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# Abstract Level Characteristics in SOLO Taxonomy during Ethnomathematics Learning

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**Abstract:** ***The purpose of this research was to describe the character of students who are at the abstract level according to SOLO Taxonomy. This research was explorative-qualitative research with this research subject was three students of SMA Kota Bengkulu chosen purposively. Data collection using task-based interviews. The main instrument was the researcher himself guided by the interview guide sheet. Data were analyzed by genetic decomposition analysis. The results of this study are the quality of students' responses are between the relational level and the extended abstract, therefore the students are included in the abstract level classification. The subject's abstract level character can explain the relation of the given statement to an argument in solving the problem, able to explain the usefulness of each statement used to solve the problem, it seeks to make a new statement beyond its original statement by referring to the existing statements, but not managed to prove the truth.***

**Keywords:** SOLO Taxonomy, abstract level

## 1. Preliminary

Mathematics was a compulsory subject for elementary and middle school students. To be able to determine the level of mathematical understanding, the teacher must determine what can be observed as a representation of student thinking internally (Widada, 2017). Education can arrange the indicators of student learning achievement. Therefore, it takes the classification of student achievement in the form of taxonomy. It was like Bloom's two-dimensional taxonomy (Anderson, et al., 2001), the SOLO ( *Structure of Observed Learning Outcome* ) Taxonomy (Biggs & Collis, 1982). The SOLO taxonomy was designed as an evaluation tool of the quality of student responses to a task (Biggs & Collis, 1982; Biggs, 1995; 1999). There are five levels of taxonomy, namely *prestructural, unistructural, multistructural, relational, and extended abstract*. Biggs & Collis (1982) describes that At a prestructural level of understanding, students' responses show that they have lost the core of new learning. Unistructural students, learning outcomes show an understanding of one aspect of the task, but this understanding was limited. Students who are at the multistructural level, some aspects of the task are understood but their relationship to each other, and the whole was not answered. As for relational students, ideas are interrelated and provide a coherent understanding of the whole. Student learning outcomes show comparative evidence, causal thinking, classification, sorting, analysis, whole-part thinking, analogy, application and question formulation. At the highest level was the extended abstract students, the understanding at the relational level was rethought at a higher level of abstraction, it was transferred to another context. Student learning outcomes show predictions, generalizations, evaluations, theories, hypotheses, creations, and/or reflections.

In accordance with the quote, SOLO was a hierarchical taxonomy based on structural analysis of questions and answers characteristics (Hattie & Brown, 2004). It identifies the characteristics of increasing the quantity and quality of thought. The quantity increase was at prestructural, unstructural and multistructural level. The level of a relational and extended abstract was an improvement in the quality of students' responses. Therefore, SOLO developed by Biggs and Collis (1982) taking into account many factors that influence student learning. The quality of students' responses in the form of constructs that have both quantitative and qualitative dimensions.

According to Biggs and Tang (2007), SOLO taxonomy was a quality rating of students' real responses to various similar tasks. SOLO Taxonomy provides a systematic way to describe how the performance of students in understanding academic tasks. A student can be at a low level and other students can be at a higher level.

Biggs and Tang (2011) state that the student response structure that appears at each stage uses the accuracy of elements and operations, as well as increased complexity. This was the basis of the formulation of the learning cycle on the SOLO taxonomy, namely prestructural, unistructural, multistructural, relational and extended abstract. The SOLO taxonomy was an evaluation approach and classification of cognitive performance in accordance with the observed learning outcomes (Chick1, 1998).

Taking into account SOLO taxonomic levels, there was a somewhat distant leap, ie, a jump from the multistructural to the relational levels, and from the relational level to the *extended abstract*. Therefore, this SOLO leveling was still somewhat crude. This was consistent with Collis & Biggs (1986) that transition responses between SOLO levels have no description. Based on Sunardi's (2006) study, two students found not belonging to one level of the SOLO taxonomy were able to respond to the problem of an algebraic nature of a real number, in the form of integrating two or more information provided, but the integration was not coherent. Both of these students have exceeded the multistructural level but can not yet be said to reach the relational level.Thus the SOLO taxonomic smoothing hypothesis was generated: between the two levels there was another level, call the *semi-relational* level. Description for *multi structural* level in response to more than one element separately.

The next level was *semirelasional* with description, the response to more than one integrated element was not good (incoherent) (Sunardi, 2006 ).The higher level of the semi-*relational* level was the *relational* level. *Relational* students create responses over one coherent integrated element for a particular case.

Therefore, the SOLO T taxonomy becomes a new taxonomy. This taxonomy was a hypothesis. This hypothesized taxonomy was called the SOLO Plus Taxonomy (TSP). TSP was hypothesized to consist of seven levels: Level 1: *prestructural*, Level 2: *unisructural*, Level 3: *multistructural*, Level 4: *semi relational*, Level 5: *relational*, Level 6: *abstract*, and Level 7: *extended abstract* (Sunardi, 2006). S ISWA which was at the level *extended abstract* can find general principles of integrated data that can be applied to new situations, and students can understand the high-level concepts (Sunardi, 2013). But what was the character of the student who was at the abstract level and how are the characteristics of that level?

Characteristics of students' mathematical thinking responses can be explored during mathematics learning. Math learning should be close to the mind of the students (Widada, 2016). Therefore, according to Widada & Herawaty (2017), in need of mathematics learning based on ethnomathematics as a starting point. Ethnomathematics was a mathematics that considers the quantitative, relational and cultural aspects of society that are integrated with the concrete things that the learners can observe or understand through the process of mathematization. This can be done through reflection from the real world, through a process of empirical abstraction (Gravemeijer, 2004; 2008).

To achieve abstract mathematical concepts, it takes a process of abstraction by students. The results of Widada & Herawaty (2017) study that by applying realistic mathematics learning based on Bengkulu ethnomathematics can improve students' concept comprehension ability. Increased cognitive level of students from Level 0 to Level 1 by 32%. Merekan recommends the need to develop a mathematics learning tool through realistic mathematical learning model oriented through Bengkulu ethnomathematics that was valid, practical and effective to improve Mathematical Representation, Mathematical Communication, and Problem Solving among students of Bengkulu Province. Thus, this research attempts to explain and trace in depth about the characteristic of students who are at an abstract level in SOLO Taxonomy during the mathematics learning oriented of ethnomathematics.

## 2. Method

This research was an explorative-qualitative research designed to determine abstract level characteristics with a natural background. The subjects of this research are 3 students of SMA Kota Bengkulu chosen purposively during the learning of mathematics with the starting point of ethnomathematics. Data collection using *task-based interviews* (Davis, 1984; Widada, 2003).Interviews are used to determine the naturalistic indicators emerging from students during a response to the given problem. The main instrument was the researcher himself guided by the interview guide sheet. The interview process was recorded using an *audiovisual recorder*.From this result will be obtained data in the form of results sheet filling tasks, and cognitive processes are recorded in videocassettes, as well as other records of observations. Data were analyzed by genetic decomposition analysis. *Genetic decomposition* was a structured collection of mental activities done by the subject to describe how mathematical concepts/principles can be developed in his mind (Widada, 2003).

## 3. Research Research and Discussion

Analysis of genetic decomposition of the structured collection of mental activities conducted subject obtained characteristics of research subjects. There was one subject of research that was at the abstract level. The subject was explored to get the real character. An analysis of the algebraic nature of the set of real numbers was done through the following interviews.

*Q: Did you finish the task I gave you?*
*SIS.02: Yes, it's ... sir.*
*P: Alright ... please explain your work?*
*SIS.03: Since a> b, and 3a are known in the problem, then a a + a> a + b and a + b> b + b*
*SIS.04: Then 2a> a + b and a + b> 2b, and equally divided by 2*
*Q: Why divide by 2?*
*SIS.05: As was known, that was 1) and 2) that exist in the matter, and 3) c), and 2 are not equal to zero, then ½ was also not equal tozero.Therefore,2.½= 1.*
*Q: Why are 2 not equal to zero?*
*SIS.06: Because 2 was the original number and according to 2) then 2 positive numbers.*
*P: Okay. What's your next move?*
*SIS.07: Yes ... from the step on the third row, the fourth row was obtained a> 1/2 (a + b) and ½ (a + b)> b. so as to obtain the seventh row a> ½ (a + b)> b, and means proved.*

Based on interview footage, SIS can use all the statements given to solve the problem, SIS can explain the relation of the given statement to an argument in solving the problem, and SIS explain the usefulness of every statement used to solve the problem. This indicates that SIS was beginning to appear at the Relational Level (Bigg & Colis, 1982). Further analysis continued with the following interview footage.

*P: Continue with Statement b.*
*SIS.09: For a = 0, it turns out the statement was wrong, which means not proven*
*P: ... What was your reason?*
*SIS.10: This sir ... on these lines [SIS pointed correctly on the answer paper ....]*
*SIS.11: Next b positive!*
*Q: Then what can you explain?*
*SIS.12: Yes, it proves for any real number a and b, then whatever real number a and b must satisfy the statement a.*
*Q: Well ...*

*SIS.14:...This means the conclusion that part b I unplug ... my conclusion was wrong.*
*Q: Why?*
*SIS.15: ... the steps I'm working on actually keep using known statements.*
*P: Okay ... more ...*
*SIS.16: ... Means I have not found another way to prove a statement a.*

Based on this excerpt, the subject tries to make a new statement as a result of proven proof. He describes the compiled statements as a result of existing statements by using good arguments and drawing conclusions that have been made on *paper and pencil*, but SIS has not been able to prove it.

*Q: Next explain the statement c?*
*SIS.17: If a / b = 0 then the above statement was not proven, ... this confuses me.*
*Q: What happened?*
*SIS.18: ... ..Forif a / b = 0, ... in order for this to be true b must not be zero, it means a which must be zero, and this has been corrected from my answer in part b.*
*Q: Now make your conclusion?*
*SIS.19: I can not find any other statement as a result of the above statement.*
*P: Try you think now?*
*SIS.20: ... I must how ... .. from my description before, I take eg a = 0, this will result ... ...*
*Q: You try to prove your last statement?*
*SIS.21: ... only up to this ability I thank you, sir ...*

This footage shows that SIS was trying to make a new statement beyond its original statement by referring to existing statements, but failing to prove the truth.

A collection of mental and physical activities of SIS Subjects, it means that subjects can use all the statements given to solve the problem. He can explain the relationship between the given statements to an argument in solving the problem. It explains the usefulness of each statement used to solve the problem. SIS seeks to make new statements as a result of proven statements. He also describes the compiled statements as a result of existing statements by using good arguments and drawing conclusions that have been made on *paper and pencil*, but the subject has not been able to prove it. SIS sought to make a new statement beyond its original statement by referring to existing statements but failed to verify. The properties of this subject have exceeded the *relational* level, but *have not yet entered* the *extended abstract* level. This means that SIS was at an *abstract* level. In addition, during a task-based intervention to SIS can explain well and correctly, and can revise errors that he did, after the task-based interviews.

When confirmed with the results of Sunardi (2006), this study supports the results of his research. S students at the Prestigious Level can substitute integers, eg 2.3 to the statement and state it as proof, ie if 3> 2 then 3> ½ (3 + 2)> 2. At the Unstructural Level, students only use 3 a) information to be manipulated as evidence. For Level Kerakter Multistruktural, students use information 1) and 3 a) just to show the true statement "Eg a, b ∈**R.** a> b ⇒ a> ½ (a + b)> b ", but there are still arguments used outside the given information. While students who are at Level 3 Semirelasional, using information 1) and 3 a) and 3 c) are integrated to show the correct statement "For example a, b δι**R.** a> b ⇒ a> ½ (a + b)> b ", but multiplication by ½ on both sides of the inequality was done without using 1, 2 and 3b supporters). Relational Level students have the characteristic of being able to use all the information provided to show the truth of the statement "Eg a, b ∈**R.** a> b ⇒ a> ½ (a + b)> b ".This verification he did right. For Abstract Level students, can use all the information provided to show the correct statement "Eg a, b ∈**R.** a> b ⇒ a> ½ (a + b)> b ".This verification he did right. He tried to make an analogy to a certain number eg 0, 2 real numbers. Because 2> 0 then 2> 1> 0. Finally, the student was at Level Extended Abstract, can use all the information provided to show the correct statement "For example, a, b ∈**R.** a> b ⇒ a> ½ (a + b)> b ".This verification he did right. He can formulate new principles. Like "If a ∈**R.** a> 0 ⇒ a> ½a> 0. "; "If a ∈**R** such that 0 ≤ a <b for each b positive real number, then a = 0 ".

The results of this study found abstract level characteristics for SOLO Taxonomy that students can perform mental and physical activities as a response to the initial stimulus on the problem of algebraic properties in the set of real numbers, which was represented in the form of writing on paper. He can use all the statements given to solve the problem. Subjects can explain the relationship between the given statements to an argument in solving the problem and explain the usefulness of each statement used to solve the problem. He attempted to make a new revelation as a result of a proven assertion, explaining the compiled statements as a result of existing statements by using good arguments and removing conclusions made on paper and pencil but having not been able to prove them. Although the subject tries to make a new statement beyond the original statement with reference to the statements that exist but failed to prove the truth. This supports the research of Herawaty, D. & Rusdi (2016) that students can perform vertical mathematical processes as long as they are able to think abstractly.

## 4. Conclusion

Based on the analysis of genetic decomposition, it can be concluded about the quality of student responses referring to SOLO Taxonomy being between the relational and extended abstract levels, therefore the students are included in the abstract level classification. The character of the student who was at the abstract level was able to use all the statements given to solve the problem, can explain the relation of the given statements to an argument in solving the problem, able to explain the usefulness of each statement used to solve the problem, as a result of a proven statement, can explain the statement composed as a result of the existing statement by using good arguments and drawing conclusions that have been made on paper and pencil, but have not been able to make the proof, and he tried to make a new statement more than his original statement refers to the existing statements, but fails to prove the truth.

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