Analysis The Mastery of Process and Product Cognitive of Students in Biology Learning Class XI Senior High School in Terms of School Favorability

Isti'farin[1], Paidi [2], Rabiatul Adawiyah [3]

[1] Biology Education, Graduate Program, Yogyakarta State University
[2]Biology Education, Mathematics and Science Program, Yogyakarta State University
[3] Biology Education, Graduate Program, Yogyakarta State University

Corresponding email: farin_isti@yahoo.com

ABSTRACT

Today, in Indonesia there are still many teachers who reveal the cognitive learning outcomes the students only based on the categorization cognitive taxonomy of Bloom, whereas the current curriculum reuire to use the cognitive taxonomy that has been revised by Anderson & Krathwohl. The aim of this research was to know the mastery level of cognitive process and cognitive product of student class XI in biology learning on human reproductive system material in senior high school in terms of school favorability. This research was a survey research, that conducted in Padang. The research population was all students class XI in senior high school in Padang, academic year of 2015/2016. The sampling technique.was using purposive sampling. The data collection used tests instrument that developed based on dimension of cognitive process and cognitive product of Anderson-Krathwohl. The test instrument used to determine the mastery of cognitive process and cognitive product form of multiple choice test items and essay test items. Data analysis was using descriptive statistic and U Mann-Whitney with significant level at 0,05. The results of this research was obtained data showed that mastery of cognitive process and cognitive product of students in biology learning class XI senior high school between favorite and non favorite school have significant difference with significant level (p) < 0,05. Based on this research is expected to educators and prospective educators have the will and awareness to develop cognitive achievement test based on the dimensions of cognitive process and cognitive product of Anderson- Krathwohl that mastery of the cognitive dimension of students is clearly known.

Keywords: cognitive process, cognitive product, biology learning, favorability school

1 INTRODUCTION

Education is important aspect of a nation. The quality of education can reflect the quality of nation. The demands of the world in global era that full of challenges require human resources in Indonesia has a variety of skills. These skills by Hosnan (2014) were translated into several skills, namely problem solving skills), critical thinking skills, collaboration skills, communication skills, and creativity and innovation skills. Those skills not only requires memorization and recall capabilities are included in the category of Lower Order Thinking Skills or LOTS but also require more complex abilities involving Higher Order Thinking Skills (HOTS). Thinking skills believed to be associated with the acquisition of cognitive skills.

Bloom (1956) explains that the cognitive domain in Bloom's taxonomy includes cognitive aspects in one dimensions that are: (1) knowledge, (2) comprehension, (3) application, (4) analysis, (5) synthesis, and (6) evaluation. Furthermore, based on the Bloom's cognitive dimension, student's skills are divided into two categories, namely

Lower Order Thinking Skills (LOTS) and Higher Order Thinking Skills (HOTS). Thinking ability of students is still relatively low level when has the capability of recalling and processing (C1- C3), and a relatively high level if the students already have the ability to critical thinking and creative thinking (C4-C6). Nitko&Brookhart (2011), explains that the cognitive taxonomy is divided into two categories: Higher Order Thinking (HOT) and Lower Order Thinking (LOT). The first two cognitive level that is remember (or knowledge) and understand (or understanding) included into the LOT category. Four levels of cognitive latter is applying, analyzing, evaluating and creating included into the HOT category.

Bloom's Cognitive taxonomy helps educators aware of the need to recall and translating course material for students, or in the language of taxonomy such as knowledge and understanding, mastery of the subject matter and assessment. Bloom's Taxonomy affect the development of curriculum and assessment and a lot of discussion in the literature of education (Dettmer, 2006). Bloom's Taxonomy has been widely used in the fields of biology like to design a rubric to evaluate the performance of learners in basic biology, developed the questions in the assessment formative based cognitive level, and provide information about learning design (Crowe, Dirks &Wenderoth (2008).

Nitko & Brookhart (2011) states that the Bloom's cognitive taxonomy is a scheme which contain levels of cognitive ability that is easily understood, especially by educators because it was classified into six major categories ranging from the simple category to complex category. This is in contrast with the psychomotor domain which is not a hierarchy. Crowe, Dirks &Wenderoth (2008) explains that three levels (knowledge, understanding and application) is a hierarchy, whereas the last three levels (analysis, synthesis and evaluation) is not a hierarchy. This means that if a question is classified at the level of the evaluation it is not always require analytical skills and synthesis skills but may require mastery levels of low cognitive ie knowledge, understanding and application.

Bloom's Cognitive Taxonomy compiled in 1956 was revised by Anderson & Krathwohl in 2001. The reason for Anderson & Krathwohl revisions is their desire to refocus the attention of educators that have exceeded the age of Bloom's taxonomy of the times and the need to integrate insights and thoughts within a framework of new categories of educational goals. That there are two dimension of cognitive that are cognitive processes and dimensions of knowledge (cognitive product). Relations between the cognitive processes and knowledge dimension called the Taxonomy Table. Dimensions of cognitive products are levels of concrete (factual) to the abstract (metacognitive). Dimensions of the cognitive process from the basic to the complex (Anderson & Krathwohl, 2001). Anderson & Krathwohl (2001) divides the dimension of cognitive processes into six categories: remember; understand, apply, analyze, evaluate, create. Furthermore, cognitive product it divides into four categories: (1) factual knowledge, (2) conceptual knowledge, (3) procedural knowledge, (4) metacognitive knowledge.

Tabel 1. Taxonomy Table of Anderson & Krathwohl

Product Cognitive	Dimension of Cognitive Process					
	1. Remember	2. Understand	3. Apply	4. Analyze	5. Evaluate	6. Create
A.Factual Knowlegde						
B.Conceptual Knowledge						
C.Procedural Knowledge						
D.Metacognitive Knowledge						

(Source: Anderson & Krathwohl, 2001)

Based on the needs in the classroom, learning objectives need to be categorized based on the thinking skills needed so that teachers are advised to use the taxonomy. The main reason the use of taxonomy for the purposes of assessment is to provide a tool for teachers to assess whether he has been teaching and assessing thinking skills of students with comprehensive coverage capabilities include high-level and low-level (Nitko&Brookhart, 2011).

In the process of learning, subjects biology developed through analytical thinking skills, inductive and deductive to resolve issues related to the events surrounding nature and problem resolution are qualitative and quantitative done using understanding in other fields of science BNSP (2006). Increased ability to think through education is through a learning process on the subjects matter at school, one of which is the subject of biology. Biology learning methods similar to the methods used to study the sciences in general, as a method of inquiry and the method of the discovery. Observations and experiments important in the study of biology. Observations underlie the ability to conduct exploration on the environment and to test the idea that engage all the senses (Nuryani Rustaman, 2005). Çimer (2012) explains that biology covers a wide range of concepts and abstract, so that to understood well by students is needed observation. In addition to be able to build knowledge, students need to prove or do experiment what they have previously learned.

Zohar & Dori (2003) explains that most of the capabilities developed by scientific inquiry that is widely used in biology arearrange hypothesis, planning research, or make conclusions included High Order thinking skills or HOTS. Based on these studies, it can be an understanding that learning biology is a way or the work done by students deliberate and purposeful involving interaction between learners, teachers, teaching materials and biological environment that can provide learning experiences to students through meaning activities not just memorize facts, principles and concepts in the classroom. Through the study of biology is expected to develop the cognitive abilities of students that will ultimately impact to thinking skills of students. Furthermore, the subject matter of biology class XI in high school, especially human reproductive system matery is suitable to develop high-level cognitive abilities of

students. It is related to the basic competence in curriculum 2013 that students are able to master the cognitive process of applying, analyzing and creating that include high level cognitive processes.

Dimensions of cognitive process and cognitive product on the human reproductive system materials can be developed include cognitive processes such as remembering (C1) to create (C6) and cognitive product in the form of factual knowledge through metacognitive knowledge according to the needs of students. The process of remember in human reproductive system eg students remember the existing organs of the reproductive system in both men and women, remember the various terms such as spermatogenesis, oogesis, fertilization, ovulation, and so on. Another example evaluates cognitive processes, the process of evaluating the human reproductive system materials eg students learn to criticize some of the events that occurred in the community such as the prohibition for pregnant women to consume alcoholic beverages or taking drugs too often and the consequences itsfor the developing fetus.

Cognitive product or called with knowledge on the human reproductive system materials eg factual knowledge. For example knowledge of various terms such as ovulation, fertilization, implantation and so on. Conceptual knowledge eg knowledge of a wide range of hormones and principle work of the human reproductive system. Products cognitive form of metacognitive knowledge is very important knowledge for students because students may consider appropriate learning strategies with itself so that it can raise the results of their study (Pintrich, 2002). Metacognitive knowledge on the human reproductive system eg learners have knowledge of strategies that need to be master difficult concepts such as strategies to understand the working principle of hormones on the human reproductive system.

In line with efforts to improve the ability of human thinking in Indonesia, the government has continuously improved quality of education one of them through improving the curriculum. The curriculum in force in Indonesia since a few years ago, the cognitive domain refers to the Bloom's cognitive taxonomy. In 2001, Bloom's cognitive taxonomy has been revised by Anderson & Krathwohl so that in effect the current curriculum in 2013 which also refers to the cognitive taxonomy revised. This is reinforced by the Regulation of the Minister of Education and Culture No. 54 Year 2013 on Graduates Competency Standards in High School that domain of knowledge requires students have the factual, conceptual, procedural, and metacognitive knowledge in science, technology, art, and culture with insight into humanity, national, state, and civilization-related causes and effects of phenomena and events.

A full picture of the results of efforts to improve the thinking ability of students through the learning process can be seen in the implementation of learning if there is a match between the learning objectives to be achieved, the learning process is carried out and the assessment of learning outcomes. Based on the preliminary survey in the field, it is known that most of the biology teachers are not yet using the new cognitive taxonomy. Therefore, the teacher should be able to uncover the cognitive achievement of students based on new cognitive taxonomy to match the demands of the 2013 curriculum.

Assessment is used to monitor the process, progress and improvement in learning outcomes of students. Assessment can be done in writing or orally. The assesment model used will affect the thinking skills of students. Assesment can be

developed to stimulate students to develop thinking skills (Edi Istiyono, Djemari Mardapi & Suparno, 2014). In this regard, the assessment can be used as part of the learning process (assessment for learning). The national curriculum implemented in schools in all regions in Indonesia both in cities and villages. Schools in some areas by local communities usually divided into favorite school and non favorite. Favorability of the school community is believed to have an influence on the success of students in the future. Students who enter in a favorite school will have a better ability than students in non favorite. Therefore in new academic year the community will compete for admission to favorite schools. That phenomenon occurs in several regions in Indonesia one of them in the city of Padang. Favorability high schools in the city of Padang can be known by looking at the amount of public interest in enrolling in the school, the value of the minimum to enter these schools are usually higher than the school that is not favorite, as well as high school graduates of a favorite school many continue to pursue State Universities.

Based on the above, the researchers felt the need to conduct research on mastery dimension of processes and products cognitive on the biology learning of human reproduction system materials in Senior High School in Padang in terms of favorability of school. Cognitive processes in this study include six cognitive processes C1-C6, whereas cognitive priduct include factual knowledge, conceptual knowledge and procedural knowledge. The results of these studies are expected to provide information on the achievements of the cognitive learning in biology leraning of high school in the Padang in accordance with the new cognitive taxonomy of Anderson & Krathwohl. The information is expected to provide benefits, especially for teachers as consideration for the necessity of improving methods of learning that has been done.

2 METHODS

The method used in this research was a survey method. The research was conducted at the Senior High School located in Padang. Time used for research that was three (3) months which starts from April to June 2016.

Research carried out by developing the instrument first. Instruments used in the form of test instrument that consists of multiple-choice test items and essay test items. Multiple choice test items were prepared based on the dimensions of cognitive processes C1-C4. Essay of test items was based on the dimensions of cognitive processes C5-C6. Every dimension of cognitive processes include of cognitive product dimensions (factual knowledge, conceptual knowledge, procedure knowledge). The test instrument consists of two packages namely Package A and Package B. Each package consists of 25 multiple choice test items and 6 test items in essay form.

Validation test instruments include the validation of content and empirical validation. The validity of the content was done through consideration of expert judgment that will judge the content of the instrument. The test instrument was subsequently revised in accordance with the instructions and advice from experts. Test instruments tested on 200 test subjects in order to know the validity and reliability as emprical validation. Tests performed on the subject which has the ability of high, medium and low with the expectation of test instruments are arranged suitable for use by subjects with levels varying abilities. Reliability of the test instrument was obtained by trying out the instrument tests on 200 test subjects and then

analyzed using QUEST program. The instrument is said to be more reliable if the value reability estimate close to 1.00.

The instrument had been developed and tested for validity and reliability are then used to determine the ability of cognitive processes and cognitive product of students in biology learning on human reproductive system material. The research subject a number of 306 students spread across the city of Padang SMA. The data were analyzed using descriptive statistics and inferential statistics two different test average values.

3 RESULTS

The mastery of cognitive process and cognitive product dimension of students (C1-C4) on human reproductive system material in Senior High School in Padang divided into two categories that is high and low. The category of low had percentage 55% more than percentage in the high category 45%. Furthermore, the percentage of high-category of students in favorites school are 53% more than percentage of high-category in non favorite school are 36%. The percentage of low-category students in favorite school are 64% mre than students in non favorite school 36%. This clearly showed the differences between the mastery of students in favorite school and student in non favorite school.

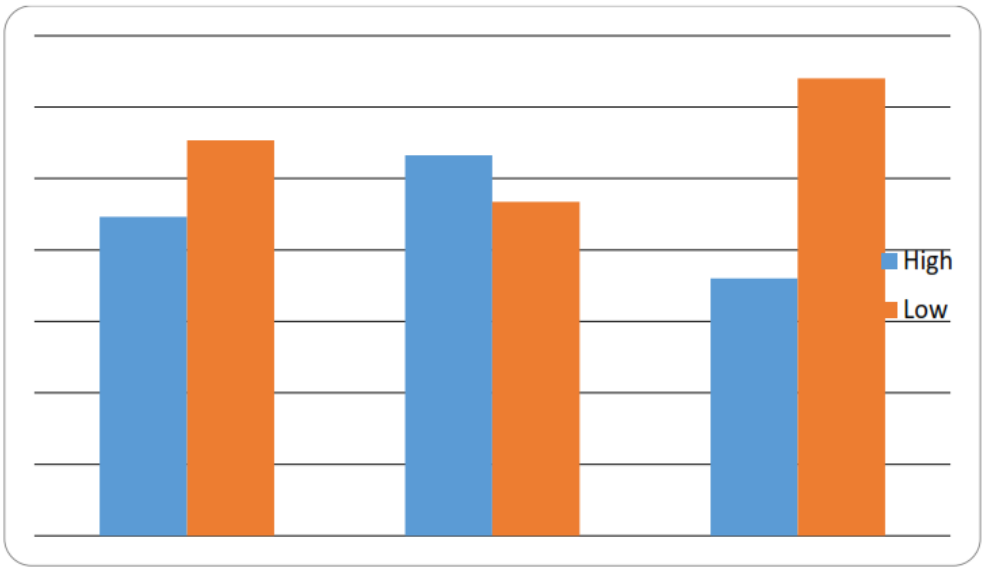

Figure 1. The mastery of cognitive process and cognitive product dimension of students (C1-C4) on human reproductive system material

In general, students in Senior High School in Padang has not mastered the dimensions of cognitive process (C5-C6) and cognitive product on the human reproductive system materials. It can be seen from the lower percentage in high-ability of students (25%) than the higher percentage in the low-ability of students (75%). This clearly showed that both students at favorite school or students at non favorite school had the ability cognitive cognitive processes and products is still low.

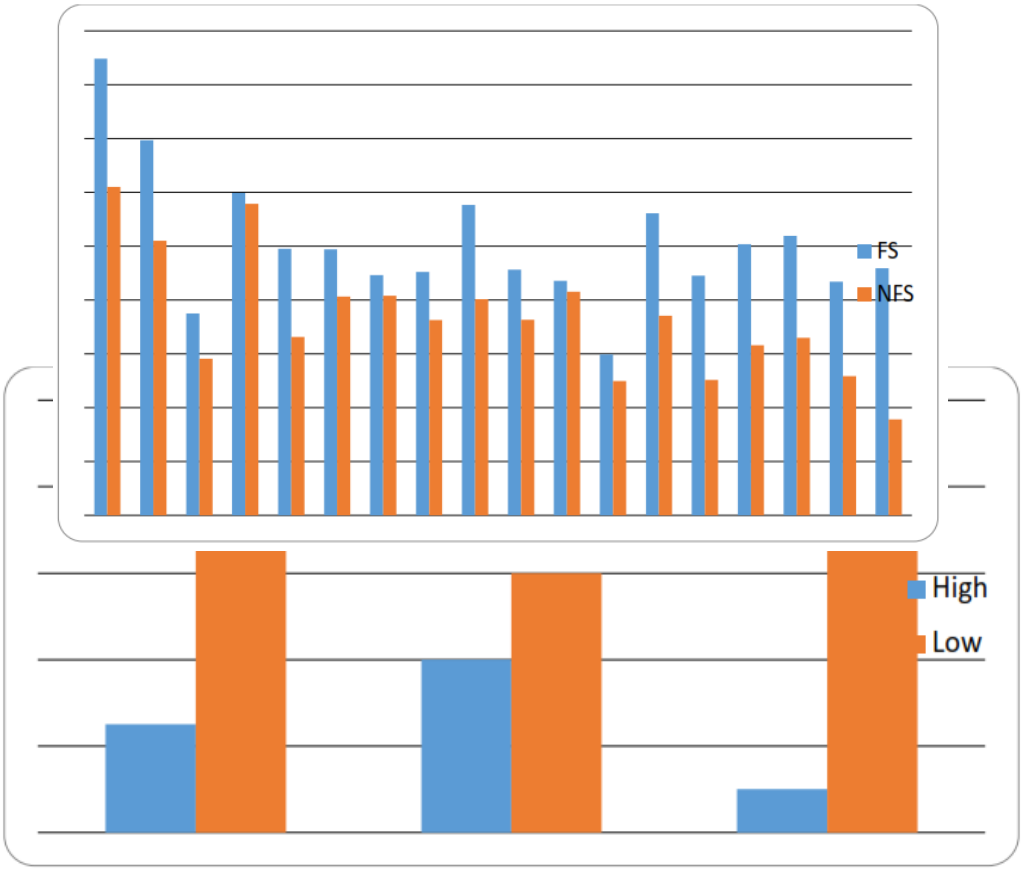

Figure 2. The mastery of cognitive process and cognitive product dimension of students (C5-C6) on human reproductive system material

Based on the results of statistical analysis using the Mann-Whitney U test was known that there are significant differences concerning the ability of students on the dimensions of cognitive process and cognitive product among students in favorite school and students in non favorite school with sig. 0.00 < 0.05 with error level of 5%.

Based on the research showed the mastery of every aspect of cognitive process and cognitive product of students in biology learning on human reproductive system material. It was also unknown whether there was any difference in the mastery of cognitive process and cognitive product of students in biology learning on human reproductive system materials among students in favorite senior high school and studentsa in non favorite senior high school in Padang. Mastery of every aspect of cognitive process and cognitive product students in biology learning materials on human reproductive system as a whole is presented in the figure below.

Figure 1. The mastery of every aspect on the cognitive process and cognitive product dimension of studentss on the human reproductive system material

4 DISCUSSIONS

In general, students in class XI Senior High School in Padang has the ability of cognitive process and cognitive product dimention in biology learning on the human reproductive system material. Based on these results can be known that there are differences in cognitive process and cognitive product among students in favorite school and students in non favorite schools.

Based on Figures 1 and 2 showed that in general students at Senior High School in Padang has not mastered the dimensions of cognitive process (C1-C6) and the cognitive product (factual knowledge, conceptual knowledge, procedural knowledge) on the biology learning on the human reproductive system material. Students in favorite school as a whole did not master the dimensions of cognitive process and cognitive product are the aspect of understanding, applying, analyzing, evaluating and creating indicated by the percentage of the ability of students who are less than 50%.

Based on Figure 3, the ability of the most widely owned favorite school students on the human reproductive system material is the ability to remember factual (C1 F) of 84.6%. While the ability of the least owned learners on the human reproductive system material is the ability to analyze procedural (C4 P) of 29.9%. Based on the research results showed that students who have mastered the ability to analyze less than 50% so there is need to be for improved. The ability to analyze is the ability of high-level cognitive process (Higher Order Thinking Skills) which is not easy to master by students and need a variety of meaningful learning activities. Things that cause students have not mastered the ability to analyze properly the possibilities for learning activities undertaken disadvantaged students on Higher Order Thinking Skill. This is in line with that proposed by the Zohar (2003) which states that the Higher Order Thinking Skills (HOTS) can be developed in school that teaches students to think, read critically or solve the complex problem in the learning process.

The ability that the most students mastered the human reproductive system material in non favorite school is the ability to remember factual (C1 F) of 61.0%, which means that students at non favorite school has had enough basic ability to develop the higher level skills. The ability to remember is the basic capabilities so that when considering the ability of students is still low it will affect the mastery of more complex skills than just remembering. The ability to remember factual is the ability that must be mastered learners as a condition to master more complex skills.

The ability of the least owned learners on the human reproductive system material is the ability to create procedural (C6 P) of 17.8%. The ability to create is the most complex and most difficult ability to learn by students. The ability to create not only requires the ability to analyze and evaluate belonging to the Higher Order Thinking Skills, but also requires the ability to remember, understand and apply belonging to the Lower Order Thinking Skills

The big difference in the ability of the dimensions of cognitive process and cognitive product among students in favorit school and non favorite school can be caused by input factors. Students in favorite school is high achiever whereas students in non favorite school is low achiever. Categorizing students including high achiever or low achiever obtained based on the test value when enrolling in high school. Students received in favorite school has an average value of at least 83.50 while learners are accepted in non favorite school has an average value of at least 67.42.

Zohar & Dori (2003) explains that the students are quite low achiever often linked with cognitive tasks a low level so that they never mastered the simplest level. While high achiever already mastered the basic skills required to accomplish tasks more complex. So it can be understood that high achiever be ready to start learning new things compared to low achiever.

By the standards of entry to a favorite school grades may indirectly cause the clustering of the learning outcomes of students (ability). Students in non favorite schools feel that they have a lower ability than students in favorite school, it led to the decline of confidence and as a result the willingness to learn is low or has managed to lower expectations (Nanang Fattah, 2013).

In addition, the difference on the mastery of process cognitive and prduct cognitive can also be caused by teacher factors. Teachers who teach in favorite schools generally have high expectations of their students are the high acheiver so in the learning process, he emphasizes more on the processes of higher level thinking than teachers who teach in non favorite schools (Zohar & Dori, 2003). Trust teachers on developing issues related to teaching and learning activities have a strong impact on the practices they employ in the classroom (Zohar, 2006: 333).

Beecher & Sweeny (2008) explains that the family has an important role to the success of students at the school. This is related to the supervision of home study and parental involvement in schools. Favorite school in Padang is an international school (RSBI). According to TeguhTriwiyanto & Yusuf Ahmad Sobri (2010), RSBI school which is also a favorite school in general only for students who come from families with high economic strata. Family economic background certainly will indirectly affect the learning outcomes of students. This is related to the ability of parents to support the learning process of students such as providing reference books and the facility to access a variety of information that can support the development ability of students (Memon, Joubish & Khurram, 2010). So it is not surprising that students in favorite schools that have a family that high economic background have better learning outcomes than students in non favorite schools.

In addition to some of the above factors, the culture and climate of the school is one of the factors that affect efforts to improve the learning outcomes of students. Improved student learning outcomes will be achieved if the positive and professional culture in schools create a positive school climate. Healthy school support high academic standards related to the success and achievement of learning outcomes of students. Both teachers and learners who have low academic motivation for culture and school climate is less support will be difficult to obtain a high learning outcomes (Macneil, Prater & Busch, 2009: 75).

5 CONCLUSION

Based on the results of this study concluded that the mastery of cognitive process and product cognitive dimensions of students in biology learning on the human reproduction systems material have the difference between students in favorite school and students in non favorite school in Padang.

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REFERENCES

Anderson, Lorin W & Krathwohl, David R. (2001). *A taxonomy for learnig, teaching, and assessing: a revision of Bloom's taxonomy of educational objevtives*. New York: Addison Wesley Longman, Inc.

Beecher, M & Sweeny, S. M. (2008). Closing the acheivement gap with curriculum enrichment and differentiation: one school's story. *Journal of Advanced Academics*, 19. 3: 502-530.

Bloom, B. S. (1956). *Taxonomy of educational objectives: the classification of educational goal*, handbook 1 cognitive domain. New York: Longmans, Green and Co.

BNSP. (2006). *Standar Isi untuk Satuan Pendidikan Dasar dan Menengah: Standar Kompetensi dan Kompetensi Dasar SMA.MA.*

Çimer, A. (2012). What makes biology learning difficult and effective: Students View. *Educatioonal Research and Review*, 7, 3: 61-71.

Crowe. A, Dirks. C & Wenderoth. (2008). Biology in Bloom: implementing Bloom's taxonomy to enhance student learning in Biology. *CBE: Life Science Education*, 7: 368-381.

Dettmer, P. (2006). New blooms in established fields: four domain of learning and doing. *Roeper Review, ProQuest Educational Journals*, 28, 2: 70-78.

Edi Istiyono, Djemari Mardapi & Suparno. (2014). Pengembangan tes kemampuan berpikir tingkat tinggi fisika (*Phys*THOT) peserta didik SMA. *Jurnal Penelitian dan Evaluasi Pendidikan*, 18, 1: 1-12.

Hosnan. (2014). *Pendekatan saintifik dan kontekstual dalam pembelajaran abad 21*. Bogor: Ghalia Indonesia.

Macneil, A. J., Prater, D. L & Busch, S. (2009). The effect of school culture and climate on student acheivement. *International Journal Leadership in Education*, 12, 1: 73-84.

Memon, G. R., Joubish, M. F & Khurram, M. A. (2010). Impact of parental socio-economic status on students' educational acheivement at secondary school of distric Malir, Karachi. *Middle-East Journal of Scientific Research*, 6, 6: 678-687.

Nanang Fattah. (2013). *Sistem penjaminan mutu sekolah*. Bandung: Remaja Rosdakarya.

Nitko, A. J & Brookhart, S. M. (2011*). Educational assessment of student (6th ed).* New Jersey: Pearson Education Inc.

Nuryani Rustaman. (2005). *Strategi belajar mengajar biologi*. Malang: UM Press

Pickard, M. J. (2007). The new Bloom's taxonomy: an overview for familiy and consumer science. *Journal of Family and Consumer Science Education*, 25, 1: 45-55.

Pintrich, P. R. (2002). The Role of metacognitive knowledge in learning, teaching and assessing. *Theory Into Practice*, 41, 4: 219-225.

Stiggins, R. J. (2002). Assessment crisis: the absence of assessment foor learning. *Phi Delta Kappan Journal*, 83, 10: 758-65.

Teguh Triwiyanto & Ahmad Yusuf Sobri. (2010). *Panduan mengelola sekolah bertaraf*

internasional. Yogyakarta: Ar-Ruzz Media.

Zohar, A & Dori, Y. J. (2003). Higher order thinking skills and low-achieving students: are they mutually exclusive?. *The Journal Of The Learning Sciences*, *12*(2), 145–181.

Zohar, A. (2006). The nature and development of teachers' metastrategic knowledge in the context of teaching higher order thinking. The *Journal of the Learning Science*, 15, 3: 331-377.