Profile of Metacognition Skill of Students with Dependent Field Cognitive Style in Solving HOT Problems in Science

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Abstract. Metacognition is a skill that focuses on monitoring activities and self-responsibility, so students are able to organize themselves in planning, monitoring and reflecting on their learning activities. The purpose of this study is to describe the metacognition skills of VIII grade students of SMPN 3 Sidoarjo in solving HOT problems. The research subject was a student who had a dependent field cognitive style. This research is a type of qualitative research. The data was in the form of HOT test results, interview transcripts and observation results. The data is described, analyzed and tested for validity using triangulation techniques. The result of this study showed that the student who had dependent field cognitive style mastered the metacognition indicators of planning, monitoring and reflection in solving the C4 and C5 HOTs problems. Meanwhile, in the case of HOTS C6, subject mastered the indicators of planning and monitoring.

Introduction

Based on competence and character basis in curriculum 2013, the students need to be actively involved in learning activities because they are a center of learning activities, and competence and character building. Curriculum 2013 is centered in constructivist and student centered learning approach. Student Centered Learning is expected to improve student’s soft skills, which are thinking skill, problem solving skill, group work in different background, and good communication [1]. As the results, the students can self-train to be an independent student. The students’ independence in learning activities can be seen from how they are initiating in learning activities, diagnosing the learning needs, deciding the learning purpose, monitoring, learning control and evaluate, and the last is deciding learning strategy.

Most of students have already aware about independent learning. It can be seen from some of the students bring their school’s note to their home, also the students know what subject that they will learn. Besides, in the learning activities, students are usually write the important things of what the teacher explains. Then, when the teacher give a task, the student do exactly what the teacher asks and finish it in time. The awareness of students to control their learning, does their task, and evaluates their learning results are some of Metacognition skills component.

Metacognition skill is a thinking skill how someone thinks. Flavell defines metacognition as a higher level skill. Thinking involves cognitive knowledge and cognitive regulation [2]. Metacognition skill is focused on monitoring activates and student’s self-responsibility, then the student is able to...
organize by themself to plan and evaluate the learning purpose [3]. Metacognition can be applied to decide the student cognitive skills, how far they can understand a problem [4].

In order to measure how far the students’ Metacognition skills in this research, researcher use a problem which is to solve the problem, we need “High Order Thinking” (HOT) skill. HOT’s question is not only from knowledge dimension but also, it measures Metacognition dimension that describes the ability to connect several different concepts, do the interpretation, problem solve, choose the strategy to solve the problem, find a new met ode, discussion, and make a right decision. HOT’s question measures Metacognition skills in analytical domain (analyze-C4), evaluation (evaluate-C5), and creation (create-C6) [5]. According to Nosratinia and Adibifar, in order to help student’s higher thinking, especially to develop student’s metacognition, the teacher needs to guide the student to develop self-management habit [6]. One of them is identification of cognitive style that suitable for themselves.

Cognitive style is individual characteristic in using cognitive function (remembering, thinking, problem solving, deciding, managing and organizing information, etc) which is consistent and for a long time period. Then, each individual has different cognitive styles in processing information or face a question or problem. Witkin distinguish cognitive styles into two, they are field dependent, and field independent cognitive styles [7].

Student with field dependent cognitive style in processing information, they are tending to be more global in analyzing the learning activities and have difficulties to solve the information from isolated parts. They aren’t imposing the structure when there is lack of content, but they prefer direct instruction in a condition that needs restructuring. In student learning assignments which is using field dependent cognitive style needs explicit learning activities in social context and also, they need some interactions between their schoolmates as skill model and learning reinforce [8]. Field dependent student depend and tend to the information resource and the teacher [9].

Even though field dependent student is less independent rather than field independent student, but still there is possibility for field dependent student has a higher thinking or equal from field independent student’s thinking. This happens, when the information, subject and the problem in the HOTS’ question changes into something that suitable with their thinking level and they could receive the information. This was reinforced by Nugraha and Awalliyyah, who stated that the enhancement of mastery concepts for field dependent students was slightly greater than independent field students [10]. This matter is predicted because of most of the learning process is in group that supports dependent cognitive style. This result is different from research by Onyekuru, explains that field dependent cognitive student could only apply metacognition activities of organizing and monitoring in the problem solving and does not apply reflection activities [11]. Angeli, et al adds about when field dependent subject face difficult problems, they have difficulties to model the problem and subject metacognitive organizing, they are general planning, particular planning, and action that does not lead into solving the problem [12].

Description above explains how student with field dependent cognitive style solves the problem in outline using the metacognition skills. However, there isn’t much research that explains about metacognition skills of field dependent student in solving HOTS basis problems. Therefore, researcher wants to analyze metacognition skills of field dependent student in solving HOTS IPA question.

Methods
This research uses qualitative research. The purpose of this research is to describe student’s metacognition skill with field dependent cognitive style to solve HOTS IPA question. The data resource of the research is students at VIII-D grade of SMPN 3 Sidoarjo, consists of 33 students. The research subject is based on the test results of cognitive styles GEFT, all of VIII-D students are given a cognitive style test GEFT. After that, they are grouped based on their cognitive styles, field dependent and field independent. The student will categorized as field dependent cognitive style if their score is between 0 to 11. In the other hand, the student that has scored around 12 to 18 is categorized as field independent student. After categorizing, the researcher chooses a student that has field dependent
cognitive style and will be used as research subject. The subjects have same cognitive skill with the others. Also, the selection of the student is based on the consideration of the IPA’s teacher, because they are fulfilled the conditions, such as easy to cooperate and communicate.

Results and Discussion
The research finding could be seen from the result of HOTS writing test, interview and observation that performed by researcher to students who had field dependent cognitive style as the subject.

1.1 HOTS Question Test Finding
The HOTS question in this research based on IPA questions concept in Bloom cognitive dimension C4, C5, and C6. The answer from the subjects can be seen in the bellow:

3.1.1 HOTS Question C4
Based on the subject’s answer in C4 question, it can be concluded that the subject can answered each of the question correctly. The subject applied metacognition skill into planning, observing, and reflecting indicator.

In the planning indicators, subject wrote about the relationship between prey and predator. They knew in the food chain, eating and be eaten will occurred between organism in a certain cycle. Subject can answered the question correctly as what the instruction asked. He chose the strategy to solve the problem, which was the subject showed the relation between one thing to the others thing (spatial) and framing. The subject related the organism and their food web, they were grouping the organism based on their food web’s level. The subject was able to solve the problems correctly and plan a representation by choosing some of organism to their food web. The subject related the organism to know the answer.

In the monitoring indicators, the subject used organism relationship rule that was prey and predator relationship. He also monitors the writing errors that can be known from the scribble in the answer number 1b. Moreover, the subject wrote argumentation to enforce their answer. The answer that was written by the subject was based on the fact in the question and the purpose.

In the reflection indicators, the subject reflected the answer with the food web concept and also reflected the answer with the question’s purpose, it can be seen from the subject’s answer that appropriated with the purpose. The subject also analyzed by giving the reason of the answer.

3.1.2 HOTS Question C5
Based on the subject’s answer of Question C5 (Figure 1), it can be described that the subject still confused about the color change concept in litmus paper. It caused why the student’s answer was incorrect. Even though there was any mistakes in the student’s answer, but in another case the subject suceeded in applying metacognition skill. It was in planning, monitoring and reflection indicator.

Figure 1. The answer of HOTS C5 question from field dependent student
In the planning indicator, the subject was able to write what they had known about the color change concept in litmus paper. However, the subject wrote incorrect answer. The right answer should be the red litmus paper wouldn’t changed the color, if it mixed with acid liquid. In another side, if blue litmus paper mixed with acid liquid, the color would changed into red color. The subject was able to understand the purpose of the question and choose the right strategy to solve the problem by using spatial strategy, even though had a wrong answer. The subject answered the question by connecting litmus paper indicator with some liquid that will effects the color changing.

In the monitoring indicator, the subject used the liquid rules, that liquid character could effects the change on litmus paper color. He also monitored some scribles in the written answer. In the reflection indicator, the subject knew that their answer was wrong, it can be seen from there is hesitation when the subject answered the question, because they wrote “maybe” in the last sentence 2a and 2b question.

3.1.3 HOTS Question C6

According to the subject’s answer at C6 question, the subject didnot know the variable concept in the research because the subject’s answer was incorrect. Nevertheless, the subject had applied metacognition skills in planning and monitoring indicator.

In the planning indicator, the subject was able to write what they had known, such as wrote “plant” and “sun rays” along with the reason why the plant needed sun rays. However, the subject couldn’t understand the purpose of the question, because the written answer didn’t compatible with the variable control. The subject didn’t explain how the variable control was set to do the experiment. The subject only explained about a plant needs sun rays.

In the monitoring indicator, the subject monitored some scribles in the written answer. In the monitoring activities, the subject monitored writting errors on the answer sheet, but couldn’t answer the question correctly. The subject didn’t do any reflection, because the subject assumed that the answer was correct and appropriate with the question’s purpose.

1.2 Interview Finding

3.2.1. Interview of HOTS C4 Question

Based on the interview finding on HOTS C4 question, there were some metagocnition activities that can be observed.

| Table 1. Metacognition activities on interview of C4 question. |
|-----------------------|------------------------------|
| **Indicator** | **Interview Quotation** |
| Planning | Q: "What are the objectives to be achieved from this problem?"
A: "We can know which animals act as predators and which prey are."
P: "Try to explain how you plan to solve this problem!"
A: "Reading the problem over and over again, observe the problem first, if there are pictures like this, be observed more thoroughly, understand the problem and write down the answer."
| Monitoring | Q: "Try to explain how you do this problem?"
A: "First, if the grass dies, then the grass does not grow anymore, grass predators cannot eat grass again, eventually the population will decrease, I imagine it like that"
| Reflection | Q: "Have the objectives in this matter been achieved?"
A: "Already achieved"

Table 1 described that the subject had applied metacognition skill C4 question. It can be known from planning, monitoring and reflection indicator.
3.2.2. Interview of HOTS C5 Question

Table 2. Metacognition activities on interview of C5 question.

| Indicator | Interview Quotation |
|-----------|---------------------|
| Planning  | Q: "What are the objectives to be achieved from this problem?"
|           | A: "The goal, I must be able to understand between red litmus paper, blue litmus and the relationship between acidic substances."
| Monitoring| Q: "Try to explain how you do this problem?"
|           | A: "I read the reading first, when I finished reading the problem I will understand it and then reread all the readings and the problem is what is in the reading that is answered in accordance with the questions given"
| Reflection| Q: "Can you explain your exhaustion and shortcomings in solving this problem?"
|           | A: "My shortcomings, I still do not understand about this litmus paper, I do not understand the change in color on litmus paper. My strength, I can know the practicum of acid solution which was given red litmus paper and blue litmus paper"

Table 2 explained that the subject had applied metacognition skill on C5 question. It can be known from planning, monitoring and reflection indicator.

3.2.3. Interview of HOTS C6 Question

Table 3. Metacognition activities on interview of C5 question.

| Indicator | Interview Quotation |
|-----------|---------------------|
| Planning  | Q: "Try to explain what you first thought after reading this problem!"
|           | A: "What I think is, there are four people who bring each of the 6 plants which are placed in the dark and light."|
| Monitoring| Q: "Try to explain how you do this problem?"
|           | A: "How, I read the problem, I described 4 people, I read the pictures how each person treated the picture, I gave the answer that I thought was right then I explained why the answer was like that and because of what."
| Reflection| -                   |

Table 3 described that the subject had applied metacognition skill on C5 question. It can be known from planning and monitoring indicator.

1.3 Observation Findings

The observation activities was conducted when the subject did the HOTS exercise. From those activities, there were some metacognition activities can be observed. The metacognition activities are thinking/writing/reading of what have been known and haven’t been known in C4, C5 and C6 Question. The researcher displayed the research data in the table 4.

Table 4. Observation Data Display of Field Dependent Subject

| Metacognition Indicator | Metacognition sub-indicator | HOTS Question |
|-------------------------|-----------------------------|---------------|
|                         |                             | C4 | C5 | C6 |
| Planning                | Thinking/ writing/reading of what have been known and haven’t been known | √  | √  | √  |
|                         | Maintain the purpose        | √  | √  | -  |
|                         | Maintain the problem solving strategy | √  | -  | -  |
|                         | Planning a representation (formula, reaction equality, | -  | √  | -  |
Metacognition Indicator | Metacognition sub-indicator | HOTS Question
---|---|---
Monitoring | texts, picture, etc.) to support the understanding | C4 | C5 | C6
| Re-reading the material until truly understand | ✓ | ✓ | ✓
| Monitoring the writing errors, formula, reaction equality, picture, etc. | ✓ | ✓ | ✓
| Carefully monitoring to solve the problem | ✓ | ✓ | ✓
| Monitoring by discussing | ✓ | ✓ | ✓
Reflection | Analyze formula, reaction equality, texts, and etc. | - | ✓ | -
| Analyze the method and the structure in decision making | ✓ | - | -
| Recognize the interaction between wrong representation and idea as a controlled theme | - | ✓ | -

Based on the test results, interview, and observation, it can be explained about the ability of field dependent student in solving the HOTS problems. When solved HOTS C4 question, the subject mastered planning, monitoring and reflection indicator. Consciously, the subject decided and used strategy to improve their thinking skill. Such as re-reading for many times and observed the food web picture carefully. Besides, they used cognitive strategy to process the information such as spatial and framing. It is in line with Matlin in Amin, et al that defined metacognition as someone knowledge, awareness, and control towards their cognitive process [13]. Metacognition is very important to help student in organising the environment and strategy selection in order to develop the next cognitive skill. The subject was able to answer the question correctly because the subject was easier to understand the problem through out the food web picture in the question sheet. As Saputra and Dahlan said that field dependent students are tend to use visual approach, which is more global in processing the information [14]. The subject was able to use appropriate scientific concept in order to answer the HOTS C4 question. According to Widiyatmoko and Shimizu, concept is a thinking foundation, when student has mastered the concept, they will have a strong thinking foundation, then the student is able to support their other skills [15]. The subject was able to do an argumentation in order to support their thinking accuracy. The last reflection activities, the subject believes what they did was right (the purpose was achieved, and their concept was right). Naug, et al stated that reflection activities is activities where the student is able to recapture their knowledge, re-think, consider and re-evaluate [16].

In the solving HOTS C5 question, the subject wasn’t able to answer correctly, because the subject didn’t master the concept in the question. The subject seemed confused by the concept, it can be seen from what the subject wrote “mungkin (maybe)” in the subject’s answer number 2a and 2b. It is also can be discovered from the interview finding about their weaknesses when answer the question, the they said that they didn’t understand the difference between red and blue litmus paper when its changing the color. However, the subject mastered the planning, monitoring and reflection indicator. In the answering process, the subject was able to discover the problem in the question but the subject failed to solve the problem. It was because the subject confused about the concept they used. The subject showed hesitation towards their answer, this was caused by the subject can’t analyze the problem. It is in line with Ngilawajan, said that field dependent student has a weakness to analyze a problem [17].

In the figuring out HOTS C6 question, the subject mastered the planning and monitoring indicator although the subject wasn’t able to answer the question correctly because can’t discovered the problem in the question. When answered the question, the subject didn’t know that they were wrong in understanding the problem, which is why they didn’t know that their answer was incorrect. However, when the student was interviewed about their answer, they said that their answer was correct and appropriate with the question purpose. The subject didn’t pay attention on the question detail, the subject more focused on the picture. In the planning activities, the subject seemed read and decided what they knew and didn’t know. However they were wrong in understanding the problem. It caused
the concept that they thought was right, was actually wrong. In the monitoring activities, the subject monitored the writing errors, but it didn’t correct the wrong answer. The subject didn’t do reflection activities, because they thought that their answer was right and appropriate with the purpose of the question. As Sozcu said that field dependent student is less of analytical, the way they process the information is global, they do not pay attention on detail and generally conclude [9].

Conclusion

Based on finding and discussion can be concluded student with field dependent cognitive style has metacognition skill which are planning, monitoring and reflection to solve the problem in HOTS C4 and C5 question. While in the HOTS C6 question, the subject only mastered planning and monitoring indicator from metacognition skill. The teacher needs to know student’s characteristic related with their cognitive styles. It will be easier for teacher to choose the strategy to improve the processing and organizing information in the learning activities, also to improve student’s metacognition skill.

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