198	r positive, $r_{\text{count}} > r_{\text{table}}$	Valid

Table 7 indicates 23 items that have valid values. While items number 4, 5, 14, 21, 22, 27, and 29 show weak correlation value. The item is valid if the correlation value is at least in the medium category based on the comparison of r_{count} and r_{table} . According to Guilford correlation value categories, the value of $r_{\text{count}} > r_{\text{table}}$ of the 23 items is classified as moderate. Therefore these 23 items were further included in the mathematical anxiety instruments.

3.2. Reliability Test Analysis

Aside from the validity test resulting in 23 valid items, reliability tests were performed as well. The test used Cronbach's Alpha calculation using SPSS type 25 software. The selection of Cronbach's alpha as a measure of instrument reliability for mathematical anxiety instruments is because Cronbach's Alpha can test a questionnaire-type instrument that has more than one answer. As Yusup (2018) suggests, Cronbach's Alpha test is suitable for instruments in the form of essays or questionnaires. Table 8 presents the reliability of mathematics anxiety instruments.

Table 8: Test Results of Mathematical Anxiety Reliability Instruments

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	No of Items
0,874	0,877	30

From the reliability test results as illustrated in the table 8, Cronbach's Alpha values for the instrument are 0.874. This number implies that instrument reliability is high. Thus, this student mathematical anxiety instrument is considered consistent to be used many times in further research.

4. Discussion

Research using questionnaire as its instrument require validity and reliability insurance before collecting data from participants. Validity and reliability are key indicators of measuring instrument quality (Kimberlin & Winterstein, 2008). The validity test implies that there are 23 valid items with the lowest r_{xy} value is 0.29 and the highest is 0.64. It has been suggested that correlation coefficients below 0.3 should be considered as low, 0.3 to less than 0.5 as moderate, while 0.5 and

above as a high (Tsang et al., 2017). We can look at some information in Table 7 that 13 items have high correlation value. This shows that 43,33% or almost half of all items in the questionnaire is sure can be used. In particular, we should stop considering moderate correlations as evidence of reliability or validity (Post, 2016). Even for purposes of applied decision making, reliance on criterion validity or content coverage is not enough (Taherdoost, 2018). If pulled back into the validity classification table (Lodico et al., 2006), these figures indicate the level of validity is in the position of low to medium. The validity coefficient values range from 1.00 to -1.00. The coefficient value of 1.00 indicates that individual test items and test criteria have relatively the same results. Whereas zero validity coefficient indicates that there is no relationship between the instrument and its criteria.

Generally, a higher validity coefficient indicates the higher validity of the instrument (Buchan et al., 2005). However, the basis for decision making on the validity test can also be determined through r_{count} and r_{table} . If r_{count} is greater than r_{table} , then the instrument can be declared significant and valid (Mahendra, 2015). Furthermore, the reliability test is a continuation of the validity test, where the items included in the test are only valid ones (Fridayanthie, 2016). The reliability test using Cronbach's Alpha calculation results showed the reliability value of the mathematics anxiety instrument was 0.874. as it is analyzed through the reliability classification proposed by Guilford (Suherman, 2003), it is found that this value classified as high reliability. Cronbach's alpha of at least 0.70 has been suggested to indicate adequate internal consistency and could be considered acceptable reliability (Bolarinwa, 2015; Lima-Rodríguez et al., 2015; Tsang et al., 2017). A rule of thumb that $\alpha = 0.7$ indicates acceptable, and $\alpha = 0.8$ represents good reliability (Wells et al., 2011). In conducting research, aside from performing proper data collection, ensuring that the instrument can function correctly is also essential (Dikko, 2016). In this case, the instrument can work properly only if the instrument is valid and reliable. As an example, a study performed an instrument trial in seventh-grade students, resulting in correlations between the two items ranged from 0.46 to 0.60. Cronbach's alpha for this scale ranged from 0.63 to 0.75, indicating acceptable internal reliability (Wang et al., 2020). Whereas if the value of instrument correlation is less than 0.40 like the seven items found in Table 7, then it is considered invalid because the correlation is weak. High or strong correlation means that two or more variables have strong validity with each other, while low correlation means that the variable is almost unrelated or invalid (Dalvi & Kant, 2018).

5. Conclusion

Research to develop Mathematical Anxiety instruments for elementary school students is carried out comprehensively. This study involved 100 elementary school students in Indonesia. Mathematical anxiety instruments have been created and arranged based on instrument modification (Cavanagh & Sparrow, 2010). The results showed there were seven invalid items due to weak correlation. Therefore, these items considered unable to measure students' mathematical anxiety. Meanwhile, the other 23 of the 30 items are valid and reliable. Hence, we claim that these 23 items are proper to use in measuring the mathematical anxiety of elementary school students. Mathematical anxiety instrument developed

through this research is expected to give contributions to teachers, parents and even researchers to solve mathematical anxiety problems experienced by elementary school students as early as possible. To conclude, mathematics anxiety items developed through this study can be used as a questionnaire-type instrument for future research.

6. Limitation

Students assume mathematics as the learning that is difficult to understand and always requires high attention. This condition leads to students' fear and anxiety in learning mathematics. It is necessary to measure elementary school students' mathematical anxiety so that teachers can design meaningful learning approaches/strategies to generate students' interest in learning and reduce students' anxiety when learning mathematics. It is expected that when students are not anxious in learning, students are more motivated to learn, which leads to better mathematical learning achievement. Teachers and researchers should avoid ambiguous statements in the questionnaire to obtain a valid and reliable instrument.

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8. References

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Appendix 1

Sample of mathematical anxiety instrument filled by a respondent.

Name : Revan
 Class : VI.A
 Name of school : Wantilan National Elementary School

Instructions:

1. Read each statement carefully. Please kindly ask the teacher if you have difficulties in understanding the statement.
2. Put a check mark () on the response that corresponds to what you experience and feel.
 Response choices are:
 SA = Strongly Agree
 A = Agree
 D = Disagree
 SD = Strongly Disagree
3. Do the questionnaire on your own.
4. Once you are sure of your response, you can submit this questionnaire to your teacher.
5. Your response to this questionnaire will not affect your grades.

Statement	Response			
	SA	A	D	SD
1. I often skip school when it is a mathematics schedule, especially when the learning is about geometry that has a lot of calculations.				
2. I always present in Mathematics subject because in my opinion Mathematics is a challenging subject, especially when discussing geometry with many calculations.				
3. In every Math lesson, I prefer to sit at the very back row, because the back seat is not visible to the teacher so I am sure I will not be appointed to come forward.				
4. I always want to sit in the front so that I can listen to the geometry material taught by my teacher.				
5. I always ask my teacher, if there is geometry material that I do not understand.				
6. I never answer questions about geometry, which is difficult for me.				
7. No matter how difficult the question about geometry is, I always try to do it				
8. Every time I get a question about geometrical volume, it always difficult to solve the question because there are many numbers that I have to calculate				
9. I have no difficulty in doing questions about geometrical volume because I am always careful in calculating the numbers.				
10. I always refuse every time the teacher appoints me to go forward to answer questions about geometry in front of the class because I am afraid my friends will laugh at me when my answer is wrong.				
11. I answered the question in front of the class with				

confidence even though my answer was wrong, that way, I came to know the right way.				
12. I always hide question papers from friends and parents when the score is below 70.				
13. I am aware of my failure in the previous Mathematics test and will try to get a better score in the future				
14. When working on the geometry test, I remember another thing that made the time running out.				
15. Mathematics is a difficult subject, so the geometry formula is hard to remember				
16. I always remember the things that I have to do even though I have dealt with material that is difficult to understand				
17. I cannot focus on when working on the geometry materials that I don't understand.				
18. I always focus when working on all questions about geometry.				
19. I am not sure about answers to geometry question that I wrote				
20. I am sure that the answer I wrote for geometry questions is correct				
21. My chest feels tight when I get a math score below 70				
22. My chest feels tight when a friend teases me because of the mistake I made when answering Math problems				
23. My heartbeat fasts every time the teacher distributes test papers that have been marked				
24. My heartbeat fasts every time the teacher asks me to describe the answers to geometry questions in front of the class.				
25. I feel normal every time the teacher asks me to make clear the answers to geometry questions in front of the class.				
26. My feet tremble every time the teacher asks me to clarify the answers to geometry questions in front of the class.				
27. I do not feel nervous when teacher appoint me to answer geometry question				
28. If tomorrow there is a geometry test, then tonight I will be difficult to sleep because I will be thinking about the questions that will come out on the test tomorrow.				
29. I will sleep well even though tomorrow there will be geometry test				
30. I often go back and forth to the toilet to pee because I am worried that I will not be able to do math questions about geometry for daily test tomorrow.				