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Tracking Student's Order Thinking Process with AKT and Learning Path

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Abstract. This study is an exploratory qualitative, aimed to describe student's order thinking process in remembering, understanding, and applying cognitive level based on Anderson Krathwohl Taxonomy (AKT) with learning path. There are 2 dimensions of AKT that cannot be separated and are equally important to maximize the potential of students and teachers in the learning process as well as learning outcomes. AKT differentiates the dimensions of the cognitive process into 2 levels of thinking, are low order thinking for the C1-C3 categories and high order thinking starting from C4-C6. The student must be mastered first on low-level thinking before reached a higher level. The development of a student's order thinking process can be tracked with a learning path. A learning path is a route that students take to reach the learning goals. The selection of learning paths can be used as an alternative to developing student's thinking process and scaffolding. Teachers are free to determine the route they feel more efficient to build students' high-order thinking. The sample of this research was selected by purposive random sampling consisted of 3 students in each level of high, middle, and low academic ability (HAA, MAA, and LAA). The research procedure sets up with knowing student's abilities, preparing instruments, conducting research, and analyzing the data. Results are: 1) The students' thinking process could be accessed using AKT and learning path; 2) The thinking process of students is influenced by academic ability in terms of the learning path; 3) All research subjects have not been able to reach the highest thinking process tested, namely PC3 so that a deeper analysis is needed to determine the cause; and 4) Learning path can be used as a tool to track students' unattainable thinking processes and scaffolding the "missed" thinking process as a solution.

Keywords: *Student's order thinking process, remembering, understanding, applying, learning path*.

INTRODUCTION

Student's thinking process or student's order thinking process (SOTP) can be accessed with Anderson's Krathwohl Taxonomy (AKT). Initially, Bloom formulates higher forms of thinking in education to find out the level of cognitive or the level of thinking skills of the students, which is known as Bloom's Taxonomy. Later on, in 2001, Bloom's Taxonomy was revised by Anderson and Krathwohl because Bloom's use was aimed at the university level which made it less understood at the school level. Anderson et al. (2001) changed the cognitive level categorization from knowledge, comprehension, application, analysis, synthesis, and evaluation, to remembering, understanding, applying, analyzing, evaluating, and creating, coded as C1-C6. In addition to the cognitive dimension, Bloom also divides the level of thinking based on the dimensions of knowledge, namely factual, conceptual, and procedural, which is then added to the metacognitive aspect by Anderson & Krathwohl at a higher position than other thinking abilities as shown in Figure 1.

THE KNOWLEDGE DIMENSION	METACOGNITIVE	M	IDENTIFY	PREDICT	USE	DECONSTRUCT	REFLECT	CREATE
	PROCEDURAL	P	RECALL	CLARIFY	CARRY OUT	INTEGRATE	JUDGE	DESIGN
	CONCEPTUAL	C	RECOGNIZE	CLASSIFY	PROVIDE	DIFFERENTIATE	DETERMINE	ASSEMBLE
	FACTUAL	F	LIST	SUMMARIZE	RESPOND	SELECT	CHECK	GENERATE
			C1	C2	C3	C4	C5	C6
			REMEMBER	UNDERSTAND	APPLY	ANALYZE	EVALUATE	CREATE
			THE COGNITIVE PROCESS DIMENSION					

FIGURE 1. Anderson's Krathwohl Taxonomy (2001)

The two dimensions of AKT cannot be separated and are equally important to maximize the potential of students and teachers in the learning process as well as learning outcomes. Marzano & Kendall (2007) argue that the two dimensions of AKT make it easier for teachers to define the definition of learning objectives wished to be achieved, changes in cognitive skills, and learners' knowledge as in the 24 thinking process boxes (Figure 1). The contact between the two dimensions cannot be avoided because the process of thinking requires knowledge, whereas knowledge must be processed at the appropriate cognitive process level so that students can understand and apply it (Alimuddin & Hariati, 2019).

AKT differentiates the dimensions of the cognitive process into 2 levels of thinking, namely low order thinking for the C1-C3 categories and high order thinking starting from C4-C6. The ability to think at a high level or HOT is recognized in various studies as an ability that must be possessed by 21st-century society to be able to engage in work and society. Governments from various countries have designed HOT-based curricula to keep up with the needs of the current development, including Indonesia with the 2013 or K13 Curriculum applications. Initially, the learning focused on the ability to answer questions around LOT (C1-C3). However, now further efforts are being made to be able to reach C4-C6.

The development of high-order thinking skills depends on low-level thinking skills that must be mastered first, as in Figure 1. Mahanal (2019) states that HOT can be trained through learning activities on purpose and planned through the application of learning models which actively involve students (student-centered). Hence, it is not only a transfer of knowledge between teachers and students who tend to only practice low-order thinking (LOT).

HOT has become the most needed ability today due to dynamic times, both information and technology. Therefore, education as a basic human foundation must follow such dynamic. The implementation of HOT during learning requires the important role of the teacher to analyze question making according to the 24 thinking boxes Putri et al., (2018). High-order thinking not just changing simple questions to be complicated or considered lengthening and become convoluted. The purpose of making HOT questions is to develop students' thinking processes so that if they are continuously trained it will form the ability to process, analyze information, to make conclusions and decisions.

The path of thinking process that can be followed when the teacher wants to deliver students' understanding towards HOT must be preceded by LOT. If the teacher wants to take students to the thinking process stage according to the learning objectives, the teacher must ensure that students have understood the questions in the lower thinking process box first. The assessment given by the teacher is one way for the teacher to stimulate students to think, but not all of them can help develop students' HOT. Therefore, a bridge that connects the teaching and learning process with assessment is needed, so that students can integrate HOT better.

The learning path is the route that students take to reach the learning goals appropriately, effectively, and efficiently (Alimuddin & Hariati, 2019). The selection of learning paths to train HOT can be selected according to AKT (Figure 1). Teachers are free to determine the route they feel more efficient to build students' HOT. Learning paths can also be used as scaffolding for students. Thus, the use of the learning path can be used as an alternative to developing student HOT (Alimuddin & Hariati, 2019).

Scaffolding can be given by adjusting students' academic abilities because students with different academic abilities have different initial understanding abilities. Students' academic abilities can be classified into high, middle, and low academic abilities. The gap in student academic ability can be reduced if students are given sufficient time to study according to their needs and abilities. The fact that happens in the classroom, all students have the same period of learning, this is what creates an academic achievement gap (Prayitno et al., 2017). Giving scaffolding from teachers to students with low academic abilities can be a solution to encourage increased student learning achievement so that their achievements are closer to students with high academic abilities (Wulaningsih et al., 2012).

The purpose of this study is to describe the students' thinking process using a learning path on high, middle, and low-academic students. The description includes thinking boxes that have not yet been fulfilled, limited to 9 thinking boxes, namely C1-C3 for the dimensions of factual, conceptual, and procedural knowledge.

METHOD

The study used a qualitative exploratory. Participants consisted of 9 students, each with 3 students for high, middle, and low academic abilities in Senior High School of Banyudono Boyolali who had studied ecology choosing with purposive random sampling. Data collected from student's answers to 9 thinking box questions, namely C1-C3 in factual, conceptual, and procedural knowledge dimensions. The questions have been used in the final exam and rechecked by three lecturers.

The procedure begins with classifying the student's academic ability based on their learning outcome in 2 semesters into high, middle, and low. Students were asked to solve questions from the 9 thinking boxes, then the researcher analyzed the results from each student and tracked their thinking process using the learning path. The flow of students' thinking process was examined and confirmed with them by interview to find out the causes of the wrong answer and traced back the learning path. If there is any, following the reference. The researcher compared the learning path before and after confirmation to reanalyze student's order thinking and concluded.

RESULT AND DISCUSSION

The resuts showed differences in the achievement of students' thinking process in the 9 thinking boxes between high, middle, and low academic students (Figure 2).

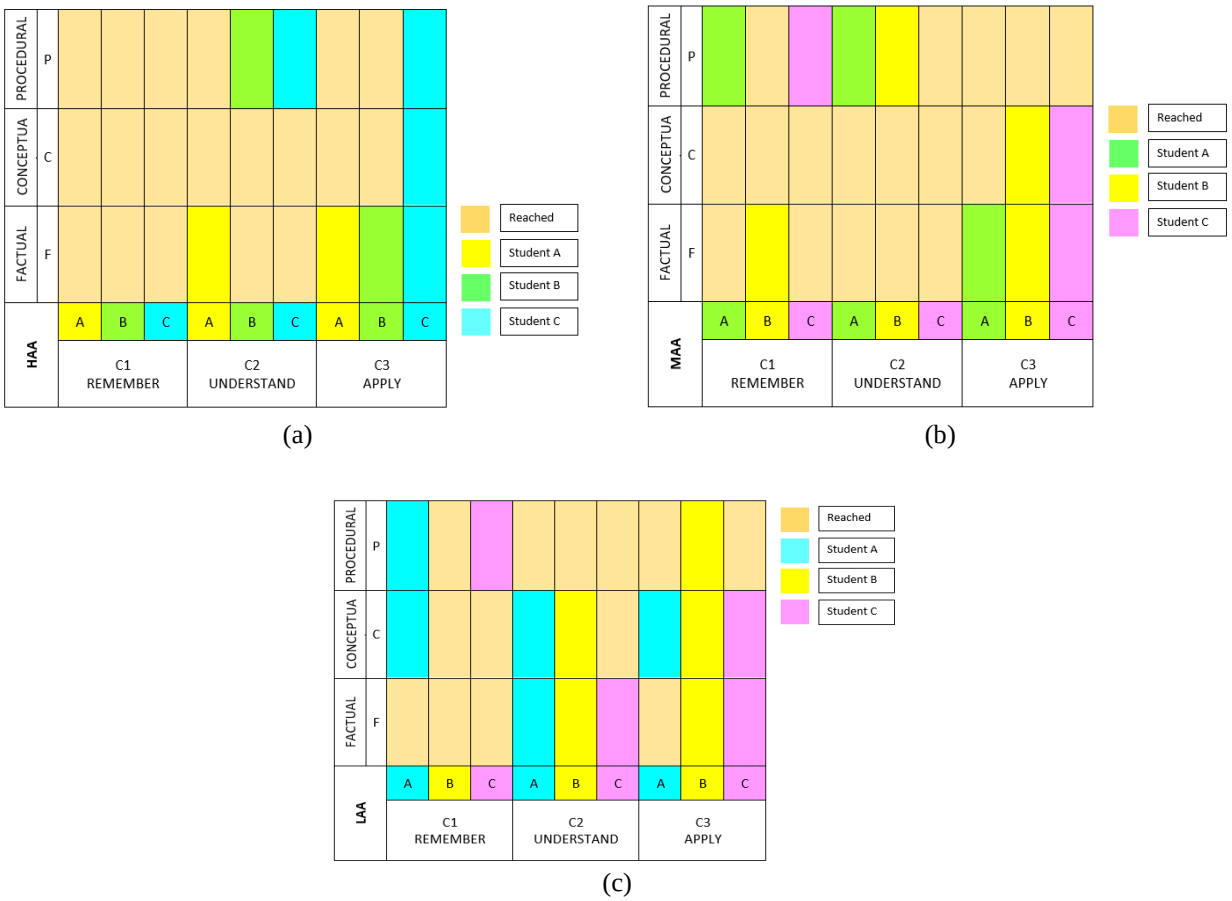

FIGURE 2. (a) Student's Order Thinking Process of HAA, (b) MAA, (c) LAA

HAA category students' thinking process

Based on the research results shown in Figure 2, it is known that the thinking process achievements of students in the HAA category. Each of the high academic students has different achievements as in Figure 3.

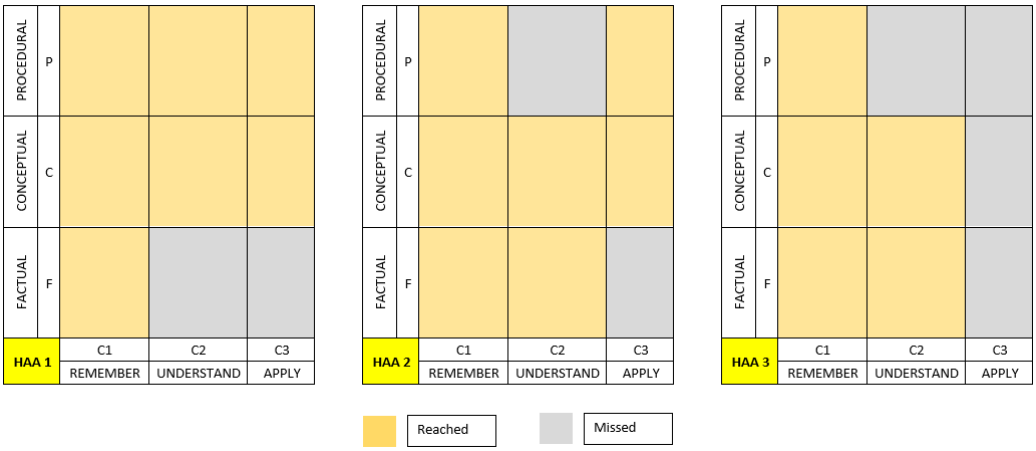

FIGURE 3. Thinking Process Scheme of High Academic Ability (HAA)

The three students have a similar thinking process scheme. The difference between the three can be seen in sections C2 and C3. Student HAA1 "missed" on the thinking box FC2 and FC3 while HAA2 experienced "missed" on PC2 and FC3. HAA3 had the most non-attainments among the three students, namely on PC2 and the entire box category C3. Variations in non-attainment can be caused due to many factors, one of which is carelessness. Based on the results of interviews with the three students, information was obtained that students were not careful and misunderstood the meaning of the questions given so that they gave wrong answers (Jha, 2012; Rahayuningsih & Qohar, 2014; Rohmah & Sutiarso, 2018).

The learning path that is formed from the three students to achieve the highest thinking process is PC3, seen from the achievement of the thinking process including:

HAA1 : FC1-CC1-CC2-CC3-PC3; FC1-CC1-CC2-PC2-PC3; FC1-CC1-PC1-PC2-PC3
HAA2 : FC1-FC2-CC2-CC3-PC3; FC1-CC1-CC2-CC3-PC3
HAA3 : FC1-FC2-CC2; FC1-CC1-CC2; FC1-CC1-PC1 (cannot achieve PC3)

MAA category students' thinking process

The achievement of students' thinking process can be seen in Figure 4.

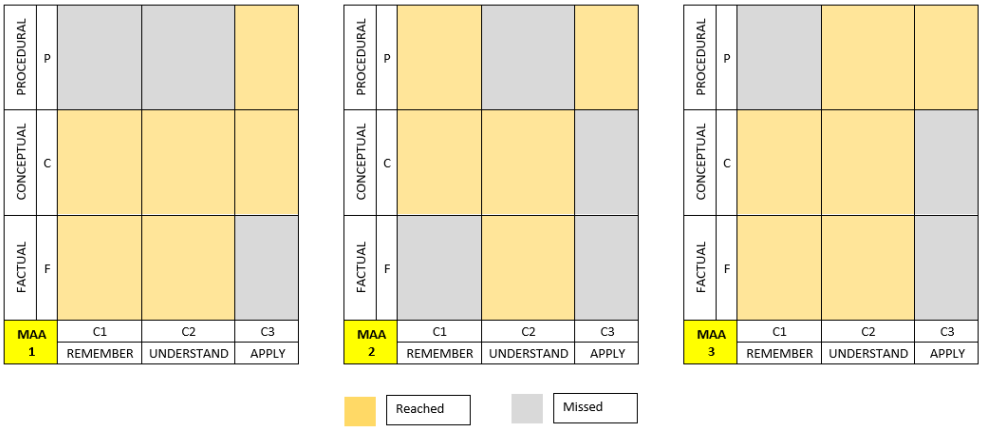

FIGURE 4. Thinking Process Scheme of Middle Academic Ability (MAA)

The thinking process of students in the MAA category has a variety of achievements among the three subjects. MAA 1 and MAA3 similarly "missed" on the PC1 and FC3 thinking boxes. The difference between the two is in the PC2 and CC3 boxes.

Another subject, MAA2, "missed" on the thinking boxes which is more random than the other 2, precisely on the FC1, PC2, FC3, and CC3 boxes. Even so, the three subjects were able to reach PC3 which could not be reached by the HAA group students while the previous box had not been reached (missed). This felt strange, so the researcher asked the question again during the interview with the three students (MAA1, MAA2, and MAA3). Based on the results of the interview, it was found that the three students missed on thinking box C2 and C3 as shown in Figure 5. Achievement of the PC3 box is considered "luck" because they can answer correctly.

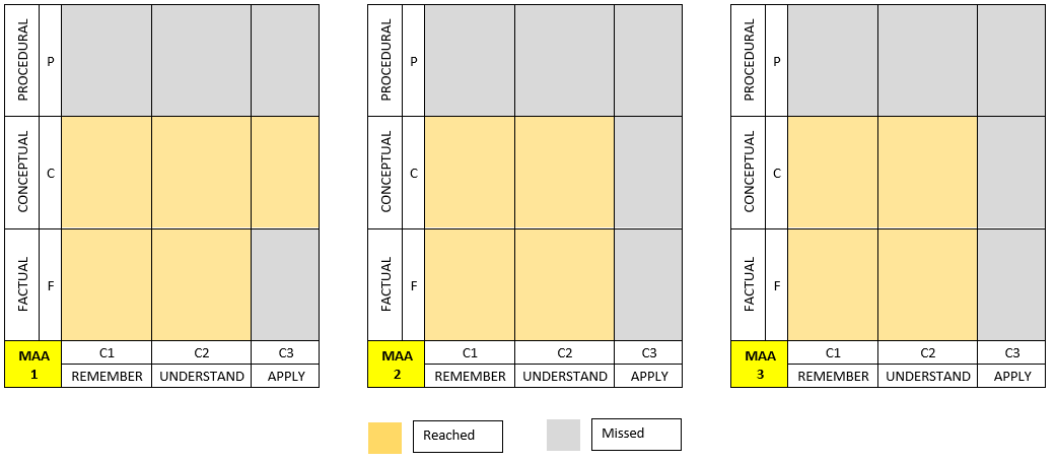

FIGURE 5. Thinking Process Scheme of Middle Academic Ability (MAA) after re-test

The learning paths formed in the MAA category are:
MAA1 : FC1-FC2-CC2-CC3; FC1-CC1-CC2-CC3
MAA2 MAA3 : FC1-FC2-CC2; FC1-CC1-CC2

LAA category students' thinking process

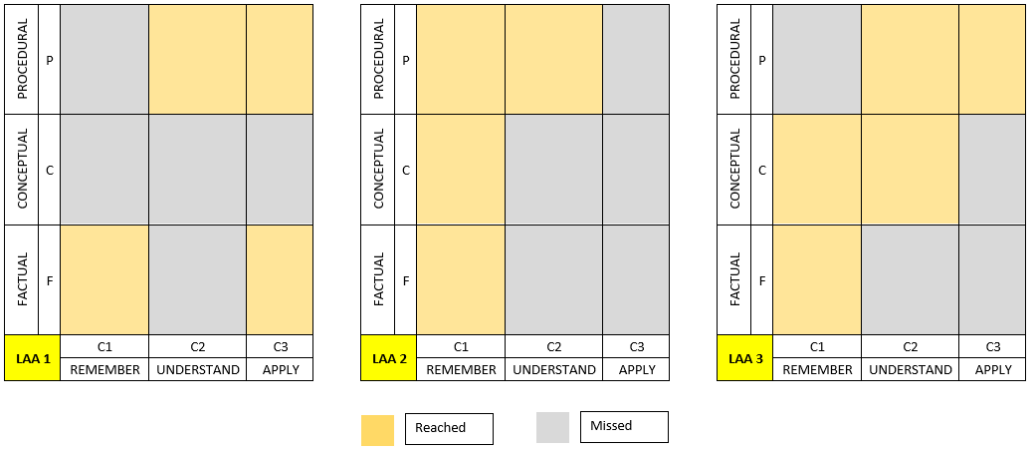

FIGURE 6. Thinking Process Scheme of Low Academic Ability (LAA)

LAA group students have a similar thinking process which is strange as in MAA. The oddity is seen in the achievement of high thinking boxes, namely PC2 and PC3 for the lower academic group. This is not following Ausubel's theory that students 'academic abilities affect students' thinking processes (Karmana, 2011). The researcher then asked the subject again and found a new scheme such as Figure 7.

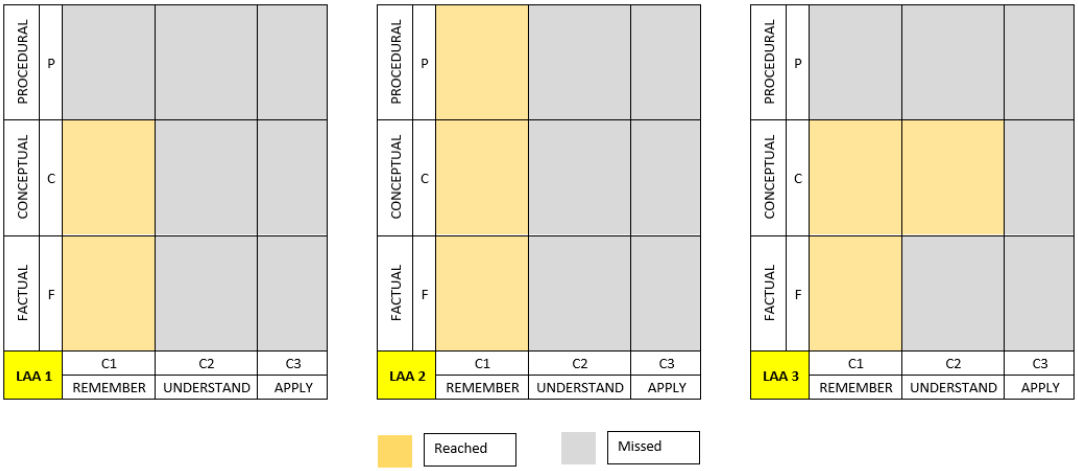

FIGURE 7. Thinking Process Scheme of Low Academic Ability (LAA) after re-test

The learning paths formed in the LAA student category can be stated as follow:
LAA1 : FC1-CC1
LAA2 : FC1-CC1-CC3
LAA3 : FC1-CC1-CC2

The thinking process achieved by MAA and LAA students shown in Figures 7 and 9 can be caused by misunderstanding the problem so that students have difficulty writing answers correctly and completely (Kristianto et al., 2019; Rahayuningsih & Qohar, 2014). Mistakes in understanding the problem become a link for students to solve the next problem, namely a higher level of the thinking process (Susanto, 2011). The inactivity of the PC3 thinking process in all academic categories is because students do not write down the stages completely and systematically to solve the problems given (Kristianto et al., 2019). Student's thinking process of three categories (high, middle, and low) showed the different results of the learning path. Low achieving students needed more help to solve all questions and could be an effect on their science process skills and learning outcomes (Prayitno et al., 2017). The learning path that is formed from each student can be used as a tracking of the inadequacy of the student's thinking process so that the teacher can do scaffolding on parts that students do not understand (Alimuddin & Hariati, 2019). Azizah et al. (2018) found that the thinking process before and after the scaffolding has different structures. The result showed that all subjects could solve the question after scaffolding.

CONCLUSION

The conclusions that can be drawn from the study are described as follow: 1) The students' thinking process could be accessed using AKT and learning path; 2) The thinking process of students is influenced by academic ability in terms of the learning path; 3) All research subjects have not been able to reach the highest thinking process tested, namely PC3 so that a deeper analysis is needed to determine the cause; and 4) Learning path can be used as a tool to track students' unattainable thinking processes and scaffolding the “missed” thinking process as a solution.

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