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Content Validity Ratio (CVR), Content Validity Index (CVI), and Confirmatory Factor Analysis (CFA) in Mathematics Learning Independence Instruments

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Abstract. *Learning independence is one of the essential things in the learning process. The demand for independent learning is enormous in the learning process at school, especially in mathematics. If responded to appropriately, these demands can help future students' psychological development. Unfortunately, only so many instruments can measure student learning independence in mathematics in Indonesia. So, the negative potential for the psychological development of students is also getting more significant. The purpose of this study was to measure the content validity of the mathematics learning independence scale to obtain instruments that are right on target. This study uses a type of quantitative research. A sample of one hundred and twenty-six students was obtained from public elementary schools in Tlogowungu District, Pati Regency. Data analysis uses the equation CVR (Content Validity Ratio), CVI (Content Validity Index), and CFA (Confirmatory Factor Analysis). The results showed that 26 of 30 items were declared valid and had a CVI value of 0.911. In contrast, for CFA, the relationship for the three indicators of learning independence was relatively high,> 0.5. This indicates that the three indicators are related; they can both measure the learning independence variable. So, the three indicators can measure learning independence variables well.*

Keywords: *Content Validity Ratio, Content Validity Index, Confirmatory Factor Analysis, Mathematics, Learning Independence*

Abstrak. Kemandirian belajar merupakan salah satu hal yang esensial dalam proses pembelajaran. Tuntutan kemandirian belajar sangat besar dalam sebuah proses pembelajaran di sekolah, apalagi dalam pembelajaran matematika. Tuntutan tersebut, apabila tidak ditanggapi dengan tepat dapat berdampak kurang baik bagi perkembangan psikologis siswa di kemudian hari. Sayangnya, belum ada instrumen yang tersedia guna mengukur kemandirian belajar siswa dalam pembelajaran matematika di Indonesia. Sehingga potensi negatif terhadap perkembangan psikologis siswa juga makin besar. Tujuan penelitian ini guna mengukur validitas isi skala kemandirian belajar matematika agar mendapatkan instrumen yang tepat sasaran. Penelitian ini menggunakan jenis penelitian kuantitatif. Sampel sejumlah seratus dua puluh enam siswa diperoleh dari sekolah dasar negeri yang ada di Kecamatan Tlogowungu, Kabupaten Pati. Analisis data menggunakan persamaan CVR (*Content Validity Ratio*), CVI (*Content Validity Index*) dan CFA (*Confirmatory Factor Analysis*). Hasil penelitian menunjukkan bahwa 26 dari 30 butir soal dinyatakan valid dan memiliki nilai CVI 0,911, sementara untuk CFA

dapat ditunjukkan bahwa hubungan untuk ke tiga indikator kemandirian belajar cukup tinggi yaitu > 0,5. Hal ini menunjukkan bahwa ketiga indikator memiliki keterkaitan yaitu sama-sama mampu mengukur variabel kemandirian belajar. Sehingga dapat dikatakan bahwa ketiga indikator mampu mengukur variabel kemandirian belajar dengan baik.
Kata kunci: Rasio Validitas Isi, Indeks Validitas Isi, Analisis Faktor Konfirmatori, Matematika, Kemandirian Belajar

INTRODUCTION

Nowadays, numeracy skills in the world of mathematics are at the center of the conversation. Numeracy is an important point in the development and learning at various levels of education. The quality of the ability of mathematics students in a country is still seen from the ranking of the results of the Program for International Student Assessment (PISA). Indonesia is ranked 75 out of 81 countries with a score of 379 (McComas, 2014). This result is not the only measure of student ability, but this result is powerful enough to make the academic world in Indonesia move towards literacy according to PISA standards.

Low student ability is in fact enough to illustrate how far the quality of learning that students do. There are various things that affect student learning ability. However, we agree that didactical educators have a significant role in impacting student learning outcomes, especially in mathematics topics and materials (Gök & Akbas, 2019). If we look further, prospective teachers and teachers really need assistance with independence. Not only that, teaching didactics in packaging and delivering material to students is very important to master. One of the good teacher didactics is reflected in independence in learning. The way teachers deliver material has a big impact on students' concept constructs (Castro et al., 2021).

Mathematics as a science involves a process of independence in individuals. Mathematics as a subject requires a strong mental role. Mentality greatly affects the mathematical ability of everyone (Lee & Ward-Penny, 2022). In learning mathematics for both students and college students, it is very necessary to have mature mental preparation in facing mathematics learning. Independence and high fighting power are very instrumental in dealing with negative perspectives in learning mathematics (Herrenkohl et al., 2019).

In every learning activity, learning independence is needed for individuals. Learning independence is a very supportive factor in the success and motivation of learning activities (Sipayung et al., 2021). Learning independence has a very important role, namely in managing goals, and forming frameworks and strategies according to one's intuition in achieving goals. This learning independence shapes the learning climate, the work climate of everyone, psychology and mentality that arises within oneself. In addition, learning independence produces high math learning power and results (Mulyono et al., 2018).

Learning independence is one of the main foundations of learning. Learning independence is needed, especially in this discussion, namely in mathematics. Its position is as a framework for achieving goals and building the desire to achieve the goals made (Isnaini & Azhar, 2021). In this scope, individuals try to solve various problems and find effective solutions. This independence is what moves individuals to move, and care about the perspective and solutions they can provide regarding a phenomenon or problem. This research on learning independence is really needed (Putri et al., 2019).

The importance of independence in learning mathematics is that it plays an important role in a variety of intelligence factors, developing concentration, improving skills and analysis, and developing a level of responsibility within oneself. There are various indicators related to learning independence including initiation, confidence, discipline, responsibility, and self-motivation (Saputra & Fahrizal, 2019). Students who have these indicators have a good attitude in everyday life. Have targets and motivation to continue to develop themselves. Current student independence is still low as seen from students who are not confident, do not show responsibility for obligations, and learning outcomes that are still not optimal (Ismail et al., 2021; Putri et al., 2019; Rakhmawati & Mustadi, 2019).

Learning independence is highly dependent on the role of the teacher in constructing learning activities and plays a direct role in student learning outcomes (Nuryanto & Ramadani, 2022). Independent learning is one of the important things in a learning process. Independent learning is needed for every teenager, both

students, and students, so that they have the responsibility to regulate and discipline themselves, in addition to being able to develop the ability to learn on their own accord. These attitudes need to be owned by every student, because these attitudes are a hallmark of the maturity of an educated person (Gow & Kember, 1990; Hidayat et al., 2020; Kusuma, 2020; Meyer et al., 2008; Moore, 1973; Nurfadilah & Hakim, 2019; Sheerin, 2014).

The demands for independence are enormous and if not responded to appropriately can have an unfavorable impact on psychological development in the future. This condition occurs because being independent is one of the main developmental tasks for adolescents. The demands of being independent to be able to complete further developmental tasks are not easy for adolescents, to be independent requires opportunities, support, and encouragement to achieve self-reliance. Independent learning is a learning activity that takes place more driven by one's own ability, self-choice, and self-responsibility in learning (Abrams et al., 2007; Dovey-Pearce et al., 2007; Hartini, 2017; Hidayat et al., 2020; Nurmi, 1993).

Adolescents are said to have been able to learn independently if they have been able to carry out learning tasks without dependence on others. Basically, independence is the behavior of individuals who can take the initiative, are able to overcome obstacles or problems, have self-confidence, and can-do things on their own without the help of others (Afrianti, 2021; Fitriasari & Fauzi, 2022; Kirkpatick & Locke, 1991). The phenomenon that often occurs among teenagers, both students and students, is that they are not able to be independent in learning this is due to some negative habits, such as studying only before the exam, truancy, cheating, and looking for leaks of exam questions. The existence of this phenomenon causes mental disorders that will continue when entering further education. Independent learning itself is very necessary in the higher education system because it will help individuals to learn actively (Fajrin, 2015; Kumalasari, 2014; Respati et al., 2006). The problem is that there needs to be a scale to measure the independence of learning mathematics in Indonesia. Valid and reliable instruments are required to calculate the autonomy of learning mathematics. Based on this, this article examines and develops a scale of freedom in learning mathematics. The author only

found research on developing independent learning instruments in Indonesia but not for mathematics subjects such as Hasibuan and Piki(Hasibuan et al., 2019; Piki Pia Arini, 2020). This research describes how teaching materials allow for building independence in learning and the scale of learning independence in science subjects. In contrast to what the writer will develop, namely an instrument that measures learning independence in mathematics.

METHODS

This study uses a descriptive quantitative approach. The location of the research data collection was carried out in an elementary school in the District Education Office of Tlogowungu, Pati Regency. The research was conducted in 2022. The subjects of this study were 126 high school and elementary school students. This was done based on the opinion of Comrey & Lee saying the sample size for factor analysis was 50 very bad, 100 bad, 200 fair, 300 good enough, 500 good, and 1,000 very good (Comrey & Lee, 1992).

The research data was collected through documentation of the results of the assessment conducted by the field supervisor. In addition, data analysis was performed with confirmatory factor analysis to prove the construct validity of the instrument. The general model of factor analysis measurement is built by the equation (Arafah, 2015):

Indicator = λ Construct + Error
$x = \lambda\xi + \delta$
where:
x : Vector for indicator variables
ξ : Exogenous latent variable
λ : Loading factor
δ : Eror

Figure 1. Model of Factor Analysis

To test the significance of each indicator using the view of Retnawati which states that the coefficient of the factor loading path will have meaningful if the magnitude is not less than 0.4. Verification of construct reliability is done using the composite score method or omega reliability. The formula to get the construct reliability coefficient is as follows (Retnawati, 2016a, 2016b).

$$\omega = \frac{\left(\sum_{i=1}^{i} \lambda_i\right)^2}{\left(\sum_{i=1}^{i} \lambda_i\right)^2 + \left(\sum_{i=1}^{i} 1 - \lambda_i^2\right)}$$

where

ω = Reliability coefficient

λ_i = Standardized loading factors

Figure 2. Construct Reliability Coefficient

As a criterion used in reliability is 0.85. Goodness of Fit Model testing is done to test the suitability / identities between empirical data and theoretical models that are designed. The model is said to be fit if the emerald data is identical to the theoretical model. If p value ≥ 0.05 and RMSEA ≤ 0.08, the model can be explained as a fit model (Bentler, 1990; Hu & Bentler, 1999; Retnawati, 2016b; Satorra & Bentler, 2001)

RESULTS AND DISCUSSION

The results of proving the content validity of the Independent Learning Instruments conducted by three experts were then analyzed using the CVR equation to determine the value of the Content Validity Ratio (CVR). The results of the instrument content validation are shown in table 1 below.

Table 1. Indicators of Independence in Learning Mathematics

Variable	Indicator	Question		Number of questions
		Positive	Negative	
Independent Learning	There is a goal setting	**1,2, 5, 9, 23**	**3,6, 7, 8, 30**	10
	There is a determination of learning strategies	**4, 13, 16, 17, 18, 20**	**14, 15, 19, 24**	10
	The existence of the determination of learning resources.	**10, 12, 21, 22, 25, 29**	**11, 26, 27, 28**	10

Table 1 above, it can be shown the distribution of positive and negative scale items. The three indicators have the same portion of question items, namely, ten. A

goal-setting indicator has ten things, where five are positive, and five are negative. There is a determination of learning strategies indicator has ten items where six are positive, and four are negative. The third indicator, the existence of the determination of learning resources, totals ten items where six are positive and four are negative.

In compiling the independent learning scale, the authors first define independent learning from experts' references. The definition taken is that learning independence is an ability to control and regulate thoughts, feelings, and actions in the form of real action, namely teaching activities to achieve competency within the student by paying attention to goals, strategies, and learning resources. Examples of the questions posed in the independent learning variables in the three indicators are shown in table two below.

Table 2. Samples of questions asked

Variable	Indicator	Question	
		Positive	Negative
Independent Learning	There is a goal setting	To better understand the math material at school, I open notes back at home	I feel that studying alone is a waste of time because I still don't understand
	There is a determination of learning strategies	I visited the library to broaden my mathematical knowledge	I like to put off doing homework until it piles up a lot
	The existence of the determination of learning resources.	I use HP to find out answers to math assignments.	The tutor didn't help me understand the math material

Each item statement has five categories: strongly agree, agree, undecided, disagree, and strongly disagree. Furthermore, the statement items were tested for validation by experts. Here the researcher uses three expert validators in their field.

Furthermore, related to the Validation Results of Independent Mathematics Learning Instruments are shown in table 3 below.

Table 3 Validation Results of Independent Mathematics Learning Instruments

Question points	Validators 1	2	3	Score CVR	Result
1	V	V	V	1,000	Valid
2	V	V	V	1,000	Valid
3	TV	V	V	0,333	Invalid
4	V	V	V	1,000	Valid
5	TV	V	V	0,333	Invalid
6	V	V	V	1,000	Valid
7	V	V	V	1,000	Valid
8	V	V	V	1,000	Valid
9	TV	V	V	0,333	Invalid
10	V	V	V	1,000	Valid
11	V	V	V	1,000	Valid
12	V	V	V	1,000	Valid
13	V	V	V	1,000	Valid
14	V	V	V	1,000	Valid
15	V	V	V	1,000	Valid
16	V	V	V	1,000	Valid
17	V	V	V	1,000	Valid
18	V	V	V	1,000	Valid
19	V	V	V	1,000	Valid
20	V	V	V	1,000	Valid
21	V	V	V	1,000	Valid
22	V	V	V	1,000	Valid
23	V	V	V	1,000	Valid
24	V	V	V	1,000	Valid
25	TV	V	V	0,333	Invalid
26	V	V	V	1,000	Valid
27	V	V	V	1,000	Valid
28	V	V	V	1,000	Valid
29	V	V	V	1,000	Valid
30	V	V	V	1,000	Valid
Proportion	0,867	1,000	1,000		

Information:
V : Valid
TV : Invalid

From the table 3, it is shown that of the 30 questions that have been validated by the validator, the CVR value above 0.99 is 26 items, so from the table it is stated that 26 questions are valid, while 4 questions are invalid. Invalid questions of 4 items were not used and were not given to the respondent. Meanwhile, the CVI (Content Validity Index) value is shown as follows:

$$CVI = \frac{\sum CVR}{k}$$

$$CVI = \frac{27{,}333}{30} = 0{,}911$$

Figure 3. Content Validity Index

From the information on the value of $CVI \geq 0$, it can be shown that the mathematics learning independence instrument is suitable for use in the very good category. Furthermore, the distribution of Independent Learning Variable Items is shown in table 4.

Table 4 Distribution of Independent Learning Variable Items

Variable	Indicator	Question	Number of questions
Independent Learning	There is a goal setting	**1,2, 4, 5, 18, 23**	6
	There is a determination of learning strategies	**3, 9, 10, 11, 12, 13, 14, 15, 16, 19**	10
	The existence of the determination of learning resources.	**6, 7, 8, 17, 20, 21, 22**	7

Table 4 above, it can be seen the Distribution of Independent Learning Variable Items. The first indicator is goal setting, obtained by several six items spread over questions 1, 2, 4, 5, 18, and 23. The second indicator There is a determination of learning strategies obtained by ten items spread over question items 3, 9, 10, 11, 12, 13, 14, 15, 16, and 19. While the third indicator, The existence of the determination of learning resources, obtained seven items spread across questions number 6, 7, 8, 17, 20, 21, and 22.

Furthermore, Confirmatory Factor Analysis (CFA) was carried out to convince researchers of the independent learning instrument in learning mathematics. This is done to confirm the factors presented in the compiled independent learning instrument in mathematics learning. The Path Diagram of

Independent Mathematics Learning Variables can be seen in Figure 1 below.

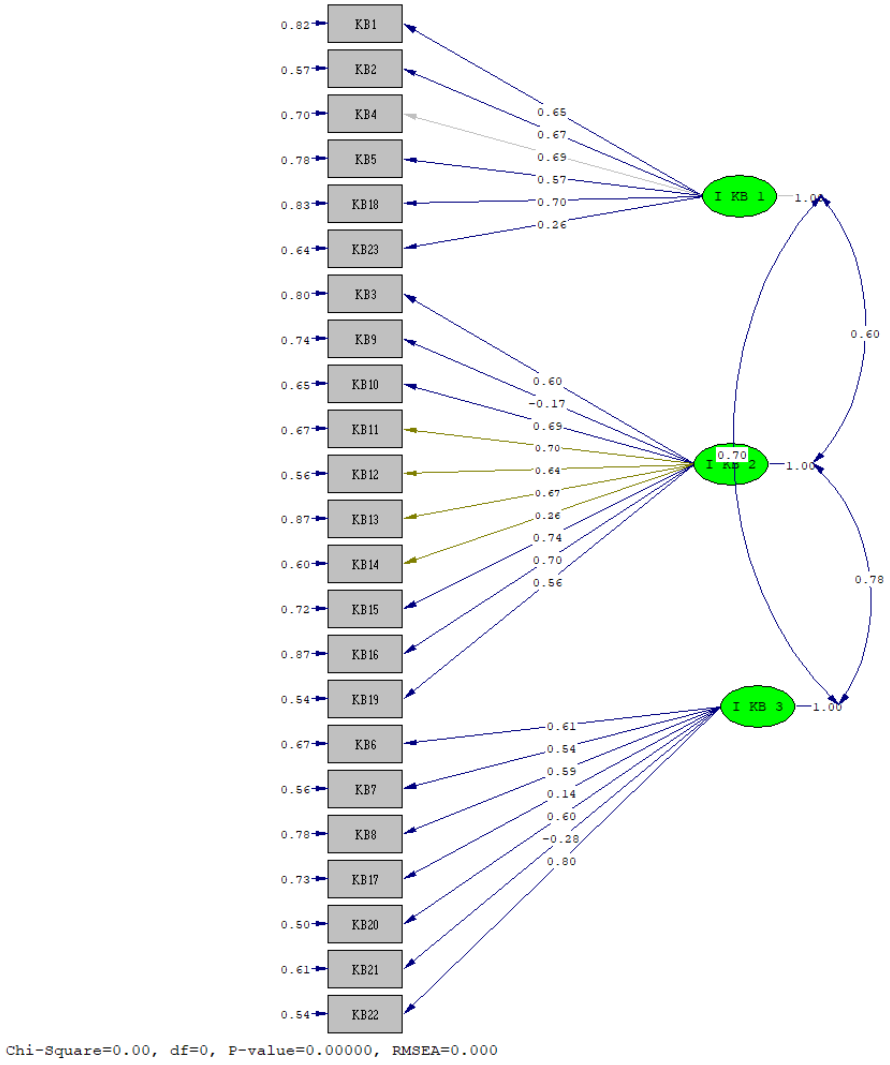

Figure 4. Path Diagram of Independent Mathematics Learning Variables

Figure 4 can be interpreted as follows Indicator of learning independence 1: The existence of goal setting. Question 23 has a loading factor of <0.5 so it has not been able to measure the indicator properly. Questions 1,2, 4, 5, and 18, have a factor loading > 0.5 so they can measure indicators well. Indicator of learning independence 2: There is a determination of learning strategies. Questions 9 and 14 have a loading factor of < 0.5 so they have not been able to measure indicators properly. 3, 10, 11, 12, 13, 15, 16, and 19 have a loading factor of > 0.5 so they can

measure indicators well. Learning independence indicator 3: There is a determination of learning resources. Questions 17 and 21 have a loading factor of <0.5 so they have not been able to measure indicators properly. Questions 6, 7, 8, 20, and 22 have a factor loading > 0.5 so they can measure indicators well. The relationship for the three indicators is quite high, namely > 0.5. This shows that the three indicators are related, namely they are both able to measure the learning independence variable. So the instrument being developed with these three indicators will be able to measure learning independence variables well based on the statistical tests.

In this study, independent learning can be assessed through the process of determining goals, determining strategies, and being consistent in carrying out the learning process. This research is in line with research (Mulyono et al., 2018) which found that determining independent learning requires students' style of learning, exploring according to their needs, exploring interests, and having the desire to strive according to their talents. These two studies are in harmony that in determining independent learning, it is very necessary to have a desire that arises within the students themselves.

The findings of this study prove that independent learning in mathematics is strongly influenced by one's own desire. The instrument presented leads and examines that the potential within oneself contributes greatly. Independent learning is a form of deep desire that is proven in the form of actions such as discipline towards one's own goals and schedule (Alfiani, 2021). This is in accordance with the research findings that goals formed by oneself can be realized in a disciplined attitude in setting strategies and consistently achieving the goal design.

Various studies on mathematical independent learning, and this has become one of the most urgent studies. The need for independent learning in mathematics is needed for students to overcome learning problems in mathematics (Rostina & Izzati, 2020). Through the instrument on mathematical independent learning that has been compiled, readers and teachers can anticipate what indicators need to be developed in the classroom. In addition, it can be used as a valid instrument in assessing students.

Independent learning is what helps students not to depend on others. As with various problems in mathematics, many students do not have confidence and independence in learning mathematics (Pratiwi, 2018). In instruments number 1, 2, 4, 5, and 18 about determining learning goals, students who have learning independence in mathematics must have learning goals that suit them. Some of these research instruments are about students making goals without being influenced by others, being able to measure their own abilities.

Independent learning in mathematics can help students to develop their own abilities. In questions no. 10, 11, 12, 13, 15, 16, and 19 about determining learning strategies, this instrument is strongly influenced by students themselves. This instrument examines how students organize frameworks and strategies to achieve learning goals. This part is needed to determine students' learning success through independent learning (Notika, 2018).

In questions 6, 7, 8, 20, and 22 about self-consistency in learning activities. This indicator discusses individual actions in reflecting the desire to carry out actions in real terms. This research is in accordance with the results of research (Sumantri, 2016) which proves that this indicator includes student initiative, choice, and student responsibility. Thus, this research is in line with previous research. With the various discussions above, it is found that there are interesting findings, namely the actions of learning independence originating from students. Actions that are reflected such as discipline, having initiative, being strong in action, having their own choices, and having responsibility in organizing, acting, and achieving goals.

CONCLUSION

Based on the results of research and discussion, it can be concluded that the scale of independence in learning mathematics is measured through three indicators with 30 items distributed. The three indicators are the determination of goals, the determination of learning strategies, and the determination of learning resources. It was also emphasized that in the first learning independence indicator variable, 5 questions were able to measure well. In the second learning independence indicator, 8 questions can measure indicators well, and in the third learning indicator 5

questions are able to measure indicators well. The relationship for the three indicators is quite high, namely > 0.5. This shows that the three indicators are related, namely they are both able to measure the learning independence variable. So, it can be said that the three indicators are able to measure learning independence variables well. Thus, the instrument or scale of learning independence in mathematics has been tested as valid and reliable. Readers can send an email if they plan to use the developed self-learning scale.

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