The contribution of metacognitive in the inquiry-based learning to students' thinking skill based on SOLO Taxonomy

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Abstract. Thinking skill based on SOLO (Structure of Observed Learning Outcomes) taxonomy and metacognitive are two variables on which many researches start to be conducted throughout the world and in Indonesia. That there is no investigation to study the contribution of metacognitive towards thinking skill base on SOLO taxonomy. This research aimed to examine the contribution of metacognitive toward students' thinking skill based on SOLO taxonomy through inquiry-based learning implementation. This research was correlational research which connects an independent variable (Metacognitive) and a dependent variable (thinking skill). This research takes 104 students of XI_{MIA} grade of SMA Negeri 01 Manokwari as its participants. The collected data were evaluated used rubric of metacognitive and thinking skill and analyzed by employing simple regression method. The results showed that $P < 0.05$, indicating that metacognitive contributes towards students' thinking skill based on SOLO taxonomy for 51.5%. Based on findings related to student metacognitive, learning is more focused on teaching that can train students' metacognitive by considering appropriate learning model, one of which is inquiry-based learning.

1. Introduction

In the last decade, youngsters' interest in science is declining, but biology remain their favorite [1]. Students' investigation process in learning, particularly in biology learning, has not been well developed [2]. The 21st-century learning suggests using inquiry-based learning in in-class learning process [3]. In the last century, inquiry-based learning has been widely implemented in Senior High Schools [4]. Science learning environment is highly influenced by inquiry-based learning [5].

It is suggested for future researches to employ inquiry to assisting students in developing their metacognitive [6]. Metacognitive is a predictor of student's success is 90% [7]. Students' academic success is related to their metacognitive skill [8]. Metacognitive skill needs to be empowered or developed since learners with high metacognitive skill will also have higher learning outcome. Based on the results of observation conducted in SMA Negeri 01 Manokwari, learners' metacognitive skill has not well developed since their teachers still apply conventional learning model in the form of discussion and expository learning. Developing learners metacognitive skill requires a learning model which may improve their learners' metacognitive skill, which is inquiry-based learning.

In addition to metacognitive skill, students' thinking skill must also be developed. Development of students' thinking skills needs to be done because there are still students who are low thinking skills [9]. In-class learning is implemented on the purpose that students will have good attitude and skill, good creativity and concept proposing ability and to make them understand problems, particularly those related to biology materials taught by teachers [10].

Thinking skill may be measured by employing SOLO (Structure of Observed Learning Outcomes) Taxonomy. SOLO taxonomy consists of five levels, namely prestructural level, unistructural level, multicultural level, relational level and extended abstract [11]. SOLO taxonomy may be implemented in class in various subjects, both process oriented (focusing on practice) and concept oriented (focusing on outcome), such as mathematics [12], chemistry [13], biology [14,15], sociology [16], and computer science [17] from secondary school to higher education [18,19].

Teachers use SOLO taxonomy to plan, describe, recognize and create learning outcome, learning experience and learning assessment in various cognitive difficulty levels to fulfill highly expected goals of curriculum development and competency standard [20]. SOLO taxonomy may be favorably utilized to evaluate students' ability, determine students' weakness and strength in learning and reduce such weakness [21]. When students are involved in inquiry nature, SOLO level of students can achieve an extended abstract. In the pretest, the 1 student reaches extended abstract, and the posttest increases to 24 [22].

In inquiry-based learning, students will briefly think to search for and find an answer for a given question in learning, thus they are not only required to master any materials, but also to utilize their potentials in order to develop their metacognitive skill. If their metacognitive skill develops well, their learning outcome and thinking skill will also be influenced.

To solve problems in inquiry-based learning, students need metacognitive [23]. in which they start with answering question, and then continue to solving factual problems from their observation [24]. Guided inquiry-based learning quite successfully enhances students' metacognitive skill [25], and, in other cases, inquiry-based learning in mixed learning also enhances students' metacognitive [2]. In learning, human brain needs nutrition, and substantive nutrition is metacognitive [26]. High level thinking activity is also called metacognitive, since thinking process in someone's mind is controlled by his metacognitive [27]. Changing students' learning process from passive to active learning and developing students' thinking skill in integrated science, including biology, may be made by implementing inquiry-based learning [25].

According to the description above, it is explained that inquiry-based learning help develop students' metacognitive skill and thinking skill. Each of the skills is well trained using inquiry-based learning and influences their success in learning. However, the contribution of metacognitive skill towards thinking skill has not been found, particularly thinking skill based on SOLO taxonomy. Thus, this paper attempts to study the contribution of metacognitive skill towards Senior High School students' thinking skill based on SOLO taxonomy.

2. Methods

This was a correlational research which connects an independent variable, which was Metacognitive (X), and a dependent variable, which was thinking skill based on SOLO taxonomy (Y). This research employs a simple thinking paradigm of description of the contribution of variable X to variable Y (contribution of metacognitive towards thinking skill based on SOLO taxonomy) on the topic of human coordination system.

The population of this research was all students of XI_{MIA} grade of SMA Negeri 01 Manokwari. The 104 samples from four classes are taught by employing inquiry-based learning. Students' metacognitive was measured used Corebima's rubric [28]. and students' thinking skill was measured used thinking skill rubric based on SOLO taxonomy. All of the rubrics were used on the learning outcome test. 12 learning outcome tests were validated by three experts, with result of validation of 0.986 (valid) and of reliability of 0.703 (reliable).

The data analysis was in the form of percentage of each achieved level of thinking skill based on SOLO taxonomy, comprising prestructural, unistructural, multistructural, relational and extended abstract. A simple regression analysis was employed to examine the contribution of metacognitive skill to thinking skill, with a normality test conducted before this analysis used Kolmogorov Smirnov's one sample.

Table 1. The Result of Normality

		Unstandardized Residual
N		104
Normal Parameters[a,b]	Mean	0E-7
	Std. Deviation	14.45937754
Most Extreme Difference	Absolute	0.59
	Positive	0.50
	Negative	-0.59
Kolmogorov-Smirnov Z		0.607
Asymp. Sig. (2-tailed)		0.855

Table 1. showed that 0.855 > 0.05, it mean that the metacognitive and thinking skill was normality.

3. Result and Discussion

This article presents data in the form of percentage of each achieved level of thinking skill based on SOLO taxonomy and regression analysis results. The data analysis results are presented below:

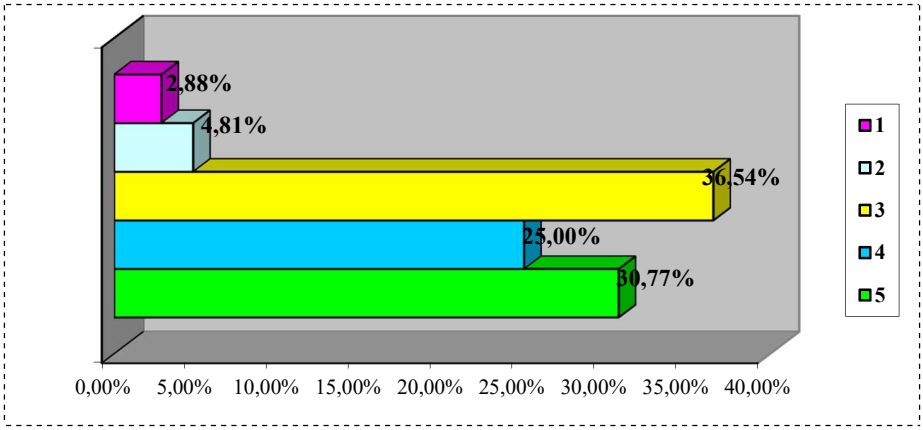

Figure 1. Graph of achieved level of thinking skill based on SOLO taxonomy; (1) prestructural, (2) unistructural, (3) multistructural, (4) relational, and (5) extended abstract

According to the graph of figure 1 above, it is found that the 104 students achieve different levels of thinking skill based on SOLO taxonomy. Two students achieve prestructural level, in which they have various answers for the given question and they do not understand the existing materials or, in other words, cannot complete the given question. Five students achieve the unistructural level, in which they are able to simply complete the question using one fact or information, but without explanation. The multistructural level is achieved by 38 students, in which they complete the question using two or more information and are able to correctly determine more than one method of completion. On the relational level, 26 students complete the question by connecting several methods of completion. On the final/highest level of thinking skill based on SOLO taxonomy, 32 students complete the question by connecting one new concept to previously taught concept.

The ascending order of percentages of students' achieved levels of thinking skill based on SOLO taxonomy is prestructural, unistructural, relational, extended abstract and multistructural. According to the order, the multistructural level is achieved by the highest number of students, which is different for 5.77 % with the extended abstract level and for 11.54 % with the relational level, which is the highest level of thinking skill based on SOLO taxonomy. Although the achievement of extended abstract level is lower than that of multi-structural level, but it is relatively high or not really different with the multi-structural level. In this research, we may state that students' achieved levels of thinking skill based on SOLO taxonomy in inquiry-based learning are good, since 92.31% of the students achieve from multi-

structural to extended abstract levels, while in previous research, only 75% out of 60 students achieve from multi-structural to extended abstract levels [16].

Table 2. ANOVA Summary of the relationship between metacognitive and thinking skill based on SOLO taxonomy in Inquiry-based learning

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	22861.573	1	22861.573	108.285	0.000[b]
	Residual	21534.581	102	211.123		
	Total	44396.154	103			

The Table 2 shows that 0.000 < 0.05, indicating that there is relationship between metacognitive and thinking skill based on SOLO taxonomy in Inquiry-based learning. Metacognitive becomes predictor for students' thinking skill based on SOLO taxonomy.

Table 3. Regression coefficient of the relationship between metacognitive and thinking skill based on SOLO taxonomy in Inquiry-based learning

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	25.711	4.964		5.180	0.000
	Metacognitive	0.865	0.083	0.718	10.406	0.000

The Table 3 shows that 0.000 < 0.05, indicating that the relationship between metacognitive and thinking skill based on SOLO taxonomy in Inquiry-based learning is significant. The regression equation model is y = 25.711 + 0.865x, which means that each one value increment of metacognitive enhances thinking skill based on SOLO taxonomy value for 0.865.

Table 4. Regression summary of the relationship between metacognitive and thinking skill based on SOLO taxonomy in Inquiry-based learning

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.718[a]	0.515	0.510	14.53008

The Table 4 shows that the R value is 0.718, indicating that there is strong relationship between metacognitive and thinking skill in Inquiry-based learning. The R square is 0.515, which means that metacognitive contributes about 51.5% to thinking skill based on SOLO taxonomy.

According to the research findings, it is examined that metacognitive contributes towards Senior High School students' thinking skill based on SOLO taxonomy in inquiry-based learning, particularly in the topic of human coordination system. Previous researches have studied metacognitive and students' thinking skill in inquiry-based learning, however, no study has been conducted on how metacognitive contributes towards thinking skill, particularly thinking skill based on SOLO taxonomy.

Students' involvement in high level thinking and learning needs investigation-based learning, which will be quite helpful for students to develop their thinking skill [29–31]. Other researches also show that inquiry successfully enhances students' metacognitive, and metacognitive becomes the main focus in inquiry development [2,25,32,33], in which these two variables contribute towards students' success in learning. As disclosed by previous researches, the author has not found to what extent the contribution of metacognitive towards students' thinking skill. The research findings show that metacognitive contributes for 51.5% towards students' thinking skill. Metacognitive and thinking skill based on SOLO taxonomy are related and, in addition, these two variables influences students' success in learning. Developing thinking skill based on SOLO taxonomy requires improvement of students' metacognitive, which may be performed by employing current development-pursuant learning. The inquiry-based learning that has been implemented with Senior High School students specifically on the human coordination system material in biology subject makes students' metacognitive enhanced, and metacognitive contributes to the development of students' thinking skill based on SOLO taxonomy.

However, metacognitive does not influences students' thinking skill based on SOLO taxonomy for 100%, since other 48.5% factors also have contribution.

4. Conclusion

According to the author's finding, it is concluded that biology learning, particularly on the topic of human coordination system, metacognitive contributes towards students' thinking skill based on SOLO taxonomy. To develop students' thinking skill, their metacognitive needs also to be developed. Students' good metacognitive will well influence their thinking skill. The highest percentage of achievement of students' thinking skill based on SOLO taxonomy is at multistructural level, however, the students' highest achieved level is that of extended abstract. Future researches may study the utilization of inquiry-based learning or instructional media to enhance students' thinking skill level based on SOLO taxonomy, or study the relationship of metacognitive and thinking skill based on SOLO taxonomy on different topic of discussion, other subject or other related variables.

Acknowledgments

The author would like to express his gratitude to the Ministry of Research and Technology and Higher Education for its funding through PKPT grant.

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