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# STUDENTS' METACOGNITION PROFILE BASED ON SOLO TAXONOMY AT RELATIONAL AND EXTENDED ABSTRACT LEVELS

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**ABSTRACT**

Penelitian ini bertujuan untuk mengevaluasi kemampuan metakognisi siswa berdasarkan taksonomi SOLO pada level *relasional* dan *extended abstrak*. Jenis penelitian yang digunakan yaitu kualitatif dengan metode penelitian deskriptif. Teknik pengumpulan data dilakukan dengan tes dan wawancara tak terstruktur. Teknik analisis data yang digunakan dengan model Miles and Huberman yaitu *data reduction, data display,* dan *conclusion*. Hasil penelitian didapat bahwa subjek pada level *relasional* dan *extended abstrak* melakukan semua kegiatan metakognisi tetapi indikator yang dicapai dalam menyelesaikan soal HOTS materi barisan aritmatika berbeda-beda. Subjek SR-1 mampu melalukan indikator perencanaan namun masih terdapat kesalahan, mampu melakukan indikator pemantauan dengan benar, dan melakukan indikator namun masih terdapat keesalahan. Subjek SR-2 mampu melalukan indikator perencanaan dengan benar, mampu melakukan indikator pemantauan tetapi masih terdapat kesalahan, dan melakukan indikator penilaian dengan benar. Subjek SR-3 mampu melakukan indikator perencanaan, pemantauan, dan penilaian dengan benar. Subjek SR-4 mampu melakukan indikator indikator perencanaan namun masih terdapat kesalahan, mampu melakukan indikator pemantauan dengan benar, dan melakukan indikator penilaian namun masih terdapat kesalahan. Subjek SEA-1 & Subjek SEA-2 mampu melakukan indikator perencanaan, pemantauan, dan penilaian dengan benar.

*The aim of this research is to evaluate students' metacognitive abilities based on the SOLO taxonomy at the relational and extended abstract levels. This study adopts a qualitative research approach with a descriptive research method. Data collection techniques include tests and unstructured interviews. Data analysis techniques, following the Miles and Huberman model, involve data reduction, data display, and conclusion drawing. The results showed that subjects at the relational and extended abstract levels performed all metacognitive activities, but the indicators achieved in solving HOTS*

*problems on arithmetic progression varied. Subject SR-1 was able to perform planning indicators, but with errors, could monitor correctly, and performed evaluation indicators, but with errors. Subject SR-2 was able to plan correctly, could monitor but with errors, and performed evaluation indicators correctly. Subject SR-3 was able to perform planning, monitoring, and evaluation indicators correctly. Subject SR-4 was able to perform planning indicators, but with errors, could monitor correctly, and performed evaluation indicators, but with errors. Subjects SEA-1 and SEA-2 were able to perform planning, monitoring, and evaluation indicators correctly.*

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## 1. INTRODUCTION

The students' awareness in solving problems is undoubtedly important, as with this awareness, they can understand whether the problem-solving process they conducted is correct, the accuracy of its correctness, and also capable to evaluate whether the mistakes in solving the problem lies in conceptual or procedural understanding. This types of awareness is known as metacognition (Amir & Kusuma W, 2018).

Metacognition has an important role in solving mathematics problems. This is in line with (Elita et al., 2019), which states that metacognition plays a very important role in solving problems. In this case, students will become more aware of their own thinking abilities and evaluate themselves regarding the results of their thinking abilities. In the process of problem solving, students require awareness to organize their ideas by using their knowledge and reflect the process and results of their own thinking. This awarenes helps them in solving the problems (Novita et al., 2018).

Metacognition involves students' understanding and beliefs about how they processed the information and material learned, as well as their conscious efforts to engage in thinking and behavioural process that able improve their learning process and memory. Students might aware of their thinking ability and evaluate the results of their own thinking ability, thus improving their thinking awareness in learning achievement. The more students recognise their metacognition, the better their learning process and results. Each student has their own abilities in solving problems, according to Arum (2017) the mastery of students' metacognition abilities' indicators are identified through three main aspects, namely planning, monitoring, and assessment (Rustina & Muzdalipah, 2023).

A number of researchers have found that metacognitive ability is a key factor in successful mathematical problem solving. Problem solving activities are intrinsically connected to cognitive processes. Biggs and Collis (1982) suggested that each cognitive level shows a progression of responses from simple to a more conceptual one. This theory is known as Structure of the Observed Learning Outcome (SOLO), which describes the structure of visible learning outcomes. The Structure of Observed Learning Outcomes' (SOLO) taxonomy can be used to measure student responses or answers in solving problems which are divided into 5 different levels, namely prestructural, unistructural, multistructural, relational and extended abstract (Luruk et al., 2021).

The studies of metacognitive abilities have been widely conducted, such as from (Rustina & Muzdalipah, 2023) who investigates students' mathematical metacognition based on intelligence quotient (IQ), whereas (Handayani et al., 2021) examines the characterisation of metacognitive abilities in solving problems on straight line equation material. However, the studies that examined the profile of metacognition based on SOLO taxonomy are still limited. Meanwhile, the facts in the field obtained by researchers from interviews with several mathematics teachers at SMK Negeri 3 Tasikmalaya City, in solving mathematics problems, students sometimes use inappropriate solution steps and avoid alternative approaches. They tend to simply follow the procedures taught by the teacher without exploring their own methods. The students have not fully realised their own weaknesses. Therefore, it is important to evaluate students' metacognition ability based on SOLO taxonomy.

According to research conducted by Biggs and Collis (1982) and Romberg (1992) in (Listiana et al., 2013) stated that at an average age of 17 years, students are at the relational level in SOLO taxonomy. This shows that generaly the students of class X of Vocational High School (SMK) are 16 years old, thus they are experiencing a transition from the multistructural level to the relational level. Therefore, this study only focused on the Relational and Extended Abstract levels.

## 2. METHOD

### 2.1. Research Subject

The research subjects in this study were the students of class X Visual Communication Design of SMK Negeri 3 Tasikmalaya semester II of the 2023/2024 academic year. The subjects in this study were selected based on the results of written tests and the students were taken at the relational and extended abstract levels and fulfilled each metacognition indicator. From the test results, it was obtained that from 34 students who categorised into the relational level, 4 students and 2 students were categorised into the extended abstract level.

### 2.2. Data Collection

The data collection method used in this study was descriptive qualitative research. According to (Ruseffendi, 2005) Descriptive research is a type of research that utilised observations, interviews, or questionnaires or describe the current situation related to the subject. This research method was used to analyse students' metacognition profile in solving HOTS problems based on SOLO taxonomy.

The instrument used in this research was the researcher itself. (Sugiyono, 2016) stated that in qualitative research, the main research is the researcher itself, furthermore other instruments might be developed to complete the data. The data collection techniques In this study were divided into two parts, namely test techniques and non-test techniques. The test technique obtained the data through written procedural steps in solving problems, whereas the non-test technique involved interviews to clarify the analysis of problem solving. In this study, the researchers conducted a metacognition test in the form of a description test (Essay). The metacognition test was validated by the validator then given to students to categorise into SOLO taxonomy based on (Hardina & Jamaan, 2018).

**Table 1** Indicators achieved on the SOLO Taxonomy

| SOLO Taxonomy Level | Indikator Achieved |
|---|---|
| *Relational* | Students write down the known information and the questions asked from the given problem.<br>Students have the ability to create plans and choose strategies in solving problems.<br>Students are able to complete the chosen strategy |
| *Extended Abstract* | Students write down the known information and the questions asked from the given problem.<br>Students are able to create the plan and select the problem solving strategies<br>Students are able to complete the chosen strategy<br>Students analyse the problem solving steps and interpret the intended answer from the given problem.<br>Students verify it with other solutions<br>Students are able to discover new formulas from the solutions made thus they are able to verify the answers obtained. |

Table 1 is used to categorise the students into SOLO taxonomy's levels. The metacognition indicators used refer to the indicators from (Choridha et al., 2019) found in Table 2.

**Table 2** Indicators of Metacognition Ability

| Metacognition Ability Indicators | Measured Aspect |
|---|---|
| *Planning* | - Stating what is known in the problem<br>- Stating what is the question<br>- Able to involve the information in the problem to design a plan for solving the problem |
| *Monitoring* | - Determining the solution steps to applied<br>- Implementing the solution steps correctly |
| *Evaluating* | - Writing the final answer<br>- Assured with the final answer<br>- Writing the conclusion correctly |

## 2.3. Data Analisys

The data analysis technique adopted in this research were the data analysis approach proposed by Miles and Huberman (1984) in (Sugiyono, 2016). This approach includes three main stages: data reduction, data presentation, and conclusion. After collecting research data, the data reduced (summarised) to determine the focus of the research and interviewed the research subjects to determined their metacognition. Furthermore, the data is described or presented in narrative form. Finally, the data is concluded to present the findings.

## 3. RESULT AND DISCUSSION

The leveling process were conducted by describing and analysing the subject's problem solving process on the test given, the results of student's work and interviews related to activities in solving the test, used by the researcher to determine the level of student problem solving based on SOLO taxonomy, as well as to explore the students' metacognition process that occurs at relational and extended abstract level of SOLO taxonomy.

### *Relational Subject (SR-1, SR-2,SR-3 dan SR-4)*

The subject's metacognitive process at the relational level in answering questions, reflect when in the planning indicator the subjects are all able to write down what is known and asked in the problem and all subjects at the relational level are also able to involve the information contained in the problem for designing a plan for solving the problem. However, in the subjects SR-1 and SR-4 there was a mistake in writing the difference at point b, it should be negative. However, for the next work SR-1 and SR-4 used negative and when being interviewed SR-1 and SR-4 realised their mistake.

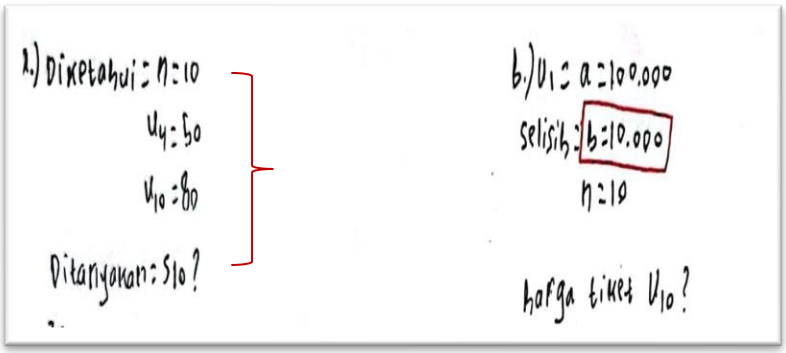


**Figure 1.** Planning Indicator' Work

The relational level on the observation indicator able to determine and explain and also implement the solution steps by using previous knowledge that have been learned to create a mathematical model to determine the values of a and b by using elimination and substitution and used the formulas that previously have learned.

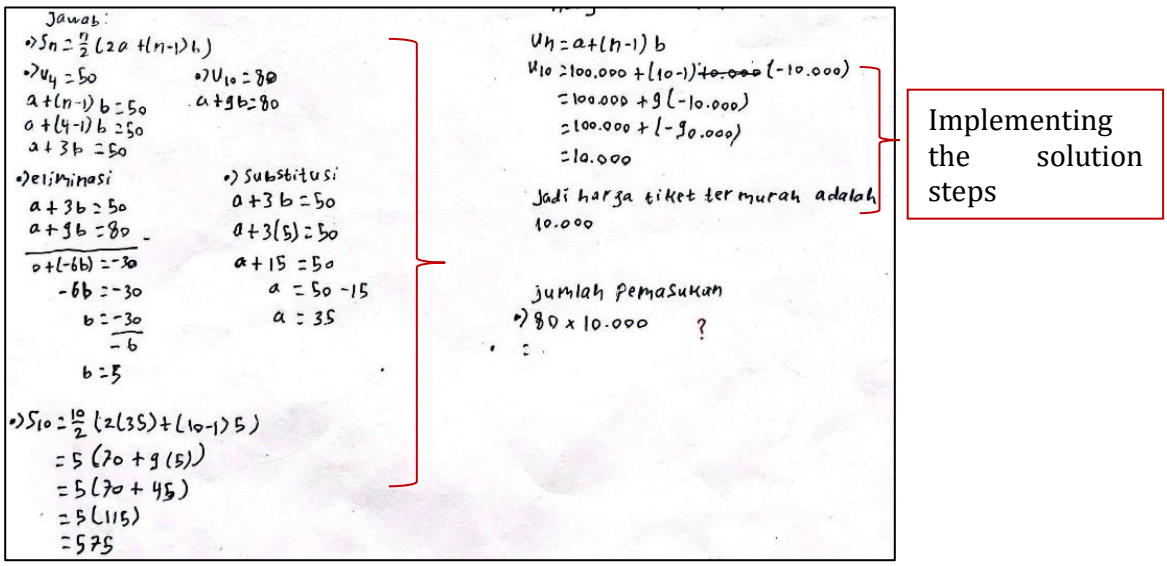


**Figure 2** Monitoring Indicators' Work

The relational level on the assessment indicator all subjects wrote the final answer, wrote the conclusion, and were convinced of the final answer they obtained however they were unable to test whether the answer was correct or incorrect by using other alternatives.

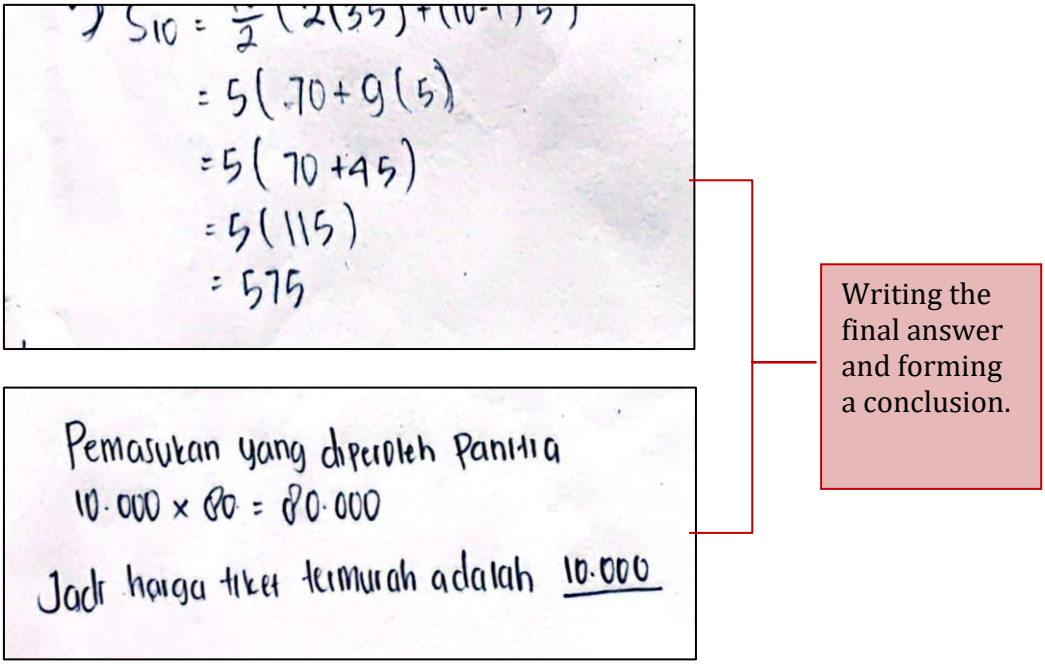


**Figure 3.** Assessment Indicators' Work

Subjects SR-1, SR-2, SR-3 and SR-4 with relational level, from the analysis conducted, the subjects at relational level in planning stage were able to state what is known and what is asked in the problem correctly. All the subjects at this level are able to understand the information & the problems thus they were able to determine the concepts used by combining the separate information fragments in the problem to produce the right solution, they have passed the multistructural level because they were able to understand all the statements given and associate the statements with the problem. At the monitoring stage All subjects at the relational level were able to identify and understand the information thus enabling them to apply the concepts used, namely the average by using prior knowledge to create a mathematical models to determine the values of a and b by using elimination and substitution and applying the formulas and all the subjects were able to implement the solution plan. It is aligned with Biggs and Collis (Hasan, 2017) which stated that relational level is the level where learners use all data/information to apply concepts or processes and then provide temporary results and correlate with other data or processes thus enabling them to elaborate an explanation of the final answer that is relevant at the assessment stage. at this stage SR-1, SR-2, SR-3 and SR-4 were able to compile the final answer and were convinced of the answer they had obtained but they could not prove their beliefs by using other alternatives.

***Extended Abstrak Subject (SEA-1 dan SEA-2)***

Subjects SEA-1 and SEA-2 at the extended abstract level, from the analysis conducted, at the planning stage SEA-1 and SEA-2 were able to state what is known, asked correctly. SEA-1 and SEA-2 were able to understand the information and problems thus they were able to determine the concepts needed to combine separate fragments of information in the problem to produce a correct solution, indicating that they have passed

the multistructural level because they were able to understand all the statements given and corelate the statements to the problem. At the monitoring stage, SEA-1 was able to determined and explained and also implemented the solution steps using prior knowledge as the subjects at the relational level.

Furthermore, SEA-1 and SEA-2 were able to demonstrate a higher understanding of the concept by looking for other alternatives to ensure the correctness of the answers they had obtained using previous knowledge & formulas that they have learnt (Luruk et al., 2021). This is also in line with Biggs and Collis in (Hasan, 2017) which stated that the Extended Abstract level is a level where students use all data or information then apply the concept/process then provide relevant results and enable to make other alternatives from the results obtained.

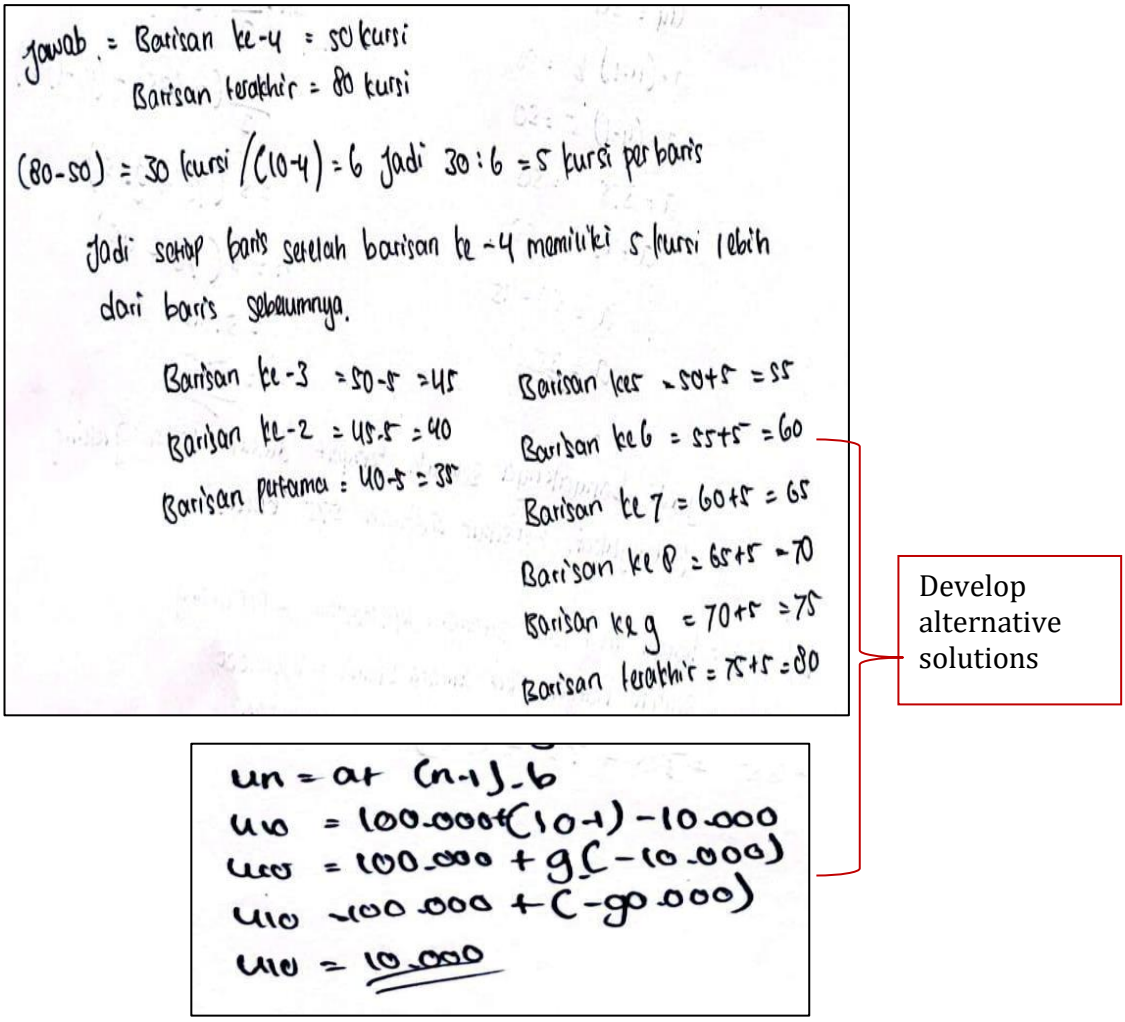


**Figure 4.** SEA-1's Works on Assessment Indicators

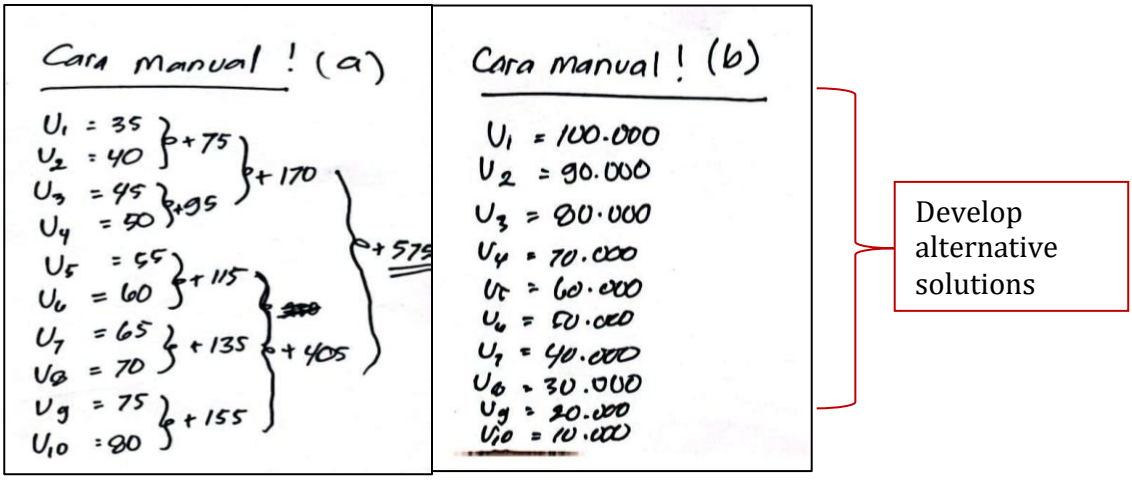


**Figure 5.** SEA-2's Works on Assessment Indicators

## CONCLUSION

Based on the results and discussion of the research regarding metacognition abilities based on SOLO taxonomy at the relational and extended abstract levels, it can be concluded that the subjects at the relational and extended abstract levels perform all metacognition activities however the indicators achieved in solving HOTS questions on arithmetic sequence material are different. Subject SR-1 was able to conduct planning indicators however there were still some mistakes, able to conduct monitoring indicators correctly, and conduct assessment indicators however there were still some mistakes. Subject SR-2 were able to conduct the planning indicators correctly, able to do the monitoring indicators however there were still mistakes, and conduct the assessment indicators correctly. Subject SR-3 were able to conduct the planning, monitoring, and assessment indicators correctly. Subject SR-4 were able to conduct the planning indicators however there were still errors, enable to conduct the monitoring indicators correctly, and performed the assessment indicators however there were still mistakes. Subject SEA-1 & Subject SEA-2 were able to perform the planning, monitoring, and assessment indicators correctly.

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