



## Ability to Understand Concepts: Cognitive Style, Cognitive Structure, Learning Styles and Learning Motivation



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### ABSTRACT

Mathematics is a compulsory subject in vocational high schools throughout Indonesia. The ability to understand concepts is a competency that must be possessed in mathematics learning. The purpose of this study was to examine the variables that affect the ability to understand mathematical concepts. The variables are cognitive style, cognitive structure, learning style and learning motivation. This is a survey research, with a sample of 100 people. The sample was selected by simple random technique from all vocational high school students in Bengkulu City. The research instrument consisted of five instruments, namely a test of the ability to understand mathematical concepts, and four questionnaires of cognitive style, cognitive structure, learning styles and learning motivation questionnaire. The research data were analyzed through path analysis using SPSS and the Lisrel Application Program. The results of this study are the variables of cognitive style, cognitive structure, learning style, and learning motivation have a positive direct effect on the ability to understand mathematical concepts. From this study it can be concluded that the ability to understand mathematical concepts through cognitive styles, cognitive structures, learning styles, and student learning motivation is in a good category.

**Keywords:** Cognitive style, cognitive structure, learning style, learning motivation, concept comprehension ability.

### INTRODUCTION

Efforts to improve math skills continue, but the results of national mathematics exams are still low. One of the difficulties experienced by students is solving math problems. It is a must-have ability in learning mathematics. Problem solving ability is one part of learning mathematics.

Mathematics education is a conscious effort to improve the quality of students' thinking. Therefore, mathematics is an important and compulsory subject for vocational high schools (Suharto & Widada, 2019b). Mathematics is a core subject in vocational high schools. At the end of the year, students are required to

take a national math exam. Many students have difficulty facing exams. According to the National Joint Committee of Learning Disabilities (Abdurrahman, 2010), learning difficulties are a general term for various types of difficulties in listening, conversing, reading, writing, reasoning, or possibly in the field of mathematics studies.

Mathematics education is seen as something that can reliably prepare humans for the various changes that occur in society. Education means something that is static in nature but is something that is dynamic, so it always demands a continuous improvement.

Mathematics education is a very important tool in creating quality humans.

In this case, mathematics education requires innovation in accordance with the progress of science and technology and does not ignore human values. Student anxiety can be controlled through increased learning motivation and self-confidence. Students also have basic abilities that become the strength to think logically. These are cognitive styles, cognitive structures and learning styles (Hooda & Devi, 2017) (Lu & Lin, 2017) (Chrysostomou, Tsingi, Cleanthous, & Pitta-Pantazi, 2011). There are also significant differences in cognitive styles between boys and girls at school. The government should warn teachers about the importance of cognitive styles during the teaching and learning process. Mathematics teachers must consider students' cognitive styles while preparing their lesson plans and teaching aids (Ramlah & Jantan, 2014). The results show that the anxiety faced by the national exam is related to the ability to understand mathematics (Suharto & Widada, 2019c).

The process of learning mathematics becomes something important in this regard. Therefore, the government has made various efforts in providing innovation to the world of education, such as by introducing various innovative learning methods. The government has also completed learning facilities and infrastructure, for example by providing free books through the BSE (Electronic School Book) program. Even the increase in the professionalism of mathematics teachers can also be improved, through the Professional Education Program (PPG), providing scholarships to teachers to continue their education, and various other professional education and training programs.

Mathematics trains students to develop thinking skills. Mathematics is a means of logical, analytical, and systematic

thinking. Basically, mathematics is a scientific discipline of the long process of human civilization on earth and is part of human life (Benefits, 2010). Meanwhile, Fathani (2009) argues that mathematics is an exact science and is systematically organized and is also related to logical reasoning so that problems are related to numbers. Mathematics learning is an effort to form individual mindsets to gain understanding, reasoning, and solving mathematical problems. Learning mathematics is able to train students to think critically, logically, analytically and systematically at every opportunity. Oleh karena itu diperlukan strategi pengajaran yang tepat.

The strategies of teaching explicit general problem solving and guided inquiry have comparable effectiveness in solving teaching problems (Mataka, Cobern, Grunert, Mutambuki, & Akom, 2014). In learning mathematical problem solving, mathematical objects become content which is a prerequisite for students. These objects are facts, concepts, principles and operations (W. Widada & Herawaty, 2017). This means that the ability to understand concepts is one of the variables that students must have to be able to solve math problems. Concepts are abstract ideas that can be used to classify objects as examples or not examples of the concept.

The ability to understand concepts is one of the competencies that a student must have (Suharto & Widada, 2018). Mathematics learning should be more student-centered, this is so that students are more actively involved in learning. The activities of students who are more active in learning mathematics will certainly greatly affect students' attitudes and personalities, so that students will feel more comfortable and interested in mathematical concepts and will not again consider that mathematics is a subject that is considered

difficult. This is in line with what Hamdani (2011: 7) states that learning is basically a process of developing student attitudes and personalities through various stages and experiences. Through mathematics learning which is packaged more attractively, students will feel comfortable in learning and be able to understand abstract mathematical concepts or ideas.

Therefore, students who understand the concept are able to explain with various real examples and are able to show the position of the concept in the deductive structure of mathematics (Dewi Herawaty, Widada, Herdian, & Nugroho, 2019; Dewi Herawaty, Widada, Handayani, Febrianti, & Abdurrobbil, 2020). This means that the realistic mathematics learning process with an ethnomathematic approach can be a vehicle for students to simplify the concept of function to make it more meaningful (Dewi Herawaty, Widada, Adhitya, Sari, & Novianita, 2020).

Based on this research, it is stated that the ability to understand mathematical concepts is influenced by cognitive styles, cognitive structures, learning styles, and learning motivation. The ability to understand mathematical concepts is an important component in learning mathematics. According to (Akinmola, 2014), mathematics is an excellent vehicle for developing one's intellectual competence in logical reasoning, spatial visualization, analysis, and abstract thinking. Students develop numeracy, reasoning, thinking and problem solving skills through learning and applying mathematics. It is valued not only in science and technology, but also in everyday life and at work. Thus, we are interested in examining the causal relationship between cognitive style, cognitive structure, learning styles, and learning motivation, and the ability to understand mathematical concepts.

## RESEARCH METHODS

This research is a survey research with a quantitative approach. Information obtained from samples collected directly on the scene empirically, with the aim of knowing the opinion of the object the sample under study. The population of this study were all students of class XI SMK in Bengkulu City, amounting to 2,323 students. The sample was selected by simple random sampling technique of 100 people. The data collection used five research instruments, namely a cognitive style questionnaire, a cognitive structure questionnaire, a learning style questionnaire, a learning motivation questionnaire and a test of the ability to understand mathematical concepts. The validity and reliability of the five instruments have been tested in the very high category. Data were analyzed using path analysis. For this purpose, we are using the Lisrel 8.8 application.

## RESULTS AND DISCUSSION

The data of this research include five construct variables, namely  $X_1$  = Cognitive Style (GK)  $X_2$  = Cognitive Structure (SK),  $X_3$  = Learning Style (GB),  $X_4$  = Learning Motivation (MB), and  $Y$  = Ability to Understand Mathematical Concepts (KPK). Data were analyzed using inferential statistics. For this reason, we first conduct prerequisite tests. The normality of error estimation through the Lilliefors test is the difference between the theoretical frequency and the real frequency at each error value. The maximum absolute price of the difference is what we call  $Lo$ . Based on the normality test for estimation errors, the following results are obtained:

1. The distribution of the estimation error of the ability to understand mathematical concepts for cognitive style ( $Y$  over  $X_1$ ) obtained by L-count statistic = 0.0788, this value is smaller than L-table =

( $n = 100$ ;  $\alpha = 0.05$ ) = 0,0886. This means that the Y data against X1 comes from data that is normally distributed.

2. As with the previous statistical calculations, the following results are obtained successively:

a. The distribution of the estimated error in the ability to understand mathematical concepts for cognitive structures (Y over X2), with  $L_{hitung} = (0.0585) < L_{tabel} = (0.0886)$ , meaning that the error data Y against X2 comes from normally distributed data.

b. The distribution of the estimated error in the ability to understand mathematical concepts for learning styles (Y over X3), with  $L_{hitung} = (0.0672) < L_{tabel} = (0.0886)$ , meaning that the error data Y for X3 comes from normally distributed data.

c. The distribution of the estimated error in the ability to understand mathematical concepts for learning motivation (Y over X4), with  $L_{hitung} = (0.0674) < L_{tabel} = (0.0886)$ , meaning that the error data Y for X4 comes from normally distributed data.

d. The estimated distribution of learning motivation errors for cognitive style (X4 over X1), with  $L_{hitung} = (0.0853) < L_{tabel} = (0.0886)$ , meaning that the X4 error data for X1 comes from normally distributed data.

e. The distribution of the estimated error of learning motivation for cognitive structures (X4 over X2), with  $L_{hitung} = (0.0585) < L_{tabel} = (0.0886)$ , meaning that X4 error data for X2 came from normally distributed data.

f. The estimated distribution of learning motivation errors for learning styles (X4 over X3), with  $L_{hitung} = (0.0853) < L_{tabel} = (0.0886)$ , meaning that the X4 error data for X3 comes from normally distributed data.

Based on the error estimation analysis, everything comes from data that is normally distributed. It shows that the first prerequisite tests have been met.

- a. The next prerequisite test is the linearity and significance of the regression coefficient. The test is intended to find out how much the regression line equation connects the variable to the dependent variable. The linearity test of the data used the F test.
- b. In accordance with the previous analysis of linearity and significance of the regression coefficients, the results of other analyzes are presented as follows:
- c. Linearity test of the ability to understand mathematical concepts for cognitive style (Y over X1), the results of the regression equation  $Y = 52.905 + 0.0112 X_1$ . Based on statistical calculations, it is obtained that  $F_{count} = 7.421$  with a real level of  $\alpha = 0.05$  and dk (1; 98)  $F_{table} = 3.938$ . Because  $F_{count} > F_{table}$ , the regression is very significant. Linearity test obtained  $F_{count} = 0.746$  while at the real level  $\alpha = 0.05$  and dk (28; 70) obtained  $F_{table} = 1.643$  then  $F_{count} < F_{table}$  so that the linear model can be accepted.
- d. In accordance with the previous analysis of linearity and significance of the regression coefficients, the results of other analyzes are presented as follows:
- e. The linearity test of the ability to understand mathematical concepts for cognitive structures (Y over X2) obtained the regression equation  $= 51.472 + 0.142 X_2$ .  $F_{count} = 17.480$ , and the real level  $\alpha = 0.05$  and dk (1; 98) obtained by  $F_{table} = 3.938$ .  $F_{count} > F_{table}$ , the

regression is very significant. Linearity test from the calculation results obtained  $F_{count} = -1.554$  while at the real level  $\alpha = 0.05$  and  $dk (34:64)$  obtained  $F_{table} = 1.988$  then  $F_{count} < F_{table}$  so that the regression model is linear.

- f. The linearity test of the ability to understand mathematical concepts for learning styles (Y over X3) obtained the regression equation  $= 50.151 + 0.120 X_3$ .  $F_{count} = 12.397$ , and the real level  $\alpha = 0.05$  and  $dk (1; 98)$  obtained by  $F_{table} = 3.938$ .  $F_{count} > F_{table}$ , the regression is very significant. Linearity test from the calculation results obtained  $F_{count} = 0.721$  while at the real level  $\alpha = 0.05$  and  $dk (29:69)$  obtained  $F_{table} = 1.632$  then  $F_{count} < F_{table}$  so that the regression model is linear.
- g. Analogous to (a), the regression equation  $Y = 59.037 + 0.377 X_4$ ; regression equation  $X_4 = 86.068 + 0.310 X_1$ ; regression equation  $X_4 = 93.767 + 0.256 X_2$ , regression equation  $X_4 = 56.803 + 0.528 X_3$ ; Based on statistical tests, all values of  $F_{count} > F_{table}$  are at the real level ( $\alpha = 0.05$ ). This means that all regression models have a very significant coefficient value and form linear regression.

The prerequisite test has been fulfilled, followed by testing the causality model through path analysis. We use MS help. Excel Windows 8, the SPSS version of the program. 22 and Lisrel Application

Version 8.8. The results of the research data analysis can be presented in Table 1.

**Table 1.** Summary of Path Analysis

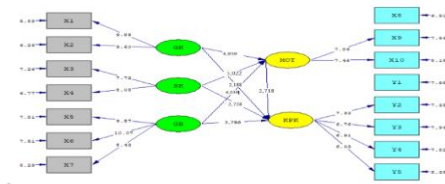
Causal	$F_{count}$	$F_{table}$	$T_{count}$	$T_{table}$	Sig	Conclusion
$X_1 \rightarrow Y$	7,421	3,938	2,188	1,980	0,038	There is influence
$X_2 \rightarrow Y$	17,480	3,938	2,728	1,980	0,008	There is influence
$X_3 \rightarrow Y$	12,397	3,938	3,786	1,980	0,034	There is influence
$X_4 \rightarrow Y$	8,942	3,938	2,718	1,980	0,008	There is influence
$X_1 \rightarrow X_4$	10,001	3,938	4,959	1,980	0,000	There is influence
$X_2 \rightarrow X_4$	8,918	3,938	5,022	1,980	0,000	There is influence
$X_3 \rightarrow X_4$	58,052	3,938	6,039	1,980	0,000	There is influence

Table 1 shows the results of the path coefficient significance analysis between the construct variables. These variables are  $X_1$  = Cognitive Style (GK)  $X_2$  = Cognitive Structure (SK),  $X_3$  = Learning Style (GB),  $X_4$  = Learning Motivation (MB), and  $Y$  = Ability to Understand Mathematical Concepts (KPKM).

Based on Table 1, there are seven significant direct effects between variables. First, there is a direct effect of  $X_1$  on  $Y$  with  $F_{count} = 7,421 > 3,938 = F_{table}$ , with  $T_{count} = 2,188 > 1,980 = T_{table}$  for sig. = 0.038. There is a direct effect of  $X_2$  on  $Y$  with  $F_{count} = 17,480 > 3,938 = F_{table}$ , with  $T_{count} = 2,728 > 1,980 = T_{table}$  for sig. = 0.008. There is a direct effect of  $X_3$  on  $Y$  with  $F_{count} = 12,397 > 3,938 = F_{table}$ , with  $T_{count} = 3,786 > 1,980 = T_{table}$  for sig. = 0.034. There is a direct effect of  $X_4$  on  $Y$  with  $F_{count} = 8,942 > 3,938 = F_{table}$ , with  $T_{count} = 2,718 > 1,980 = T_{table}$  for sig. = 0.008. There is a direct effect of  $X_1$  on  $X_4$  with  $F_{count} = 10,001 > 3,938 = F_{table}$ , with  $T_{count} = 4,959 > 1,980 = T_{table}$  for sig. = 0,000. There is a direct effect of  $X_2$  on  $X_4$  with  $F_{count} = 8,918 > 3,938 = F_{table}$ , with  $T_{count} = 5,022 > 1,980 = T_{table}$  for sig. = 0,000. There is a direct effect of  $X_3$  on  $X_4$  with  $F_{count} = 58,052 > 3,938 = F_{table}$ , with

$T_{count} = 6,039 > 1,980 = T_{table}$  for sig. = 0,000.

These results can be illustrated in a complete path diagram based on statistical tests using Lisrel, see Figure 1.



**Figure 1:** T-Value Basic Model

Based on Figure 1, and the results of the complete path coefficient calculation, it is known that the coefficient of each path is significant. This is shown from the calculation of road efficiency, namely  $py1 = 0.731$  for the direct effect of X1 on Y;  $py2 = 0.809$  for the direct effect of X2 on Y;  $py3 = 0.930$  for the direct effect of X3 on Y;  $py4 = 0.765$  for the direct effect of X4 on Y;  $p41 = 0.847$  for the direct effect of X1 on X4;  $p42 = 0.764$  for the direct effect of X2 on X4;  $p43 = 0.770$  for the direct effect of X3 on X4.

Thus, there is a significant direct effect of cognitive style on the ability to understand mathematical concepts; There is a significant direct effect of cognitive structure on the ability to understand mathematical concepts; There is a significant direct effect of learning styles on the ability to understand mathematical concepts; There is a significant direct effect of learning motivation on the ability to understand mathematical concepts; There is a significant direct effect of learning motivation on the ability to understand mathematical concepts; There is a significant direct effect of cognitive style on learning motivation; There is a significant effect of cognitive structure on learning motivation; There is a significant

direct effect of learning styles on learning motivation;

These results support some of the results of previous research, the better the student's learning motivation, the better the understanding of the concept of a student (Mutoharo, 2015). There is a relationship that understanding the concept of mathematics is a competency possessed by a student in understanding concepts and performing algorithms precisely and accurately shown by students during the learning process (Jihad and Haris, 2013). Understanding a mathematical concept is very important to improve in mathematics learning (Murnaka and Dewi, 2018). The results of other research state that there are still many teachers implementing conventional learning in which the teacher explains the subject matter, and students only listen to convey the material without them understanding the meaning of the material, there is a lack of relationship between teachers and students, so learning becomes passive ).

Student anxiety can be controlled through increased learning motivation and self-confidence. Students also have basic abilities that become the strength to think logically. These are cognitive styles, cognitive structures and learning styles (Hooda & Devi, 2017) (Lu & Lin, 2017) (Chrysostomou, Tsingi, Cleanthous, & Pitta-Pantazi, 2011). There are also significant differences in cognitive styles between boys and girls at school. The government should warn teachers about the importance of cognitive styles during the teaching and learning process. Mathematics teachers must consider students' cognitive styles while preparing their lesson plans and teaching aids (Ramlah & Jantan, 2014).

The application of the Knisley mathematics learning model has a significant effect on the ability to understand students' mathematical concepts

based on learning styles (Mahampang, 2019).

In the mathematics learning model, Knisley also pays attention to differences in the learning styles possessed by each student. Visual learning style students prefer learning that is more explained by others and the presence of teaching aids, while students who use audiotorial learning styles prefer learning with discussion and question and answer, and students who use kinesthetic learning styles will prefer practical and touching learning. props. In learning, students' learning styles play an important role in increasing understanding of mathematical concepts, but students' ability to understand concepts with visual learning styles, auditory learning styles, and kinesthetic learning styles are different.

This happens because students who use different learning styles have different ways of absorbing and processing information that has been received in learning.

## CONCLUSION

The ability to understand mathematical concepts is one of the abilities that students must have in learning mathematics. The results of this study concluded that the variable cognitive style, cognitive structure, learning style, and learning motivation had a positive direct effect on the ability to understand mathematical concepts. Therefore, teachers and developers of mathematics learning must explicitly and implement these variables in the implementation of learning.

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