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Taxonomies of Educational Objective Domain

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ABSTRACT: This paper highlights an effort to study the educational objective domain taxonomies including Bloom's taxonomy, Lorin Anderson's taxonomy, and Wilson's taxonomy. In this study a comparison among these three taxonomies have been done. Results show that Bloom's taxonomy is more suitable as an analysis tool to Educational Objective domain.

KEYWORDS: Educational Objective domain, Bloom's taxonomy, Lorin Anderson's taxonomy, Wilson's taxonomy.

1. Introduction

Education is one of the most important aspects in human development and comprises the most influential social institution in any society (Baytak, Akbiyik, & Usak, 2012; Perovic, 2012; Stosic, Isljamovic, & Hanic, 2012). In general, education aims to transmit a common set of beliefs, values, norms, and understanding from the adult generation to the youth. Morality, on the other hand, aims to maintain order in a society; to respect people and regard them 'holistically'(Kabir, 2008).

The educational process is clearly necessary for human upbringing and the formation of a balanced, proper, and integrated personality. The educational process is as important as the nutrition needed by the body. Education preserves humans and directs them to a safe life. In particular, considering that the period of human childhood is longer compared with that of other creatures, parents and educators are given the responsibilities to provide an educational system (Alzantani, 1993).

In 1956, Bloom et al. published their widely accepted taxonomy for classifying objectives and assessment items for the cognitive domain. Their system specified six levels of understanding, with each higher level subsuming the properties of the lower level. The levels of the taxonomy were from the lowest to the highest: knowledge, comprehension, application, analysis, synthesis, and evaluation (Alul, 2000).

Typically, the achievement and higher thinking skills of students are assessed by using different forms of questions or tests. However, most items used in these assessments address the level of knowing and thinking without any connection with higher thinking skills. (Hoeppel, 1980) and (Humblen, 1984) found that objective question items used in all educational levels overwhelmingly tap the lower understanding levels (knowledge, comprehension). Thus, if the

test items used only lower level thinking skills, students would not be able to develop and use their higher-order skills.(Hoeppel, 1980; Humblen, 1984)

2. Taxonomies

2.1. Bloom's taxonomy

Benjamin Bloom developed the Taxonomy of Cognitive Objectives in the 1950s by qualitatively expressing different types of thinking. Benjamin Samuel Bloom was born on February 21, 1913 in Lansford, Pennsylvania, USA. He earned his bachelor's and master's degrees from the Pennsylvania State University in 1935. In March 1942, he received his doctoral degree from the University of Chicago. Bloom died on September 13, 1999 (Honan, 1999).

Bloom's Taxonomy provided carefully developed definitions for each of the six major categories that he defined in the cognitive domain. The categories are knowledge, comprehension, application, analysis, synthesis, and evaluation (Krathwohl, 2002).

In 1956, Bloom's research team published the now widely accepted taxonomy (Bloom's taxonomy) for classifying the objectives and assessment items in the cognitive domain. Their system specified six levels of cognitive domain, and each higher level would subsume the properties of the lower ones. The taxonomy levels from the lowest to the highest are: knowledge, comprehension, application, analysis, synthesis, and evaluation (Alul, 2000).

Bloom's Taxonomy outlines six hierarchical levels (Fig. 1) of cognitive complexity: knowledge, comprehension, application, analysis, synthesis, and evaluation. Each category represents an increasingly complex type of cognition that is sometimes referred to as lower and higher levels of learning. Each taxonomy component builds on the successful completion of the previous levels.

Figure 1: Design of Bloom's Taxonomy

Each classification within the hierarchy demanded the mastery of skills and abilities that were lower in the classification order. Progressing from lower-level skills (knowledge) to higher-level

skills (evaluation), Bloom's taxonomy presents cognitive development as the achievement of higher order abilities as the learner moves from knowledge to evaluation (Christi, 2012).
Educators who train future teachers often refer to Bloom's taxonomy during each aspect of the instructional cycle, from planning to assessing instruction. Bloom and his associates developed a system to help teachers identify the types of learning expected from students. The value of using Bloom's taxonomy in the development of learning outcomes represents a tool for planning, implementing, and assessing instruction. Bloom's taxonomy provides educators with a common frame of reference that clarifies various types of learning outcomes. In addition, this taxonomy illustrates the wide array of learning outcomes that can be included in any given instructional area (Almerico & Baker, 2004).

Bloom's Taxonomy can be a very powerful tool in assisting a student to learn critical higher-level thinking skills. This process entails a minimum amount of time for the teacher to prepare the phrasing of higher-level questions. However, this process is easy to integrate with the content of the lesson. (Truschel & Deming, 2007)
Booker (Booker, 2007) reported that basic skill education has been devalued by using Bloom's Taxonomy but has promoted "higher-order thinking" at its expense.
Algobory (Algobory & Alajrash, 2008) see that Bloom's Taxonomy is an extensive range of behavioural styles to be achieved by a learner. And Bloom's Taxonomy is the most commonly used classification in selecting the educational objectives of behavioral styles.
As students become adept at analyzing sustainability case studies, developing and building sustainable designs, and assessing products and processes for sustainability at the first two levels (knowledge and comprehension), they move on to the next Bloom stages. (Pappas, Pierrakos, & Nagel, 2012)
Each cognition level in Bloom's Taxonomy offers a precise description of the learning targets. Cognition levels can help teachers clarify their intended learning outcomes, illustrate a planning basis, and set the stage for both assessment and teaching. (Almerico, 2004)
The following are the definitions of Bloom's Taxonomy levels according to Bloom himself and other researchers:

1- Knowledge:

Bloom (1956) defined knowledge as remembering previously learned material. This involved recalling a wide range of material, from specific facts to complete theories. However, all that is required is remembering the appropriate information. Knowledge represents the lowest level of learning outcomes in the cognitive domain.
Alaimam & Rahman (Alaimam & Rahman, 1983) defined knowledge as the level where the student remembers information either by retrieving or by highlighting the correct information from the wrong ones in textbooks.
Lister (Lister, 2006) defined knowledge as the level in which the student can regurgitate a fact when prompted without necessarily understanding its significance. This level of competence can simply be achieved via rote learning.
The first_domain is [Knowledge], which is defined as knowledge of previously learned material or retrieving, recognizing, and recalling relevant knowledge from long-term memory. This

domain may involve the recall of a wide range of materials, from common terms to specific facts, methods, procedures, basic concepts, and principles. (Truschel & Deming, 2007)

2- Comprehension:

Bloom (1956) defined comprehension as the ability to grasp the meaning of materials. This may be demonstrated by translating materials from one form to another (words to numbers), interpreting materials (explaining or summarizing), and estimating future trends (predicting consequences or effects). These learning outcomes move one step beyond the simple rememberance of materials, and represent the lowest level of understanding.

Lister (Lister, 2006) defined comprehension as the level in which the student understands the significance of a fact. A student, when prompted, manifests understanding by supplying knowledge, but which may be different from how the material was first taught.

The second domain is [Comprehension]. This domain involves awareness of the literal message contained in communication and being able to grasp the relationships between each of these elements.(Truschel & Deming, 2007)

3- Application:

Bloom (1956) defined application as the ability to use learned material in new and concrete situations. This ability includes the application of rules, methods, concepts, principles, laws, and theories. The learning outcomes in this area require a higher level of understanding than those under comprehension.

The third domain is [Application], which refers to the ability to use learned material in a new or unprompted use of an abstraction. It also includes applying what was learned to a novel situation in another setting. This domain may involve applying rules, methods, concepts, principles, laws, and theories.(Truschel & Deming, 2007)

4- Analysis:

(Bloom, 1956) defined analysis as the ability to break down materials into component parts to understand its organizational structure. This ability includes the identification of parts, analysis of the relationships between parts, and recognition of the organizational principles involved. Requiring an understanding of both the content and the structural form of the material, the learning outcomes of analysis represent a higher intellectual level than those of comprehension and application.

[Analysis] is the fourth domain and can be described as the ability to examine a problem area in a given subject and identify the various components [breaking the problem down] to focus more on each component. Analysis distinguishes between facts and inferences and determines how the parts relate to one another and to an overall structure. (Truschel & Deming, 2007)

(Lister, 2006) defined application and analysis as intermediate levels of the taxonomy where students are expected to create and analyze artefacts, but within a well defined context.

5- Synthesis:

Bloom (1956) defined synthesis as the ability to fit parts together to form a new idea. This ability involves the production of a unique communication (theme or speech), operational plan (research proposal), or a set of abstract relations (scheme for classifying information). The

learning outcomes in this area stress creative behaviors, with major emphasis on the formulation of new patterns or structures.

Truschel & Deming (Truschel & Deming, 2007) defined [Synthesis] is the fifth domain and refers to the ability to make judgments based on criteria or standards or to combine parts to form a new concept or idea.

Alaimam & Rahman (Alaimam & Rahman, 1983) defined synthesis as the level where the student could assemble the parts to form an integrated idea. This level includes the production of new ideas.

6- Evaluation:

Bloom (1956) defined evaluation as the ability to judge the value of materials (statement, novel, poem, and research report) for a given purpose. The judgments are based on definite criteria, which could be internal (organization) or external (relevance to the purpose). Furthermore, the criteria can be determined by or given to the student. The learning outcomes in this area are the highest in the cognitive hierarchy because they contain elements of all the other categories, as well as conscious value judgments based on clearly defined criteria.

Truschel & Deming (Truschel & Deming, 2007) defined the sixth and final domain is [Evaluation]. This domain is the highest in the cognitive hierarchy because it contains elements of all the other categories as well as conscious value judgments based on clearly defined criteria.

(Lister, 2006) defined this level of taxonomy as that where students are expected to demonstrate considerable skill in setting and achieving their own goals as well as in analyzing artefacts with minimal assistance from the teacher.

According to (Pappas et al., 2012), each level of the hierarchy is characterized by the following descriptors which identify the thinking processes included at each level:

1. Knowledge: describe, identify, recognize, record;
2. Comprehension: discuss, explain, summarize;
3. Application: change, choose, apply, assess;
4. Analysis: analyze, classify, research, compare;
5. Synthesis: create, design, integrate, construct; and
6. Evaluation: assess, choose, evaluate, prioritize, predict, justify.

Krathwohl (Krathwohl, 2002) stated that Bloom considered his taxonomy as more than a measurement tool. He also reported that Bloom believed his taxonomy could serve as a common language about learning goals to facilitate communication across persons, subject matters, and grade levels; as well as a basis for determining the specific meaning of broad educational goals for particular courses or curriculum, such as those in the currently prevalent national, state, and local standards. Krathwohl (Krathwohl, 2002) stated that Bloom's taxonomy aims to determine the congruence of educational objectives, activities, and assessments in a unit, course, and a curriculum. Krathwohl (Krathwohl, 2002) considered Bloom's taxonomy as a panorama of the range of educational possibilities against which the limited breadth and depth of any particular educational course or curriculum can be consider.

Successive levels of Bloom's Taxonomy can be classified into two groups (lower and higher) which have different values. The "synthesis, evaluation, and analysis" level in Bloom's Taxonomy can be classified as higher-order thinking, whereas "knowledge and comprehension" can be classified as lower-order thinking. The application level can be included in both groups of Bloom's Taxonomy. At this level of taxonomy (application), students are expected to demonstrate their ability in the "knowledge and comprehension" levels. (Junoh, Muhamad, Abu, Jusoh, & Desae, 2012).

2.2. Lorin Anderson's taxonomy

Lorin W. Anderson is a distinguished professor emeritus at the University of South Carolina, where he served as a member of the faculty from August, 1973 to August, 2006. He holds a B.A. in Mathematics from Macalester College, an M.A. in Educational Psychology from the University of Minnesota, and a Ph.D. in Measurement, Evaluation, and Statistical Analysis from the University of Chicago. He was also a student of Benjamin S. Bloom at the University of South Carolina.

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In the 1990s, Lorin Anderson revised Bloom's taxonomy as it reflects different forms of thinking, which is an active process that requires more accurate verbs. The subcategories of the six major categories were replaced by verbs, and several subcategories were reorganized. The knowledge category was renamed. Knowledge is a product of thinking, which makes it inappropriate to be described as a category of thinking. Thus, knowledge was replaced with the word "remembering" instead. Comprehension became "understanding" and synthesis was renamed to "creating", to better reflect the nature of thinking described by each category.

Terminological changes between Bloom's and Anderson's taxonomies, as shown in Fig. 2, are the most evident and complicated ones. Constitutively, statements from Bloom's six main departments were transformed from nouns to verbs. In addition, "knowledge" situated at the bottom is renamed and changed as "remembering". Furthermore, "comprehension" and "synthesis" were renamed as "understanding" and "creating". (Tutkun, Guzel, Koroğlu, & Ilhan, 2012)

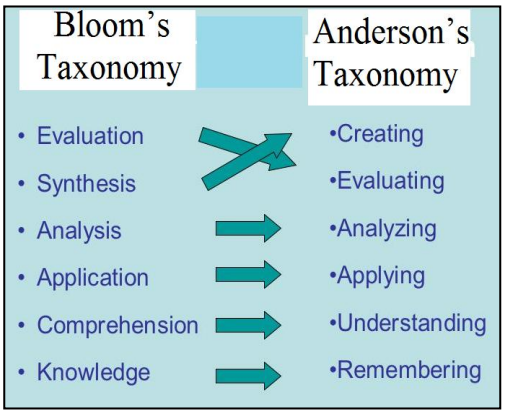

Figure 2: Comparison between Bloom and Anderson's Taxonomies

Anderson provided a revised version of Bloom's Taxonomy and studied higher-order thinking (revisions of Bloom's Taxonomy) as well as generative, original knowledge in greater detail. Analysis was combined with Synthesis, and the top level of the pyramid was assumed to be Creating. Furthermore, the knowledge dimension was classified into the following four facets of knowledge: factual, conceptual, procedural, and metacognitive. Each facet at each level has indicators. (Wang & Farmer, 2008)

Following the definitions of Anderson's taxonomy levels according to other researchers:

Mary J. Pickard defined Lorin Anderson's taxonomy levels as follows (Pickard, 2007):

1- Remembering: the ability of the student to recall or remember information
2- Understanding: the ability to explain ideas or concepts
3- Applying: the ability to use information in a new way
4- Analyzing: the ability to distinguish between the different parts
5- Evaluating: the ability to justify a stand or decision
6- Creating: the ability to create new products or points of view

Denise Tarlinto (2003) defined Lorin Anderson's taxonomy levels as follows:

1- Remembering: the ability to recall, restate, and remember learned information
2- Understanding: the ability to grasp the meaning of information by interpreting and translating what has been learned
3- Applying: the ability to make use of information in a context different from that in which it was learned.
4- Analyzing: the ability to break learned information into parts to understand said information
5- Evaluating: the ability to make decisions based on in-depth reflections, criticisms, and assessments
6- Creating: the ability to create new ideas and information using what was previously learned.

2.3. Wilson's Taxonomy

James Wilson was a Professor of Mathematics and Science in the University of Georgia. He earned his Bachelor's degree in Social Science and Science from the Kansas State Teachers College in 1958 and his M.A. in Mathematics from the same institution. He earned his Ph.D in Mathematics Education from Stanford University in 1967.

Wilson's classification of levels in the cognitive domain is considered as an extension of Bloom's taxonomy, and is thus called an expanded model. James Wilson adapted his model from Bloom's taxonomy to fit the nature of Mathematics as shown in Fig. 3. This model aims to provide a sample table of specifications that would help mathematics teachers and mathematicians working on the curriculum to build a test that would effectively evaluate mathematics students. This model aims to resolve the issues on curriculum, teaching methods, and evaluation. In Wilson's model, the objectives in the cognitive domain are classified into four levels: remembering, understanding, application, and analysis (Khuder, 1984).

Nadalh Khidr (Khuder, 1984) indicated that the levels in the cognitive domain of Bloom's taxonomy is sometimes unacceptable, makes questions artificial, and adds confusion in mathematical ideas.

Following the definitions of Wilson's model, the levels according to other researchers are as follows:

1- Remembering is the retrieval and remembrance of what was studied, which include facts, terms, and exercises. Remembering represents the lowest level of skill expected from the student.

2- Understanding was designed to be more complex than remembering, and is the ability to translate ideas from verbal or symbolic form to another.

3- Application is defined as the ability to select and correctly use appropriate theories, rules, or principles in problem solving. Questions placed in application should be familiar to the students and similar to the material they learned during the learning process, but not completely identical.

4- Analysis represents the highest levels of the cognitive domain in Wilson's model, and includes the analysis, synthesis, and evaluation in Bloom's taxonomy. Analysis includes solving non-routine (any similar case has never been solved) questions and discover mathematical experiences. Moreover, this level is characterized by originality and creativity in Mathematics.

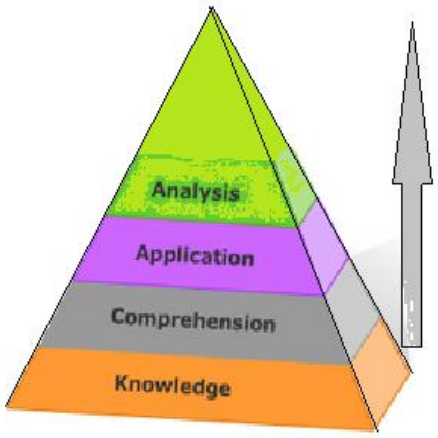

Figure 3: Design of Wilson's Taxonomy

3. Bloom's Taxonomy advantages

1- When compared with other methods of classifications and Bloom's Taxonomy of educational objectives analysis can provide a means to determine the level at which an objective is written and the corresponding questions which need to be asked to achieve the objectives.
2- Bloom's Taxonomy has proved its superiority and effectiveness over other methods after it was verified widely and successfully in research and studies for the analysis of the instructional questions.
3- Krathwohl (Krathwohl, 2002) stated that Bloom considered his taxonomy as more than a measurement tool. He also reported that Bloom believed his taxonomy could serve as a common language about learning goals to facilitate communication across persons, subject matters, and grade levels as well as serve as a basis for determining the specific meaning of broad educational goals for particular courses or curriculum, such as those in the currently prevalent national, state, and local standards.
4- Almerico et al (Almerico & Baker, 2004) defined Bloom's Taxonomy as a tool for planning, implementing, and assessing instruction. One important merit of Bloom's Taxonomy is that it provides teachers and educators with a common frame of reference that clarifies various types of learning outcomes. Another important advantage is that the taxonomy illustrates a wide array of learning outcomes that can be included in any given instructional area.
5- According to (Junoh et al., 2012), educators must use Bloom's Taxonomy in preparing questions for student exams because in this way, students can be tested with different types of questions according to Bloom's Taxonomy cognitive levels.

4. Conclusion

This paper studies Bloom's taxonomy, Lorin Anderson's taxonomy, and Wilson's taxonomy as a tool to analyze Educational Objective domain taxonomies. According to results in section 3, it

can be concluded that Bloom's Taxonomy has many merits to use as a tool to analyze the Educational Objective domain, it can provide a means to determine the level at which an objective is written. Bloom's Taxonomy has proved its superiority and effectiveness over other methods and it could serve as a common language about learning goals, Bloom's Taxonomy provides teachers and educators with a common frame of reference that clarifies various types of learning outcomes.

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