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THE PROFILE OF STUDENTS' METACOGNITION IN LEARNING THROUGH REALISTIC MATHEMATICS EDUCATION

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Abstract

This was qualitative research. The research objectives were to reveal the profile of Junior Secondary Schools students' metacognition at Makassar within a learning through realistic mathematics education involving metacognition. The research results were as follows. Within the realistic mathematics instruction, the first step was to understand the contextual problems; the second step was to solve the contextual problems; the third step was to discuss and compare the solution of the contextual problems; and the fourth step was to conclude the solution of the contextual problems. The research results showed that: (1) Within the first step, the subject C19, C21, C27, and C29 applied their predicting, planning, and monitoring skills; the subject C25 applied their planning and monitoring skills; the subject C26 applied their planning skills. (2) Within the second step, the subject C19, C21, C25, C27, and C29 applied their declarative, procedural, and conditional knowledge, as well as their monitoring skills; the subject C26 applied his procedural and conditional knowledge. (3) Within the third step, the subject C19 applied their declarative, procedural, and conditional knowledge, as well as his monitoring skills; the subject C21 and C27 applied their evaluation skill; while the subject C25, C26, and C29 did not apply their metacognitive knowledge and skill. Meanwhile, (4) Within the fourth step, the subject C19, C27, C21, and C29 applied their evaluation skill; the subject C25 and C26 did not apply their metacognitive knowledge and skill.

Key words: Metacognition . Ralistic Mathematics Education

A. INTRODUCTION

Mathematics is a universal discipline underpinning the development of modern technology, having great role in a variety of disciplines and helping forwad human contemplative faculties. Rapid development in the field of information and communication technology recently is based on the development of mathematics in the fields of number theory, algebra, analysis, probability theory and discrete mathematics. Therefore, to mastery and use technology in the future, it is early on required the strong mastery in mathematics (mathematics competence).

In terms of mathematics competence that students have to mastery, mathematics learning in practice, particularly in the primary and secondary levels must be related to students' experiences in real life, so that what they learn become meaningful and highly fruitful in their daily life. One of mathematics learning approaches relating students' experiences in real life to mathematics material is Realistic Mathematics Education (RME). Freudenthal (1991) states that mathematics must be related to reality and it is as human activity. This means that mathematics must be close to students and be relevant to their daily life. Mathematics as human activity means human must be given to reinvent mathematics idea and concept through an adult guidance (Gravemeijer, 1994). Therefore, the principle of reinventing mathematics idea and concept may be inspired by informal procedures, whereas the process of reinventing mathematics idea and concept uses mathematization concept.

The attempt is taken through exploring a variety of situations and 'realistic' problems. Realistic in this term is intended to not only refer to the reality, but also to something that students can imagine (Slettenhaar, 2000).

Some years lately, the development of cognitive psychology is at the same time of the development of the way of teacher to evaluate students' learning achievement, particularly for cognitive domain. One of interesting development is the attempts of experts in education to revise Bloom's Taxonomy concerning the cognitive dimension. Anderson & Krathwohl (2001) revise Bloom's Taxonomy regarding cognitive aspect by deviding it into two dimensions, that is: cognitive process and knowledge. The prominent results of the revision to the dimension of cognitive process is the omit of synthesis aspect between analysis and evaluation aspects, then the add of creativity aspect after evaluation aspect. Meanwhile aspects of knowledge dimension stated are: (1) factual knowledge, (2) conceptual knowledge, (3) procedural knowledge, and (4) metacognitive knowledge. One of the aspects that is interesting to study deeply, particularly in realistic mathematics learning is metacognition.

Based upon the theoretical outline about metacognition, it can be stated that metacognition plays a great role in mathematics learning, particularly in managing and controlling students' cognitive activity when learning and thinking, so that learning and thinking that students do in learning through realistic mathematics education may be more effective and efficient. Learning through realistic mathematics education starts from contextual problem. The problem is then outlined in order that mathematics elements contained become recognizable. Through introducing mathematics elements contained, students can translate them into their own production of mathematics model, so that students can use mathematics to carry out contextual problem. Mathematical solution that students obtain is then re-translated in order to arrive at the true answer to the contextual problem. Therefore, it is important to study deeply for revealing the profile of state junior secondary schools students' metacognition at Makassar in learning through realistic mathematics education.

B. Research Method

1. Research Type and Research Subjects

This is a qualitative research aimed at revealing deeply students' metacognition (metacognitive knowledge and skill) in learning through RME in the state junior secondary schools in Makassar city. The research subjects are grade VII students that are selected by using purposive random sampling. In addition, they are chosen by considering mathematics ability and sex, so that those selected as subjects are the representatives of students' characteristics in the research site.

2. Research Procedure

The procedure for collecting data to reveal the profile of students' metacognition, that is: (1) observing and recording by video the execution of learning in the classroom; (2) catechizing for confirming obtained data through observation, video recording and research subjects answer to the contextual problem carried out in student worksheet; and (3) interviewing for exploring research subject's answer orally to the contextual problem corresponding to that carried out in student worksheet.

3. Instrument and Technique for Collecting Data

The main instrument of this research is the researcher himself and assistance instrumen such as interview protocol and observation sheet. Data analysis for revealing the profile of students' metacognition in learning through RME are conducted through the stages as the following: (1) analyzing research subjects' answers that are intended to investigate the metacognitive aspect that students use in solving problem; (2) analyzing the interview results to know the metacognitive aspect that research subjects use in answering problem orally. The given problem is the problem corresponding to that carried out in student worksheet; (3) reducing; and (4) triangulating.

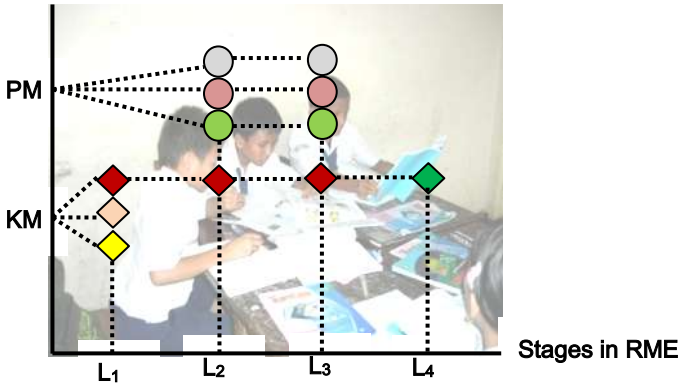
C. RESEARCH RESULTS

1. Description of Metacognitive Activity of Subject A

First, Subject A did reading activity when he or she encounterd the contextual problem for the first time. The activity was intended to direct his or her thinking to understand contextual problem. Based on his or her understanding, Subject A were aware to do classification before executing the contextual problem. He or she always did the activity either in learning or when attending the regular tests (daily or semester). Subsequently, he or she wrote what was given and asked in the contextual problem at the student worksheet, realized the importance of writing the two things and knew their advantage. This showed that Subject A were aware of his or her action to achieve the goal of the contextual problem, and tried to recognize it in learning. Therefore, it could be stated that Subject A applied prediction, planning and monitoring skills in understanding contextual problem. Second, Subject A wrote his or her mathematical knowledge in the student worksheet in the light of his or her understanding on the problem. He or she was aware of writing his or her mathematical knowledge and knew the advantage. This means Subject A had awareness to write his or her knowledge on mathematical facts and concepts assisting in carrying out the problem. Henceforth, Subject A wrote the solution of the problem in the student worksheet. However, prior to writing it, he or she thought the solution stages by making a rough copy in the blueprint papers, organized, checked the solution stages and made a decision for correcting the mistakes acquired through a certain reason. In addition, if there was a contextual problem in learning that he or she had not understood, then he or she asked to his or her teacher or looked for relevant examples inside text book, so that he or she were really sure of his or her writing. This indicated that Subject A had awareness of implementing a strategy in carrying out contextual problem, knew when and why the strategy was implemented, so that he or she recognized the problem. Besides, he or she knew how to handle conditions affecting his or her learning during instructional process, such as when asking question to his or her teacher or looking for relevant examples in text book, if there is a contextual problem that he or she had not understood. Therefore, it could be stated that Subject A applied declarative, procedural, and conditional knowledge along with monitoring skill in carrying out the problem. Third, when conducted team discussion, Subject A explained the solution stages while checking their appropriateness, answering his or her friends questions and knowing when and why the stages were used in carrying out the problem. Despite, if there was something that he or she had not understood, he or she then asked question to the teacher or looking for relevant examples in textbook. Therefore, it could be stated that Subject A had awareness of explaining to his or her friends about the strategy that he used in solving the problem, knew when and why the strategy was implemented, so that he or she recognized the problem. In addition, he or she knew condition that affected his or her learning and knew the way of handling it. Further, Subject A rechecked the solution by glossing sign (√). The activity was taken by depending on the availability of time in learning, but he or she realized the imporance of looking back the solution after carrying it out. At the end of learning, he or she wrote (important concepts that might be used in the subsequent learning) the summary in his or her note book. Therefore, it could be stated that Subject A applied evaluation skill after carrying the problem out.

Based on the aforementioned description, it is then presented the metacognitive profile of Subject A in learning through RME as shown in Figure 1 below.

Student's Metacognition



Notes:

Background : Learning state in the classroom

: Declarative knowledge

: Procedural knowledge

: Conditional knowledge

: Prediction skill

: Planning skill

: Monitoring skill

: Evaluation skill

L_1 : Understanding contextual problem

L_2 : Carrying out contextual problem

L_3 : Comparing and discussing solution

L_4 : Concluding

PM : Metacognitive knowledge

KM : Metacognitive skill

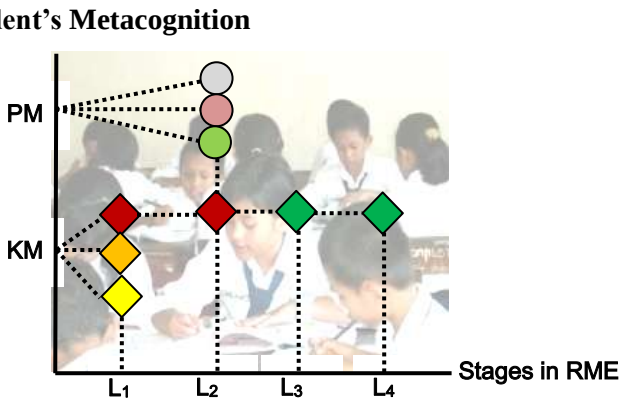
Figure 1. The Profile of The Metacognition of Subject A in Learning through RME

2. Description of Metacognitive Activity of Subject B

First, Subject B did reading activity when he or she for the first time encountered the contextual problem. The activity was intended to be able to concentrate in understanding problem. Based on the understanding results to the problem, he or she wrote wat was given, what was asked, and did classification (predicting time) to the problem in the student worksheet. He or she was aware of the importance of writingthe things and knew the advantages. This showed that Subject B was aware of the action that would be taken to achieve the problem goal, and tried to recognize the contextual problem in learning. Therefore, it could be stated that Subject B implemented predicting, planning and monitoring skills in understanding contextual problem. Second, Subject B wrote his or her mathematical knowledge in the student worksheet on the basis of his or her understanding to the problem. He or she had awareness to write his or her mathematical knowledge and knew the advantage. It meant Subject B had awareness to write his or her knowledge on mathematical facts and concepts assisting in carrying out the problem. When carrying out problem, Subject B made a rough copy on the paper about his or her solution stages, organized and managed them before writing them in the student worksheet. When carrying out problem, he or she made a decision to correct the mistakes and decision that he or she made was on the basis of certain reason. In addition, he or she was aware of the condition affecting his or her learning and knew the way of handling it, that is: asking question to the teacher, friend or looking for relevant examples in the textbook, if there is a problem that he or she had not understood, so that he or she knew how to carry out the problem. This indicated that Subject B had an awareness of applying a strategy in solving the problem, knew when and how to implement the strategy, so that he or she recognized it. Besides, he or she knew how to tackle the condition affecting his or her learning during the learning session in the classroom, such as when asking question to the teacher, friend or looking for relevant examples in the text book, if there is a contextual problem that he had not understood. Hence, it could be said that Subject B applied declarative, procedural, conditional knowledge and monitoring skill in carrying it out.

Third, when conducted team or classroom discussion, Subject B was active to pay attention to his or her friend's explanation or teacher while checking his or her homework. In addition, Subject B applied the way of thinking or strategy that he or she conducted to the other problems, and rechecking the solution based on the availability of time. However, the activity of checking that he or she was taken generally when team or classroom discussion or when concluding answer to the problem in spite of the activity of making summary. Therefore, it could be stated that Subject B implemented evaluation skill when discussion took place and concluded the answer to the problem.

Based on the description above, it it then displayed the profile metacognition of Subject B in learning through RME as displayed in following Figure 2.



Notes:

Background : Learning state in the classroom

: Declarative knowledge

: Procedural knowledge

: Conditional knowledge

: Prediction skill

: Planning skill

: Monitoring skill

: Evaluation skill

L_1 : Understanding contextual problem

L_2 : Carrying out contextual problem

L_3 : Comparing and discussing solution

L_4 : Concluding

PM : Metacognitive knowledge

KM : Metacognitive skill

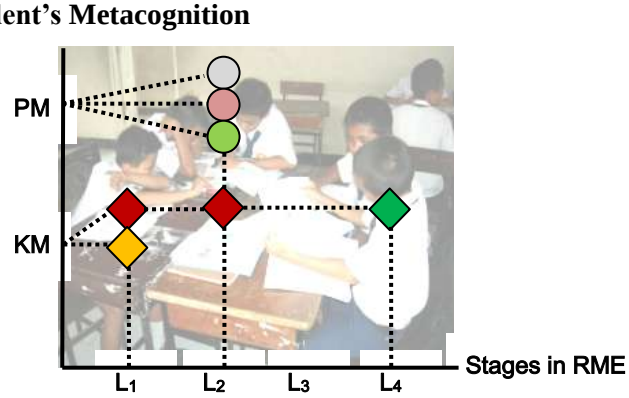
Figure 2. The Profile of The Metacognition of Subject B in Learning through RME

3. Description of Metacognitive Activity of Subject C

First, Subject C did reading activity, then looked at problem example in the textbook when looking at problem for the first time. This activity was intended to lead his or her thinking to understand problem. Based on his or her understanding, he or she wrote what was given and what was asked in the student worksheet. He or she was aware of the importance of writing the things and knew the advantage, that is: in order to not to repeat in reading problem. However, he or she did not do classification (predicting time) and was not aware of the importance of writing the cases. This showed that Subject C was not aware of the action that would be taken to achieve the goal problem, and tried to recognize problem in learning. Therefore, it could be stated that Subject C applied planning and monitoring skills in understanding problem. Second, Subject C wrote his or her mathematical knowledge in the student worksheet. He or she had awareness to write his or her mathematical knnowledge and knew the advantage. This meant Subject C had awareness to write his or her knowledge on mathematical facts and concepts assisting in carrying out problem. When solving contextual problem, he or she wrote a rough copy of his or her solution stages and ensured the appropriateness in the light of the difficulty level of the problem. Nevertheless, if there was problem that had not been understood, he or she then asked question to the teacher, friend or looked

for relevant examples in textbook. This meant Subject C had awareness to apply a strategy, knew when and why the strategy was applied in solving problem. In addition, he or she knew how to handle the condition affecting his or her learning when solving problem, that is: asking question to the teacher, friend or looking for relevant examples in textbook, if there was problem concerning learning material that had not been comprehended. But after completing the problem, Subject C did not re-check his or her solution and was not aware of the importance of doing the re-check activity. This meant that Subject C did not apply the evaluation skill in learning. Hence, it could be stated that Subject C implemented declarative, procedural, conditional knowledge, and monitoring skill in solving problem.

Based on the description above, it is then presented the profile of students' metacognition of Subject C in learning through RME as shown in Figure 3 below.



Notes:

Background : Learning state in the classroom

: Declarative knowledge

: Procedural knowledge

: Conditional knowledge

: Predicting skill

: Planning skill

: Monitoring skill

: Evaluating skill

L_1 : Understanding contextual problem

L_2 : Carrying out contextual problem

L_3 : Comparing and discussing solution

L_4 : Concluding

PM : Metacognitive knowledge

KM : Metacognitive skill

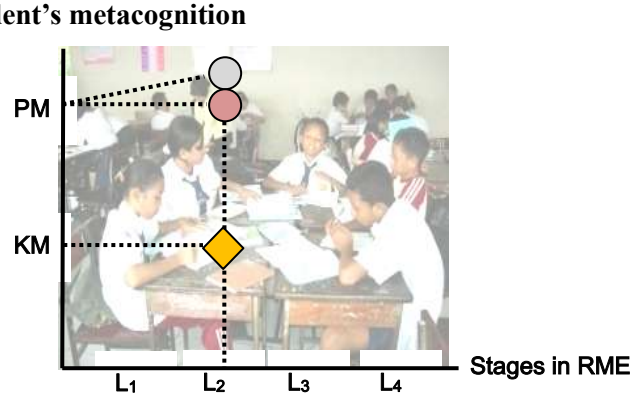
Figure 3. The Profile of The Metacognition of Subject C in Learning through RME

4. Description of Metacognitive Activity of Subject D

First, Subject D wrote some false answers about his or her mathematical knowledge in the student worksheet and did not undertake classification (predicting time) to the problem. He or she was not aware of the significance of doing the instances in the learning. Subsequently, he or she wrote what was given and what was asked question to the problem. But he or she was not aware of the importance of writing the things and did not know the advantage. When carrying out the contextual problem, he or she wrote the solution stages of contextual problem in the student worksheet based on his or her understanding. However, he or she was not sure of the appropriateness of the solution. In addition, he or she knew the condition affecting his or her learning, but he or she did not know what he had to do (to handle the problem) like when acquiring disturbance from his or her friends and so on. Besides, he or she did not re-check and was not aware of the importance of re-checking answer to the solved contextual problem. This indicated that he or she was aware of the action he or she took to achieve the goal of the contextual problem, so that he or she implemented a strategy in carrying out contextual problem. Hence, it could be stated that Subject D applied planning skill and procedural knowledge in solving problem. Second, Subject D did reading activity

when encountering problem for the first time. After that, he or she looked at the example of solving problem in textbook. When solving problem, he or she did a rough copy of his or her solution in the draft paper prior to writing it in the student worksheet. This showed that he or she implemented a strategy and knew when it was applied, but he or she did not know why it was implemented (he or she only looked at the example of solution existing in textbook) when carrying out problem. Therefore, it could be stated that Subject D applied procedural and conditional knowledge in solving problem.

Based on the aforementioned description, the profile of metacognition of Subject D in learning through RME was shown in Figure 4 below.



Notes:

Background : Learning state in the classroom
: Declarative knowledge
: Procedural knowledge
: Conditional knowledge
: Predicting skill
: Planning skill
: Monitoring skill
: Evaluating skill

L_1 : Understanding contextual problem
L_2 : Carrying out contextual problem
L_3 : Comparing and discussing solution
L_4 : Concluding

PM : Metacognitive knowledge
KM : Metacognitive skill

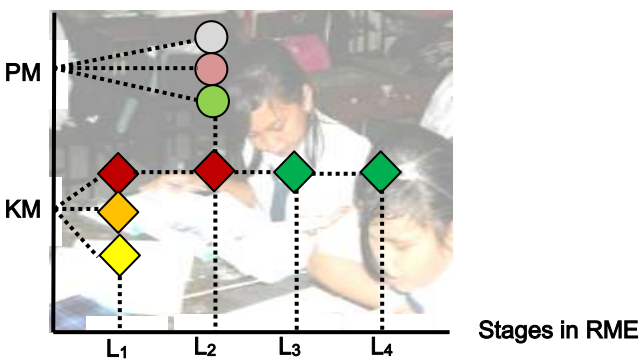
Figure 4. The Profile of The Metacognition of Subject D in Learning through RME

5. Description of Metacognitive Activity of Subject E

First, Subject E did reading activity when facing problem for the first time. He or she was aware of the importance of writing the instance and knew the advantage. This indicated that Subject E realized the action that he or she took and attempted to recognize it. Therefore, it could be stated that he or she implemented predicting, planning and monitoring skills in understanding problem. Second, he or she understood problem and based on his or her understanding, he or she had awareness to write his or her mathematical knoledge and knew the advantage. Further, he or she carried out problems in the student worksheet. But before that, he or she though the solution stages while writing in a rough copy paper; organized the stages, made a decision to make correction to the encountered inappropriateness, and the decision made was also based on a certain reason. Furthermore, if there was problem that had not been understood, he or she then asked to the teacher or looked for relevant examples in textbook/considered notes, so that ensuring the correctness of the solution stages prior to writing them in the student worksheet. But he or she was sure about the appropriateness of the solution, if the problem was not so difficult. This indicated that he or she had awaareness to implement a strategy, knew when and why the strategy was applied in carrying out problem, so that he or she recognized problem; knew

how to tackle the condition affecting his or her learning, such as asking question to the teacher or looking for relevant examples in textbook, if there was problem that had not been understood. Henceforth, after carrying out the problem, he or she re-checked the solution by providing the sign (√) while considering the solution stage. He or she was aware of the importance of looking back the solution. However this instance was conducted in the light of the availability of time. Whereas when it was conducted team (group) or classroom discussion, he or she looked not so active, but he or she focused on the activity to look back the solution in the student worksheet. Besides, at the end of the learning, he or she considered/wrote the teacher's explanation and wrote the core of the lesson in the note book. Thus, Subject E implemented: (1) Pengetahuan declarative, procedural, and conditional knowledge, along with monitoring skill in solving problem; and (2) evaluating skill in discussing and concluding answer to the problem.

Building on the description above, it was then displayed the profile of metacognition of Subject E in learning through RME as shown in the following Figure 5.



Notes:

Background : Learning state in the classroom

: Declarative knowledge

: Procedural knowledge

: Conditional knowledge

: Predicting skill

: Planning skill

: Monitoring skill

: Evaluating skill

L_1 : Understanding contextual problem

L_2 : Carrying out contextual problem

L_3 : Comparing and discussing solution

L_4 : Concluding

PM : Metacognitive knowledge

KM : Metacognitive skill

Figure 5. The Profile of The Metacognition of Subject C in Learning through RME

Description of Metacognitive Activity of Subject F

First, Subject F wrote what was given and what was asked in the contextual problem in the student worksheet. He or she was aware of the importance of writing the instances and knew the advantage. In addition, he or she did classification (predicting time) and realized the significance of doing it on the basis of his or her understanding and knew the advantage. This indicated that Subject F was ware of the action he or she would take to achieve the problem goal and attempted to recognize problem. Therefore, it could be stated that he or she applied predicting, planning and monitoring skills in understanding problem. Second, Subject F wrote his or her mathematical knowledge in the student worksheet. He or she had awareness to write his or her mathematical knowledge and knew the advantage. When carrying out the contextual problem, he or she wrote the solution in the student worksheet. But before that, he or she worked the solution stages in the rough copy and was sure of his or her solution appropriateness based on the difficulty level of the

problem, prior to writing the solution in the student worksheet. In addition, if there was problem that he or she had not understood, he or she asked question to the teacher or looked for relevant examples in textbook, and at the end of his or her solution, he or she wrote the word 'thus', so that there was an indication that the strategy that he or she took could generate his or her awareness to carry out problem appropriately. Subsequently, Subject F re-checked his or her solution, but this instance was conducted based on the availability of time. This indicated that he or she had awareness to apply a strategy, knew when and why the strategy was implemented in solving problem, so that he or she recognized the problem. Therefore, it could be stated that Subject F implemented: (1) declarative, procedural, and conditional knowledge, along with monitoring skill in executing problem; and (2) evaluating skill when concluding answer to the problem.

In the light of the description above, it was then presented the profile of metacognition of Subject F in learning through RME as shown in Figure 6 below.

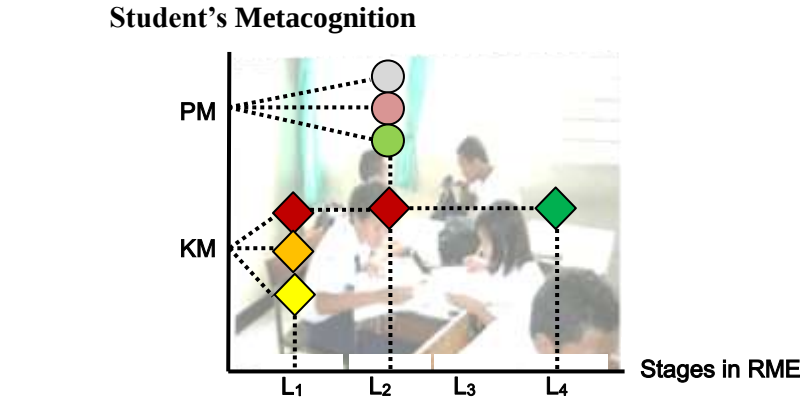


Figure 6. The Profile of The Metacognition of Subject F in Learning through RME

D. RESEARCH FINDINGS

First, of six subjects in this research, four of them (A, E, B dan F) implemented metacognitive knowledge and metacognitive skill consistently in learning through RME. Therefore, it could be stated that subjects A, E, B and F applied their metacognitive ability in the learning. Whereas subjects C and D had not consistently implement their metacognitive ability in the learning. However, those were caused by individual factor. Hence, it could be stated that Subjects C and D had not implemented their metacognitive ability in the learning.

Second, of four subjects applying their metacognitive ability in the learning, Subjects A and E were students with high ability, Subject B was student with moderate ability, and Subject F was

student with low ability. Therefore, it could be stated that the students were able to implement their metacognitive ability in the learning, without considering their academic ability. This means that those with high, moderate and low abilities applied their metacognitive ability in the learning with RME.

E. CLOSING

First, the profile students' metacognition in learning through RME, that is: (1) the profile of students' metacognition when understanding contextual problem, namely: (a) Subjects A, B, E and F applied: predicting, planning and monitoring skills; (b) Subject C implemented planning and monitoring skills; (c) Subject D applied planning skill. (2) the profile of students' metacognition in carrying out contextual problem, that is: (a) Subjects A, B, C, E and F applied: declarative, procedural, conditional knowledge, along with monitoring skill; and (b) Subject D implemented: procedural and conditional knowledge. (3) the profile of students' metacognition in comparing and descussing answer, that is: (a) Subject A applied: declarative, procedural and conditional knowledge, along with monitoring skill; (b) Subject B and E executed evaluation skill and did not apply declarative, procedural and conditional knowledge, along with monitoring skill; (c) Subject C, D and F did not apply metacognitive knowledge and metacognitive skill. (4) the profile of students' metacognition in concluding answer to the contextual problem, that is: (1) Subjects A, B, E and F implemented evaluation skill; and (b) Subjects C and D did not apply metacognitive knowledge and metacognitive skill.

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