ISSN 2303-0992
ISSN online 2621-3176
Matematika dan Pembelajaran
Volume 10, No. 2, December 2022, h. 140-156
Submitted: July 2, 2022; **Revised**: December 19, 2022; **Accepted**: December 30, 2022

STUDENTS' REFLECTIVE ABSTRACTION LEVEL IN SOLVING MATHEMATICS PROBLEMS BASED ON COGNITIVE STYLES FIELD INDEPENDENT (FI) AND FIELD INDEPENDENT (FD)

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Abstrak

Abstraksi reflektif merupakan aktivitas mengambil kesamaan-kesamaan yang ada untuk membangun konsep matematika dengan menggunakan koordinasi, operasi dan relasi dari struktur-struktur yang telah dibangun dan direorganisasikan yang mencakup 4 level yaitu pengenalan, representasi, abstraksi struktural, dan kesadaran struktural. Masing-masing individu mempunyai gaya kognitif yang berbeda dalam mengolah informasi yang berpengaruh terhadap kemampuan dalam memahami masalah. Penelitian ini bertujuan untuk mendeskripsikan tingkat abstraksi reflektif siswa dalam menyelesaikan masalah matematika ditinjau dari gaya kognitif *field independent* (FI) dan *field dependent* (FD). Penelitian ini merupakan penelitian deskriptif kualitatif. Teknik pengumpulan data dilakukan dengan wawancara berbasis tugas. Hasil penelitian diperoleh bahwa siswa dengan gaya kognitif FI dalam memecahkan masalah matematika dapat melakukan semua tingkatan abstraksi reflektif (4 level), sedangkan siswa dengan gaya kognitif FD hanya dapat melakukan 2 level abstraksi reflektif yaitu pengenalan dan representasi saja.

Kata kunci: Abstraksi reflektif; Gaya kognitif; *Field independent; Field dependent*

Abstract

Reflective abstraction is an activity to construct mathematical concepts through similarities and combinations of existing structures and reorganized into four levels: (1) recognition, (2) representation, (3) structural abstraction, and (4) structural awareness. Each individual has different characteristics of cognitive style in processing information. Differences in cognitive style affect the individual's ability to understand the problem. This study aims to describe students' level of reflective abstraction in solving mathematical problems in terms of field-independent (FI) and field-dependent (FD) cognitive styles. This research is a qualitative descriptive study. Task-based interviews carried out the data collection technique. The results are that field-independent (FI) students can correctly perform all levels of reflective abstraction in the stages of solving mathematical problems, but field-dependent (FD) students can only do abstraction on the introduction and representation.

Keywords: Reflective abstraction; Cognitive style; Field independent; Field dependent

Citation: Yanti, A. W. Arrifadah, Y. and Mustikarini, A. A. 2022. Students' Reflective Abstraction Level in Solving Mathematics Problems Based on Cognitive Styles field Independent (FI) and Field Independent (FD). *Matematika dan Pembelajaran*, 10(2), 140-156. DOI: http://dx.doi.org/10.33477/mp.v10i2.2968

INTRODUCTION

Problem solving as an important part of the mathematics learning process that can develop aspects of mathematical abilities such as better generalization of patterns (Haryati et al., 2017). Mathematical problem-solving ability is a high-level thinking ability that includes the ability to construct, understand ideas, analogy, mathematical communication, generalize logical reasoning, and associate mathematical ideas with other intellectual activities, where these abilities are mathematical powers that must be possessed by students (Diputera, 2019).

Students can improve their ability to solve mathematical problems if the student has multiple abilities (Umar, 2016). One of these multi-abilities is the abstraction ability that is needed in mathematics education (Merliza, 2016). So the ability to abstraction is the ability to bring a problem into a mathematical model.

Abstraction as a process of mental action that is influenced by mental concepts is divided into 3 types of abstraction, namely empirical abstraction as an abstraction that focuses on the methods used by students in constructing the meaning of object properties, empirical-false abstraction (pseudo-empirical abstraction) as an abstraction that focuses the methods used by students in constructing, as well as reflective abstraction as an abstraction that focuses on thinking or assimilation carried out by students (Wiryanto, 2014). Whereas according to (Fuady, 2016), reflective abstraction as an abstraction used in the thinking of higher mathematical logic.

Reflective abstraction consists of 4 levels. The first level is recognition, the second level is representation, the third level is structural abstraction, the fourth level is structural awareness (Fuady et al., 2019; Hong & Kim, 2016). These levels of reflective abstraction are special levels because these levels are stages that can be used to identify and describe problem solvers when carrying out problem-solving activities on certain concepts (Wiryanto, 2014).

Students in the problem do activities to analyze the problem and adapt it to the data that already exists in their memory to obtain a solution to the problem (Mawardi et al., 2020). Each student has a different way of compiling and digesting the data they already have, whereone of them is because of the differences in cognitive styles possessed by students. Differences in cognitive styles have a huge influence on students' knowledge.

According to Zagoto et al.(2019), the cognitive style of the individual as one of the characters is very important and influential in achieving learning outcomes. Whereas according to (Sarnoto, 2021), cognitive styles can explain how individuals learn and characterize each individual through their own way of doing so. Cognitive styles are closely related to how all information is received and processed during the learning process. Each individual tends to choose his preferred method of processing information in response to environmental stimuli. Cognitive styles that are influenced by the use and processing of information using the learning environment are field-dependent (FD) and field-independent (FI) cognitive styles.

Cognitive style FI as a characteristic of individuals who tend to be able to read things related to known problems and be able to identify previous activities related to a given problem as well as already being able to do interiorization well, the cognitive style FD as a characteristic of individuals who have a tendency to not be able to identify previous activities with a given problem and easily influenced by the manipulation of disturbing elements (Yanti et al., 2021). Cognitive styles can affect students' ability to solve problems. Students need reflective abstraction activities when solving a problem because the result of student reflective abstraction is a process used for understanding and problem solving (Fuady, 2016).

The results of research conducted by Fuady (Fuady, 2016), on reflective abstraction in terms of field dependent and field independent cognitive styles show that students with field independent cognitive styles on the interiorization component are able to read things related to known problems and can identify previous activities related to a given problem. interiorization well, whereas the cognitive style of field dependent on the interiorization component has not been able to identify previous activities with a given problem. The research conducted by Fuady refers to the

components of interiorization, coordination, encapsulation, and generalization. Research on previous reflective abstractions has also been carried out by Djasuli (Djasuli, 2017), entitled Student's Reflective Abstraction in Solving Number Sequence Problem, the results of the study show that problem-solving strategies are not directly proportional to the level of reflective abstraction of students. If Fuady's research refers to the reflective abstraction component, Djasuli's research refers to the level of reflective abstraction. In this study, researchers are more interested in the level of reflective abstraction, because these levels are a stage to identify and describe problemsolvers on certain concepts when carrying out problem-solving activities researchers are also interested in differences in cognitive styles because students with different cognitive styles will produce ways of processing information and selection of strategies in problem solving, so researchers want to Researching Reflective Abstraction Students refers to the levels of reflective abstraction based on differences in the way information is processed and the selection of strategies in problem solving. The difference between the research that the researcher will take with Fuady is that if Fuady's research refers to the reflective abstraction component, this research will refer to the level of reflective abstraction. Meanwhile, the difference between this study and Djasuli is the way the subject is taken. If Djasuli's research took Djasuli randomly, this study used field independent and field dependent cognitive style classification.

Thus, this study aims to describe the abstraction of students'reflexes with field-independent (FI) and field-dependent (FD) cognitive styles in solving mathematical problems.

METHOD

This research is a qualitative descriptive research. This research was conducted at SMAN 1 Tarik Sidoarjo. The subjects in the study were 2 students who had a cognitive style of FI and 2 students who had a cognitive style of FD obtained based on the results of the Group Embeded Figure Test (GEFT) test by taking the 2 best scores from each of the cognitive styles of FI and FD.

The selected student being the subject of the study is presented in the following table 1.

Table 1. List of Research Subjects

No	Subject Initials	Subject Type	Subject Code	GEFT Test Scores
1	MYA	BE	Subject FI_1	13
2	TW	BE	Subject FI_2	11
3	DIS	FD	Subject FD_1	9
4	YSR	FD	Subject FD_2	9

The indicators of the stages of the solution at the level of reflective abstraction used in this study are presented in the following table 2.

Table 2. Indicators of The Stages of The Solution at The Level of Reflective Abstraction

Reflective Abstraction Level	Solution Stages	Subject Solution Indicators
Recognition	Observing/recognizing patterns	Write one or more numbers later
	Planning actions from observed patterns	Writing number codes
		Create a pattern from a new number
Representation	Designing strategies through new patterns	Writing patterns into symbols
		Change the old pattern to the new one
	Take action based on a strategy that has been created	Writing a new symbol
		Define a symbol from some pattern or symbol
Structural Abstraction	Modeling action into a new concept	Writing patterns into concepts
		Defining concepts into new variables
		Writing conditions from the definition of the concept
Structural Awareness	Summing up a new concept as a formal form	Summing up decisions from phenomena verbally
		Determining the mathematical form of the nth term
	Checking the correctness of tribal validity	Test validation for any n-n

The researchwas taken based on the results of the GEFT (Group Embedded Figures Test) test which This test was adopted from Almubarrok's research which originated from Witkin's findings and has been revalidated by psychologists. The

GEFT test sheet is a test adopted from Bilqis Azizah which originated from the development of Witkin which contains commands to remove simple images in complex images and this test is used to determine the cognitive style of students who are cognitively field dependent or students who are cognitively field independent. If students can answer 10-18 questions, then the students are grouped in a field independent cognitive style, while students who only answer less than 10 questions, then the students are grouped in a dependent field cognitive style.

The research procedure used includes 3 stages, namely the preparation stage, the implementation stage, and the final stage. Data collection techniques were carried out using problem-solving tests (TPM) on number row materials and task line interviews. The instruments used in this study were problem-solving test sheets, and interview guidelines.

The problem-solving task (TPM) given to students to find out the level of reflective abstraction of students on the material of the row of numbers, the TPM questions given are as follows:

Given a row of numbers :$1, 2, 1, 4, 1, 6, \ldots$. From the above row, specify: (a) The next number and (b) The formula of the to- tribal . n

The analysis of problem solving test (TPM) data in this study is not in the form of scores obtained from the work of students because the data analyzed is qualitative data. The results of the analysis are in the form of images or descriptions of reflective abstractions of students in solving mathematical problems distinguished based on field dependent and field independent cognitive styles.

Analisis data interview reflective abstraction test using theories from Huberman and Miles, which include data reduction steps, data presentation, and finally Figureing conclusions. This study used source triangulation to test the validity of the data. If the results of this triangulation indicate a data match between sources, valid data will be obtained. If the data tends to be different, it requires a third source in order to find many similarities between these sources in order for the data to be valid.

RESULT AND DISCUSSION

The data presented are data obtained from research conducted on 2 subjects who have FI and FD cognitive styles. Subjects were given a written test to find out their reflective abstractions. After the subjects have completed the problem-solving test, interviews are then conducted with each of the research subjects.

Description of Data Subject FI_1

Recognation

Written answer to the subject of FI_1 presented the following:

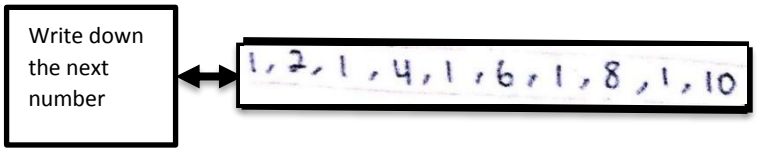

Figure 1. Problem Solving Task Answers (a) subject FI_1

Level Representation

Written answer to the subject of FI_1 presented the following:

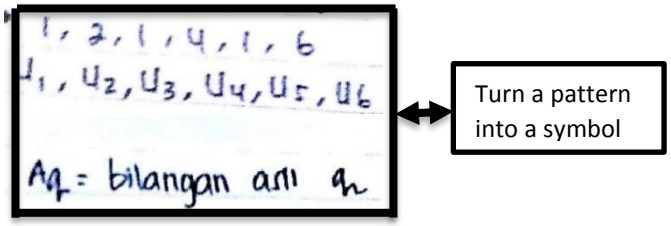

Figure 2. Problem Solving Task Answers (b) subject FI_1

Level of Structural Abstraction

The written answer to subject FI_1 is presented as follows:

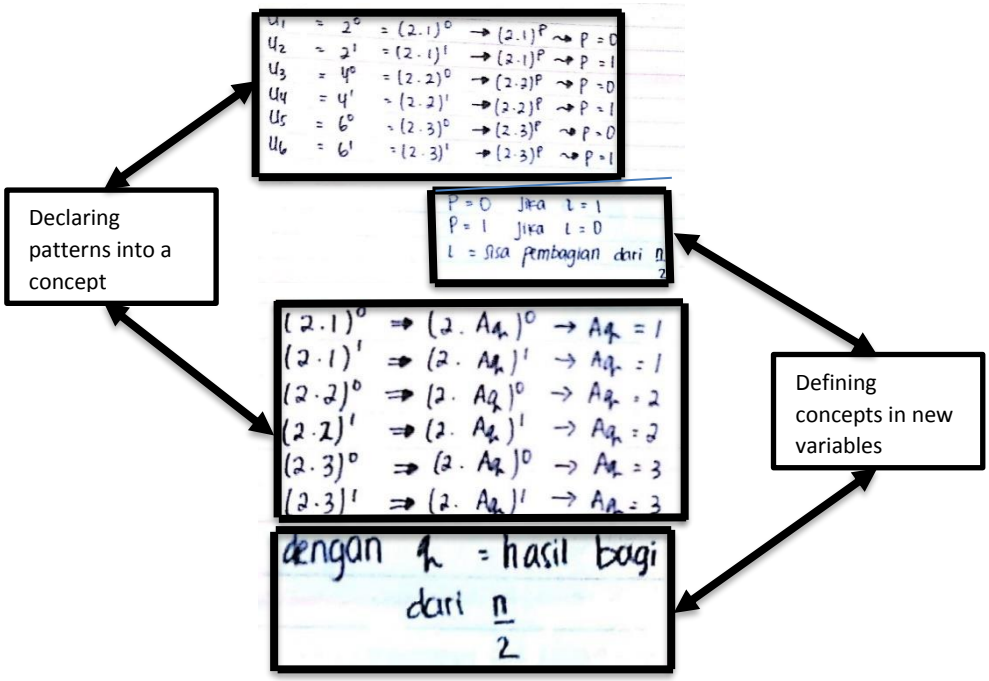

Figure 3. Problem Solving Task Answers (b) Subject FI_1

Structural Awareness Level

The written answer to subject FI_1 is presented as follows:

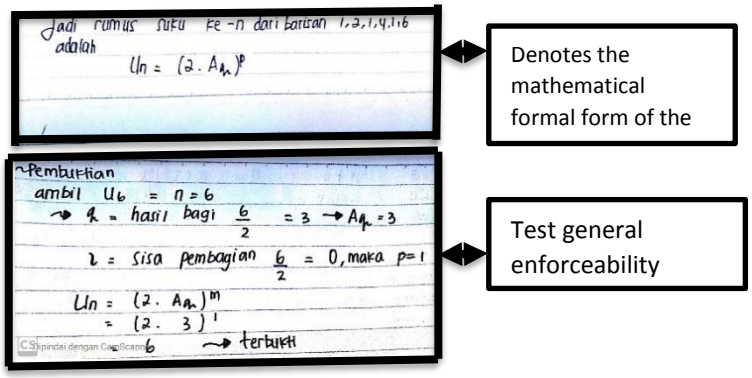

Figure 4. Problem Solving Task Answers (b) Subject FI_1

Description of Data Subject FI_2

Recognation

The written answer to subject FI_2 is presented as follows:

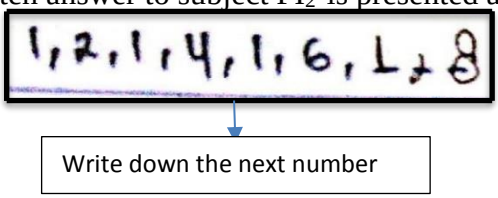

Figure 5. Problem Solving Task Answers (a) Subject FI_2

Level Representation

Written answer to the subject of FI_2 presented the following:

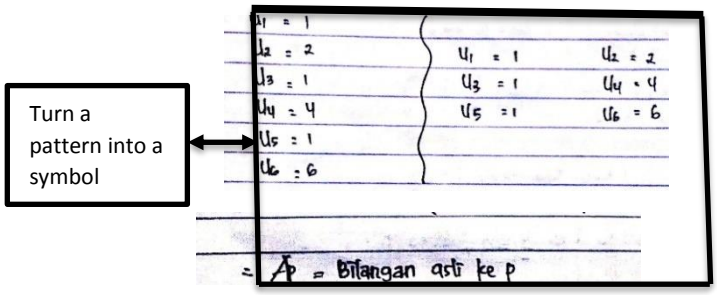

Figure 6. Problem Solving Task Answers (b) Subject FI_2

Level of Structural Abstraction

Written answer to the subject of FI_2 presented the following:

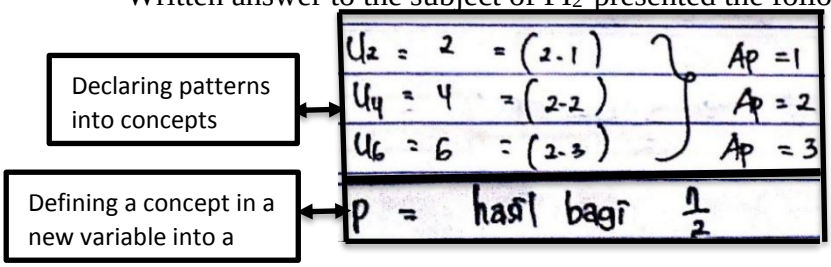

Figure 7. Problem Solving Task Answers (b) Subject FI_2

Structural Awareness Level

The written answer to subject FI_2 is presented as follows:

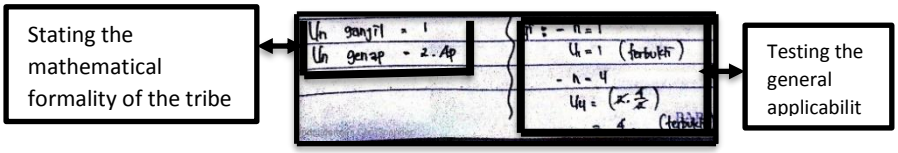

Figure 8. Problem Solving Task Answers (b) subject FI

Data level reflective abstraction of subjects who have a cognitive style of FI in solving problems as in Table 3 below.

Table 3. Subject Reflective Abstraction Levels FI_1 and FI_2 in Solving Math Problems

Reflective Abstraction Level	Solution Stages	Reflective Abstraction of the Subject	
		FI_1	FI_2
Recognition	Observe patterns in depth. Planning action on number patterns.	Able to write down the numbers afterwards correctly.	Able to write down the next number.
		The subject of FI meets the level of recognition that is to write down the next number correctly.	
Representation	Designing strategies through new patterns.	Able to write down patterns with symbols.	Able to express patterns with symbols. Able to achieve indicators expressing new patterns.
	Realizing strategies.	Able to express symbols over multiple symbols or patterns.	Able to express a symbol over some symbol or pattern.
		The subject of FI meets the level of representation that is able to express a pattern with a symbol and express a symbol over some symbol or pattern.	
Structural Abstraction	Stating a new concept.	Able to express patterns into a concept. Able to define concepts in a new variable.	Able to express patterns into a concept. Able to define concepts in a new variable.
		The subject of FI meets the level of structural abstraction, which is able to express patterns into a concept and define concepts in a new variable, although the concepts and variables used are different, but students' definitions of concepts and variables are well conveyed.	
Structural Awareness	Summing up new concepts into formal forms.	Able to express the mathematical formal form of the ke- .n	Able to express the mathematical formal form of the ke- .n

	Test validation of the form pattern formed.	Able to test validation for any .n	Able to test the general applicability of formal forms for any .n
		The subject of FI meets the level of structural awareness that is able to state the mathematical model of the tribe to- and test validation for any . The nth tribal formula nn inferred by the two students is different, but both are able to test the truth and validity for any -n correctly.	

Description of Data Subject FD_1

Recognition Level

Written answer to the subject of FD_1 presented the following:

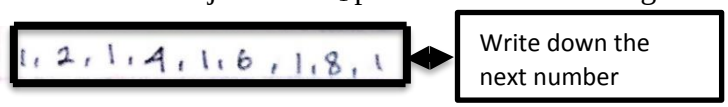

Figure 9. Troubleshooting Task Answers (a) Subject FD_1

Level Representation

The written answer to subject FD_1 is presented as follows:

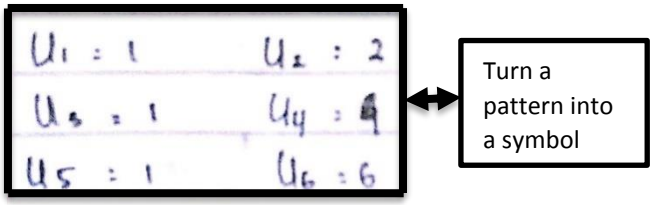

Figure 10. Problem Solving Task Answers (b) Subject FD_1

Level of Structural Abstraction

The written answer to subject FD_1 is presented as follows:

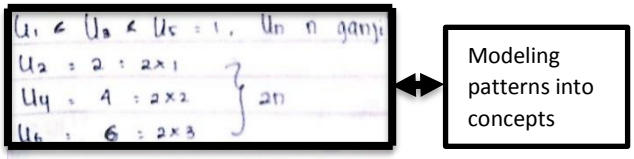

Figure 11. Problem-Solving Task Answers (b) subject FD_1

Structural Awareness Level

The written answer to subject FD_1 is presented as follows:

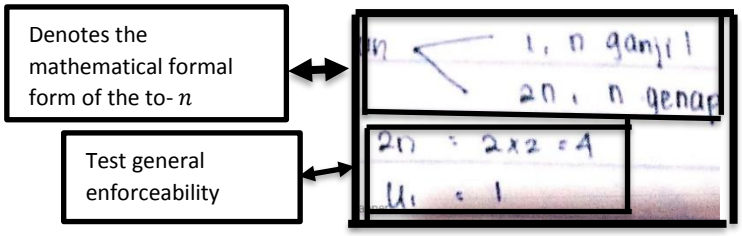

Figure 12. Problem Solving Task Answers (b) Subject FD_1

Description of Data Subject FD_2

Recognition Level

Written answer to the subject of FD_2 presented the following:

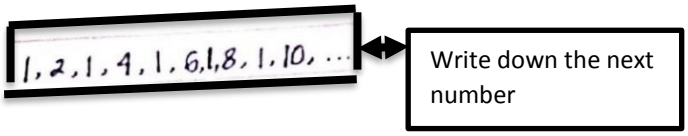

Figure 13. Problem-Solving Task Answers (a) Subject FD_2

Level Representation

Written answer to the subject of FD_2 presented the following:

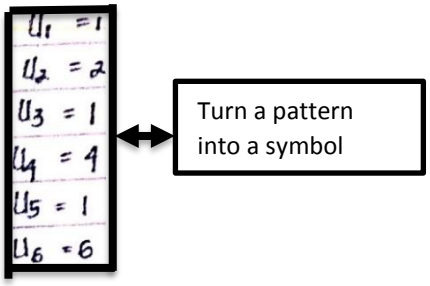

Figure 14. Problem Solving Task Answers (b) Subject FD_2

Level of Structural Abstraction

The written answer to the subject of FD_2 is presented as follows:

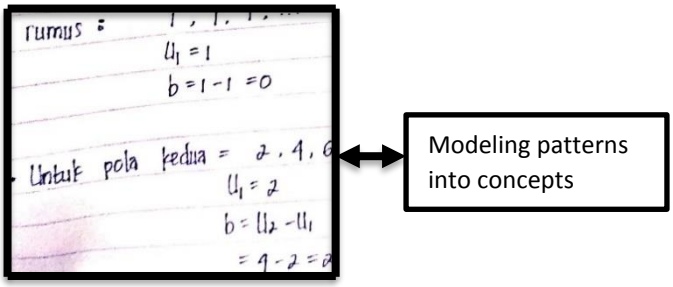

Figure 15. Problem-Solving Task Answers (b) subject FD_2

Structural Awareness Level

Written answer to the subject of FD_2 presented the following:

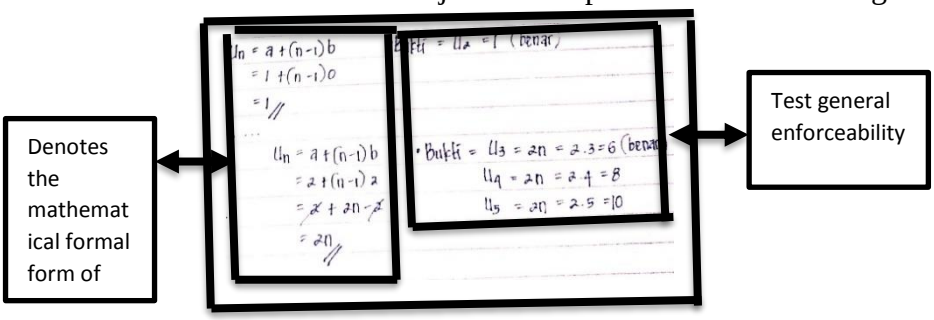

Figure 16. Problem Solving Task Answers (b) Subject FD_2

Data on the level of reflective abstraction of subjects who have the FD cognitive style of solving problems as shown in Table 4 below.

Table 4. Subject Reflective Abstraction Levels FD $_1$ and FD_2 in Solving Math Problems

Reflective Abstraction Level	Solution Stages	Reflective Abstraction of the Subject FD_1	FD_2
Recognition	Observe patterns in depth Planning action on number patterns.	Able to write down the next number. The subject of FD meets the level of recognition that is to write down the next number correctly.	Able to write down the next number.

Representation	Designing strategies through new patterns. Realizing a strategy in an action.	Able to express patterns with symbols.	Able to express patterns with symbols.
		FD subjects are able to meet the level of representation, namely being able to express patterns with symbols and being able to achieve indicators stating a symbol over several symbols or patterns.	
Structural Abstraction	Stating a new concept.	Students write down patterns into a concept, and the concepts written are not quite right, so the final answer is affected.	Students write down patterns into a concept, but the concepts written are not quite right, resulting in the final answer being affected.
		FD subjects are unable to meet the level of structural abstraction.	
Structural Awareness	Summing up new concepts into formal forms.	Incapable of declaring mathematical models of the ke-tribe tribe.n	Incapable of declaring mathematical models of the ke-tribe tribe.n
	Test validation of the form pattern formed.	Unable to test validity for any .n	Incapable of testing the general applicability of formal forms for any .n
		The subject of FD is not able to meet the level of abstraction of stru k tural, so the subject of FD is also incapable of meeting the level of consciousness of struktural because it is easy to be fooled by the environment so that the mathematical model or formulation of the nth sukuk formed is wrong.	

The subject of FI is able to continue the number pattern correctly as well as confidently. This means that theFI project is able to surpass the recognition level well, according to dengan Fuady et al. (2019) that students who have an FI style are able to read problems well than already known.

The subject of FI is also able to make the pattern of numbers into a mathematical form with several symbols written. Thisshows that the FI project is capable of exceeding the level of representation. This is according to dengan Fuady et al. (2019).

FI subjects are able to use different concepts carefully. This shows that subjek FI is able to surpass the level of abstraction of struktural, according to Leach-Krouse (2017), that students who have a cognitive style of FI tend to be stable in solving problems so that they are not easily fooled by obstacles or deceptions that exist in the questions provided.

The subject of FI is able to test the truth on any n-that has been formed from the mathematical model he created, present the mathematical model accurately and perform a validity investigation has been carried out correctly for any n. This shows that the FI project is able to surpass the level of structural consciousness well in accordance with Amalia et al. (2020), who said that students who have a cognitive style of FI tend to be analytical and have a creative spirit when faced with problems that tend to be manipulatif and many deceptionists.

FD subjects are able to perform all indicators at the recognition level and representation level well. This is demonstrated by the FD being able to perform all indicators at the recognition level and representation level appropriately. This proves that students with the FD style are able to know and read exactly according to Fuady (2016).

However, at the level of structural abstraction, the subject of FD is fooled by the given concept, so at this level it is not capable of performing the indicators and stages of the solution precisely. This proves that students with the FD style are less concentrated and relatively easier to be fooled, so their perception is easily influenced by environmental changes according to Yanti et al (2020). One of the concepts used at the level of structural abstraction, affects at the next level that is structural consciousness, so that the formulation of the inferred tribe is wrong. n Thus the subject of FD is incapable of going beyond the level of structural abstraction and is incapable of going beyond the level of structural consciousness.

CONCLUSION

Based on the results of data analysis and discussion, it was obtained that students with a field independent (FI) cognitive style were able to achieve all levels of reflective abstraction (4 levels), namely recognition, representation, structural abstraction, structural awareness. Meanwhile, students with a field dependent cognitive style (FD) are only able to achieve 2 levels of reflective abstraction, namely recognition and (2) representation. At the level of structural abstraction, students with FD cognitive style tend to think less narrowly to the problem, besides that they are also fooled by the variety of questions that have been made, resulting in the concepts used incorrectly, so that students with field dependent cognitive style (FD) cannot go beyond the level of structural abstraction and structural awareness.

Based on these conclusions, the advice given by the researchers is that because the level of reflective abstraction that can be achieved by students with a field independent (FI) cognitive style is different from students with a field dependent cognitive style (FD), teacher should pay attention to the cognitive style possessed by students so that learning objectives are achieved because the characteristics of students differ when obtaining and using information affects the level of reflective abstraction that can be achieved.

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