Characteristics of Understanding Field Independent Students in Solving Mathematical Problems

Dian Septi Nur Afifah

[1] Mathematics Education, STKIP PGRI Tulungagung, Tulungagung, Indonesia

DOI: 10.29322/IJSRP.9.09.2019.p9382
http://dx.doi.org/10.29322/IJSRP.9.09.2019.p9382

Abstract- The purpose of this study is to describe the characteristics of understanding students Field Independent in solving mathematical problems. This type of research is a descriptive study with a qualitative approach. The research subjects were high school students in class X. Determination of the subject was done by giving a cognitive style test that is GEFT as many as 18 questions in the form of geometric images. The instrument used was problem-solving tests and interview guidelines. To test the validity of the data using time triangulation. Data analysis included: reduction, exposure and drawing conclusions of students' understanding in solving mathematical problems and other findings. Based on the results of the study, it can be concluded that the characteristics of Field Independent students' understanding in solving mathematical problems are identifying the known, asked and using strategies by drawing triangles using the concept of three-figure majors and can explain the steps used by the concept of the number of angles in a triangle, the number straight angle, Pythagorean formula, cosine rules and sine rules so that the dominant type of understanding of Field Independent students is formal understanding.

Index Terms- Understanding, Mathematical Problem, Field Independent.

I. INTRODUCTION

The dominant education paradigm for improving the quality of education includes curriculum, pedagogy, and assessment of learning outcomes [1]. To achieve these three things we need an understanding of students related to the material being studied. For this reason, mathematics lessons are given to understand concepts, explain the interrelationships between concepts and apply concepts or logarithms efficiently, accurately and precisely in problem-solving. Furthermore, it was also explained that mathematics was intended to develop problem-solving skills. The ability to solve problems becomes a measure of student success in learning mathematics [2].

The above goal is a high enough demand that can not be achieved only through rote, practice questions that are routine. After learning mathematics takes place, students are expected to master and understand mathematical concepts to solve problems. The word master implies that students do not just know (know) and memorize (memorize) about mathematical concepts, but students must understand and understand (to understand) and connect relationships with other concepts, so students can solve problems well. In addition, students 'mistakes in working in mathematics need to get attention because if they are not immediately resolved, these errors will affect students' understanding of the next mathematical concepts [3]. Therefore it is necessary to further study student understanding in solving mathematical problems.

In addition, understanding is an important element of almost all studies in the field of mathematics education including assessment [4]; curriculum development [5]; problem-solving [6]; teaching and learning [7]–[9]. Likewise with Hiebert and Carpenter said that the purpose of research and implementation in mathematics education is to promote learning with understanding[10].

But not all students can understand the material that has been well studied. This is seen when students experience difficulties when faced with solving mathematical problems [11]. These difficulties can be seen from the mistakes made by students in the problem-solving process. In addition, based on the results of observations by researchers at Qu Al-Bahjah Tulungagung Middle School, most of them were able to solve the problem. However, some students do not know why after being asked the reason for the answer, and some are able to explain the reason for their answer. In addition, there are also students who not only know about solving a mathematical problem but can also apply it to other situations.

Fatqurhohman examines students' understanding of mathematical concepts in solving flat problems which results show that students have not been able to properly use mathematical concepts in solving problems (still tend to be procedural) [12], students cannot compare by presenting alternative solutions the other is the response obtained, mastery and understanding of mathematical concepts in solving non-routine problems is still low. Research on student understanding has also been carried out by several previous researchers, one of which is who examines junior high school students' understanding of geometrical story problems stating that there are still many students who do not understand the purpose of story problems and lack understanding of geometrical concepts. Furthermore, in solving mathematical problems students have their own ways that might differ from one student to another student because students' understanding also varies.

Problem-solving is a strategy adopted by students to find a solution to the difficulty experienced by interpreting the concepts they have learned. Polya states problem solving "as an effort to find a way out of a difficulty, achieve goals that are not immediately achieved" [13]. So problem-solving is a way that students do to solve a mathematical problem by using their knowledge, skills, and understanding.

Jung states that one of the ideas that are widely accepted in mathematics education is that students must understand mathematics. Furthermore, Jung suggests three kinds of understanding, namely Instrumental understanding (students' ability to apply memorized or memorized formulas in problem solving without knowing why the formula is used), relational understanding (ability to draw conclusions from certain formulas or procedures from more general mathematical relations), formal understanding (the ability to connect mathematical symbols and mathematical notation with relevant mathematical ideas and to combine ideas into logical sequences) [14].

To find out the success of students, the teacher makes an assessment of the understanding of the material that has been learned. To find out how far students' understanding can be seen from the ability of students to solve mathematical problems. Solving mathematical problems is not an easy thing for students. Ardana states that each person has specific ways of acting, which are expressed through perceptual and intellectual activities known as cognitive styles [15].

Cognitive style is the way a person processes, stores or uses the information to respond to a task or various types of environment. Witkin distinguishes styles into two types namely Independent Field and Field Dependent. Field Dependent is a cognitive style that students have by accepting something more global. While Field Independent is a cognitive style possessed by students who tend to state things analytically. In this study using students who have the Field Independent cognitive style. Judging from the cognitive style, students may have a tendency of understanding in solving mathematical problems. Previous research, Ulya examined the relationship between cognitive style and problem-solving abilities, the results of which showed that there was a positive relationship at a high level between students 'cognitive styles and students' problem-solving abilities [16].

Based on the differences in cognitive style it is interesting to be able to be revealed about students' understanding in solving mathematical problems from each cognitive style group. A teacher who knows how students' understanding of solving mathematical problems can help teachers in teaching and determine alternative learning approaches to support the learning process so that better results are achieved. Because an understanding of a matter, in this case especially mathematics will be the key to student success in solving mathematical problems and can improve learning outcomes. In this study, the characteristics of students who have the Independent Field cognitive style in solving mathematical problems will be analyzed.

II. METHODS

This type of research is exploratory research using a qualitative approach. This research was conducted in class X SMA Muhammadiyah 4 Surabaya Indonesia. The instrument of this study was the Group Embebbed Figure test (GEFT) for selecting research subjects, problem-solving questions and interview guidelines for analyzing students' understanding in solving mathematical problems. Data collection is done by tests and interviews. After each subject is selected a problem-solving test (TPM) is given and the interview is analyzed according to the understanding indicator. Furthermore, to check the validity of the data triangulation time is used by giving TPM after a week the first TPM is done with an equivalent problem. Valid data are data from TPM 1 and TPM 2 triangulation. Time triangulation results data is valid data which is the result of research. After valid data is obtained, an analysis is performed. The data analyzed are the results of the TPM and the results of the interview to determine the type of student understanding. The analysis conducted in this study using procedures including reducing data, data exposure, drawing conclusions based on understanding indicators. The indicators of student understanding used in analyzing the data obtained are as follows.

Table 1. Indicators of Student Understanding in Solving Mathematical Problems

Type of Understanding	Understanding Indicators
Formal	a. Students can answer correctly b. Students can use mathematical formulas appropriately c. Students can explain the reasons for using mathematical formulas d. Students can explain symbols or notations used in mathematics
Relational	a. Students can answer correctly b. Students can use mathematical formulas appropriately c. Students can explain the reasons for using the formula
Instrumental	a. Students can answer correctly b. Students can use mathematical formulas appropriately c. Students can explain the reasons for using the formula

III. RESULT AND DISCUSSION

This research data in the form of written test results from research subjects on the problem-solving tests provided and also the interview transcript data conducted to confirm the written test answers. The following is a description of the data from students' understanding of the independent fields in solving mathematical problems.

First Subject (FI1)

The subject of FI1 in solving mathematical problems using Polya's steps, namely understanding the problem (by writing what is known and what is known and what is asked), planning to plan Polya's understanding of the data results namely understanding the problem (by writing what is known and what is asked) , plan completion (draw a triangle to describe what is known and what will be sought) and carry out from what has been planned (work according to the image that has been made). For Polya's last step, which is to re-examine the answer, it is not clear from the results of the problem-solving tests that were undertaken. The following answer is written FI1.

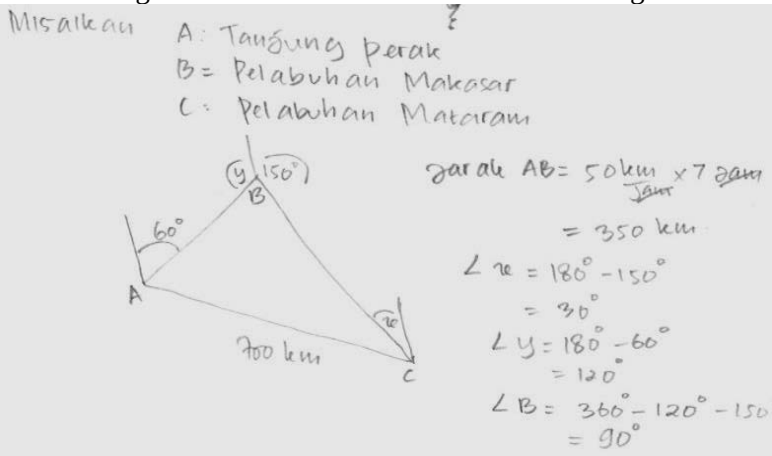

Figure 1. FI1's Answer Using the Triangle Image

FI1 draw a port using a triangle. From the triangle picture, FI1 gives symbols and signs (A), (B), (x), (y), (_), 0. Next, determine the distance AB using the speed formula. FI1 determines each angle in the triangle image, namely the x, y and angles B using the sum formula in a triangle and straightforward. To find out the understanding of FI1 researchers in solving mathematical problems, the researchers conducted interviews to find out the reason for each answer.

Q: "Why are there three lines in the direction of all up arrows?"
FI1: "That is a benchmark for drawing the angle"
Q: "What does that mean?"
FI1: "To start drawing the corner"
Q: "Why determine the distance of AB that's speed times time?"
FI1: "Because of the speed and time taken, I use the distance formula in physics, ma'am."
Q: "What's the formula?"
FI1: "s = v.t"
Q: "Where did the formula come from?"

FI1: "I don't know, just like that in physics."

FI1 draws three lines in the direction of all up arrows with the reason as a pot to draw the angle. Benchmarks are meant for starting corner images. FI1 determines the distance AB using the formula of speed and time taken is s = v. t. FI1 explains the gotten formula when studying physics. In this case, FI1 cannot explain the reason for using the formula, so it belongs to the type of instrumental understanding.

P: "Then what are x and y for and what are these symbols?"

FI1: "I suppose the x angle is aligned with an angle of 30^0. While the angle of y is aligned with an angle of 150^0. If this is the symbol of the angle"

P: "Why are you looking for x and y?"

FI1: "Because the number of straightening angles is 180^0".

P: "I see, where did you get 120^0?"

FI1: "That's right with the angle A, from 180^0-60^0."

FI1: "It's easier, ma'am, it's already known that there are two angles, so all that's left is 360^0-120^0-150^0 = 90^0."

Q: "Why do you use that method?"

FI1: "Yes, that's the formula, ma'am ..."

Q: "If I use 180^0 instead of 360^0, what do I do?"

FI1: "You can't, you have to do 360^0 if you have a circular shape."

FI1 uses the symbol x as a corner with an angle of 300^0, while the symbol y with an angle of 150^0. To determine the angle of x uses the formula for the number of angles to the point that is 180^0. And to determine the angle of y uses 360^0-120^0-150^0 = 90^0 with the reason two angles have known, then including the type of formal understanding.

Following is the written answer FI1 in determining the direction of the Nusantara ship from the port of Mataram to the port of Tanjung Perak in Surabaya.

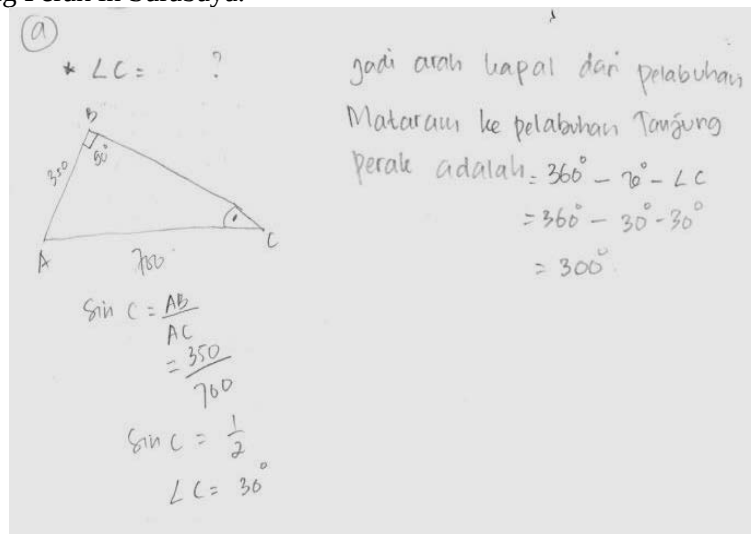

Figure 2. FI1's answer in determining the Direction of the Nusantara Ship and the Port of Mataram to the Port of Tanjung Perak, Surabaya

FI1 uses the sine rule formula to determine the angle of C. In finding the angle of C the formula used is correct. To find out the understanding of FI1 in using the sine rule formula, the researchers conducted interviews. Following are excerpts from the results of the interview.

P: "How do I do it?"

FI1: "Using the rules of the sinus comparison ratio?"

P: "Why do you use that formula?"

FI1: "It's easier, ma'am because it's a right triangle and the one asked for the angle so I use a syndrome".

Q: "What is a syndrome?"

FI1: "Sin is a comparison of the front side and the hypotenuse".

P: "how?"

FI1: "Same as looking for angle B in the triangle, so that 300^0 is obtained."

Q: "Why is it like that?"

FI1: "Because that's also circular, ma'am ... so the number of angles is 360^0."

FI1 uses the rules of the sine comparison formula with easier reasons and the triangles are right angles. FI1 calls sine rules the term "syndrome" which means that sin is obtained from a comparison of the front side and the hypotenuse, so a C angle of 30^0 is obtained. In this case, it is a formal type of understanding. Furthermore, to

determine the direction of the Nusantara ship from the port of Mataram to the port of Tanjung Perak Surabaya using the formula of the number of angles of 360^0, namely 360^O-30^0-30^0 = 300^0. The reason for using this method is because it is circular so it uses the formula for the number of angles of 360^0, so it is a formal type of understanding.

Following is the written answer FI1 in determining the distance from Makassar port to Mataram port.

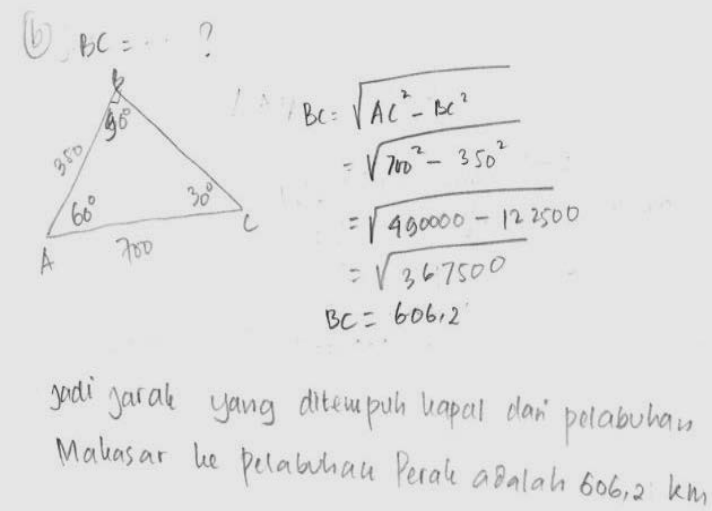

Figure 3. FI1's Answer in Determining Distance from the Port of Makassar to the Port of Mataram

FI1 uses the Pythagorean formula to determine the distance from the port of Makassar to the port of Mataram. The distance from Makassar port to Mataram port is assumed by BC. To find out the type of understanding of FI1 in using the formula, the researchers conducted interviews. The following are highlights of the interview results.

Q: "Why are you looking for BC using this method?"
FI1: "Now this is a right triangle, so I can simply use the Pythagorean formula."
P: "So, what is more, difficult to use?"
FI1: "I don't know, ma'am ...".

The reason FI1 uses the Pythagorean formula in determining the distance from the port of Makassar to the port of Mataram. The distance from the Makassar port to the port of Mataram is easier and the right triangle is known by two sides so that the BC value is equal to 606,2. In this case, the type of understanding FI1 is the type of relational understanding.

From the analysis of the characteristics of understanding of FI1 in solving mathematical problems, there are three types of understanding in solving the first problem, namely formal, relational, and instrumental understanding. However, the dominant characteristic of FI1 understanding is formal understanding.

Second Subject (FI2*)*

FI2 subjects solve mathematical problems by using Polya's steps to understand the problem (indicated by writing what is known and what is asked), planning a solution (shown by drawing a triangle to describe what is known) and carrying out from what has been planned (indicated by answer the question). The following answer is written FI2.

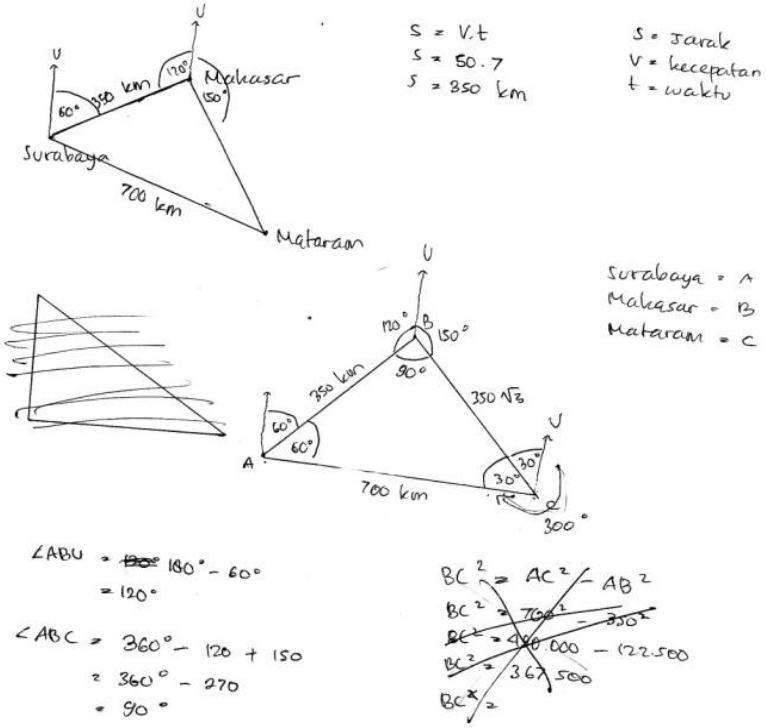

Figure 4. FI2 Answers Using Triangles

FI2 draw a port using a triangle. From the triangle picture, FI2 is supposed that A is the same as Surabaya, B is the same as Makassar, and C is the same as Mataram. It also uses the symbol (∠) which is a symbol from an angle.

Next FI2 determines the shrinkage size of ABC and ABU. To find out the understanding of FI2 researchers in solving mathematical problems, the researchers conducted interviews to find out the reason for each answer. The following are the results of the interviews.

P: "What picture is this Abdurahman?"
FI2: "Yes, the picture of the port, ma'am."
P: "Why did you draw the port first?"
FI2: "Let me know the picture, ma'am and know which one to look for".
P: "Why did you use the north to draw it?"
FI2: "Yes ma'am as a benchmark to determine the angle."
Q: "How is Abdurahman?"
FI2: "Use the physics formula, s = v.t then a distance of = 350 km is obtained."
Q: "Why do you use that formula?"
FI2: "Yes ma'am, if in physics to find the distance the formula is used if the known speed and time".
P: "I see, ... where is the ABU angle of 120 º?"
FI2: "That is aligned with the UAB angle, then the ABU angle is from 180º -60º.
Q: "Why are you looking for an ABC angle?
FI2: "Yes, it's known ABU's angle and UBU's angle ... the ABC's angle is 360º - 120º -150º = 90º".
P: "Why is it like that?"
FI2: "Really, really".
P: "The reason?"
FI2: "Because the angle in a circle is 360º".

FI2 draws three lines in the direction of all up arrows for reasons to know the location of the port. It also illustrates the north with a reason to determine the angle. FI2 determines the distance AB using the formula of speed and time taken is s = v. t. FI2 explains the formula obtained when studying physics because to find the distance used the formula if it is known to speed and time. In this case FI2 can explain the reason for using the formula so that it includes the type of relational understanding.

FI2 determines the angle of the ABU by 180^0-60^0 with the reason that the ABU angle is aligned with the UAB angle. Next FI2 looks for the angle of ABC using 360º-120º-150º with the reason for the angle in the circle. In this case, FI2 can explain the reasons for using the formula so that it includes the type of formal understanding.

Following is the written answer FI2 in determining the direction of the Nusantara ship from the port of Mataram to the port of Tanjung Perak in Surabaya.

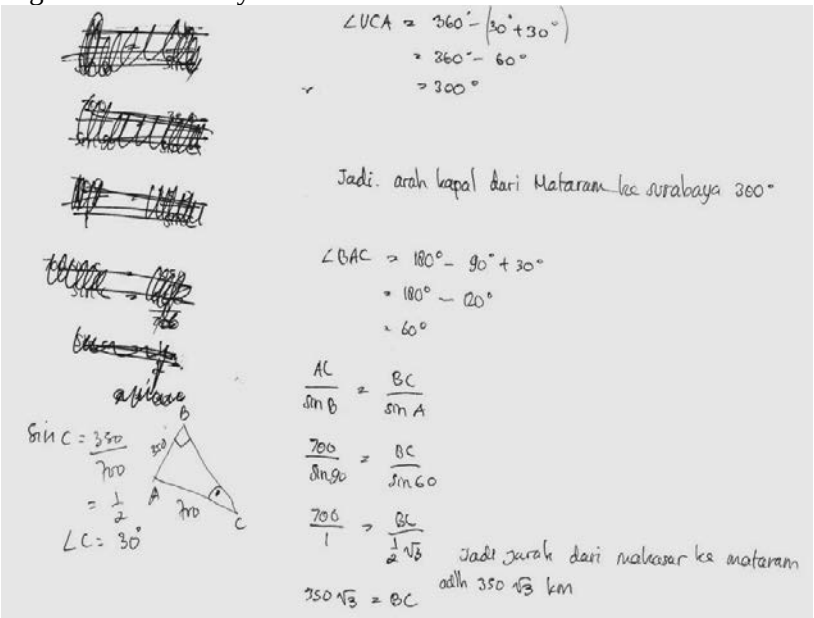

Figure 5. FI2 Answers in Determining Ship Direction

P: "Why do you use sine rules?"
FI2: "Because of that right triangle and already known the length of the two sides".
P: "Why not use another formula?".
FI2: "It's easier to use the formula, ma'am."
P: "How do you look for it?".
FI2: "Same thing, ma'am as before 360º-30º-30 º = 300º".
P: "The reason?"
FI2: "Idem ma ... so the ship's boat from Mataram to Surabaya is 300º ".
Q: "Why for you to use the sine rule to determine BC?"
FI2: "It's easier, mom."
P: "Then how difficult is it?"
FI2: "I don't know, ma'am ...".

FI2 determines the direction of the ship from Mataram to Surabaya by taking the UCA angle by way of 360º-30º-30º = 300º "by reason of using the formula in a circle. In this case, FI2 answers correctly but it also uses an angle symbol in mathematics and can explain the reason for using the formula, so it is a formal type of understanding.

FI2 determines the BAC angle by means of 180º-90º+30º equal to 60º. The BAC angle is used to determine the length of BC. To determine BC, FI2 uses the sine rule, uses a mathematical symbol but cannot explain the reason for using the sine rule. In this case, including the type of instrumental understanding.

From the analysis of the characteristics of understanding of FI2 in solving mathematical problems, there are three types of understanding in solving the first problem, namely formal, relational, and instrumental understanding. But the characteristic of dominant FI2 understanding is formal understanding.

From figure 4 and figure 5 above, showing the types of understanding of independent field students in solving mathematical problems, namely formal, relational, and instrumental understanding. For instrumental and relational understanding only once is generated by independent field students. Instrumental understanding produced by field-independent students has the advantage that students solve math problems more quickly. However, this does not guarantee that independent field students understand what has been done. While understanding relational, independent field students in addition to answering correctly, he understood the reasons for using the concepts and procedures carried out. Instrumental understanding that occurs because the involvement of students in the class only pays attention to the computation done. So in learning the teacher must pay attention to the understanding achieved by students. Less involvement of students in learning mathematics can also cause students to forget quickly what they

have learned. The teacher must guide students intensively to maintain the memories and understanding of students who have been taught, and still be creative in presenting learning so that children do not get bored [17].

For the type of formal understanding produced by independent field students is more dominant This is because independent field students are accustomed to using symbols, formulas, and images in solving mathematical problems in class. This is in accordance with the characteristics of high school students who, according to Piaget, have entered a formal stage in their development. In addition, field-independent students, independent field students can connect one concept to another that is used in solving mathematical problems. Completion by independent field students is also correct.

Another characteristic found is that many concepts are used in solving problems. Moreover, independent field students do not depend on the concepts used at the beginning. This is in accordance with one of the types of understanding expressed by Skemp [14]. Besides that in solving the problem of independent field students do not depend on the initial mathematical concepts used, it is in accordance with Witkin states that field-independent students in responding to an assignment tend to respond to stimulus using their own perceptions, more analytical and analyze patterns based on their components [15]. Henceforth, in learning in the classroom especially for students who have independent field cognitive style more given more complex problem exercises in order to improve the ability to solve mathematical problems.

IV. CONCLUSION

Based on the results of the analysis and discussion of the research data that has been described, the researcher can conclude that the understanding of field-independent students in solving mathematical problems is identifying the known, asked, using strategies by drawing triangles using the three-figure majors concept and can explain the steps used with the concept of the number of angles in a triangle, the number of angular angles, the Pythagorean formula, the cosine rule and the sine rule. The characteristics of understanding independent field students in solving mathematical problems are answering correctly, using mathematical formulas, using symbols or notations in mathematics and being able to explain the reason for the answers, so that the dominant independent field students' understanding that emerges is a type of formal understanding. Based on the research results obtained, the researcher suggests that teachers pay more attention to the selection of learning designs that emphasize understanding of concepts and familiarize students with independent fields as peer tutors in classroom learning.

REFERENCES

[1] A. Muhson, “Upaya peningkatan minat belajar dan pemahaman mahasiswa melalui penerapan problem base learning,” *J. Kependidikan*, vol. 39, no. 2, pp. 171–182, 2009.
[2] J. P. Mairing, “Kemampuan siswa kelas VII dalam memecahkan masalah matematika berdasarkan tingkat akreditasi,” *J. Kependidikan*, vol. 46, no. 2, pp. 179–192, 2016.
[3] A. Prayitno, “Characterization of scaffolding based on the student’s thinking error in solving mathematic problem,” *J. Kependidikan*, vol. 1, no. 1, pp. 50–66, 2017.
[4] S. B. Berenson and G. S. Carter, “Changing assessment practices in science and mathematics,” *Soc. Sci. Math.*, vol. 95, pp. 182–186, 1995.
[5] NCTM, *Curriculum and evaluation standards for school mathematics*. Reston: VA: Author, 1989.
[6] R. Baranes, M. Perry, and J. W. Stigler, “Activation of real-world knowledge in the solution of word problems,” *Cogn. Instr.*, vol. 6, pp. 287–318, 1989.
[7] D. P. Ausubel, “Facilitating meaningful verbal learning in the classroom,” *Arith. Teach.*, vol. 15, pp. 126–132, 1968.
[8] J. Hiebert and T. P. Carpenter, “Learning and teaching with understanding,” in *Handbook of research on mathematics teaching and learning*, D. A. Grouws, Ed. New York: Macmillan, 1992, pp. 65–97.
[9] L. Linchevski and B. Kutscher, “Tell me with whom you’re learning, and I’ll tell you how much you’ve learned: Mixed-ability versus same-ability grouping in mathematics. Some issues in the psychology of mathematics instruction,” *J. Res. Math. Educ.*, vol. 29, pp. 533–554, 1998.
[10] J. Hiebert and T. P. Carpenter, “Handbook of research on mathematics teaching and learning,” in *Learning and teaching with understanding. In D. A. Grouws (Ed.)*, New York: Macmillan, 1992, pp. 65–97.
[11] D. S. N. Afifah, “Onto semiotic approach profile of senior high school student basen on cognitive style in solving statistics problem,” in *International Conference on Mathematics, Science, and Education*, 2016.
[12] Fatqurhohman, “Pemahaman konsep matematika siswa dalam menyelesaikan masalah,” *J. Ilm. Pendidik. Mat.*, vol. 4, no. 2, pp. 127–133, 2015.
[13] G. Polya, *How to Solve it?* Princeton, NJ: Princeton University Press, 1945.

[14] I. C. Jung, “Student representation and understanding of geometric transformation with technology experience,” The university of Georgia, 2002.
[15] I. M. Ardana, “Pengembangan model pembelajaran matematika berwawasan konstruktivis yang berorientasi pada gaya kognitif dan budaya siswa,” Universitas Negeri Surabaya, 2007.
[16] H. Ulya, “Hubungan gaya kognitif dengan kemampuan pemecahan masalah matematika siswa,” *J. Konseling Gusjigang*, vol. 1, no. 2, 2015.
[17] M. M. Aulia and R. Budiyono, “Pengembangan perangkat pembelajaran dengan desain didaktik untuk mengurangi hambatan belajar siswa pada topik segiempat dalam pembelajaran matematika SMP,” *J. Pembelajaran Mat.*, vol. 1, no. 7, pp. 583–592, 2013.