



ANALYSIS OF STUDENTS' COGNITIVE STYLE ACCORDING TO WITKIN IN SOLVING PYTHAGORAS PROBLEMS

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Abstrak

Gaya kognitif adalah cara berpikir siswa yang dilakukan untuk membantu dalam proses pemecahan suatu masalah sesuai dengan pengetahuan maupun pengalamannya. Tujuan penelitian ini adalah untuk menganalisis gaya kognitif siswa menurut Witkin dalam memecahkan masalah Pythagoras. Subjek dalam penelitian ini adalah dua siswa yang masing-masing memenuhi gaya kognitif FI dan FD berdasarkan tes GEFT. Penelitian ini dilaksanakan di kelas VII MTs Nurul Ikhlas Ambon. Metode yang digunakan pada penelitian ini yaitu deskriptif dengan pendekatan kualitatif. Hasil penelitian diperoleh bahwa Siswa FI cenderung menggunakan cara yang berbeda sesuai dengan pengetahuan yang dimiliki dan pemecahan yang dilakukan cenderung tidak terstruktur. Cara yang digunakan siswa FI yaitu cara cepat dalam memecahkan masalah Pythagoras. Selain itu gambar yang dibuat dengan mengacu pada informasi-informasi yang diperoleh dilakukan dengan sederhana sesuai dengan konsep yang dipahami. Sementara untuk siswa FD cenderung menggunakan cara yang sama persis diajarkan guru sebelumnya. Proses pemecahan dilakukan secara terstruktur hingga memperoleh hasil akhir. Cara yang digunakan siswa FD yaitu rumus Pythagoras. Selanjutnya dalam membuat gambar, siswa FD menggambarkan dengan jelas informasi-informasi yang ada pada soal secara detail dan kompleks.

Kata kunci: Gaya Kognitif; Memecahkan Masalah; Pythagoras.

Abstract

Cognitive style is a way of thinking that students use to help solve a problem according to their knowledge and experience. This research aims to analyze students' cognitive styles according to Witkin in solving Pythagorean problems. The subjects in this research were two students, each of whom met the FI and FD cognitive styles based on the GEFT test. This research was carried out in class VII of MTs Nurul Ikhlas Ambon. The method used in this research is descriptive with a qualitative approach. The research results showed that FI students use different methods according to their knowledge, and the solutions they carry out tend to be unstructured. The method FI students use is a fast way to solve Pythagorean problems. Apart from that, the images created by referring to the information obtained are done simply by the concepts understood. Meanwhile, FD students use the same method their previous teacher taught. The solving process is carried out in a structured manner to obtain the final result. The method used by FD students is the Pythagorean



formula. Furthermore, in making pictures, FD students clearly describe the information in the problem in detail and complexly.

Keywords: Cognitive Style; Solve the problem; Pythagoras.

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INTRODUCTION

The Trends in International Mathematics and Science Study (TIMSS) report shows that Indonesia's achievements are far below other Asian countries, where Indonesian students are in 38th position out of 42 countries surveyed. The average international score is 500, the standard deviation is 100, and the Indonesian mathematics score obtained is 379 (Prastyo, 2020; Hendriani et al., 2022; Nurjanah, Sa'dijah, and Susiswo, 2021). Likewise, with the PISA test in the field of mathematics, it was found that Indonesia ranked 64th out of 65 countries surveyed with an average mathematics score of 375 compared to the international standard average of 494 (Tohir, 2019; Kemdikbud, 2019; Munfarikhatin, Pagiling, and Natsir, 2022). Several factors can cause the low TIMSS and PISA results; one is students needing to be used to working on PISA-type questions, which include literacy and higher-order thinking (Meryansumayeka et al., 2021). Apart from that, the variety of students' cognitive styles can be a determining factor in answering non-routine questions (Ilmu et al., 2023).

Non-routine questions require advanced thinking in the solving process (Harahap, 2022). According to Daane (in Suandito, Darmawijoyo, and Purwoko, 2019), these questions encourage logical thinking, increase students' understanding of concepts, develop mathematical reasoning powers, develop abstract thinking abilities, and transfer mathematical abilities to unfamiliar situations. When solving non-routine questions, students' results and processes may differ. According to Afriyati, Roza, and Maimunah (2019), a person's problem-solving ability varies. Students often have to take different ways to solve the same problem. The student's cognitive style influences this.



Cognitive style is a person's processing, storing, and using information to respond to a task or various environmental situations (Istigosah and Noordiyana, 2022). According to Nasution (in Ernaningsih, 2020), specific cognitive styles concerning the teaching and learning process include: (1) field dependent-field independent; (2) impulsive-reflexive; (3) presentive-receptive; and (4) systematic and intuitive. There are many variations in cognitive styles, but the ones that are most popular with educators are field-independent and field-dependent (Witkin et al., 1971). This is what makes researchers interested in analyzing cognitive styles according to Witkin. According to Witkin et al. (1971), students with a field-independent cognitive style can connect new knowledge with the knowledge they already have to reconstruct new information. Furthermore, students with a field-dependent cognitive style find it difficult to connect new knowledge with their existing knowledge, making it challenging to reconstruct new information. Even though there are two groups of different cognitive styles, it cannot be said that field-independent students are better than field-dependent students or vice versa. Students who fall into one type are acceptable, whether good or bad. Each field-independent or field-dependent student has advantages in their field.

Apart from that, both cognitive styles have another characteristic: field independence is more analytical. When faced with a problem, students can choose stimuli based on the situation so that their perception is only slightly affected when there is a change. In contrast to the field-dependent cognitive style, students tend to experience difficulties differentiating stimuli, so their perceptions are easily influenced by manipulation of the surrounding situation (Kaliky, 2018).

In line with research conducted by Ulya (2015), it found that the correlation coefficient between cognitive style and students' problem-solving abilities (r_{XY}) was 0.624, meaning there was a high level of positive relationship between students' cognitive styles and problem-solving abilities. The coefficient of determination value of 0.390 shows that 39% of students' problem-solving abilities are influenced by cognitive style through a linear relationship, while 61% are



influenced by factors other than cognitive style. Similar research was also carried out by Yuliyani and Setyaningsih (2022) was found that students with the field-independent cognitive style can fulfill mathematical literacy skills in the aspects of communication, reasoning, and argument, devising strategies for solving problems, using symbolic, formal, and technical language, and operation, representation. The achievement of mathematical literacy skills from field-dependent students is in communication, reasoning, and argument, using symbolic, formal, and technical language, operation, and representation. The same thing was done by Saputri (2018), who found a significant influence of cognitive style on students' mathematics learning achievement that can be proven by obtaining a Sig value = $0.000 < 0.05$ and a t-count value = 4.607.

Based on similar research that has been carried out, cognitive style plays a critical role in solving a problem. Apart from that, each student's cognitive style has strengths and weaknesses in solving a problem, so that they will get different methods. The basic thing that can differentiate previous research from this research is that the research conducted by Ulya (2015) and Saputri (2018) tended to use a quantitative approach with each sequentially looking at the influence of cognitive style on problem solving and learning achievement. Meanwhile, this research tends to use a qualitative approach to analyze students' cognitive styles. Furthermore, research conducted by Yuliyani and Setyaningsih (2022) tends to analyze the literacy abilities of each student's cognitive style using mathematical literacy indicators

One material that is suitable for use in this research is Pythagoras. Pythagoras is a concept that contains several concepts, including triangles, algebra, and exponents. Students sometimes need these concepts on an ongoing basis to facilitate solving a problem. According to Rudi, et al. (2020), The Pythagorean theorem only applies to right triangles. It was further revealed that the Pythagorean theorem is always found in all mathematics, science and history of science reference



books so students need to understand. Thus, This research aims to analyze students' cognitive styles according to Witkin in solving Pythagorean problems.

METHOD

The method used in this research is descriptive qualitative. Therefore, This research aims to analyze students' cognitive styles according to Witkin in solving Pythagorean problems. The subjects in this research were two students who tended to have FI and FD cognitive styles based on the GEFT test. The conditions for categorizing FI and FD students refer to the test scores obtained. If the score is greater than 9, they are grouped into the FI cognitive style, while scores obtained less than or equal to 9 are grouped into the FD cognitive style. The FI and FD cognitive style indicators can be described in Table 1 below.

Table 1. Cognitive Style Indicators

Variable	Dimensions	Indicator	Student Behavior
Cognitive Style	Field Independent (FI)	a. It tends not to depend on the surrounding environment	a. In solving Pythagorean problems, students tend to rely on their abilities
		b. It is easy to abandon the method that has been taught and tend to use other methods	b. Students can use methods that are rarely taught by teachers in solving Pythagorean problems
		c. It tends to be narrow in concept formation	c. The concepts used by students tend to be very limited
		d. Pay less attention to the differences between observed objects	d. Less able to differentiate objects in the question in the form of information.
	Field Dependent (FD)	a. It tends to depend on the environment	a. In solving Pythagorean problems, students tend to be influenced by the surrounding environment
		b. It tends to be consistent with the method that has been taught	b. Students can use the method usually taught by teachers to solve Pythagorean problems
		c. It tends to be broad in forming concepts	
		d. Tends to pay close attention to differences between observed objects	



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- c. The concepts used by students tend to be very broad
 - d. Able to distinguish the objects in the question in the form of information
-

The instruments used consist of the main instrument in the form of the researcher himself and supporting instruments in the form of test question sheets and interview guides. Next, qualitative data analysis techniques, according to Miles and Huberman (in Rezkia, 2020), consist of three components, namely data reduction, data presentation, and conclusion.

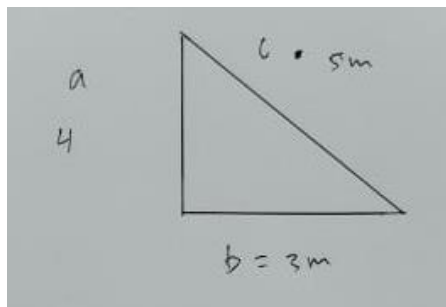
RESULT AND DISCUSSION

This research was conducted in class VII of MTs Nurul Ikhlas Ambon by first identifying students' cognitive styles by administering the GEFT test. The results of the GEFT test on 17 students were obtained by six students with the FD cognitive style and 11 with the FI cognitive style. Next, the researcher took each person as a representative from the two groups of cognitive styles based on the test results concerning the characteristics of the cognitive style that emerged when solving the given problem. The two students are initially with ML and CK. The exposure of the two subjects can be explained as follows.

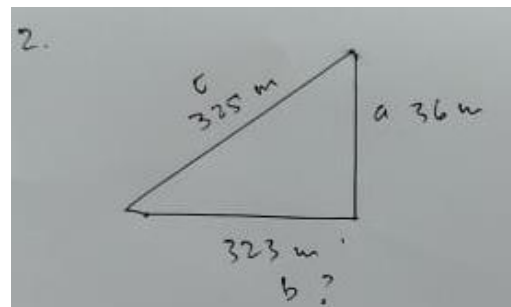
a. Exposure to FI Cognitive-style ML Subject Data

The problem-solving process carried out by students usually begins by first reading the problem given. In reading the questions, the ML subject is very careful and thorough, shown by paying attention so that the information can be understood and remembered well. It follows the activities carried out by ML after reading the questions, as shown in Figure 1 below.





Problem number 1



Problem number 2

Figure 1. Information Transformation

Based on Figure 1, the ML subject appears to change the information obtained from the questions in the images. The image created by the subject forms a right triangle. It is done to make it easier for ML subjects to find the final solution: the value of a or the front side of the angle in question no. 1 and the value of b or the side near the angle in question no. 2. Apart from that, the drawings made by the subject are simple, and the subject gives symbols a , b , and c to represent the sides of the triangle.

This follows the subject's statement: "*When solving problems related to Pythagoras, I usually make pictures from the existing information to make it easier to find the side being asked.*" In line with Gagne's opinion (in Zunidar, 2017) that in the learning process, children transform from input in the form of information to output in the form of images. According to Woolfolk (in Kusaeri, 2018; Yusnaini, 2021), information transformation occurs, starting with processing, entering, and performing various operations on the information to change its form. According to Slavin (in Asmendri and Sari, 2018), this condition is because of the mind's processing, storing, and retrieving knowledge.

After the subject carries out the information transformation process, the next step is decision-making in solving the problem. In making decisions, ML subjects immediately apply formulas that are understood based on their knowledge. The results of solving the subject can be displayed in Figure 2 below.



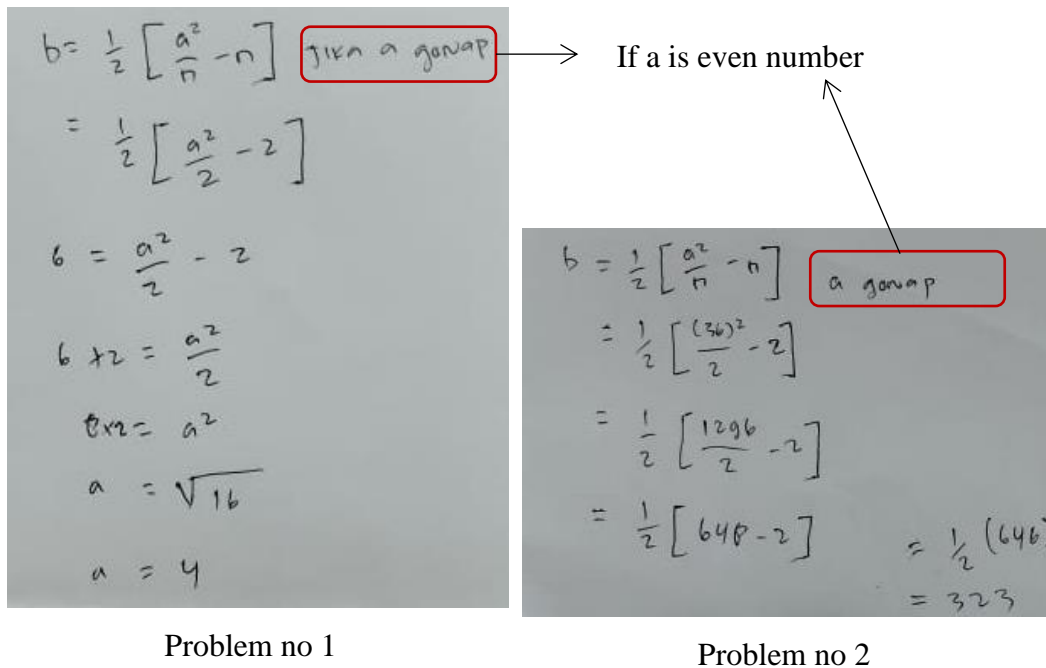


Figure 2. Solution to Problem

Based on Figure 2, the ML subject in answering the problem did not use the Pythagorean formula as taught by the teacher or the habit of most students in solving it. ML subjects tend to use formulas they understand in solving Pythagorean problems. It follows the ML subject's statement: *"The formula I use is a fast formula for solving Pythagorean problems."* The researcher then followed up with a question, namely, *"Where did you know this fast method? Did a teacher teach it?"* subject ML then said that *"the formula used was obtained based on the results of his reading through learning videos on YouTube or in practical learning books."* Furthermore, subject ML said, *"In classroom learning, teachers usually use the Pythagorean formula and do not use the fast formula."* It shows that ML subjects who solve Pythagorean problems tend to rely on their abilities. ML subjects do not need guidance from teachers or friends because the basic knowledge of the concepts taught has been studied by ML subjects previously. According to Nugraha and Awalliyah (2016), someone with FI characteristics will try to find more information outside the content that has been studied. Apart from that, FI individuals prefer non-



linear solutions and perceive themselves as not influenced by the environment (Nurmalia, Yuhana, and Fatah, 2019).

To apply the formula used by ML subjects, the researcher further explored it through a follow-up question, namely, *"Are there any special requirements for using this formula?"* Subject ML then said that *"in using the formula $b = \frac{1}{2} \left[\frac{a^2}{n} - n \right]$. There is a condition that needs to be considered, namely if a is even, then side b or the side under the corner is added by 2 to get the hypotenuse value. However, if the value of a is odd, then the value of b will be added by 1 to get the hypotenuse value".* ML subject information shows that subjects tend to be able to use their methods, which are rarely taught by teachers in solving Pythagorean problems. It follows the results of research conducted by Handayani and Rahaju (2018) that field-independent students in solving mathematics problems tend to use their own methods, not relying on examples of problems given by the teacher or problems they have worked on before. In line with this opinion, Nurdin (in Mailili, 2016) suggests that people with a field-independent cognitive style tend to respond using their perceptions. The different method used by field-independent students is due to the pleasure of preferring to study individually. Students with this cognitive style can respond better and are more independent Slameto (in Nurmalia, Yuhana, and Fatah, 2019).

Apart from that, the subject of ML in solving problems, given the concepts used, is minimal. The concept used by ML subjects is only a quick formula that is applied to get the desired side. It is under the work of the ML subject, including in solving problem number 1; the ML subject looks for the value of a or the vertical side using the formula previously stated. The results obtained are the value $a = 4$ m. Similarly to problem number 2, ML subjects can find the value of b by substituting the value of a in the formula with the value $n = 2$. The result obtained is the value of $b = 323$ m. Suppose researchers observe the process carried out in both questions. In that case, it appears to be the relationship between the hypotenuse and the side under the angle or side b , where the hypotenuse is obtained from the value of the



side under the angle or b added to 2. The condition for side b to be added to 2 is because the front side of the angle or side a is an even number. This condition shows what the ML subject previously expressed.

After completing the given problem to obtain the final result, the ML subject concludes the problem. The conclusions ML subjects can make are shown in Figure 3 below.

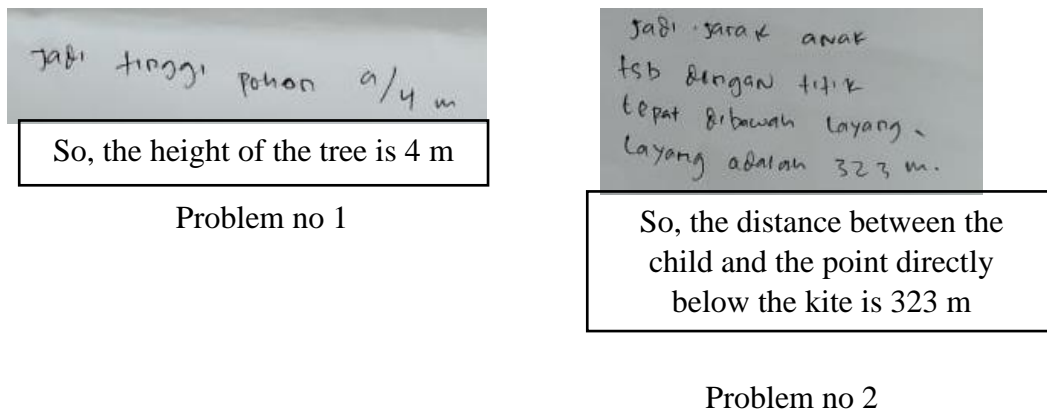


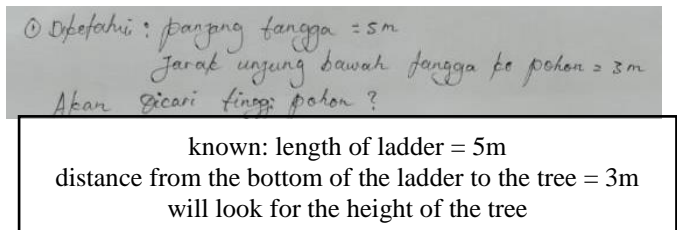
Figure 3. Make Conclusions

Figure 3 shows that the ML subject can conclude correctly. In conclusion, the ML subject changes the form of symbols previously exemplified at the information transformation stage into sentence form based on the problem being asked. It is in line with the information on the subject of ML, namely "because what will be looked for in problem number 1 is the height of the tree, where the initial example I did was by taking the height of the tree as a to make it easier to apply the formula so that when concluding, it can automatically be returned to its original form according to what was asked. Similarly, with problem number 2, what was asked was the distance between the child on the ground and the point directly under the kite. Hence, the conclusion was to return the symbol to the form of the initial problem". It shows that the ML subject has reflected on the completion process that has been carried out so that he can write the conclusion correctly. It follows Vendiagrys' opinion (in Lambertus, Kodirun, and Busnawir, 2020; Siahaan, Dewi, and Said, 2019) that field-independent subjects in solving problems can obtain the correct answer.



b. Exposure to CK subject data with FD cognitive style

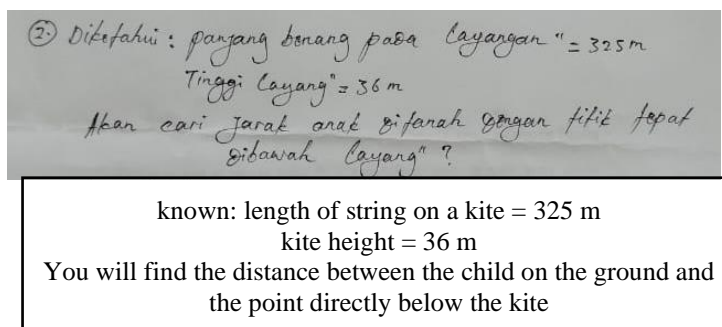
Understanding the problem is an important thing that students must do and is the initial stage after reading the questions given. After reading the problem, it appeared that CK subjects understood the problem given. It can be seen in the following fragment of the subject's work.



① Diketahui: panjang tangga = 5m
Jarak ujung bawah tangga ke pohon = 3m
Akan dicari tinggi pohon?

known: length of ladder = 5m
distance from the bottom of the ladder to the tree = 3m
will look for the height of the tree

Problem no1



② Diketahui: panjang benang pada layangan = 325m
Tinggi layangan = 36m
Akan cari jarak anak diantara gonggan titik tepat dibawah layangan?

known: length of string on a kite = 325 m
kite height = 36 m
You will find the distance between the child on the ground and the point directly below the kite

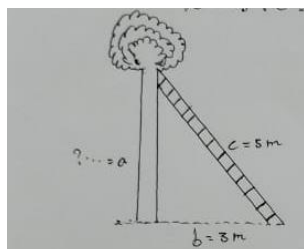
Problem no 2

Figure 4. Understand the Problem

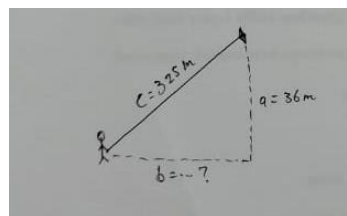
Based on Figure 4, subject CK wrote down all the information obtained carefully and entirely for problem number 1 and number 2. The information written by subject CK was known or asked about the problem. According to Ngilawajan (in Sekarsari, Zuhri, and Ariyanto, 2021), individuals who have a field dependent cognitive style tend to find it difficult to separate information and are not selective in absorbing information. In line with the opinions of Istiqomah and Rahayu (in Wijaya, 2020), someone with a field-dependent cognitive style prefers to receive information globally. Its conclusion means that whatever is contained in the problem will be written clearly, regardless of the sentence in the problem.



After writing down all the information on the problem, the CK subject then transformed the information obtained into an image. It can be shown in Figure 5 below.



Problem no 1



Problem no 2

Figure 5. Information Transformation

Figure 5 shows that subject CK transformed information from sentence form into image form very clearly. In the picture of problem number 1, subject CK depicts trees and stairs according to the instructions in the problem. Likewise with problem number 2, subject CK also clearly described the shape of a human and a kite. It is Desmita (2012) opinion, that the learning characteristics of students who have a field-dependent cognitive style tend to accept the concepts given and have difficulty reorganizing them. Apart from that, the subject also made symbols as replacements for each side to make it easier to complete. Under the student's expression during the interview, "*I usually solve problems if the question leads to an image, so I prefer to make the image first so that it is easier to substitute in the formula.*" Next, the researcher explored this through the question, namely, "*How can you make such detailed drawings?*" subject CK then revealed that "*because the question tells about a tree and a ladder that is propped up, so when I drew it I adjusted it to the storyline in question number 1 so I did not make a mistake.*" "*Question number 2 is also the same; in the question about a child playing with a kite, I drew a picture according to the story in the question so that it was clear and there was no mistake in writing down the known numbers.*"

Based on student information, it shows that CK subjects tend to be influenced by the surrounding environment, which presents problems. CK subjects are attached to the information obtained and explore their role in the problem, so



they do so in detail when creating images. It is under the characteristics of students with a field-dependent cognitive style: When solving a problem, they tend to focus on the general picture and only follow existing information (Nugraha & Awalliyah, 2016).

After transforming the information into image form, the CK subject continues problem-solving. The solution process begins with writing a formula and then substituting the information in the formula to get the final result. Its formula is shown in Figure 6 below.

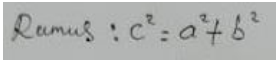
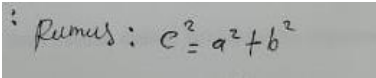
	
Problem no 1	Problem no 2

Figure 6. Formula

In Figure 6, it can be seen that subject CK started the solution by writing the formula first. The formula written by the subject refers to the Pythagorean formula. It applies to both problems where the Pythagorean formula is symbolized by a, b, and c based on the Pythagorean definition. Witkin et al. (1975) stated that field-dependent students needed help to choose different strategies that would be used to solve problems, so they tended to use the method usually taught by the teacher. The researcher then interviewed to explore the subject with the question, "How did you find this formula?". Subject CK then answered, "I saw that the picture I made turned out to be a right triangle, so I used the Pythagorean formula with the symbols that I used." The researcher then continued with the question, "What is the basis for your writing the Pythagorean formula like that?". Subject CK continued to answer, "I am referring to the Pythagorean sound taught by the teacher, namely the sum of the square of the upright side and the square of the side near the corner is equal to the square of the hypotenuse." In line with Witkin et al. (1975) opinion, that field dependent students will work better if given extra or more instructions or guidance.

After writing the formula, subject CK continued with the problem-solving process. It looks like Figure 7 below.



$$\begin{aligned}5^2 &= a^2 + b^2 \\25 &= a^2 + 9 \\25 - 9 &= a^2 \\a^2 &= 16 \\a &= \sqrt{16} \\a &= 4\end{aligned}$$

Problem no 1

$$\begin{aligned}c^2 &= a^2 + b^2 \\(325)^2 &= (36)^2 + b^2 \\105.625 &= (1296)^2 + b^2 \\105.625 - 1296 &= b^2 \\104.329 &= b^2 \\b &= \sqrt{104.329} \\b &= 323\end{aligned}$$

Problem no 2

Figure 7. Problem-solving

Based on Figure 7, CK can solve the problem very well for the two questions. The CK subject appears to substitute all the information in the problem into the formula for use. Through the operation process, obtain the correct final results. It contradicts the opinion of Vendiagrays, Junaedi, and Masrukan (2015) that field-dependent students solving problems sometimes need help to get the correct answer. The researcher then confirmed through interviews, namely, "*Is there another way that can be used to solve this problem?*". Subject CK then answered: "I only know that way, namely using the Pythagorean formula. This method is also what teachers usually use when teaching Pythagorean material." In line with the opinion of Haloho (2016) that students with a field-dependent cognitive style are also very dependent on sources of information from the teacher. When given a problem, students with a field-dependent cognitive style tend to use methods or methods that have been established, studied, or known previously and require more explicit instructions in solving the problem. It shows that the concepts used by CK subjects must be broad, including Pythagorean concepts, right triangle concepts, and algebraic concepts.

The next step after obtaining the final results is concluding. This step is significant for students to ensure that the answers obtained are correct so that decisions can be made. The conclusions drawn by subject CK can be presented in Figure 8 below.



Jadi tinggi pohon adalah 4m

so the height of the tree is 4 m

Problem no 1

Jadi jarak anak tersebut dengan
titik tepat di bawah layang" = 323 m

So, the distance between the child and the point
directly below the kite = 323

Problem no 2

Figure 8. Make Conclusions

Figure 8 shows that CK subjects can make conclusions about the problems given correctly. The conclusion drawn by subject CK refers to the reflection process of Putra et al. (2021), which is carried out through the activity of reviewing the overall completion that has been carried out. It is under the interview activities carried out by researchers through the question: "*Are you sure about the final results obtained?*". Subject CK stated, "*I am confident in the results obtained because I have reviewed my solutions.*"

CONCLUSION

Based on the research and discussion results, students with field-independent and field-dependent cognitive styles in solving problems tend to have different ways. Field-independent students use different methods according to their knowledge, and their solutions tend to be unstructured. The method used by field-independent students is a fast way to solve Pythagorean problems. Apart from that, the images created by referring to the information obtained are done simply by the concepts understood. Meanwhile, field-dependent students use the same method their previous teacher taught. The solving process is carried out in a structured



manner to obtain the final result. The method used by field-dependent students is the Pythagorean formula. Furthermore, in making pictures, field-dependent students clearly describe the information in the problem in detail and complexly.

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