An Analysis on the Achievement of Biology Cognitive Process and Product of Grade Eleven Students in Kulon Progo Based on the Teacher's Teaching Experience

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Abstract: This study aims to determine the ability of cognitive process and product of grade eleven students in Kulon Progo based on teacher's teaching experience. The data collection technique used in this study was the survey technique. The sample of this research was students of grade XI in Yogyakarta, selected by using purposive sampling technique. Data collected was then analyzed by using descriptive statistics and inferential statistics. Based on the research, it was found that there is an influence of teacher's teaching experience to the ability of biology cognitive process and product of grade eleven students in Kulon Progo with sig p = 0,000 (p <0,05), meaning that there is a significant difference between teacher's teaching experience and the achievement of biology cognitive process and product of of grade eleven students in Kulon Progo.

Keyword: **Cognitive Process Ability, Cognitive Product Ability, Biology, Teaching Experience**

1. Introduction

Along with the development in the of globalization era in the 21st century, there is a shift in the development paradigm around the world. The most striking changes can be seen from the paradigm shift of natural wealth into the wealth of civilization. To build the wealth of civilization, civilized human resources are needed as one of the development capitals. In order to respond to future challenges associated with this, education is a sector that must be observed to produce civilized and quality human resources. One of the considerable competencies to be developed by Indonesian human resources in this global era is related to the cognitive domain or higher order thinking skills (HOTS).

Suggestions to develop thinking skills based on the dimensions of cognitive process and product are listed in Standar Kompetensi Lulusan (graduate competence standard) of Indonesian Permendikbud No. 20 of 2016. As a part of the subjects learned by students at secondary education level, biology actually has a role in developing the students' ability to think through the learning process (Permendikbud, 2016). In Permendikbud No. 20 of 2016 the graduate competence standard of high schools is put on the knowledge domain: factual, conceptual, procedural, and metacognitive. The graduate competence

standard in the curriculum of 2013 refers to the cognitive taxonomy revised by Anderson & Krathwohl (2001).

Students cognitive development is an indicator that shows progress on the success of learning applied by teachers. The existence of students cognitive development is determined from the active interaction of students with their learning environment. McLaughlin & Marsh (1990) linked the teacher's experience (in teaching) over the years, verbal skills, and self efficacy make a strong and significant influence on the learning process. Specifically, the total number of teacher's experience (in teaching) in years is related to all the dependent variables. In other words, the more experienced the teachers, the more likely they are to achieve their goals, and can improve the students' performance.

Based on the description proposed, a research on the analysis of the achievement of the biology cognitive process and product dimensions of students based on cognitive dimensions that had been revised by Anderson & Krathwohl (2001) based on the teacher's teaching expereince is needed. The experienced teacher stated above refers to a teacher who has taught for over 15 years, while the new teacher is a teacher who has less than 15 years of teaching experience. Kulon Progo is one of the regencies located in the Special Region of Yogyakarta, Indonesia.

2. Literature Review

Taxonomy of education designed by Bloom (1956), commonly known as Bloom's Taxonomy includes three aspects, namely the cognitive, affective and psychomotor aspects, which are then defined as the aspects that need to be considered and assessed in the education components. In the taxonomy proposed by Bloom, the cognitive domain is a unity that reflects the students' learning outcomes at level C1 to C6, while in the revised taxonomy by Anderson & Krathwohl (2001) the cognitive domain is divided into two terms, namely the cognitive process dimension that refers to the process which is characterized by the use of operational verbs; and cognitive product dimension that is the result of the cognitive process. The cognitive process dimension includes remembering, understanding, applying, analyzing, evaluating and creating, while the cognitive product dimension includes factual, conceptual, procedural, and metacognitive knowledge. Anderson and Krathwohl had previously revised the domain of C5, which was originally 'synthesis' to 'evaluate', and C6 which was 'evaluate' to 'create'. This can be illustrated in Table 1. Meanwhile, the cognitive product dimension of Anderson and Krathwohl added factual knowledge, conceptual knowledge, procedural knowledge and metacognitive knowledge in it.

Table 1: Revised taxonomy by Anderson & Krathwohl (2001)

Cognitive domain	Bloom's Taxonomy	Anderson & Krathwohl's Taxonomy
C1	*Knowledge*	*Remember*
C2	*Understand*	*Understand*
C3	*Apply*	*Apply*
C4	*Analyze*	*Analyze*
C5	*Synthesis*	*Evaluate*
C6	*Evaluate*	*Create*

In this case, the cognitive processes that have been revised by Anderson & Krathwohl (2001) can be explained as follows: 1) **Remembering**: The two processes related to this category are realizing and recalling. 2) **Understanding**: The cognitive processes that fall into the category of understanding include the process of interpreting, modeling, classifying, summarizing, estimating, comparing, and explaining. 3) **Applying**: This cognitive process involves the use of certain procedures or working methods to do an exercise or solve a problem. The category includes the process of doing and implementing. 4) **Analyzing**: This cognitive process category includes the processes of differentiating, organizing, and linking processes. 5) **Evaluating**: The evaluating category is defined as the act of making a judgment based on certain criteria and standards. This category includes a number of cognitive processes namely checking and criticizing. 6) **Creating**: The creating category includes the process of generating, planning, and producing.

Meanwhile, the dimensions of cognitive products according to Anderson & Krathwohl (2001) consist of 4 types: 1) **Factual knowledge**: Factual knowledge mostly arises at a relatively low level of abstraction. Two types of factual knowledge are knowledge of terminology and detailed knowledge & specific elements. 2) **Conceptual Knowledge**: Conceptual knowledge includes three types: classification and category knowledge, knowledge of principles and generalizations, and knowledge of models, theories, and structures. 3) **Procedural knowledge**: Procedural knowledge is "knowledge of how" to do something. 4) **Metacognitive Knowledge**: Metacognitive knowledge is general cognitive knowledge and knowledge of one's personal consciousness. Metacognitive knowledge includes strategic knowledge, knowledge of cognitive tasks, and self-knowledge.

Anderson & Krathwohl (2001) emphasized the need for a thought process or cognitive process to be able to master the knowledge from the factual knowledge level, to conceptual knowledge, procedural knowledge, and metacognitive knowledge. Anderson & Krathwohl stated that there is an appropriateness between the learning objectives to be achieved, the learning process undertaken, and the assessment of learning outcomes conducted.

3. Method

This research used the survey technique and was conducted in some high schools located in Kulon Progo Regency which is supervised by several experienced teachers and new teachers. In this research method, the researcher did not give any treatments to the research object. This survey research was focused on the achievement of the cognitive process and products dimensions of grade eleven students in Kulon Progo. It took 2 months (from May to June 2017) in the second semester of the academic year 2016/2017. The sample of this research was 394 students of grade XI in Yogyakarta, selected by using purposive sampling technique.

This research used test and non-test instruments. The test instrument of the biology cognitive process and product ability of grade eleven students that was used had fulfilled logical validity, empirical validity, and reliability developed by Paidi et al. (2017). The test instrument consists of 35 multiple choice questions and descriptions with C1-C6 levels integrated by factual knowledge, conceptual knowledge, and procedural knowledge, while for metacognitive ability the non-test instruments that are MAI-Jr (metacognitive awareness inventory-Jr) with 29 items of statement consisting of the knowledge

of cognition and regulation of cognition aspects was used. Metacognitive instruments developed by Paidi (2014) have also met the logical validity, empirical validity and reliability. The overall instruments are in accordance with the taxonomic bloom revised by Anderson & Kratwohl (2001).

Data analysis techniques used in this research were descriptive statistics and inferential statistics. The descriptive statistics technique was used for the maximum score, minimum score, average score, and standard deviation. The maximum score obtained by the students if they correctly answer all questions is 100, if the students get all the questions wrong then they will get 0. The average score obtained is used to indicate the level of process ability and biology cognitive products of the students, then the inferential statistics technique used the T-test by using SPSS 16 cognitive process and product dimensions based on the teacher's teaching experience or product, while the determination of cognitive processes and product abilities is used in Table 2.

Table 2: Criteria of cognitive process and product ability

Interval	Categories of proces and product
75<X	Very High
58.35 <X≤75	High
41.65<X≤ 58.3	Medium
25<X≤41.65	Low
X≤25	Very Low

4. Results and Discussion

This study aims to determine the cognitive process and product ability of grade eleven students in Kulon Progo seen from the measurement results on the teacher's teaching experience. Based on the research, the following results are obtained:

Table 3: Cognitive process and product ability of high school students in kulon progo based on the teacher's teaching experience

Statistics	Kulon Progo High Schools	New Teacher	Experienced Teacher
Mean	47.6802	45.16	49.63
STDEV	10.48878	11.50	9.19
Min. Score	20	22	20
Max. Score	72	72	70

Based on Table 3, the data shows that the highest achievement of the cognitive process and product of students came from schools that are taught by experienced teachers (who had taught for a long time), with an average score of 49.63 and is classified as "Medium"; the lowest are schools that are taught by

new (inexperienced) teachers with an average score of 45.16 and is also classified as “Medium". The standard deviation of high schools taught by experienced teachers received a score of 9.16 and the standard deviation of high schools taught by new (inexperienced) teachers received 11.50. Standard deviation is the statistical score used to determine how the data is distributed in a sample. Thus, the sample distribution in this research shows that the score in the set is not homogeneous.

To find out more on the differences in the achievement of cognitive process and product ability between teacher's teaching experience variables, a T-test was conducted by using SPSS 16 sig value p = 0,000 (p <0.05), which means that there is a significant difference between the teacher’s teaching experience towards the achievement of cognitive process and product of grade eleven students in Kulon Progo.

The results of measurements by the teacher’s teaching experience and the contribution to the achievement of cognitive process and product ability presented in Table 3 which shows that schools taught by experienced teachers got higher scores than those that are taught by new teachers. Zamroni (2007) stated that the quality of teacher-student interaction is determined by the ability of the teacher readiness status in conducting the learning process on one side and by the students’ readiness in undergoing the learning process on the other side.

Nitko & Brookhart (2011) explained that the formulation of learning objectives on what the learners should learn and master is an important step in the learning process. Pickard (2007) also explained that meaningful learning activities can support the development of cognitive knowledge and process of the students. Sudarma (2013) explained that every teacher has different teaching motivation and it is influenced by several factors, such as: those who think that they are obliged to only deliver the materials that had been designed, those who are more concerned in having good relationships with the students, and also those who implement learning process based on certain purposes for example focusing only for the national examination and to make all the students pass the examination.

Teaching experience is related to the ability of teachers in conducting the learning process, starting from formulating objectives and making a range of teaching and learning activities. Darling-Hammond (2000) explained that many studies have proved that new (inexperienced) teachers are usually less effective in teaching than experienced ones. Ewetan and Ewetan (2015) said that the teaching period of the teachers can determine the quality of the teacher’s teaching ability and the students’ learning outcomes. The longer the teaching period of a teacher results to better quality of teaching ability. This is in accordance with the results of the research done by Unal and Unal (2012) which stated that teachers with longer teaching period can carry out the learning process better than teachers who have less or short teaching period.

Based on the formulation above, it can be concluded that the teacher’s teaching experience can improve the academic achievement, but there are other studies which stated that the actual effectiveness can be decreased after some experience, especially among high school teachers. Rice (2013) showed evidence that there were experienced mathematics teachers in high school who were less effective (in teaching) rather than their less experienced colleagues or even their inexperienced colleagues. This is also in accordance with the metacognitive results presented in Table 3, it is known that the metacognitive results of schools that are taught by new (inexperienced) teachers are even higher than those taught by

experienced teachers. This is possible because the teacher's teaching experience period variables do not contribute to the students' metacognitive ability.

Table 4: Metacognitive ability of high school students based on the teacher's teaching experience

Metacognitive Aspect		New Teacher	Experienced Teacher
Knowledge of Cognition	*Declarative Knowledge*	73.63	72.41
	Procedural Knowledge	70.42	68.49
	Conditional Knowledge	74.16	71.44
	Average	**72.74**	**70.78**
Regulation of Cognition	*Planning*	65.76	67.68
	Information Management Strategies	67.98	67.87
	Comprehension Monitoring	70.79	69.96
	Debuging Strategis	74.07	73.65
	Evaluation	74.22	72.75
	Average	**70.56**	**70.38**

The results presented in Table 4 show that the metacognitive ability of students who are taught by new (inexperienced) teachers earned the score on knowledge of cognition aspect of 72.74, and regulation of cognition aspect with higher result of 70.56, while the metacognitive ability of students who are taught by experienced teachers earned the score on knowledge of cognition aspect of 70.78, and regulation of cognition aspect with a higher result of 70.38. The overall result shows that the two aspects have slightly different scores, this is in accordance with the claim that knowledge of cognition refers to what individuals know about their own cognition or about cognition in general. Regulation of cognition refers to a set of activities that help students control their learning, supporting the assumption that metacognitive rules improve performance in various ways, including using existing strategies and greater awareness of understanding disorders (Schraw, 1998). This finding is parallel to the findings shown by Schraw and Dennison (1994) which support the claim that the two components of metacognition (knowledge of cognition and regulation of cognition) can work harmoniously in the learning process.

Metacognitive ability is part of the learning activities carried out by the teacher. Sengul and Katranci (2012) explained that metacognitive is an act of recognizing the cognitive structures and characteristics of one's own learning. Metacognitive is a system that organizes information, experiences, goals and strategies. Metacognitive, which means thinking about thinking, generally includes various interrelated skills for thinking and learning that impact on students' cognitive outcomes, whereas the results obtained are different, there is an opinion stated that the implementation of learning activities does not depend on the teacher's teaching experience (Sugiyarti, 2014) and also one's working period is not significant to his/her performance (Thomas & Feldman, 2013).

It is assumed that a teacher's teaching experience of over 15 years has no effect on students' metacognitive abilities, in line with Rice (2010) findings which stated that teaching teachers with quality learning processes will have an unsure impact. Teacher's teaching experience is sometimes just seen as a

target that teachers must achieve to meet the salary rise criteria and does not have a significant positive impact in the learning process.

In addition to the above circumstances, in fact, the ability of teachers in empowering students' metacognitive abilities is still lacking, the results of a survey conducted by Efendi (2013) showed that there are 11.37% of teachers who have developed metacognitive skills, while 88.63% of teachers have never done such. Widodo (2006) also conducted a survey on the teaching and learning activities in the classroom. The results of a survey conducted on the questions types on the teachers and students in the science learning showed that there were 15 questions (52%) which included questions about factual knowledge and 14 questions (48%) about conceptual knowledge. Procedural knowledge and metacognitive knowledge were never asked even once.

Based on several surveys that have been conducted, it can be assumed that the teacher's insignificant teaching experience on students' metacognitive outcomes relates to teacher performance in teaching that lacks in observing metacognitive skills and has not yet realized that metacognitive skills can affect students' learning process and outcomes. Metacognitive strategies are a way of learning to raise awareness and empower thinking skills with the guidance of teachers through a process that students use in observing self-learning, controlling cognitive activities, and ensuring that a cognitive goal is completed (Sumampouw, 2011).

5. Conclusion

Based on the result of the research, it can be concluded that the ability of cognitive process and product of grade eleven students in Kulon Progo has a significant relationship between the experienced teachers and new (inexperienced) teachers on the students' cognitive ability, but the result of the metacognitive ability in schools taught by experienced teachers is lower than those by new (inexperienced) teachers. Based on the results of the analysis of Biology Cognitive Process and Product, teachers can design Biology teaching in high school, which will be more effective, efficient, and need-based.

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