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CONSTRUCTION OF ASSESSMENT INSTRUMENTS IN THE FORM OFSELECTED RESPONSE TEST TO MEASURE THE ANALYTICAL THINKING SKILLS IN BIOLOGY LEARNING OF SENIOR HIGH SCHOOL

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Abstract

The purpose of science learning is to master knowledge, understand and apply the concept of science, apply the skills of the science process and develop the attitude of science. Biology is a part of science, so to achieve the goal in the learning must be in accordance with the nature of science, namely science as a process, product, attitude, and application. Assessment of the achievement of knowledge competence is an assessment of students' intellectual/cognitive potential in biology learning, for which a valid and reliable assessment instrument is required. The assessment instrument reviewed here is a written test instrument. Written tests for measuring cognitive abilities can be distinguished into tests for measuring low-level cognitive abilities and measuring high-level cognitive abilities including analytical thinking skills. Analytical thinking skills is very important as a basis in solving problems faced by students especially in Biology learning. Therefore, teachers need to train students with problem-based learning solving and practice questions in the form of higher order thinking test. The form of higher order thinking test can be a choice test (chosen response test) that can measure analytical thinking skills in high school biology learning with respect to substantial aspects, constructs and language.

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INTRODUCTION

The effectiveness of a learning program must be measurable to assess students' understanding of facts, phenomena, principles, concepts, laws and applications, so teachers need valid and reliable assessment instruments to measure the outcomes of the lessons learned in the classroom. Assessment itself has three main functions, namely: 1) Align misconceptions owned by students before learning; 2) Measuring the achievement of learning outcomes in the class as a whole; 3) Measure the strengths and weaknesses held by students. Therefore, the assessment instrument can be used to measure how well students understand the key concepts before, during and after the learning process (Bunawan, 2014). Understanding concepts related to students' cognitive abilities is always a major concern for teachers. Based on the results of an international study of students' cognitive abilities namely the Trends in Mathematics and Science Study (TIMSS) which is conducted by the International Association for the Evaluation of Educational Achievement (IEA). The results of TIMSS 2011 in the field of science (IPA) shows Indonesia get the value of 406 where this value is below the international average value of 500. Students cognitive abilities are still below the average shows that students' thinking skills still need to be improved. Many factors affect the students' thinking skills, not only the learning factors in the classroom but also the type of evaluation tests which can not train the students' thinking skills, especially the analytical thinking skills.

Bloom's cognitive domain thinking ability (1979) includes knowledge, understanding, application, analysis, synthesis and evaluation. Knowledge, understanding, and application capabilities include low-level thinking skills, while analytical skills, synthesis and evaluation include high-order thinking skills. While Anderson and Krathwohl (2010) describes a two-dimensional perspective to higher order thinking skills and operational verb classification based on a revised taxonomy of Bloom, in Table 1 below.

Table 1. Knowledge Dimensions and Sample Operational Verbs of Higher Order Thinking Skills (Bloom's Taxonomic Revisions)

Dimensions of Knowledge	Dimension of Cognitive Process		
	Analyze	Evaluate	Create
Actual knowledge	Create a sequence, group	Compare, connect	Combine
Conceptual Knowledge	Explain, analyze	Assess, interpret	Plan
Procedural Knowledge	Distinguish	Summing up, summarize	Compile, formulate
Knowledge Metacognition	Realizing, discovering	Create, rate	Realize

Bloom (1979) emphasizes the analytical thinking skills on solving subject into its compiler parts, and then detects relationship of each part and how to organize it. That is also can be directed at techniques and device used to deliver the meaning or forming conclusion. Sternberg (2008) explains that intelligence include analytical, creative and practical skills. Thinking analysis means trying to solve problems by using strategies that manipulate elements of a problem or relationship between the various elements. In the process of problem solving and decision making both use analytical thinking skills. Chijioke and Offiah (2013) add that analytical thinking skills can be defined as the ability needed to solve complex problems. Meanwhile, according to Anderson and Krathwohl (2010), analyzing is the ability to decipher the material or concepts into sections, determine the relationship between the parts, or the relationship between each part with the structure or goal as a whole.

Analytical thinking is the ability to researching and parsing factas well as thought. Develop capacity for think in wise and intelligent ways to solve problems, analyze data and remember as well as using information (Amer, 2005). Interpretation and analysis involve a higher level of thinking that is significantly influenced by individual beliefs about knowledge. When knowledge is seen as something that evolves, one will have a tendency to continue searching the data, seeking relationships and considering the possibilities of the results (Fazey, 2010). Elder and Paul (2007) add that in developing the analytical thinking requires guidance, instruction, and practicein monitoring the

students thought, so that students need to learn to get to know the essence of questions, goals, definitions,
problems, information, concepts and so forth .

Analytical thinking skills is very important as a basis in solving problems faced by students especially in Biology learning. Biology is part of science, so its learning must be given according to the nature of science, namely science as process, product, attitude, and application. The educational process should also demonstrate the characteristics of biological learning, which can develop logical, critical, and analytical thinking skills (Edles, et al, 2014: 2). While Thaneerananon (2016: 214) explains that analytical thinking skills is very important for students to develop rational thinking andproblem solving, so that students will be trained to make decisions and explore their own knowledge, this will help them in facing the challenges of the rapid development of science.

DISCUSSION

When constructing a test item, we should pay attention to the competence to be measured. The measured competence also can not be separated from the goalsset. In addition, the characteristics of the studied material should also be considered. Therefore, in preparing the test items should begin with the preparation of the outline to meet the validity of the content, which in this case is more directed to the fulfillment of curricular validity. Therefore, it is necessary to study the competencies that have been formulated, the development of the indicators of achievement of its competenceand the way of preparing its test outline (Subali, 2014: 1). Arranging the test outline certainly can not be separated from the aspects to be measured so that the construction of the resulting problem can be tested its validity and relevance.

This paper will present the aspects of analytical thinking skills which can be used as a guide for the analytical thinking test instrument preparation for the high school students. According to Bloom (1979: 145), the ability to analyze is divided into three aspects, namely: 1) the analysis of parts (elements) such as doing the facts separation, defined elements, arguments, assumptions, propositions, hypotheses and conclusions; 2) analysis of relationships (relations) such as connecting between elements of a system/structure; 3) analysis of organizational principles such as being able to recognize the elements and their relation to the organized structure. Meanwhile, Sternberg and Grigorenko (2010: 56) explains that the analytical ability consists of several basic components that are skills in problem solving, including: 1) identifying problems; 2) allocate resources; 3) collect and organize information; 4) formulate a strategy; 5) monitoring problem solving strategies and 6) evaluating solutions. Sternberg also explained that defining and identifying problems is one of the main components of analytical skills that involve the ability to define and manage problems. The component of the analytical skills is very important in teaching and learning science.

Anderson and Krathwhol (2010: 120) divide the aspects of analysis ability into three categories, namely: 1) Differentiating including the ability to differentiate between parts of the whole structure in the appropriate form;2) Organizing, including the ability to identify the elements together intointerrelated structures; 3) Attributing, is the ability of students to mention about point of view, values or intent of a problem posed. Components in the analytical thinking level are the capabilities to identify assumptions and ability to Evaluating evidence is an important element in critical thinking (Renaud and Murray, 2007: 323). Harsanto (2007: 97) adds an example of developing analytical thinking skills in learning, among others: identifying causal factors, formulating problems, asking questions for information, graphs and drawing. Based on the explanations of several theories, then in this paper the authors prepare aspects analytical thinking skills consists of:

1. The ability to distinguish;
2. Identify the problem/relationship of a phenomenon with other phenomena;
3. Determine/assign special features to an object of observation or a problem.

Measuring The Students' Analytical Thinking Skills

According to Gronlund (2009), there are two methods to collect students' cognitive ability data. First through tests, namely supply response test and essay writing, second through performance assessment. Subali (2014) explains the ability of higher order thinking– in this case – analytical thinking is the ability to think above the level of understanding. In the context of assessment for learning, high-order thinking skills needed to stimulate students to practice thinking in order to develop the rationality and logics. Meanwhile, Brookhart (2010) explains that to assess students' analytical thinking skills by giving a statement or problem or a research result, then ask students to determine the subject or the problem. In addition, it can also ask students to determine the quality or truth of an argument or conclusion.

The questions contained in the matter of analytical thinking skills reflect the question of higher order thinking (Renaud and Murray, 2007).The main guidance in the making of item choice items according to Mardapi (2008), namely: 1) the subject matter must be clear; 2) choice of answers must be logical and homogeneous; 3) the length of the sentence of choice is relatively the same answer; 4) no correct answer hint; 5) avoid choice of answers: all true or all wrong; 6) selection of numeric answers sorted; 7) does not use double negative words; 8) sentences used in accordance with the level of development of test participants; 9) using the standard Indonesian language;10) the location of the correct answer choice is determined randomly.

According to Subali (2014), several things to consider in preparing the test item, in terms of both aspects of the material/substance, construction and language aspects, as follows. 1) Material/substance aspects, questions items in accordance with indicator, statement/ question and key answer formulated correctly, material/ substance questioned in accordance with the purpose of measurement (measuring analytical thinking skills), material/ substance questioned according to level school grades and grade levels; 2) The construction aspect, in the form of a sentence in the form of a sentence or command that demands the answer to unravel, there are clear instructions on how to do the problem, the rubrics and the scoring guidelines are clear, the tables, graphs, diagrams or cases are meaningful or related to the question asked, not dependent on one another; 3) The language aspect , the sentence of the communicative question, the sentence using good and correct language, the formulation of the sentence does not lead to a double interpretation or misunderstanding, using common language/ word, the formula does not contain words that can offend the testimonial.

Subali (2012) describes the form of a written test can be a selected response test and supply response test. The selected response test consists of multiple choice test, true-false test, matching test or answer form. Analytical thinking skills can be measured by using written test in the form of selected response test with test questions used in the form of case studies and analysis of some research results relevant to biology learning materials so as to improve students' analytical thinking and problems solving skills also students understanding of the material being studied shall be better.

Multiple choice test consists of statement (subject matter) or stem, alternative answer and deception. The subject matter is a sentence containing the information or notification of an incomplete material which must be completed by selecting an answer that is available or may be a question and some beginning with a case or graphic description. The key answer is one alternative answer that is the right choice, while the deception is an alternative answer that is not the key answer (Mardapi, 2004: 74). There are several types of multiple choice form tests, namely:

1. Distracters, i.e. every question or statement have the correct answer. The learner's job is to choose one correct answer.
2. Analysis of the relationship between things, namely the form of questions that can be used to see the ability of learners in

analyzing the relationship between statements and reasons.

3. Negative variation, i.e. each question and statement has several correct answer choices, but provided one possible answer wrong. The learner's job is to choose the wrong answer.
4. Multiple variations, choosing multiple possible answers are all true, but there is one true answer. The task of the learner is to choose the most correct answer.
5. Incomplete variations, which are questions or statements that have some possible incomplete answers. The task of the learner is to find one of the most correct answers and complete it.

The item is in the form of a true-false form of a statement that is offered to be decided true or false, yes or no. The true-false item will be relevant if the proposed statement contains elements of analysis or synthesis, so it can be used to measure students' analytical thinking skills. It is important to note that on the items of true- false issues must be accompanied by clear instructions on how to work.Unlike the question item in the form of causation, the issue of causationis a form of question items that have a relatively higher difficulty level than other forms, so that the form is still widely used for college entrance exams. Basically a causal form consists of two statements (stem). The first statement is the consequences and the second statement serves as cause or reason. Some of the things that need to be taken into account in constructing items of cause-and-effect form the construction aspect, namely: the nature of the relationship must be clear, each statement must be firm and in composing a statement avoid the words "always", "surely", "impossible", etc. (Subali, 2014).

The following is presented some formulation of biology subject about respiratory for the second grade of senior high school to measure students' analytical thinking skills..

If the contents of the following sentence are reversed, choose whether the content of the sentence is true (T), remains false (F), become true (BT) or become false (BF).

T F BT BF 1. Exhaust fume of vehicle may disturb the respiratory health **due to** the exhaust fume of vehicle contains various harmful compounds.

T F BT BF 2. CO gas may cause dyspnea **due to** CO reduce Hb affinity towards oxygen.

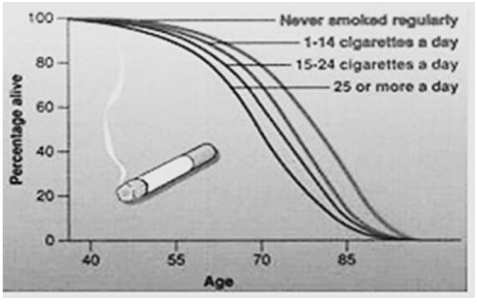
T F BT BF 3. Respiratory frequency will increase **if** someone's activity increases.

T F BT BF 4. Pollutants which mainly contained in the exhaust fumes **is** carbon monoxide (CO), various hydrocarbon compound nitrogen oxides (NOx), sulfur (SOx), and dust particulate include lead (Pb).

Look closely to the graphic below !

Choose **A** If in accordance with the graphic data
B If in contrary with the graphic data
C If have no relation with the graphic data

Graphic of the relationship between the number of cigarettes smoked and the percentage of one's life at a specific age.



A B C 5. A person who smokes 11 cigarettes a day has a 20% live percentage at 55 years old.

A B C 6. The more cigarettes

smoked the percentage of a person's life decreases.

A B C 7. People who never smoked had a live percentage of more than 20% at 85 years old.

A B C 8. The more cigarettes smoked will make a man look more mature.

Choose the answer that you think is the most correct and choose the reason for the answer.

Smoking can be said to be the main cause of lung cancer. People most at risk for lung cancer are the active smoker. Approximately 80-90% of lung cancers are associated with smoking habits. Even so, does not mean every smoker will get lung cancer. In addition, people who do not smoke are also likely to develop lung cancer, although lower in number. Based on these explanations, smoking habits can cause lung cancer because .....

A. Cigarettes produce CO_2 gas which is harmful to the body.
B. Cigarettes contain tar that can irritate the respiratory system.
C. Cigarettes produce very dangerous radon gas.
D. Cigarettes can absorb O_2 gas that is in the lungs.
E. Cigarettes contain a lot of caffeine.

Reason:

A. CO_2 gas decreases the O_2 affinity for binding to Hb.
B. Tar can stick in the lungs and is a carcinogen.
C. Tar can stick in the heart and clog the blood vessels.
D. Radon gas can block the respiratory tract.
E. Caffeine is a substance that can cause cancer.

CONCLUSION

The analytical thinking skills in this case is defined as one of the higher order thinking skills that becomes the basis for solving a complex problem and can describe it so that the problem can be solved through the strategies and knowledge that students have. The author formulates aspect of analytical thinking skills include: Ability to distinguish, identify the problem/ relationship of a phenomenon with other phenomena, and determine/ give specific features of an object of observation or a problem. The test instrument to measure the analytical thinking skills in biology subjects of Senior High School not only can be constructed in the form of an essay test, but the selected response test form can be also used as a good evaluation tool to measure the analytical thinking skills with due respect to the substance, the proper construction and language.

REFERENCES

Amer, A. (2005). *Analytical Thinking*. Center for Advancement of Postgraduate Studies and Research in Engineering Sciences, Faculty of Engineering, Cairo University. Diakses 2 Februari 2018, dari http://www.pathways.cu.edu.eg/subpages/training_courses/C10-Analytical-EN.pdf

Anderson, L. W. & David, R. K. (2010). *Pembelajaran, Pengajaran dan Asesmen* (Terjemahan Agung Prihantoro). New York: Addison Wesley Longman.

Bloom, B. (1979). *Taxonomy of Educational Objectives: Handbook I Cognitive Domain*. London: Longmans Group Ltd.

Brookhart, S. M. (2010). *How to Assess Higher-Order Thinking Skills in Your Classroom*. Alexandria: ASCD.

Bunawan, W. (2014). Pengembangan Instrumen Tes Diagnostik Pilihan Ganda Tiga Tingkat untuk Mengakses Kemampuan Mahasiswa Calon Guru Fisika. *Jurnal EDUSAINS.* Volume VI Nomor 02 Tahun 2014, 138 – 144.

Chijioke & Offiah (2013). The Relationship between Senior Secondary School Students Analytical Skill and Their Achievement in Chemistry in Anambra State. *International Journal of Engineering Science Invention* volume 2 issue 7, 44-57.

Edles, I., Suciati S. & Baskoro A. P. (2014). Pembelajaran Biologi dengan Generative Learning Model (GLM) disertai Media Dickey dan Polkey ditinjau dari Kemampuan Berpikir Kritis dan Analitis. *Jurnal Pascasarjana Universitas Sebelas Maret Surakarta.* Diakses 2 Februari 2018, dari http://jurnal.fkip.uns.ac.id/index.php/sains/article/download/5027/3536.

Elder, L. & Richard, P. (2007). *Analytic Thinking: How To Take Thinking Apart And What To Look For When You Do*. Diakses 2 Februari 2018, dari http://www.criticalthinking.org/files/SAM_Analytic_Think2007b.pdf.

Fazey, I. (2010). *Resilience and Higher Order Thinking. Ecology and Society*. Published under license by the Resilience Alliance, 15(3): 9. Diakses 2 Februari 2018, dari http://www.ecologyandsociety.org/vol15/iss3/art9/.

Gronlund, N. E. (2009). *Measurement andAssessment in Teaching (10th ed)*. Boston: Pearson Education Inc.

Harsanto, R. (2007). *Pengelolaan Kelas yang Dinamis*. Yogyakarta: Kanisius.

Mardapi, D. (2004). *Penyusunan Tes Hasil Belajar*. Yogyakarta: PPs Universitas Negeri Yogyakarta.

Mardapi, D. (2008). *Teknik Penyusunan Instrumen Tes dan Nontes*. Yogyakarta: Mitra Cendikia.

Renaud, R. D. & Harry G. M. (2007). The Validity of Higher-Order Questions as a Process Indicator of Educational Quality. *Springer Science Business Media, Inc. Research in Higher Education*, Vol. 48, No. 3.

Sternberg, J. R. & Elena, L. G. (2010). *Mengajarkan Kecerdasan Sukses* (Terjemahan Gun Mardiatmoko). Arlington Heights, IL: Skylight.

Sternberg, J. R. (2008). *Psikologi Kognitif Edisi Keempat* (Terjemahan Yudi Susanto). Belmont, CA: Wadsworth, Cengage Learning.

Subali, B. (2012). *Prinsip Asesmen dan Evaluasi Pembelajaran*. Yogyakarta: UNY Press.

Subali, B. (2014). *Makalah disampaikan dalam Seminar Pelatihan Pengembangan Instrumen Tes untuk Dosen Pendidikan Biologi*. Yogyakarta: UNY (tidak diterbitkan).

Thaneerananon, T. (2016). Development of a Test to Evaluate Students' Analytical Thinking Based on Fact versus Opinion Differentiation**.** *International Journal of Instruction July 2016, Vol.9, No.2, e-ISSN: 1308-1470, p-ISSN: 1694-609X*

TIMSS 2011. TIMSS & PIRLS Internasional Study Center. (2012). *TIMSS 2011 Internasional Result In Science*. Boston: The TIMSS & PIRLS Internasional Study Center, Boston College. Diakses 2 Februari 2018, dari http://timss.bc.edu/timss2011/release.html.