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Construct Validity of Mathematical Resilience: Confirmatory Factor Analysis

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***Abstract*—In this study, the validity of the construct of mathematical resilience was measured. Confirmatory factor analysis was performed and followed by testing the correlation between mathematical resilience factor. Subjects in this study amounted to 98 students. The results showed that the construct of mathematical resilience consists of five dimensions: a) uncertainties show the desire to socialize, easy to provide assistance, discuss with peers, and adapt to the environment; b) showing diligence, confidence, hard work and not easily giving up facing problems, failures, and; c) create new ideas and find creative solutions to challenges; d) using the experience of failure to build self-motivation; e) having curiosity, reflecting, researching, and utilizing various sources; f) have the ability to control themselves; aware of his feelings.**

Keywords—mathematical resilience; construct validity; confirmatory factor analysis

I. INTRODUCTION

Mathematics has played a huge role in the development of science and technology. Mathematics is queen and servant of the sciences [1]. The phrase implies that mathematics is a way to study science and science can't develop without mathematics. Mathematics is a universal science that underlies the development of modern technology, has an important role in various disciplines, and advances the human mind.

Today, mathematics is not merely science, but mathematics is the key of opportunity; for students, it open doors to careers; for citizens, it enables informed decisions; for nations, it provides knowledge to compete in a technological economy [2]. To master and create technology in the future, strong mathematical mastery is needed early on. The progress of a country depends on its progress in mathematics [3].

Recognizing the importance of mathematical mastery for a nation, many countries pay great attention to improving the quality of mathematics learning in schools. The United States has established the Committee on the Mathematical Sciences in the Year 2000, whose goal is to make US mathematics education the best in the world [4]. Similar efforts were also undertaken in Indonesia, for example by developing a mathematics curriculum that matched the conditions of Indonesia [5] and improved the quality of mathematics learning strategies in the classroom [6].

Mathematics consists of abstract ideas or concepts arranged hierarchically based on deductive reasoning [5]. Mathematics was born because of human thoughts associated with ideas, processes, and reasoning. Mathematics consists of arithmetic, algebra, geometry, and analysis [7]. Mathematics has the nature that conclusions are not experiential but based on certain rules through deductive steps and thinking [8]. Mathematics may be defined as the subject in the which we never know what we are talking about, nor whether what we are saying is true [1].

Based on the above explanation can be emphasized that the lesson of mathematics has a very important position in human life and the progress of a nation. Similarly, the existence of mathematics lessons for students in Indonesia, because with the ability of good mathematics lessons then the students can compete with other nations in an increasingly competitive global life.

On the other hand, many hold that mathematics is one of the major stressors in school learning. The high level of anxiety in the learning of mathematics leads to the dislike of the mathematics lesson so that this decreases the students' understanding of mathematics.

Based on research [9], it has been found that many students have difficulty and don't like to learn math, for example, they show anxiety and avoid activities that require mathematical reasoning. Anxiety in learning mathematics also made many students learn mathematics with fear [10]. High school students also had difficulty in solving mathematical problems [11] [12] and in reasoning [13] [14]. However, after obtaining innovative learning that involves values and character education, problemsolving abilities, reasoning, and mathematical abilities increase and students show a positive attitude toward learning math.

When teachers choose and implement a mathematics learning approach, they should try to help students overcome difficulties in achieving mathematical ability, and develop positive attitudes toward mathematics and mathematics learning. Positive attitudes are among others contained in selfconfidence, self-ability, self-concept, diligent and resilient to face the challenges or difficulties in learning mathematics. This determined and resilient attitude is called the term mathematical resilience [9].

Mathematical resilience is needed when the teacher intends to educate students using mathematics, and to think and behave

mathematically and not just to get good grades or pass math tests. Students with strong resilience will have the necessary mathematical skills to answer the exam questions and more importantly they also have the necessary mathematical skills outside the school and are eager to apply them whenever necessary. Development of mathematical resilience also requires a reflective and sensitive attitude toward learning math. Students with good mathematical resilience, aware that if they think hard, discuss with their friends, read mathematical ideas and reflect on the knowledge they gain, they will also be resilient and able to overcome obstacles in mathematical learning and be able to solve difficult mathematical problems [9].

Mathematical resilience is a qualified attitude in learning mathematics that includes: confidence in its success through hard work; showing diligence in the face of adversity; willing to discuss, reflect, and research. With such resilience allows students to overcome barriers to learning mathematics. Basically, in any study required resilience. But that does not mean that mathematical resilience as a result of various factors such as the type of learning, the nature of mathematics, and the view that mathematical ability is fixed [15].

Mathematical resilience has four factors: (a) believing that the ability of the brain can be grown; b) personal understanding of mathematical values; (c) understanding how to work in mathematics; and (d) awareness of peer support, other adults, the internet, and so on. Developing mathematical resilience requires a learning approach that enables the above-mentioned attitudes to grow and creates a positive mathematical class atmosphere so that students can overcome obstacles in achieving mathematical concepts [9].

There are three key factors for developing mathematical resilience: to provide opportunities for students to (a) select and define what they will do during class; (b) train them as part of their environment; and (c) feel engaged in the learning process, both in attitude and value. In such an environment, students are motivated to be diligent and persistent in the face of adversity and understand the value of collaborative work with peers, attain language skills to express their mathematical understanding, examine questions, and have strong and effective beliefs and strive harder to achieve results are higher [16].

The mathematical resilience gauge is a questionnaire [17]. Questionnaires include several components, namely: a) Opinions on intelligence and learning in general; b) Opinions on learning mathematics; c) Belief in learning mathematics. Based on some previous opinions then the indicators of mathematical resilience are as follows: MR1) show the desire to socialize, easy to provide assistance, discuss with peers, and adapt to the environment; MR2) showing a diligent attitude, confidence, hard work and not easily give up facing problems, failures, and uncertainty; MR3) create new ideas and find creative solutions to challenges; MR4) using the experience of failure to build selfmotivation; MR5) having curiosity, reflecting, researching, and utilizing various sources; MR6) have the ability to control themselves; aware of his feelings [18]. The mathematical resilience indicator used in this study is an indicator of Sumarmo's development results as the result of his research [18] is relatively new and as an attempt to improve the previous mathematical resilience questionnaire.

In quantitative research, the quality of research instruments becomes an important factor in uncovering and knowing the extent to which the measurement scores can reflect the theoretical constructs on which the measuring instrument is based. The purpose of this study is to examine the construct validity of mathematical resilience.

II. Research Method

An instrument is said to be valid if it can measure what it wants to measure. The validity test needs to be done to measure whether or not an instrument is valid. Instruments that have high validity will have a small measurement error, which means the score of each subject obtained by the instrument is not much different from the actual score.

There are three validity models, namely (a) content validity; (b) construct validity; (c) criterion-related validity [19]. The validity test of this research will use the construct validity. The intended construct validity is to find out how far the measurement scores can reflect the theoretical constructs on which the measuring instrument is based. This validity model is a complex process, requiring logical analysis and empirical data support. To fulfill the validity of this construct can be done by using factor analysis [19].

Factor analysis used in this research is using confirmatory factor analysis model. The confirmatory analysis is intended to measure the dimensions that make up a factor of a measuring instrument [20]. This measurement model relates to a factor to confirm whether the indicator variables used can confirm a factor. In simple terms, the confirmatory factor analysis is used to determine whether the observed variable (as the indicator variable) can define its latent variables, or it can be stated that the confirmatory factor analysis will reflect a measurement model in which the observed variables define the constants or latent variables. For the purposes of this analysis using SPSS software program.

Factor analysis can also be interpreted as a means used to identify the basic variables or factors that explain the pattern of relationships in a set of observable variables. Factor analysis is often used in data reduction to identify a small number of factors that explain several factors that have character similarities. The purpose of data reduction is to eliminate independent variables that correlate each other so that will be obtained the number of fewer variables and not correlated. The correlated variables have character similarities with other variables so that they can be a factor.

The main purpose of factor analysis is to define the structure of a matrix data and analyze the interrelated structure (correlation) between a large number of variables by defining a set of similarities of variables or dimensions or factors. By factor analysis we will identify the dimensions of a structure and then determine how far each variable can be explained by each dimension. So factor analysis wants to find a way to summarize the information that exists in the original variable or the initial variable into a set of new dimensions.

The sample size or the number of respondents is 5 to 10 times the number of items [21], in this study in one questionnaire contained 16 items, the number of respondents who have to fill questionnaires between 80 people up to 160 people. Respondents in this study were conducted on 98 students of class XI SMK Farmasi Samarinda, East Kalimantan.

III. Results And Discussion

Factor analysis is one of the procedures that can be used to test the construct validity of a non-test instrument such as a questionnaire. The test factor analysis is interdependent between the variables and summarizes a number of variables into fewer and names it as a factor [21]. In this study in analyzing data using SPSS program.

The steps for performing construct validity tests using factor analysis are: (1) selecting variables to be analyzed, (2) initial extraction of a set of factors, (3) final extraction of a set of factors with rotation, and (4) scaling for analysis continue [22].

Before performing the test must first determine the hypothesis.

Ho:samples (variables) are not sufficient for further analysis

H1: samples (variables) is sufficient for further analysis

To know Ho accepted or rejected it can be reviewed from SPSS result to KMO value and significant level.

TABLE I. KMO And Barttlet's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		,802
Bartlett's Test of Sphericity	***Approx. Chi-Square***	86,154
	df	15
	Sig.	,000

The value of KMO and Bartlett's test is 0.802 with a significance of 0.00. Since the value is already above 0.6 and the significance is far below 0.05, then Ho is accepted and the variables and samples are actually quite able to be analyzed further. However, still need to note the value of MSA from the output table view of Anti Image.

TABLE II. Anti Image-Correlation

MR1	,741[a]	-,273	,068	-,454	,095	-,020
MR2	-,273	,834[a]	-,271	-,084	,040	-,134
MR3	,068	-,271	,830[a]	-,215	-,193	-,175
MR4	-,454	-,084	-,215	,763[a]	-,279	-,287
MR 5	,095	,040	-,193	-,279	,805[a]	-,079
MR 6	-,020	-,134	-,287	-,287	-,079	,870[a]

Notice the Anti-Image Correlation table, especially on the correlation value marked a (diagonal direction from top left to bottom right). With the criteria of the MSA value, the MSA value of all variables is more than 0,5 then further analysis can be done.

The next step is Factoring process. The core process of factor analysis is to extract the existing set of variables, thus forming one or more factors. In the extraction process, the method used is Principal Component Analysis.

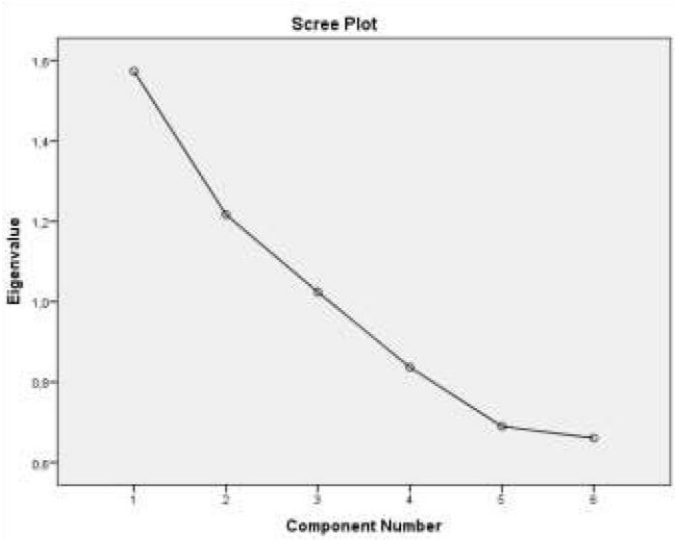

Fig. 1. *Graph of eigenvalues*

The result of factoring process shown in figure 1. If eigenvalue more than 1 then there is variable form factor. Thus, there are 3 factors that are formed.

TABLE III. Component Matrix

	Component		
	1	***2***	***3***
MR3	,691	-,348	-,027
MR5	,646	-,123	,035
MR4	,622	-,197	-,363
MR2	,287	,719	,257
MR6	,410	,688	-,084
MR1	,202	-,225	,904

The Component Matrix table above shows the loading factor value of each variable to the factor. Loading Factor is a value that shows the correlation of a variable to a factor. If a variable has the largest loading factor value on certain factors (compared to other factors), then the variable will be the member or the shaper of that factor. Since the loading factor value for all variables is more than 0.05 it can be said that there is a strong relationship between the latent variables of mathematical resilience. If the extraction is still considered unbelievable, for example, the existence of an unclear variable will be a component of which factor, then the rotation step should be done.

TABLE IV. ROTATED COMPONENT MATRIX

	Component		
	1	*2*	*3*
MR3	,760	-,051	-,142
MR4	,712	,015	-,224
MR5	,625	,144	,150
MR2	-,051	,801	,146
MR6	,143	,776	-,161
MR1	,077	-,008	,950

After the rotation process then the conclusion is that all indicators of mathematical resilience can define the latent variables. The results of the analysis of the 6 indicators can be simplified into 3 factors. After getting the factors formed, then the next step can determine the score factor. Of these values can perform further analysis, eg linear regression analysis, discriminant analysis or other analysis.

IV. CONCLUSION

Based on the results of the confirmatory factor analysis of this study indicates that the scale of mathematical resilience sources can be explained by indicators MR1, MR2, MR3, MR4, MR5, and MR6. These six indicators can be simplified into 3 factors. The naming of these three factors can be based on the Grotberg classification of I HAVE, I AM, and I CAN [24]. The first factor consists of MR1 used the term I HAVE which is characteristic of resilience that comes from the meaning of students to the amount of support and resources provided by the social environment. The second factor consisting of M2 and M6 used the term I AM which is characteristic of resilience that comes from the personal power owned by the students. The third factor consists of M3, M4, and M5 in terms of I CAN which is a characteristic of resilience derived from anything students can do with respect to social and interpersonal skills.

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