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Analysis of 5th Grade Science Learning Outcomes and Exam Questions According to Revised Bloom Taxonomy

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Abstract

In this study, the relationship between the levels of 5th grade science course exam questions and the 5th class learning outcomes of the science curriculum in the revised Bloom taxonomy was examined. The research was carried out using document analysis method. Since the revised Bloom taxonomy categories were used for the analysis, the data obtained were analyzed with the descriptive analysis technique. The study included 967 science questions and 40 learning outcomes in the 2017-2018 academic year. These questions and learning outcomes were analyzed. At the end of analysis, the relationship between the learning outcomes and exam questions was determined. The inter-rater reliability computing has been made in the analysis of questions-learning outcomes. The reliability co-efficient was calculated .81 for learning outcomes and .77 for questions, indicating an acceptable reliability. According to the results of the analysis, it was determined that the most learning outcomes were in the conceptual knowledge dimension and the most questions were included in the factual knowledge dimension. In the cognitive processes dimension, it was determined that most learning outcomes are at the level of understanding, and the most questions are at the level of remembering. It is understood that 37% of the exam questions are at the level of

learning outcomes. In addition, it was determined that there were no questions about some learning outcomes (24%).

Keywords: Learning Outcomes, Science Curriculum, Science Questions, Revised Bloom Taxonomy

1. Introduction

The learning outcomes of the curriculum constitute the basis for realization of the teaching. The objectives-learning outcomes for a consistent education program should be determined correctly and carried out as defined (Bümen, 2006; Cooper, 2007; Davis, Janssen, & Van Driel, 2016). The learning outcomes in the curriculums of the Ministry of National Education (MNE) and the books prepared in accordance with the learning outcomes are used as the main source of information during teaching. Teaching is carried out through teachers by taking into consideration the learning outcomes and books.

In order to save the learning outcomes in the curriculums, the learning outcomes in the curriculums should be taken into consideration while arranging the units and the subjects in the units (Cooper, 2007; Hubball, Gold, Mighty & Britnell, 2007; Sönmez, 1999). Most of the time, the teacher organizes learning-teaching-evaluation activities by accepting the information contained in the subjects of the textbooks as the limit without examining the learning outcomes in the curriculum. As the textbooks are perceived by teachers as equivalent to the learning outcomes in the curriculum, they are tried to be transferred directly to students. Therefore, teachers should analyze the textbooks and teach the subjects by associating them with what needs to be acquired in the current curriculum (Güneş & Çelikler, 2010). In addition, the objectives and learning outcomes should be used as an evaluation criterion to guide the assessment (Bümen, 2006).

The evaluation process is used to determine which items are inadequate or counterproductive in the education system, find out which element is the source of the problems in the curriculum, and to make corrections about them (Demirel, 2004). Taxonomies are frequently used in systematic evaluation of curriculums and education. Taxonomies form a common language for facilitating communication among practitioners by informing the practitioners about the learning objectives/learning outcomes in the curriculums (Bloom, Engelhart, Furst, Hill, & Krathwohl, 1956). In addition, practitioners and evaluators are informed about the advantages and disadvantages of curriculums through taxonomy (Krathwohl, 2002). The taxonomy was developed by Bloom in order to guide the practitioners and evaluators of education (Bloom et al., 1956).

As a result of the developments in education, the Original Bloom Taxonomy (Bloom, et al., 1956) was considered to be inadequate, and Revised Bloom Taxonomy (RBT) was introduced with the development of Original Bloom Taxonomy by Anderson and Krathwohl (2001). Because of the changes in cognitive psychology, meta-cognitive knowledge has taken its place in this taxonomy. In addition, the expressions of the sub-categories of the cognitive process in the original taxonomy as the noun/noun clause were converted into verbal expressions in the RBT. Among the main categories, comprehension category has been changed as the understanding and the synthesis category has been changed as the creating. The creating is the last category after the evaluating (Anderson & Krathwohl, 2001). In its final form, RBT consists of two dimensions: cognitive process and knowledge. Remembering, understanding, applying, analyzing, evaluating, and creating are the categories that form the cognitive process dimension. Knowledge dimension consists of factual, conceptual, procedural, and meta-cognitive knowledge.

Full learning in learning is based on previously learned information. Therefore, incomplete cognitive behaviors should be completed at the beginning of learning (Nas, 2000). Incomplete information can be completed in different ways (Anderson & Krathwohl, 2001): (1) The learning outcomes covering any subject have different levels of learning outcomes according to the RBT, (2) low-level learning outcomes compared to RBT are placed in the lower grades, and high-level learning outcomes compared to RBT are placed in upper grades. In this way, the student can configure information at all levels and full learning can be provided (Zorluoğlu, Bağrıyanık, & Şahintürk, 2019).

For the evaluation of learning or full learning, assessment should be carried out. The data obtained from the assessment should be evaluated by comparing with certain criteria. The criteria used in the evaluation process cause the evaluation judgment and accordingly the decision to be differentiated (Turgut, 1986). Therefore, the criteria to be used in the evaluation should be equivalent to the criteria used in the formation of the curriculum.

In our country, Bloom Taxonomy is used during the determination of the learning outcomes in the curricula of MNE in the central exams conducted by Student Selection and Placement Centre and MNE, and in the preparation of examinations in schools. For this reason, in the study, the learning outcomes of the 5th grade science education curriculum, which was applied for the first time in the 2017-2018 academic year, the developed textbook according to curriculum, and the exam questions prepared for evaluation purposes were analyzed by taking the RBT into consideration. In addition, the compatibilities of the 5th grade science education curriculum, which was applied for the first time in the 2017-2018 academic year, the developed textbook according to curriculum, and the exam questions prepared were examined according to RBT and results were obtained about the program effectiveness.

This study is of utmost importance in terms of determining the compatibility of the learning outcomes of the 5th grade science education curriculum, textbook developed according to the curriculum, and the exam questions prepared for assessment-evaluation purposes. Because the exam questions of the teacher should be at the same level as the curriculum learning outcomes and textbook contents. Teachers' exam questions, which are at the same levels with RBT levels of learning outcomes in the curriculum and the subjects in the textbook, affect the success of the student in a positive way (Anderson & Krathwohl, 2001; Zorluoğlu & Kızılaslan, 2019). Therefore, the increase in the success of the students will increase the success of the central examinations conducted throughout the country and increase the provision of quality education. In addition, practitioners who take these analyzes into account will increase the adaptability of the learning outcome-application-evaluation in the curriculum (Krathwohl, 2002).

2. Method

The study was carried out by the document analysis method. Document analysis is used for reviewing and analyzing the printed or electronic documents that the researcher has reached on the subject (Bowen, 2009). In the document analysis, the researcher analyzes the data he needs without observing or interviewing in order to examine the written materials, to obtain information, and to infer (Corbin & Strauss, 2008). In the study, Science Education Curriculum (MNE, 2017) learning outcomes and exam questions asked by 21 teachers who work in seven different regions of Turkey (three different teachers from each region) in the 2017-2018 academic year are used for document analysis.

During the data analysis; in the first step, one chemistry education and 3 science education experts came together to form a common language in the learning outcomes of the 5th grade science education curriculum (MNE, 2017), identified a learning outcome from each unit, and carried out a joint analysis. Then each expert performed a separate analysis. Finally, an expert moderator has gathered all the experts to find differences in analysis and try to meet on a common ground. At this step, a total of 40 learning outcomes were analyzed and the reliability coefficient of the learning outcome analysis was calculated as .81. At the second step, the same experts carried out a joint analysis by choosing examples from the questions prepared by seven teachers working in each region of Turkey with the aim to create a common language in the analysis of the questions. Then the experts continued the joint analysis. In the analyzes which were not met on a common ground, the dimension of the step exam question chosen by the majority was determined according to RBT. In this step, 967 exam questions were analyzed and the reliability coefficient of the analysis of the exam questions was calculated as .77. Since the reliability coefficient was calculated as over .70 in both learning outcome analysis and exam question analysis, the analysis was accepted as reliable. In the last step, the analyses of the learning outcome and evaluation questions made by the experts were compared and the realization of the learning outcome was determined.

An example of the learning outcome analysis, question analysis, and the realization of the learning outcome is given below:

While the learning outcome "5.1.3.2. Explains the relationship between the Moon's phases and the Moon's movement around the Earth" is included in the understanding dimension of cognitive process skills as it contains the actual explanation expression, the noun expression is at conceptual knowledge level as it is a related sentence. For this reason, it is at the B2 dimension according to RBT. The example question asked for this learning outcome is to determine that the sentence "It will take 29 days to see a phase of the moon." is true-false. The question is of A1 dimension because it contains factual knowledge and is at the level of remembering. When the dimension of the learning outcome is considered, it is necessary to realize the evaluation at the minimum learning outcome dimension in order to realize the learning outcome. However, it was accepted that the learning outcome could not be realized in the evaluation dimension because the question dimension (A1) was lower than the learning outcome dimension (B2). But, since there is more than one question for learning outcome in the exam questions collected from seven regions, the dimension composed of the questions about learning outcome predominantly is accepted as the dimension of the evaluation question in the determination of the evaluation questions and the realization status of the learning outcome. For example, six evaluation questions were asked for any learning outcome. When three of the questions are at B2 dimension, two of them are at B1 dimension and one of them is at A1 dimension, the dimension of the evaluation question for learning outcome is accepted as B2. Apart from this, there were no cases to cover the different evaluation process related to the determination of the evaluation question dimension.

3. Finding

In this section, first of all, the analysis of the learning outcomes and exam questions according to the RBT will be given. Then, the relationship between the exam questions and learning outcomes will be presented. For this purpose, data collected from RBT based classification of the learning outcomes of the 5th grade science education curriculum is shown at Figures 1 and 2. Analysis of exams' questions according to RBT based classification is show at Figures 3 and 4. In addition, the relationship between the exam questions and learning outcomes is shown at Figure 5.

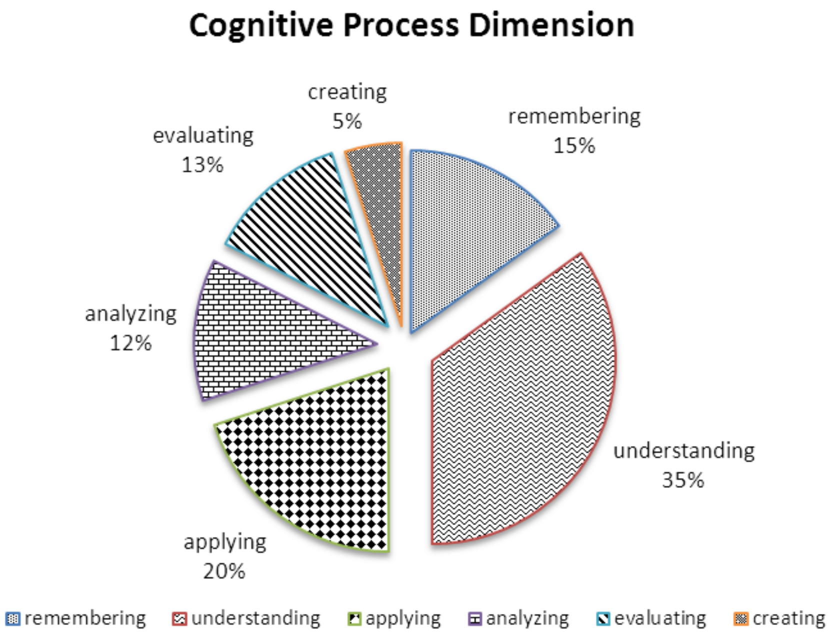

Figure 1. Analysis of the Science Curriculum's Learning Outcomes
(According to Cognitive Process Dimension on RBT)

According to Figure 1, distribution of learning outcomes in terms of the cognitive process dimension is as follows respectively: remembering (15%), understanding (35%), applying (20%), analysing (12%), evaluating (13%) and creating (5%). As seen at Figure 1, cognitive process dimension analysis of the most of learning outcomes focus the understanding category.

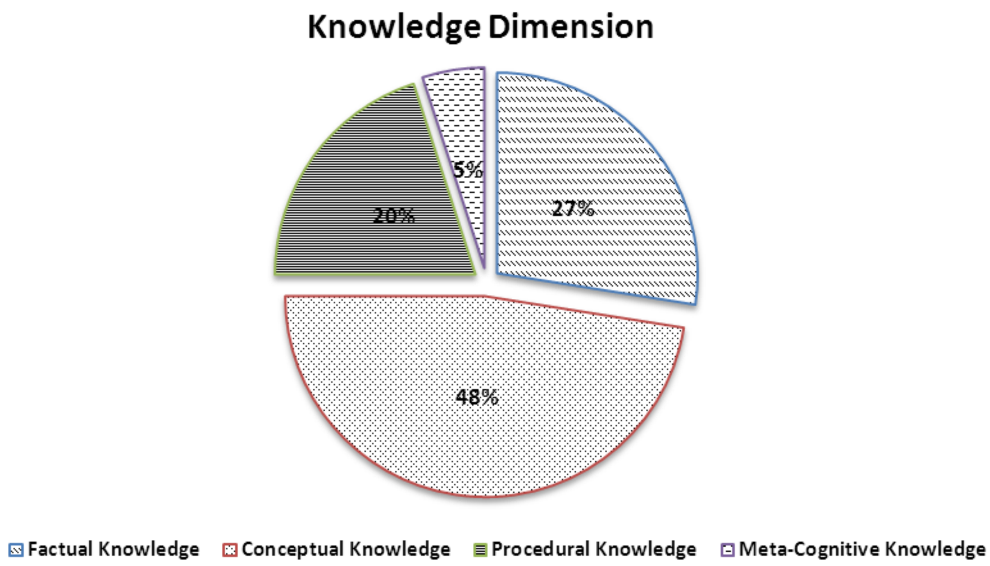

Figure 2. Analysis of the Science Curriculum's Learning Outcomes
(According to Knowledge Dimension on RBT)

As seen at Figure 2, the distribution of learning outcomes in terms of the cognitive process dimension is as follows: factual knowledge (27%), conceptual knowledge (48%) procedural knowledge (20%) and meta-cognitive knowledge (5%). It can be said that the level of conceptual knowledge category is more dominant within the learning outcomes of 5th Grade Science Education Curriculum.

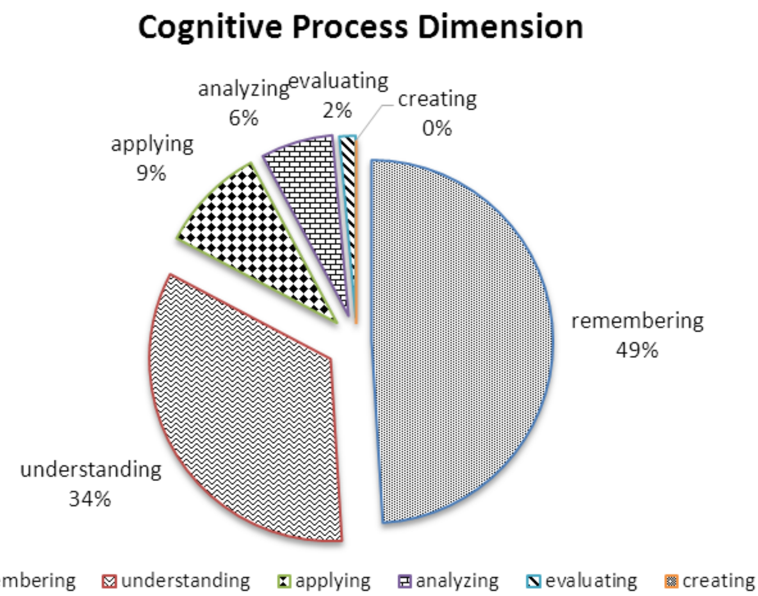

Figure 3. Analysis of the Exam Questions
(According to Cognitive Process Dimension on RBT)

Analysis according to the cognitive process domain of the exam questions is given in Figure 3. As seen from Figure 3, whereas majority of the questions are focused on remembering (49%) and understanding (34%) categories. Also, the distribution of other cognitive categories in exam questions are as follow: applying (9%), analyzing (6%), evaluating (2%) and creating (0%). The exams have no questions that focus creating category.

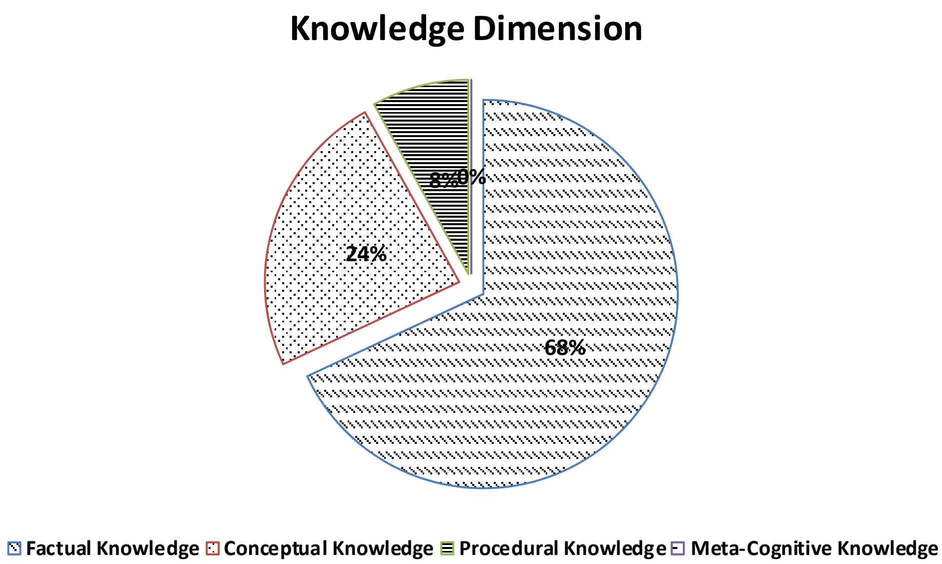

Figure 4. Analysis of the Exam Questions (According to Knowledge Dimension on RBT)

Exam questions analysis in terms of the cognitive dimension are shown at Figure 4. The distribution of knowledge domain analysis of exam questions is as follows: factual knowledge (68%), conceptual knowledge (24%) and procedural knowledge (8%). On the other hand, there is no question in meta-cognitive knowledge.

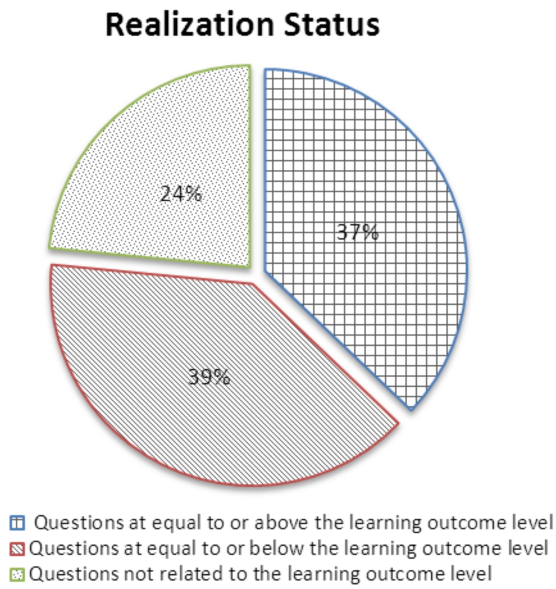

Figure 5. Realization of science learning outcomes (According to RBT)

Dimension analysis of the exam questions in terms of the learning outcomes is given at Figure 5. 37% of the exam questions are designed and prepared according to the learning outcomes. When the relationship between the exam questions and the achievements are examined, it has been determined that there is no question related to 12 learning outcomes (%24). Analysis of the evaluation questions dimension shows that; it has been determined that the questions prepared for 21 learning outcomes are at the lower level of the determined learning outcomes. It is about 39% of exam questions.

4. Results

When the analysis results of the 5th grade science education curriculum were examined according to RBT, it has been determined that each cognitive process had learning outcomes and these learning outcomes were not homogenously distributed to the categories of cognitive process dimension. It was found that science learning outcomes for 5th grade were prepared at a more understanding level and the learning outcomes in the creating category were given less. Considering that, different students have different cognitive process skills and learn in different ways, the learning outcomes that will support the teaching should be distributed at different levels (Anderson & Krathwohl, 2001; Zorluoğlu, Bağrıyanık, & Şahintürk, 2019). This situation shows that the 5th grade science learning outcomes were given more emphasis on the lower levels than the upper-level cognitive process dimension. The results of this study show similarities with the studies of Lee, Kim, and Yoon (2015), and Mosallanejad (2008). Although learning-centered teaching systems, it is stated that the majority of the learning outcomes are at the level of understanding in Korea and Singapore science curriculums. When the learning outcomes in the curriculum are prepared for low-level cognitive categories, it causes program practitioners to provide education and evaluation for lower-level cognitive categories (Miller, 2004). In order to prevent such situations, it should be ensured that the learning outcomes of the curriculum are prepared by taking into consideration the RBT (Jideani & Jideani, 2012) and homogeneously distributed to the cognitive process dimension categories. In addition, in order to increase student learning and to achieve an absolute level of success in evaluation, achieving homogeneity in the distribution of learning outcomes or providing an increasing structure towards the advanced dimensions in the taxonomy dimension at the class-level (Bouchachia, 2010) will both make the teaching effective and increase the effectiveness of the students. In Figure 2, it was determined that there was learning outcome in each knowledge dimension according to RBT and the learning outcome in conceptual knowledge level was the highest in the learning outcomes of the 5th grade science education curriculum. Therefore, it was evaluated that the learning outcomes were not distributed homogeneously to the categories of knowledge dimension. This situation is in parallel with the studies within different lectures being in the literature (Razmjoo & Kazempourfard, 2012). However, in order to minimize such situations and to increase learning experiences (Cannon & Feinstein, 2014), the learning outcomes towards the upper level of knowledge dimension and cognitive process skills (Marley, 2014) can be included in the process or teaching can be done.

When the exam questions that teachers have made throughout Turkey were analyzed according to cognitive process skills, it was determined that the questions were asked for each category except creating but the questions were mostly asked in remembering level. Since it is a prerequisite checking whether the objectives of each education activity are achieved to maintain the healthy structure of the education system, assessment and evaluation have an important place in education (İşman, 2000). Therefore, it is necessary to perform teaching and evaluation at the lowest learning outcome level according to taxonomies (Anderson & Krathwohl, 2001). When the exam questions were examined according to the knowledge dimension, it was determined that the questions were asked mostly at the factual knowledge level, not at the level of meta-cognitive knowledge. Questions at the meta-cognitive knowledge can be included in the evaluation process for providing rich educational opportunities and conducting teaching evaluations (Irvine, 2017).

When the relationship between the 5th grade science education curriculum learning outcomes and the exam questions were examined, it was understood that 24% of the questions asked are not related to the learning outcomes, 37% meet the learning outcomes, and 39% do not meet the level of learning outcomes. Examinations should be such as to include all the learning outcomes of the educations (Yılmaz, 2004). Therefore, when the exams held in Turkey were examined in the scope of the research, it was understood they were prepared without taking a majority of the learning outcomes into consideration. In addition, exam questions were considered to be prepared without paying attention to the level of learning outcomes.

The quality of both teaching and evaluation can be increased by the fact that teachers first determine the level of learning outcomes, they perform the education at the level they have determined and at a higher level, and perform the evaluation for this. In addition, asking evaluation questions related to the learning outcomes in existing curriculums can strengthen the relationship between curriculum, teaching, and evaluation. Therefore, it is suggested that teachers should be informed about taxonomies and necessary in-service training should be given.

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