The Analysis of Students' Cognitive Ability Based on Assesments of the Revised Bloom's Taxonomy on Statistic Materials

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Abstract

This research is descriptive research with quantitative approach that aims to describe students' cognitive abilities based on assessment of the Revised Bloom's Taxonomy on statistics material. The subjects of this research were 36 students of class XI Science. Data obtained by using a research instruments that was learning achievement test accordance with the Revised Bloom's Taxonomy on statistic material. The data analysis technique was descriptive analysis. The results of this research indicate that: (1) on factual knowledge the ability percentage of student's cognitive process begins from the highest to the lowest percentage that is the level of ability C1 (remember), C2 (understand), C3 (apply), C4 (analyze), C5 (evaluate), and C6 (create); (2) on conceptual knowledge the ability percentage of students' cognitive process begins from the highest to the lowest percentage that is the level of ability C1 (remember), C2 (understand), C3 (apply), C4 (analyze), C6 (create), and C5 (evaluate); (3) on procedural knowledge the ability percentage of students' cognitive process begins from the highest to the lowest percentage that is the level of ability C1 (remember), C2 (understand), C3 (apply), C4 (analyze), C6 (create), and C5 (evaluate); (4) on metacognitive knowledge the ability percentage of students' cognitive process begins from the highest to the lowest percentage that is the level of ability C1 (remember), C2 (understand), C3 (apply), C4 (analyze), C5 (evaluate), and C6 (create).

Keywords: Descriptive Analysis, Cognitive Ability, Revised Bloom's Taxonomy

Introduction

Background oh the Study

Education quality of a nation is one of the key aspects of the country development, since with education each individual can have a chance to enhance the quality of their existence and participate in the development process. Along with the rapid change of the world in the globalized era, especially in the field of science and technology, Indonesia's national education has to be sustainably improved together with the era development.

National education aims to improve the quality of Indonesia's human resources, to be specific, to produce human beings who believe in God Almighty, have virtuous characters such as independent, advanced, tough, intelligent, creative, discipline, hard-working, professional, responsible, productive, and physically and mentally healthy. Those aspects become more crucial after it is mandated that the objective of national education is to enhance the quality of education on all kinds and levels of education.

Related to the issue above mentioned, Hamalik (2003:16) states that the goals of education are a set of educational outcomes achieved by learners after the implementation of educational activities. All of the educational activities that are teaching guidance and practices are directed to reach the goals of education. To this extent, the goals of education constitute the components of educational system that occupy the central position and function.

Hadis dan Nurhayati (2010:67) argue, "Teachers are the determinant of quality and success of education by their good performances both on institutional and instructional levels".

On the contrary, teachers tend to focus on measuring students' cognitive aspect that only focuses on three lowest aspects of Bloom's Taxonomy: know (C1), understand (C2), and apply (C3) that are included in factual, procedural, and sometimes conceptual dimensions. However, measuring other cognitive aspects (such as to analyze, evaluate, and create) included

in the four knowledge dimension is also necessary so that they can have the whole picture of students' ability on a particular field.

Taxonomy is a categorizing process. Teachers expect that learners succeed in learning a particular thing. The success, by all means, has to be assessed or measured. Bloom's Taxonomy means to bring ease to teachers in classifying things that have to be learnt by the learners at a certain time.

Bloom's taxonomy in cognitive domain is one of the basic frameworks for categorizing the goals of education, curriculum, and test preparation throughout the world (Chung, 1994; Lewy dan Bathory, 1994; Postlethwaite, 1994). This education taxonomy is contained in the book *The Taxonomy of Educational Objectives, the Classification of Educational Goals, Handbook I: Cognitive Domain* that has been published in 1956 as a work of Benjamin Samuel Bloom (editor), M.D. Engelhart, E.J. Furst, W.H. Hill, dan Krathwohl.

Bloom's Taxonomy makes defining of learning objectives easier for teachers. Learning goals are equipped with verbs and nouns. Verbs define the cognitive mastery desired; while nouns indicate knowledge expected (Anderson et al., 2001; Sausa, 2006).

An article reveals the comparison between the benefits of the old Bloom' Taxonomy and the revised one and concludes that the use of the Revised Bloom's Taxonomy for *"Pre-service Teachers"* in Turkey shows positive results if compared to the use of the old Bloom's Taxonomy in terms of arranging lesson plans (Bümen, 2007). The implementation of the Revised Bloom's Taxonomy in the design of "*Computer Based Assessment"* has been published with the details and thus it can be concluded that Revised Bloom's Taxonomy helps design assessment (Mayer, 2002).

Based on the initial observation, the researcher received information that teachers in general have not implemented cognitive aspects of the Revised Bloom's Taxonomy, teachers only give questions focusing on three cognitive aspects of Bloom's Taxonomy that are know (C1), understand (C2), and apply (C3) in which the three of them are only included in three knowledge dimension so that such ability has not been able to give a detailed picture of every cognitive skill of the students based on the Revised Bloom's Taxonomy covering remember (C1), understand (C2), apply (C3), analyze (C4), evaluate (C5), and create (C6) and the four categories of knowledge dimension. Due to the facts, the researcher considers that conducting a study regarding students' cognitive ability based on the assessment of the revised Bloom Taxonomy is important.

Objectives

This study aims to describe students' cognitive abilities based on the assessment of the Revised Bloom's Taxonomy on the subject matter of statistics for twelfth grade of one senior high school in Indonesia.

Methodology

This research is a descriptive research employing quantitative approach. Descriptive research aims to describe a status of condition or phenomenon. Therefore, the research will be able to analyze and give the picture of students' cognitive ability based on the assessment of the Revised Bloom' Taxonomy on the subject matter of statistics. This research involved 36 students taken from 144 students of SMA Negeri 3 Polewali, West Sulawesi, Indonesia. The instrument used in this research was a cognitive test. The cognitive test included questions regarding Statistics divided into six categories based on cognitive domain and four knowledge levels of the Revised Bloom's Taxonomy. The questions given consisted of fifteen multiple choice and nine essay questions.

The data were collected by utilizing an instrument that was the mathematical tests given to the students to observe the validity of instrument items. This test method was hired to observe students' cognitive ability. Validation of multiple-choice questions was examined by hiring the biserial correlation coefficient test; while validity of each question item was examined by using Pearson's correlation coefficient test.

The data analysis technique used was the descriptive-statistic data analysis technique examining the data percentage. Descriptive statistics is the statistics employed to analyze data by describing or defining the collected data as they are without any intention to draw a general conclusion. The descriptive-statistic analysis has objectives on describing students' cognitive ability based on the Revised Bloom's Taxonomy on statistic materials in one senior high school in Indonesia.

To comprehend such ability, scores were given to students' responses. Then, the responses were grouped into four dimensions of knowledge by the Revised Bloom's Taxonomy that are factual, conceptual, procedural, and metacognitive knowledge as well as six cognitive processes of the Revised Bloom's Taxonomy that are remembering, understanding, applying, analyzing, evaluating, and creating. Scores were given to responses of multiple choice and essay questions by being based on the question rate.

Theoretical Framework

Blooms' Taxonomy and Revised Bloom's Taxonomy

In 1949, Benjamin S. Bloom proposed an idea on division or cognitive taxonomy to ease the preparation process of question bank in order to create the same learning objectives (Krathwohl, 2002). Bloom and his team published the taxonomy in 1956. 45 years later, David R. Krathwohl, a member of Bloom's team proposed the Revised Bloom's Taxonomy. To formulate the taxonomy, Krathwohl worked with seven experts of physicological education and education (Anderson *et al*., 2001). The change from the original frame of mind to the revision is illustrated in Table 1.

Tabel 1. Bloom's Taxonomy and Revised Bloom's Taxonomy

Bloom's Taxonomy (1965)	Revised Bloom's Taxonomy (2001)
Knowledge	Remember (C1)
Comprehension	Understand (C2)
Application	Apply (C3)
Analysis	Analyze (C4)
Synthesis	Evaluate (C5)
Evaluation	Create (C6)

Anderson and Krathwohl (2001:66-88) suggest six cognitive taxonomies of the Revised Bloom's Taxonomy that are remember, understand, apply, analyze, evaluate, and create. Each category consists of two or more cognitive processes. Specifically, there are nineteen cognitive processes described by the means of verbs. The detail explanation is as follows:

Table 2. Six Process Categories of Cognitive Process Dimension

Process Category	Other Names	Cognitive Process and Example
Remember: Taking knowledge from long-term memories		
Recognize Reremember	Identify Pick	Positioning knowledge in long-term memories suitable for the type of the knowledge itself (ex. recognizing important dates of Indonesia historical events) Picking relevant knowledge of long-term memory (ex. reremembering important dates of Indonesia historical events)
Understand: Constructing meaning of learning materials including learning materials stated, written, and illustrated by teachers		
Intepret Give examples Classify Make summary	Classify, paraphrasing, represent, translate Illustrate, give examples Categorize, group Abstract, generalize	Altering a description (ex. number) to be another description (ex. paraphrasing importan statements and documents) Finding examples or illustrations of a concept or principle (ex. providing examples of movements of art of painting) Placing a certain thing in one category (ex. classifying the examined or described mental disorders) Abstracting general themes or main points (ex. making a summary of phenomena shown at the television)
Conclude Compare Explain	Abstract, extrapolate, interpolate, predict Contrast, map, match Make a model	Making a logic conclusion based on received information (ex. formulating grammar based on examples given during foreign language learning) Determining the relationship between two ideas, two objects, and so on (ex. comparing historical events to current condition) Making a causality model in a system house (ex. explaining causes of important events)
Apply: Implementing or utilizing a certain procedure in a certain condition		
Execute Implement	Execute Utilize	Implementing a procedure in a familiar task (ex. dividing one number to another number, this two numbers are consisted of

Process Category	Other Names	Cognitive Process and Example
		several digit numbers) Implementing a procedure in a unfamiliar task (ex. utilizing a correct context)
Analyze: Breaking a material into several structuring fragments and determining the relationship between those fragments and the relationship between those fragments and the whole structure or objective.		
Differentiate Organizing Attribute	Isolate, sort, focus, select Find the coherence, integrate, design an outline, describe roles Structure, deconstruct	Differentiating relevant study materials from irrelevant study materials, important materials (ex. differentiating relevant numbers from irrelevant numbers in a mathematical problem) Determining how elements perform their works or function in a certain structure (ex. compiling evidence in a historical narrative to be either supportive evidence or opposing evidence of a historical description) Determining a point of view, bias, value, or intention of a learning material (ex. pointing a writer's point of view in a certain essay based on the writer's political perspective)
Evaluate: Taking decision based on criteria and/or standards		
Examine Criticize	Coordinate, detect, monitore, test Assess	Finding inconsistency or falseness in a process or product; determining whether a proces or product has an internal consistency; finding the effectivity of a procedure being practiced (ex. examining whether or not a scientist's conclusion are in accordance with the observed data) Finding an inconsistency between a product and external criteria; determining whether a product has an external consistency; finding the accuracy of a procedure to solve a certain problem (ex. determining one best method of two methods to solve a problem)
Create: Integrating fragments to form a new, coherent material or to make an original product		
Formulate Plan Produce	Make hypotheses Design Construct	Making hypotheses based on criteria (ex. making a hypothesis of causes of a certain phenomenon) Planning a procedure to finish a task (ex. planning a research proposal about a certain historical topic) Creating a product (ex. creating a habitat for a certain species with a certain objective)

Findings and Discussion

Based on the test given to students, the researcher gained the data of students' cognitive abilities based on assessment of the Revised Bloom's Taxonomy. The test results gathered were analyzed based on the number of students' correct answers. The researcher determined one correct answer of multiple choice question should be given one point; while the score of one correct answer of essay problem was determined by using assessment rubrics. Those problems were categorized based on the Revised Bloom's Taxonomy. The data of analysis of 36 students' cognitive abilities based on assessment of Revised Bloom's Taxonomy on statistic materials of twelfth grade are presented in Table 3.

Table 3. The Percentage of Students' Cognitive Ability

Bloom's Revised Taxonomy						
Knowledge Dimension	Cognitive Process Dimension					
	C1 Remember	C2 Understand	C3 Apply	C4 Analyze	C5 Evaluate	C6 Create
Factual	72.22 %	66.67%	47.22%	27.22%	19.44%	13.89%
Conceptual	80.55%	75%	41.67%	36.11%	19.44%	26.11%
Procedural	52.78%	47.22%	36.11%	33.33%	13.89%	23.89%
Metacognitive	48.61%	42.36%	39.58%	23.33%	22.22%	20%

Table 3. displays that in general, the ability of remembering achieves the highest percentage in every knowledge dimension if compared to other abilities of cognitive process dimension. Moreover, the ability of creating on the conceptual and

metaconitive knowledge dimensions has the lowest percentage if compared to other abilities on the cognitive process dimension. Moreover, in the conceptual and procedural knowledge dimensions, the ability of creating (C5) gains the lowest percentage on the cognitive process dimension. Furthermore, Table 3. also indicates that the highest percentage of all knowledge and cognitive process dimensions is conceptual knowledge on the ability of remembering; while the lowest percentage is obtained by the ability of creating on factual knowledge and the ability of creating on procedural knowledge.

Table 4. The Category of Students' Cognitive Abilities

Bloom's Revised Taxonomy						
Knowledge Dimension	Cognitive Process Dimension					
	C1 Remember	C2 Understand	C3 Apply	C4 Analyze	C5 Evaluate	C6 Create
Factual	Middle	Middle	low	Very low	Very low	Very low
Conceptual	High	High	low	Very low	Very low	Very low
Procedural	low	low	Very low	Very low	Very low	Very low
Metacognitive	low	low	Very low	Very low	Very low	Very low

Table 4. shows that conceptual knowledge on the abilities of remembering and understanding has a 'high' category; whereas factual knowledge on the abilities of remembering (C1) and understanding (C2) has the 'middle' category. Besides, the abilities of analyzing, evaluating, and creating on each level of knowledge dimension possess the very 'low' category.

The result of descriptive data analysis reveals that the ability of remembering on the conceptual knowledge is higher than the ability of remembering on factual knowledge. This indicates that students in general are more capable of remembering factual knowledge than remembering procedural knowledge and possess a good awareness level in remembering learning materials.

Furthermore, the ability to remember conceptual knowledge is higher than the ability to remember factual knowledge. This proves that students are better at understanding conceptual learning materials than understanding the factual ones. The ability to understand factual knowledge is higher than the ability to understand procedural and metacognitive knowledge. This fact indicates that students tend to understand factual knowledge better and that students have a good awareness to understand learning materials.

Furthermore, the analysis result also displays that the ability to apply factual knowledge is higher than the ability to apply conceptual knowledge. This indicates that students are more capable of applying factual learning materials than applying the conceptual one. The ability to apply conceptual knowledge is higher than the ability to apply procedural and metacognitive knowledge. This proves that students is better at applying conceptual knowledge and that they own the awareness level to apply learning materials better than to apply procedural knowledge although the cognitive process of applying is closely related to procedural knowledge.

From the descriptive data analysis result, the researcher also figures out that the ability to analyze conceptual knowledge is higher than the ability to analyze procedural knowledge. This indicates that students are more capable of analyzing conceptual learning materials than analyzing procedural learning materials. Besides, the ability to analyze procedural knowledge is higher than the ability to analyze metacognitive and factual knowledge. This reveals that students tend to be better at analyzing procedural learning materials as drawing conclusion than analyzing factual learning materials as determining the size of data distribution in the form of symbol and that students is more capable of realizing their analyzing ability than realizing their factual knowledge.

Another finding from analyzing the descriptive data is that students are more advanced in evaluating metacognitive knowledge than evaluating other three types of knowledge. Hence, students have more skills to realize their abilities to evaluate statistic learning materials than to realize their abilities to evaluate the conceptual ones. Besides, students are also more capable of evaluating conceptual learning materials than evaluating factual and procedural learning materials.

The researcher is also able to draw a conclusion that the ability to create factual knowledge is higher than the ability to create conceptual knowledge after conducting the descriptive data analysis. This means that students are more skillful at

creating factual learning materials than creating conceptual learning materials. Moreover, the ability to create conceptual knowledge is higher than the ability to create procedural and metacognitive knowledge. Therefore, students are more capable of creating conceptual knowledge. Students' ability to create procedural knowledge is better than their awareness of their ability to create questions based presented data.

Conclusion

Results of this research provides conclusion that twelfth graders taking education at the subject school have better conceptual knowledge than the procedural and metacognitive ones in every level of abilities on the cognitive process dimension. Besides, students have weakness on metacognitive knowledge and the abilities of applying, analyzing, evaluating, and creating. Thus, teacher should pay more attention to every level of students' cognitive ability on every type of knowledge based on the assessment of the Revised Bloom's Taxonomy.

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