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Analysis of 10th Chemistry Curriculum According to Revised Bloom Taxonomy

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Abstract
In this study, evaluative case study was used to determine the realization level of the outcomes in the 10th chemistry curriculum. The 23 outcomes in the 10th grade chemistry curriculum were analyzed by two researchers. In order to determine the realization of the achievements based on practice, a chemistry teacher who attended the 10th grade chemistry course was observed. During the observations, notes were kept about the teaching, activity and evaluation dimensions of the application in order to make valid analyzes and shared with the other researcher to determine the size of the application according to RBT. In order to ensure the reliability of the observations, the analyzes were checked by an expert in RBT and the reliability coefficient was calculated (.79). When the realization status of the 10th grade chemistry curriculum is evaluated, it is understood that it meets 48% in teaching dimension, 57% in activity dimension and 83% in evaluation dimension.

Keywords: Science**,** Chemistry curriculum, Learning outcomes, Revised bloom taxonomy, Taxonomical analysis, Case study

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Ethical: This study follows all ethical practices during writing.

Contents

Contribution of this paper to the literature
This study will present ideas about taxonomical analysis of chemistry curriculum outcomes to researchers engaged in taxonomy.

1. Introduction

The rapid changes in science and technology, the changing needs of the individual and society, the innovations and developments in the theories and approaches of learning and teaching have directly affected the roles expected of individuals (Arı and Gökler, 2012). This change produces information, which can be used functionally in daily life, such as solving problems, thinking critically, entrepreneurship, stability, having communication skills (Ozcan and Akcan, 2010). The curricula that will serve to educate individuals with this qualitative texture have been prepared in a simple and understandable structure that aims to gain value and skill, taking individual differences into consideration rather than merely transmitting information. For this purpose, while repetitive gains and explanations with a spiral approach at different subject and class levels, on the other hand, the learning outcomes that are aimed to be gained in a holistic and at the same time are included (Kidwell *et al.*, 2012). The acquisitions and explanations in both groups are competent, current, valid and relevant to the discipline (Kızılaslan, 2014). These acquisitions and their explanations that define their limits point to a simple content from a perspective that provides integrity in the perspective of values, skills and competences at the level of classes and educational levels (Tutkun *et al.*, 2012). In this way, a total of curricula were created towards use of metacognitive skills, provide meaningful and permanent learning, which are associated with solid and previous learning and integrated with values, skills and competences with other disciplines and daily life (Miller *et al.*, 2010).

The main purpose of science education is to educate individuals with knowledge, skills and behaviors integrated with our values and competencies (Tanık and Saraçoğlu, 2011). While trying to gain knowledge, skills and behaviors through education programs, our values and competencies serve as the link and horizon that establishes the integrity between these knowledge, skills and behaviors. Our values are the distinction of national and spiritual resources of our society, which has reached from past to today and is our inheritance that we will pass on to our future (Ivanitskaya *et al.*, 2002). Competencies are our operational integrity that enables this heritage to participate and contribute to life and the human family. In this respect, our values and competencies are form an inseparable part of our theory and practice. The knowledge, skills and behaviors that we try to gain through current teaching and learning processes are the tools and bases of our values and competencies that make us we, gaining visibility within the conditions of the day; it is incidental due to its structure, which may vary within the conditions of the day, and is therefore updated and renewed through continuous reviews (Näsström, 2009).

In the process of curriculum development, a harmonic approach was adopted taking into consideration the harmony among all the components by considering the existing scientific knowledge and accumulation of the multi-faceted developmental characteristics of human beings (Razzouk, 2008). In this context, it is considered appropriate to mention some basic development principles. Curriculum has been prepared with the principle that human development does not end in a certain period and continues throughout life (Yüksel, 2007). For this reason, it is recommended to take supportive measures by considering developmental characteristics of individuals in all age periods (Crowe *et al.*, 2008). Although the development continues throughout life, it is not a single and exemplary structure. It progresses in stages and the developmental characteristics of individuals are different in each stage. The stages are not homogeneous in terms of their beginning and ending. For this reason, the programs are structured with the utmost precision to take this into consideration. Necessary adaptations are expected to be made by teachers in the process of achieving the objectives and achievements of the programs. Developmental periods follow a sequential and unchanging sequence (Temel *et al.*, 2012). On the other hand, this sequence is characterized by certain orientations: from simple to complex, general to specific and concrete to abstract (Haghshenas, 2015). In the process of curriculum development, these orientations were taken into consideration both as a prerequisite and succession of the competencies and skills that constitute the proficiency in a field, and were in the distribution of courses and their relations with each other (Zorluoğlu *et al.*, 2016). In the curriculum, the principle of human development is a whole. Human characteristics in different areas of development interact with each other (Bekdemir and Selim, 2008). For example, language development affects thought development and is also influenced by thought development. For this reason, teachers are expected to take into consideration that a student's acquisition may affect another development area. The curricula are structured with respect to individual differences. Individual differences arising from hereditary, environmental and cultural factors are also manifested in terms of interest, need and orientation (Ben-Zvi and Carton, 2008). On the other hand, this includes inter-individual and individual differences. Individuals differ both from others and are different in their own characteristics. For example, an individual's abstract thinking ability may be strong while the same individual's painting ability may be weak.

In general, taxonomy means that the gradual classification of assets from simple to complex and preconditioning each other. In program development, taxonomy implies grading the desired behaviors/outcomes from simple to complex, easy to difficult, concrete to abstract, as prerequisites of each other (Bloom, 1956). In this context, taxonomy is used to classify learned behaviors, which have a close relationship between them horizontally and vertically (Bakırcı and Erdemir, 2010). For this reason, in the 1950s and 1960s, a variety of taxonomy studies were carried out by many researchers in terms of facilitating and guiding the determination of targets and behaviors towards cognitive, affective and dynamic learning (Burnett, 1999). One of these researchers, Benjamin Bloom, developed the Cognitive Field Taxonomy, which consists of six steps, in 1956, within the scope of the classification of objectives and behaviors towards cognitive learning. This taxonomy is commonly known as Bloom's taxonomy. Despite various criticisms, it has been translated into many languages and is among the most widely used taxonomies (Hasan *et al.*, 2013).

The Revized Bloom Taxonomy (RBT) has brought significant innovations to the classification; the steps are comprehensible and comprehensive (Noble, 2004). By simplifying the writing of the outcomes, it has made it possible to evaluate performance. In addition, it provided the formation of Taxonomy table where the outcomes can be seen in two dimensions. The vertical column of these two dimensions constitutes the accumulation and the horizontal dimension constitutes the cognitive process. Where both dimensions overlap, cells form (Anderson, 2005; Amer, 2006). In teaching programs, each outcome can be classified in a cell using the Taxonomy table. The verb in the outcome sentence for this process corresponds to the steps in the cognitive process and the name corresponds to the steps in the knowledge accumulation. There are no definite distinctions between the steps, and there may be flexible transitions (Anderson and Krathwohl, 2001).

Within the scope of the study, it was aimed to determine the realization of the 10th grade gains of the chemistry curriculum according to RBT. Therefore, the following questions were sought in the study;

- How do the outcomes in the 10th Grade Chemistry Curriculum show the distribution according to RBT?
- At what stage of the RBT did grade 10th Grade Chemistry Curriculum outcomes take place?
- At what stages does the teaching of the subject take place according to the RBT?
- At what stages do the activities take place according to the RBT?
- At what stages does the assessment take place according to the RBT?
- What is the status of 10th Grade Chemistry Curriculum in terms of teaching, effectiveness and evaluation?

2. Method

The study was carried out with evaluative case study. Evaluator case study is frequently used in the evaluation of any dimension or phenomenon in the field of education (Merriam, 1998). In this study, evaluative case study was used to determine the realization level of the outcomes in the 10th chemistry curriculum.

In order to make the evaluation, the analyzes were carried out in three stages:

1. The 23 outcomes in the 10th Grade Chemistry Curriculum (Ministry of National Education (MONE), 2018) were analyzed by two researchers and then an expert was checked to ensure reliability. The reliability coefficient was calculated as .87.
2. In order to determine the realization of the achievements based on practice, a chemistry teacher who attended the 10th grade chemistry course in 2018-2019 academic year was observed by a researcher for a total of 68 lesson hours. During the observations, notes were kept about the teaching, activity and evaluation dimensions of the application in order to make valid analyzes and shared with the other researcher to determine the size of the application according to RBT. In order to ensure the reliability of the observations, the analyzes were checked by an expert in RBT and the reliability coefficient was calculated. The reliability coefficient of the application dimension was calculated as .79.
3. A researcher compared the achievements and the steps in the practice according to RBT and determined the achievements according to the teaching, activity and evaluation dimensions. Since the reliability coefficient was above .70 in the first and second steps, the analysis was accepted as reliable.

The analysis of teaching, activity and evaluation dimensions of teacher practice was carried out by taking the sample analysis given below;

The acquisition of "often matches the names of the interacting elements with their symbols", is placed from the cognitive process skills dimension to the practice dimension due to the verb expression, and from the dimension of information to the conceptual knowledge level because the name expression includes rationality. Therefore, it is said that the outcome is at B3 level. Teaching was placed in the B4 dimension, since the teacher mostly processed conceptual information in a way that students could analyze. During the realization of the activities, it was placed in the B5 dimension because of the experiment in the book and finding answers to the evaluation questions in the activity. As the teacher asked questions about the assessment of the information they learned, the assessment dimension was determined as B5 in order to test the learning while finishing the course for acquisition. In order to achieve this, teaching must be carried out at least from the dimension of attainment (Anderson and Krathwohl, 2001). For this reason, it has been examined whether the steps examined in education provide the dimension of outcome. As a result of the analysis, it was determined that the acquisition at the B3 level was at the B4 level in the teaching dimension; Since the outcome at the B3 level is at the B5 level in the activity dimension, it has been determined that the outcome is realized at the activity dimension; Since the outcome at the level of B3 is at the level of B5 in the evaluation dimension, it has been determined that the outcome is realized at the teaching dimension.

3. Results

In this section, the analysis of 10th grade chemistry learning outcomes, teaching, activity, evaluation and realization of learning outcomes according to the RBT will be given. For this purpose, first of all, data collected from RBT based classification of the 10th grade chemistry learning outcomes is shown at Figure 1 and Figure 2. Analysis of teaching, activity and evaluation according to RBT based classification is show at Figure 3-8. Also, the realization of learning outcomes is shown at Table 1.

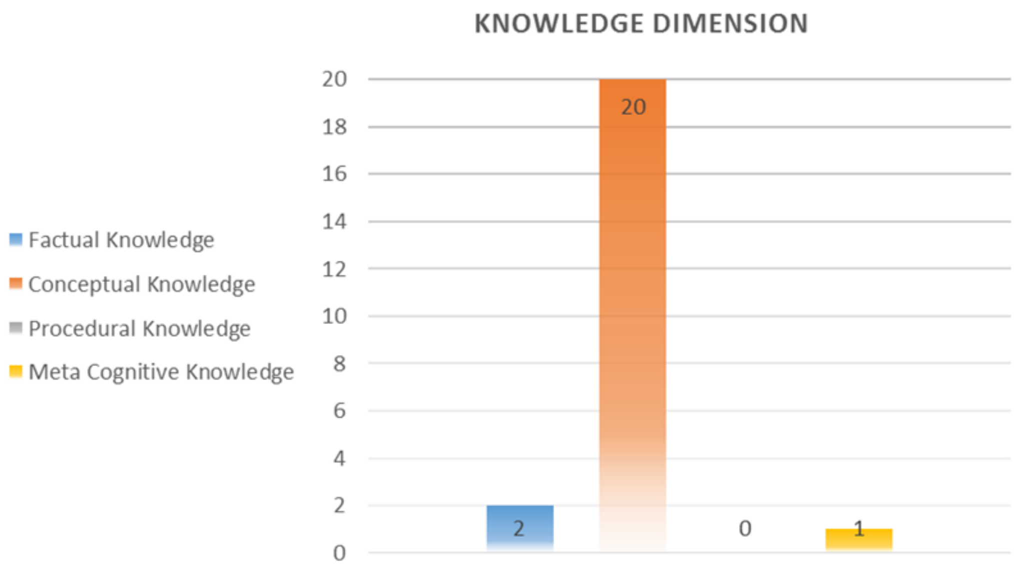

Figure-1. Analysis of learning outcomes according to knowledge dimension.

According to Figure 1 the distribution of learning outcomes in terms of the knowledge dimension is as follows: conceptual knowledge (20 learning outcomes), factual knowledge (2 learning outcomes), meta-cognitive knowledge (1 learning outcomes) and procedural knowledge (0 learning outcomes). The level of conceptual knowledge dimension is more dominant within the 9th grade chemistry curriculum learning outcomes.

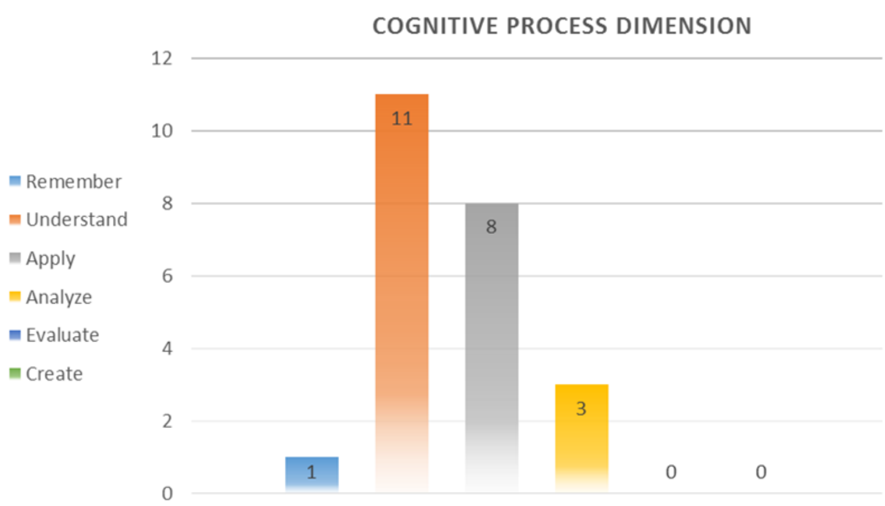

Figure-2. Analysis of learning outcomes according to cognitive process dimension.

As seen at Figure 2 distribution of learning outcomes in terms of the cognitive process dimension is respectively: Understand (11 learning outcomes), apply (8 learning outcomes), analyze (3 learning outcomes), remember (1 learning outcomes), evaluate (0 learning outcomes) and create (0 learning outcomes). Cognitive process dimension analysis 10th grade chemistry learning outcomes of the most of learning outcomes focus the understand Figure 1.

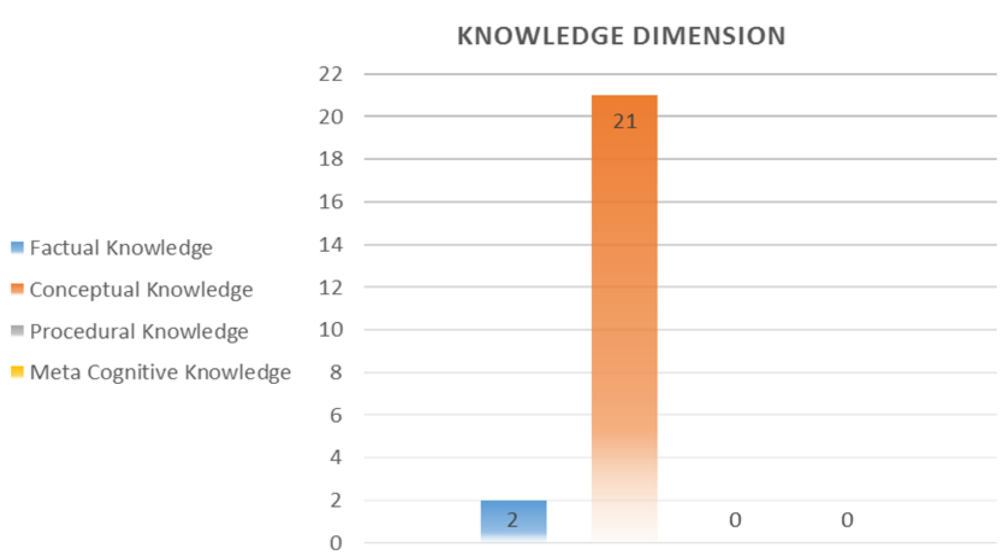

Figure-3. Analysis of teaching according to knowledge dimension.

As seen from Figure 3 whereas majority of the questions are focused on conceptual knowledge (21 learning outcomes) and factual knowledge (2 learning outcomes). Also, the distribution of other knowledge dimension in teaching of chemistry courses have not focus procedural and meta-cognitive knowledge.

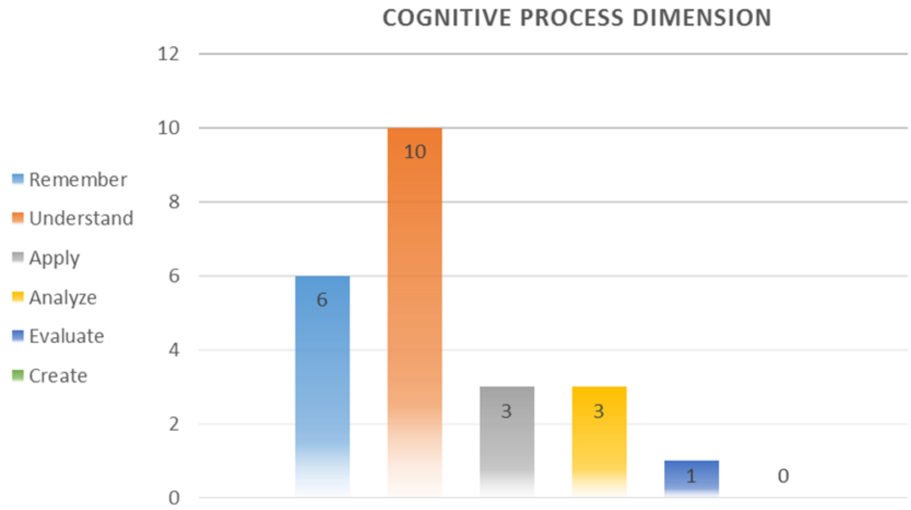

Figure-4. Analysis of teaching according to cognitive process dimension.

As can be seen in Figure 4 in the analysis of teaching are five cognitive process skills dimension; understand (10 learning outcomes), remember (6 learning outcomes), apply (3 learning outcomes), analyze (3 learning outcomes) and evaluate (1 learning outcomes). It is understood that understand dimension get the most of distribution in cognitive process dimension.

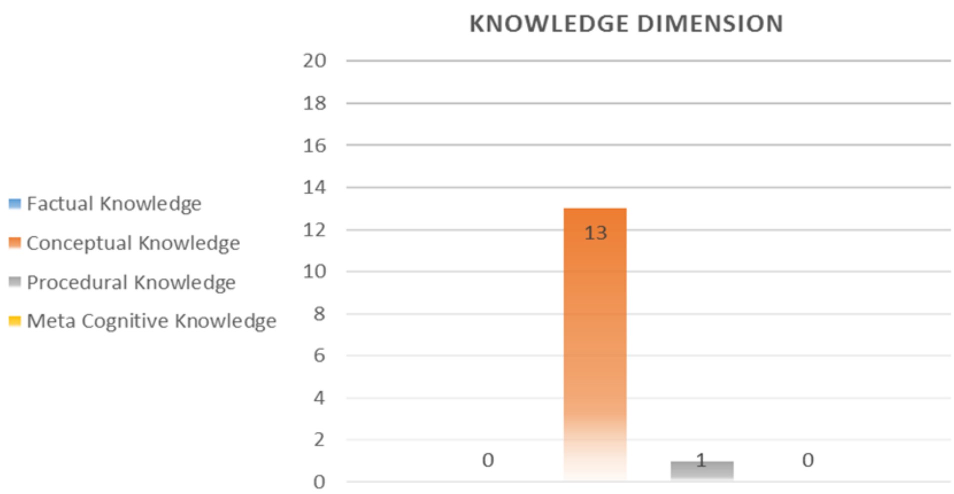

Figure-5. Analysis of activity according to knowledge dimension.

According to Figure 5 in analysis of activity dimension, activities are generally seen that it has been collected around the conceptual dimension. Distribution of activities in knowledge dimension are conceptual knowledge (13 learning outcomes) and procedural knowledge (1 learning outcomes). Also, there is no activities in knowledge dimension for factual and meta-cognitive knowledge dimension.

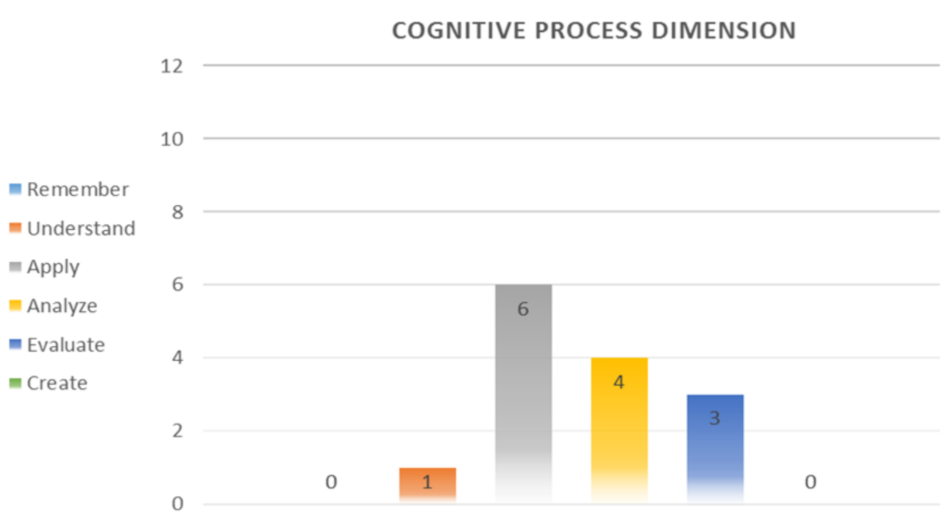

Figure-6. Analysis of activity according to cognitive process dimension.

According to Figure 6 distribution of learning outcomes in terms of the cognitive process dimension is as follows respectively: Remember (0 learning outcomes), understand (1 learning outcomes), apply (6 learning outcomes), analyze (4 learning outcomes), evaluate (3 learning outcomes) and create (0 learning outcomes). As seen at Figure 6 cognitive process dimension analysis 10th grade chemistry activities focus the apply dimension.

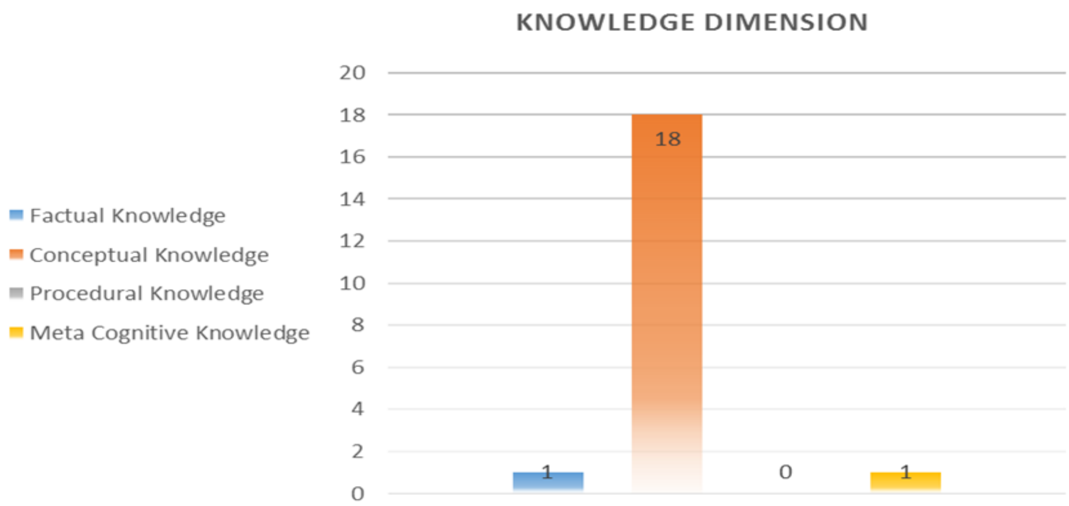

Figure-7. Analysis of evaluation according to knowledge dimension.

According to Figure 7 most of evaluation are conceptual knowledge (18 learning outcomes) level according to the knowledge dimension of RBT. Distribution of evaluation in knowledge dimension are factual knowledge (1 learning outcomes), meta-cognitive knowledge (1 learning outcomes) and procedural knowledge (0 learning outcomes).

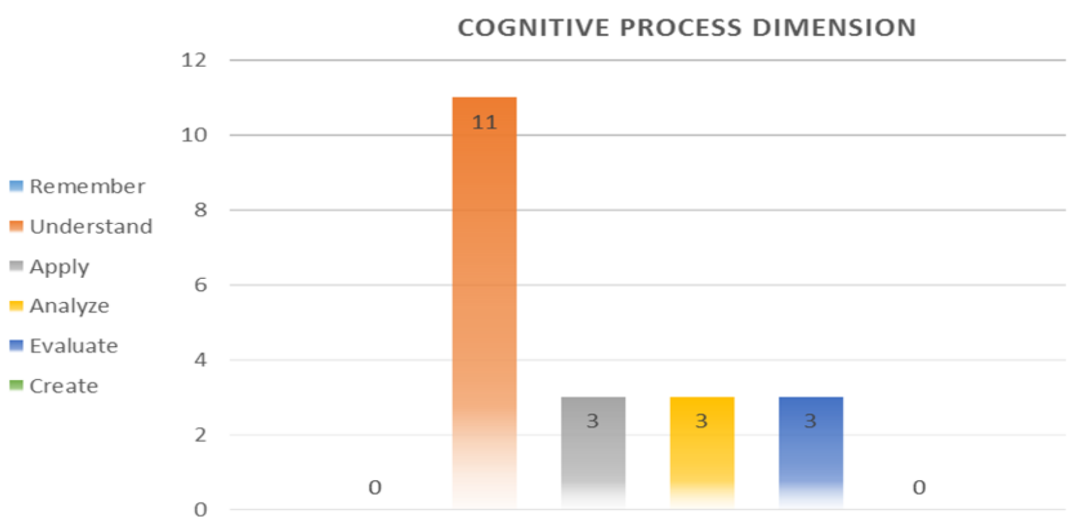

Figure-8. Analysis of evaluation according to cognitive process dimension.

As seen from Figure 8 majority of the evaluation are focused on understand (21 learning outcomes). Also, the distribution of other cognitive process dimension in evaluation have not remember and create dimension. Apply, analyze and evaluate were done equally (3 learning outcomes) in the evaluation.

Table-1. The level of realization of the learning outcomes according to teaching, activity and evaluation.

Learning outcomes	Teaching	Activity	Evaluation
1th learning outcome	-	+	+
2nd learning outcome	-	-	+
3rd learning outcome	+	+	+
4th learning outcome	+	-	+
5th learning outcome	-	+	-
6th learning outcome	-	+	+
7th learning outcome	-	-	-
8th learning outcome	+	+	+
9th learning outcome	-	+	-
10th learning outcome	-	+	-
11th learning outcome	+	-	+
12th learning outcome	+	+	+
13th learning outcome	+	+	+
14th learning outcome	-	+	+
15th learning outcome	-	-	+
16th learning outcome	-	-	+
17th learning outcome	+	-	+
18th learning outcome	+	+	+
19th learning outcome	-	-	+
20th learning outcome	+	+	+
21th learning outcome	+	-	+
22nd learning outcome	+	+	+
23th learning outcome	-	-	+
Realization Status (%)	48%	57%	83%

The level of realization of the learning outcomes according to teaching, activity and evaluation are given at Table 1. While the outcomes were realized 48% in the teaching dimension; 57% in activity dimension; 83% of the evaluation dimension. In the activities dimension, there were no activities aimed at 9 outcomes; In the evaluation dimension, it was determined that no evaluation was made for 3 outcomes.

4. Discussion

While analyzing the 10th grade Chemistry Curriculum (MONE, 2018) achievements according to RBT, the following criteria were made: General evaluation of outcomes according to knowledge dimension steps, general evaluation of outcomes according to cognitive process dimension steps, according to knowledge dimension steps, general evaluation of teaching, general evaluation of teaching according to cognitive process dimension steps, general evaluation of activity according to knowledge dimension steps, general evaluation of activity according to cognitive process dimension steps, general evaluation of evaluation according to knowledge dimension steps, cognitive process, the general evaluation of the assessment according to the dimensions of the dimensions' dimensions are explained by taking into account the dimensions.

According to the results of the analysis made by considering the information dimension steps, the outcomes of the 10th grade chemistry curriculum are mostly based on conceptual knowledge (20 learning outcomes). The fact that the outcomes in the curriculums are at the level of conceptual knowledge and above increases the effectiveness of the teaching and improves the high level learning of the students (Anderson and Krathwohl, 2001). When the cognitive process dimension steps are taken into account, 96% of the program outcomes are at the understand, apply and analyze level. The fact that the general tendency according to the cognitive process step levels of the study includes outcomes in comprehension and higher levels suggests that the program will make the student active in learning and instruction will be student centered. Integrating the outcomes towards higher-level cognitive process dimensions into a program enables the student to take an active role in learning (Anderson and Krathwohl, 2001; Crowe *et al*., 2008).

In addition to determining the general tendencies of the curriculums, it is necessary to evaluate the inputs such as books and teaching. This will help researchers provide more detailed information about their curriculum (Anderson and Krathwohl, 2001). When the teaching department, which forms part of the course applications, is examined according to the information dimension steps, it is determined that teaching is processed at the level of 21 learning outcomes as in the outcomes. In order to increase the effectiveness of the outcomes in the curriculums, it is necessary to carry out teaching at or above the acquisition dimension (Anderson and Krathwohl, 2001). For this reason, it can be said that the outcomes in the teaching dimension are realized, but no teaching above the acquisition dimension is realized. When the teaching practices were examined according to the cognitive process dimensions, it was determined that teaching was conducted at an understanding and higher level (17 learning outcomes).

In practice, activity is often used to increase learning and provide permanent learning (Amer, 2006). When the activities used by the teacher were examined according to the information dimension steps, it was determined that the activities were realized at the level of conceptual knowledge (13 learning outcomes) and procedural knowledge (1 learning outcomes). When the activity part of the course applications was examined according to the cognitive process dimension steps, it was determined that activity was performed at the apply (6 learning outcomes) level. Also, the activity for remember and create is not implemented. When the outcomes were evaluated in general, it was determined that there was no activity for 9 outcomes.

Assessment should be made to assess student learning and determine the efficiency of the process as a result of teaching (Ben-Zvi and Carton, 2008). Evaluations during teaching should take place on every surface in order to measure student tests (Anderson and Krathwohl, 2001). When the evaluations used by the teacher were examined according to the information dimension steps, it was found that the evaluations were mostly at the level of conceptual knowledge (18 learning outcomes). When the activity part of the course applications was examined according to the cognitive process dimension steps, the evaluations were mostly conducted at understand (6 learning outcomes) level. The teacher did not evaluate students to remember and create, but did less to apply, analyze and evaluate.

When the realization status of the 10th grade chemistry curriculum is evaluated by considering the above analyzes, it is understood that it meets 48% in teaching dimension, 57% in activity dimension and 83% in evaluation dimension.

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