ORIGINAL ARTICLE

Evaluation of Science Teachers' Exam and High School Entrance Exam Science Questions Based on the Revised Bloom Taxonomy¶

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***Abstract**: This study aims to evaluate exam questions set by science teachers for eighth grade students and science questions from a central high school entrance exam (HSEE) according to the Revised Bloom's Taxonomy (RBT). In this study, document analysis technique was employed, as one of the recognized methods of qualitative research. The HSEE science questions and the teacher-prepared exam questions were evaluated separately in the dimensions of knowledge and cognitive process, and the frequency and percentage distribution of the questions were examined according to the RBT. The science teachers' exam questions were found to be the most suitable for factual knowledge in the RBT knowledge dimension, and the most appropriate for the remembering and understanding levels of the cognitive process dimension. It was determined that the HSEE science questions were the most suitable for conceptual and procedural types of knowledge in the RBT knowledge dimension, and for the understanding and analyzing levels in the cognitive process dimension. Both the questions prepared by teachers and the HSEE science questions were not homogeneously distributed in terms of the RBT. It was determined that while the science teachers' exam questions were at the lower level of the cognitive process, the HSEE science questions were at a level higher than those prepared by the teachers.*

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Introduction

EDUCATION has become the most important element of human development by transferring social values to new generations, and is a branch of science that enables the development of societies both past and present. In order to achieve prosperity and peace, societies have afforded significant importance to education and learning at any age, and through this have achieved societal development. Especially over the past century, countries that have invested heavily in education in order to raise citizens who are equipped with the needs of the age have reaped the benefits in a comparatively shorter time to become leaders in every field (Çalık & Çınar 2009; Sahnoun & Abdennadher 2021).

In today's education system, it is important to train students to be successful in both their exams and to possess certain high-level skills. In this context, teachers need to employ exam questions that measure high-level cognitive thinking, and that take the cognitive differences of students into account (Çakıcı & Girgin 2012). The type and level of questions used are considered an important factor in developing higher levels of cognitive thinking skills in students (Kaya & Ahi 2022; Nakiboğlu & Yıldırır 2011). However, studies have shown that exam questions generated by teachers do not generally consider students' cognitive thinking skills (Özmen & Karamustafaoğlu 2006; Salmon & Barrera 2021).

The task of monitoring the behaviors that are desired to be gained through education is the responsibility of teachers (Özkan & Arslantaş 2013). While teachers aim to elicit the desired behaviors in individual students, the purpose of a teacher's evaluation is to determine the extent to which this behavior occurs (Baniasadi et al. 2022; Küçükahmet 2002). Teachers undertake such evaluations at every stage of the teaching process. For this reason, they have a key decision-making position in situations that can determine students' futures. Data obtained from these evaluations have revealed objective results for both the teachers' methods and their students' success. Based on these assessments and evaluation, the success-failure status of students is revealed, together with their level of success or the reasons for failure are known, as well as which students are able to move on to the next level and which students are required to repeat the program (Turgut & Baykul 2014; Yan et al. 2021).

In Turkey, not all students can attend a high school of their choosing. As the number of students who take the necessary entrance exam increases every year, the number of qualified schools remains relatively small. In this context, only students' characteristics can be measured realistically, and their success rankings determined through appropriate assessment and evaluation (Şad & Şahiner 2016). For this reason, students in Turkey are placed in schools according to a centralized exam. Since 1999, eighth-grade students (in their final year of middle school) achieve transfer to high schools via a centralized exam system, and these exams ensure that 10% of students are placed in qualified schools.

The name for this exam has changed over time, having been known as the High School Entrance Exam (HSEE) between 1999 and 2004, the Secondary Education Institutions Exam (SEIE) between 2004 and 2008, the Placement Exam (PE) between 2009 and 2013, the Transition Exam from Basic Education to Secondary Education (TFBSE) between 2013 and 2018, and then back to the High School Entrance Examination (HSEE) since 2018 (Milli Eğitim Bakanlığı [Turkish Ministry of National Education] 2018). In total, there are 1,856 "qualified high schools" throughout Turkey, with 33% as Vocational and Technical Anatolian High Schools, 23% as Science High Schools, 22% as Anatolian Imam Hatip High Schools, 16% as Anatolian High Schools, and 6% as Social Sciences High Schools (Milli Eğitim Bakanlığı [Turkish Ministry of National Education] 2020).

Purpose of the Study

The current study aims to compare the distribution of High School Entrance Examination (HSEE) science questions and questions prepared and used by science teachers in school-based exams in terms of the knowledge and cognitive process dimensions of the Revised Bloom Taxonomy (RBT). In this context, HSEE science questions between 2018 and 2021 and exam questions used by science teachers working in a province of Turkey for eighth-grade students were examined in order to determine the degree to which the science teachers' exam questions were compatible with the HSEE science questions. Answers to the following questions were sought in the study:

- How are the exam questions prepared by science teachers distributed according to the RBT knowledge dimension?
- How are the exam questions prepared by science teachers distributed according to the RBT cognitive process dimension?
- How are the HSEE science questions distributed according to the RBT knowledge dimension?
- How are the HSEE science questions distributed according to the RBT cognitive process dimension?
- To what extent are the science teachers' exam questions and the HSEE science questions compatible according to the RBT?

Importance and Rationale of the Research

Since decisions regarding education are taken in accordance with the results of measurement and evaluation systems, they are of significant importance to any education system (Alt & Raichel 2022; Anderson 2005; Korkmaz

2004). As such, parallelism is required between curricula and measurement tools used to assess student achievement levels. Exam questions asked in the HSEE have the power to affect questions asked in schools' written exams, questions included in textbooks, and those asked to students as part of their courses. For this reason, it is important that qualifying questions are asked in order to appropriately determine students' levels for entrance to qualified schools (Ardahanlı 2018).

In addition to evaluating educational programs through measurement and evaluation, student achievements can be classified by monitoring their development status (Korkmaz 2004). Classification systems are of significant importance in determining both curriculum achievement and the functionality of the teaching process. The taxonomy classification system created by Bloom et al. (1979) aimed to make the complex processes occurring in the minds of individuals as they learned more easily understood. In this context, taxonomies guide evaluation experts, educators, and students alike (Author(s) 2021; Demirel 2007). Taxonomies facilitate communication between individuals in terms of learning objectives by forming a common language, ensuring that curriculum objectives are understood by everyone in the same way, increasing the coherence of activities or evaluations performed, and providing a broad perspective on the positive and negative aspects of curricula (Krathwohl 2002; Panthalookaran 2022).

One of the most important goals of science education is to provide students with high-level thinking skills. However, these skills can only be validated through the measurement of high-level thinking characteristics in exams. Students mostly organize their studying in accordance with the exams that they will sit. Therefore, if the exam questions asked are of the kind that measures superficial knowledge, students are likely to choose a superficial learning process path. It is a common occurrence that many students who finish their high school education cannot readily solve HSEE questions since they encountered mostly low-level questions in their school exams, and are therefore surprised when they encounter higher-level questions in the HSEE since they lack the experience in solving these types of questions. The levels of questions prepared by teachers are therefore of significant importance in terms of the quality of science teaching received by students. It is thought that determining the levels of questions prepared by science teachers and then comparing them with the levels of questions in the HSEE will prove useful for education administrators, textbook developers, educational measurement and evaluation specialists, and also school teachers.

The current research is also considered important in terms of providing the opportunity to evaluate exam questions prepared by science teachers and the HSEE science questions together, and thus allowing for a general evaluation of the questions being asked to students. In most studies conducted in Turkey in this field, it has been determined that the questions only

Table 1. Original Bloom Taxonomy (Krathwohl 2002, p213).
1.0 Knowledge: Students only remember and repeat knowledge of 1.10 Specifics 1.11 Terminology 1.12 Specific facts 1.20 Ways and means of dealing with specifics 1.21 Conventions 1.22 Trends and sequences 1.23 Classifications and categories 1.24 Criteria 1.25 Methodology 1.30 Universals and abstractions in a field 1.31 Principles and generalizations 1.32 Theories and structures
2.0 Comprehension: Students' abilities to integrate behaviors gained in previous levels 2.1 Translation 2.2 Interpretation 2.3 Extrapolation
3.0 Application: Students' application of acquired knowledge and skills to new situations encountered
4.0 Analysis: Making connections between knowledge by thinking critically Analysis of …. 4.1 Elements 4.2 Relationships 4.3 Organizational principles
5.0 Synthesis: Students combine the pieces to create a new product by considering the harmony between pieces Production of …. 5.1 Unique communication 5.2 Plan, or proposed set of operations Derivation of …. 5.3 Set of abstract relations
6.0 Evaluation: Making decisions based on students' prior knowledge Evaluation in terms of …. 6.1 Internal evidence *Judgements in terms of ….* 6.2 External criteria

consider the cognitive process dimension of the RBT. In the current study, analyses were performed to take into account both the knowledge and cognitive process dimensions of the RBT.

The Original Bloom Taxonomy

Bloom's Taxonomy is a progressive one-dimensional classification of learning in the cognitive, affective, and psychomotor fields (Krathwohl 2002). The work entitled "Taxonomy of Educational Objectives the Classification of Educational Goals Handbook 1 Cognitive Domain" by Bloom et al. (1956) was the first in its field, and was aimed at helping the developers of evaluation programs and in the classification of educational goals (Bloom et al. 1979).

In Bloom's Taxonomy, the cognitive field consists of six hierarchical levels (Krathwohl 2002), which are detailed together with their subcategories in **Table 1**.

Measurement experts have used Bloom's Taxonomy as a guide to developing test situations, by those developing educational programs, and by teachers in organizing classroom-based education (Anderson 1999; Krathwohl 2002; Rayahu 2018; Urinbayeva 2022).

Although many alternatives were presented up until the revision of Bloom's Taxonomy, it managed to stay ahead of time by keeping up to date (Anderson 2005). Anderson and Krathwohl (Revised Bloom Taxonomy), Marzano and Kendall (New Taxonomy of Educational Goals), and Taba's Taxonomies, Classifications of Tuckman, Haladyna, Williams, Hannah, and Michaelis, De Block, Hauenstein, Reigeluth and Moore, Gerlach and Sullivan, Romizowski, Quellmalz, Gagne-Merrill, Stahl and Murphy, Guilford's Intelligence Model, Gardner's Multiple Intelligence Model, De Corte Model can be given as examples of taxonomies developed in the cognitive field. However, these alternative classifications did not change that much from the main view and thought presented in Bloom's original classification; mostly just changing the order and name of some levels.

The reasons for revising the original Bloom's Taxonomy were as follows:

- To accommodate changes in educational systems due to technological developments;
- With the emergence of constructivist learning theory, it was thought that the original taxonomy was insufficient to measure high-level skills;
- The incompatibility of the original taxonomy with real-world problems;
- Evaluation and analysis levels did not always present a clear answer;
- The original taxonomy was claimed to have been prepared based on higher education and failed to include examples related to primary or secondary or education;
- Deficiencies in explaining dynamism and individuality in learning;
- Knowledge levels were presented in noun and verb forms;
- The sequencing of levels was a prerequisite; and,
- The synthesis level also included the evaluation level (Arı 2011; Ayvacı & Türkdoğan 2010; Günaydın 2018; Krathwohl & Anderson 2010; Tutkun & Seçil 2012).

The Revised Bloom Taxonomy

The most important difference that distinguishes the RBT from its original is that the cognitive field was made two-dimensional (Krathwohl 2002). With RBT, noun and verb cases are separated from each other and are therefore easier to understand. In the knowledge dimension, noun cases consist of four

Table 2. RBT Knowledge Dimensions and Subcategories (Krathwohl 2002, p214).

A.	Factual knowledge: Elements necessary for students to solve problems through detailed subject knowledge. Knowledge of …. A1. Terminology (e.g., the alphabet) A2. Specific details and elements (e.g., a country's production and exports)
B.	Conceptual knowledge: Factors that ensure harmony between the basic elements of a complex structure. Knowledge of …. B1. Classifications and categories (e.g., different geological times) B2. Principles and generalization (e.g., the basic laws of physics) B3. Theories, models, and structures (e.g., genetic models in biology)
C.	Procedural knowledge: Criterion of how to apply methods, techniques, and skills to do something. Knowledge of …. C1. Subject-specific skills and algorithms (e.g., skills necessary for high jumping in athletics) C2. Subject-specific techniques and methods (e.g., techniques used by scientists to solve problems) C3. Criteria for determining when to use appropriate procedures: (e.g., which method to use to solve mathematics equations)
D.	Metacognitive knowledge: Awareness that students' possess cognitive knowledge. D1. Strategic knowledge: (e.g., auxiliary strategies to increase persistence in memory, coding, abbreviation) D2. Knowledge about cognitive tasks, including appropriate contextual and conditional knowledge (e.g., determining students' strengths and weaknesses, preparing a project according to their level) D3. Self-knowledge (e.g., students who know their weaknesses employing different strategies to achieve exam success)

categories (see **Table 2**), whilst in the cognitive process dimension, verb cases consist of six levels (see **Table 3**) in the RBT (Arı 2011).

The updated taxonomy focuses in detail on the "Comprehension, Application, Analysis, Evaluation and Creation" levels, which enable the transfer of what has been learned, rather than the "Remembering" level, so as to ensure the permanence of cognitive processes (Anderson & Krathwohl 2014). The cognitive process dimension subcategories are presented as shown in **Table 3**.

The current state of the revised taxonomy, consisting of two dimensions such as knowledge and cognitive process, is summarized in **Table 4**.

Some Related Studies in Science Education

In their study, Tanık and Saraçoğlu (2011) analyzed written exam questions prepared by science and technology teachers according to the cognitive process dimension of RBT. A total of 1,061 questions were analyzed, and it was determined that 51.6% of the exam questions were at the remembering level, 33.1% at the understanding level, 6.2% at the applying level, and 9.1% at the analyzing level. No questions were found at the levels of evaluating or

Table 3. RBT Cognitive Process Dimensions and Subcategories (Krathwohl 2002, p215).

1. REMEMBERING	Restoring knowledge from memory.
1.1 Recognizing	Comparing knowledge presented with knowledge in long-term memory.
1.2 Recalling	Accessing knowledge.
2. UNDERSTANDING	Making sense of what they previously learned in writing, verbally, and with figures.
2.1 Interpreting	Converting knowledge from one form of expression to another form of expression and representation.
2.2 Exemplifying	Students find a special example or analogy to the concepts or principles they are given.
2.3 Classifying	Student place an example or situation in a certain category of principles or concepts.
2.4 Summarizing	Students can present knowledge by extracting short summaries from a topic, theme, or video they are given.
2.5 Inferring	Students attempt to reveal the meaningful essence hidden in the body of knowledge.
2.6 Comparing	Revealing similar and different aspects between more than one event, problem, thought, situation or object.
2.7 Explaining	Expressing whole knowledge more clearly to students.
3. APPLYING	Using the transaction path in the event they encounter.
3.1 Executing	Using the link provided when solving questions.
3.2 Implementing	When facing unfamiliar tasks, students select and use actions to perform the task.
4. ANALYZING	Breaking down material into parts, and determining how parts relate to the whole and to each other.
4.1 Differentiating	How to distinguish parts in a knowledge community.
4.2 Organizing	Identifying the important and appropriate elements in the whole and organizing them coherently.
4.3 Attributing	Trying to reveal an author's point of view and the background of an article by analyzing a given text.
5. EVALUATING	Judging based on standards and measurements.
5.1 Checking	Students searching for and examination of inconsistencies in given knowledge.
5.2 Critiquing	Students make criticism according to hypotheses they create or from others to achieve the required results.
6. CREATING	Creating a unique new product by combining data.
6.1 Generating	Creating alternative solutions within certain criteria in the face of the problems faced by students.
6.2 Planning	Making arrangements to solve problems faced by students, to develop a plan.
6.3 Producing	Realizing a plan to solve a problem.

Table 4. RBT Classification Table (Krathwohl 2002, p216).

KNOWLEDGE DIMENSION	COGNITIVE PROCESS DIMENSION					
	1. Remembering	2. Understanding	3. Applying	4. Analyzing	5. Evaluating	6. Creating
A. Factual knowledge						
B. Conceptual knowledge						
C. Procedural knowledge						
D. Metacognitive knowledge						

creating. Ayvacı and Türkdoğan (2010) discussed the role of Bloom's Taxonomy in eliminating the gap in measurement and evaluation tools by analyzing the exam questions prepared by science teachers in the cognitive process dimension of RBT. As a result, it was found that most of the questions were at the level of remembering (55%).

Demir (2011) conducted a study to see if any significant difference existed between the written exam questions prepared by primary school fifth-grade teachers and sixth-grade science and technology teachers during the 2007-2008 academic year. Through document analysis, the questions were classified according to Bloom's Taxonomy, and it was seen that a significant difference existed between the levels of the exam questions. In a study by Yolcu (2019), third- and fourth-grade student achievement levels were analyzed based on the 2017 science curriculum in accordance with the RBT. Gains were noted for the conceptual level (72%) of the knowledge dimension and also for the understanding level (43%) of the cognitive process dimension. In a study by Ataş and Güneş (2020), sixth-grade written science course exam questions were evaluated based on the RBT. From the 543 exam questions examined though document analysis, it was determined that the questions were collected in the remembering and understanding levels of the cognitive process dimension and the factual knowledge type of the knowledge dimension.

In research by Sezer (2018), exam questions prepared by science teachers were analyzed through document analysis and compared to science questions asked in the TFBSE centralized exams and the international PISA and TIMSS exams according to Bloom's Taxonomy, with the aim to determine whether or not consistency existed between the teachers' exam questions and their understanding of teaching and learning. The eighth-grade science exam questions were investigated according to the cognitive knowledge levels of the RBT, TIMSS (2015), and PISA (2015). In addition, the extent to which both international exams covered the students' achievements based on the curriculum was examined. The analysis results emphasized that the TFBSE exams remained at a lower level than either the PISA or TIMSS exams, and that the exam questions prepared by the science teachers and the TFBSE exam questions did not fully address the required scientific achievements.

In her study, Akyürek (2019) analyzed HSEE science questions implemented for the first time in 2018 with those of the TFBSE exams held in 2016 and 2017, together with the achievements specified in the curriculum. Through document analysis, 60 science questions and 78 outcomes were leveled according to the two dimensions of the RBT. It was determined that the TFBSE and HSEE exam questions were stacked in the procedural knowledge level of the knowledge dimension and in the understanding level of the cognitive process dimension. However, it was noted that no questions were asked from certain cognitive levels in either exam. In addition, it was stated that although there was a consistency identified between the achievements and the exam questions, it was not possible to determine the high-level thinking skills of the students in this way.

In a research study by Cangüven (2019), the achievements identified in the science curriculum developed and implemented by the Turkish Ministry of National Education in 2013 and 2018 were analyzed and compared according to the cognitive process dimension of RBT. While a decrease was seen in the levels of remembering, applying, analyzing, and evaluating in the 2018 program compared to 2013, there was an increase noted in the levels of understanding and creating. Güven (2014) examined the questions set in the secondary school sixth-, seventh-, and eighth-grade science and technology curricula according to the cognitive process dimension of the RBT. From a total of 516 questions analyzed, it was reported that most of the questions were classified as being of low-level thinking. Through document analysis, Toksoy (2018) examined ninth-, 10th-, and 11th-grade chemistry questions in accordance to Bloom's cognitive process dimension. It was determined that the written exam questions prepared by chemistry teachers concentrated on the first three levels of the taxonomy, with very few questions having been asked from the higher cognitive levels.

In their study, Zorluoğlu et al. (2016) analyzed and evaluated secondary school chemistry course curriculum achievements in accordance to the two dimensions of the RBT. Through document review technique they examined 154 achievements published in 2013. When analyzed in terms of the knowledge dimension of the RBT, 25% was attributed to factual knowledge, conceptual knowledge was 59%, procedural knowledge was 11%, and metacognitive knowledge was 5%. When analyzed in terms of the cognitive process dimension of the RBT, they found that 7% corresponded to the remembering level, 67% to understanding, 5% to applying, 20% to analyzing, and 1% to the evaluating level. However, no objective belonging to the creating level was determined.

In a study by Gökulu (2015), science and technology questions from the TFBSE exams held in 2013-2014 were evaluated according to the RBT together with exam questions created by eighth-grade science and technology teachers working in Çanakkale for the same year. The analysis showed that 71% of the teachers' written exam questions were at the remembering level, while questions from the TFBSE exams showed 50% to be low cognitive level and 30% at high cognitive level. Eş (2005) evaluated the HSEE science questions and science course exam questions according to Bloom's Taxonomy, and stated that the teachers' exam questions accumulated in the low-level while the HSEE questions concentrated in the analysis, synthesis, and evaluation levels, which are each higher cognitive levels.

In research published by Salvato (2011), the thinking levels of 2,718 questions from four general chemistry books widely used in Texan universities were analyzed according to Bloom's Taxonomy along with 2,591 questions from a non-traditional university chemistry textbook. The analysis results revealed that 14% of the general chemistry textbook questions were identified as being in the knowledge level, plus 20.5% for comprehension, 55.2% for application, 9.8% for analysis, 0.1% for synthesis, and 0.4% in the evaluation level. The questions in the non-traditional chemistry textbook were shown to be 10.7% in the knowledge level, 49% for comprehension, 21.5% for application, 17.9% for analysis, 0.7% for synthesis, and 0.2% in the evaluation level. It was concluded that the general chemistry textbooks' questions were mostly high-level, while the non-traditional chemistry textbook questions were mostly low-level.

Lee et al. (2015) compared achievements set out in the primary school science curricula of Singapore and South Korea for the third to sixth grade, and then analyzed them according to the RBT. When Singapore's curriculum was examined, it was determined that 86.7% of the achievements in the cognitive process dimension were in the understanding and applying levels, and 13.3% were in the remembering level. No objectives were identified in the analyzing, evaluating, or creating levels. When analyzed according to the knowledge dimension of the RBT, it was seen that 59% of the objectives were accumulated at the conceptual knowledge level. When the South Korean curriculum was examined, it was determined that 87.7% of the objectives were accumulated at the cognitive process dimension, in the remembering and understanding levels, whilst 2.7% were in the creating and knowledge level, and 73.2% in the conceptual knowledge level. Amer (2006) examined the relationship between the RBT and the original taxonomy from a critical perspective. In the study, Amer criticized the original taxonomy by stating its deficiencies and explaining the reasons for its renewal. As a result, he stated that thanks to the RBT, teachers can more easily organize teaching activities, understand the relationship between learning and evaluation processes, and more readily analyze educational goals.

In summary, in the Turkish literature, attempts have been made to evaluate HSEE exam questions according to the RBT, compare the achievements set out in curricula with the HSEE exam questions, the placement of questions in textbooks according to the taxonomy, and the level of written exams in terms of the RBT. The applicability and description of the RBT and the convenience afforded to the measurement/evaluation and learning processes have been emphasized in studies conducted in other countries. Most research were conducted by examining the single dimension of the RBT. As can be understood from the literature analysis presented here, no studies were found in which the questions used by eighth-grade science teachers in their course exams and science questions from the HSEE that addressed both dimensions of the RBT, which is considered to be an important gap in the relevant literature that the current study aims to fill.

Materials and Methods

The qualitative research approach was employed in this study, incorporating data collection methods such as interviews, document analysis, and observation (Yıldırım & Şimşek 2011). The document analysis method, which is one of the recognized qualitative research approaches, was selected since the method examines materials and documents etc., and has been frequently used in educational research to examine curricula, textbooks, assignments, and written exam questions (Bowen 2009). One of the main strengths of document analysis is said to be its reliability and economical application. It is deemed reliable since the content of the documents under examination does not change, and it is seen as economical in this respect since the documents are examined and revealed by the most people (Karasar 2016).

Sampling

The sample of this study consisted of 1,100 questions applied by 35 science teachers in eighth-grade classes of schools affiliated to the Turkish Ministry of National Education in one province of Turkey, plus 80 science questions that had been asked in the HSEE during the 4 years from 2018 to 2021.

Data Collection Tools

The data were collected using the document analysis method, which is a recognized method of collecting qualitative research data through the examination of existing documents and records. According to Karasar (2016), document analysis involves finding and reading sources for a specific purpose, and then evaluating them based on the study's design. The exam questions examined in the current research were collected from teachers by visiting schools in person, whilst the HSEE science questions were extracted from the official website of the Turkish Ministry of National Education (http://meb.gov.tr/).

Process of Data Collection, Analysis, Validity, and Reliability

The science teachers were initially contacted and informed about the purpose of the study. The place and importance of Bloom's Taxonomy in education were shared with the teachers, and their contribution to the research was then requested. The exam questions prepared by science teachers were included in the research where they were provided voluntarily.

The study determined the knowledge type and cognitive process level of each question examined. It was determined which questions corresponded to which knowledge type (i.e., factual, conceptual, procedural, or metacognitive). For the cognitive process dimension, it was determined which levels (i.e., remembering, understanding, applying, analyzing, evaluating, or creating) were deemed appropriate for each question. Frequency and percentage distributions of the exam questions prepared by the science teachers in both the knowledge and the cognitive process dimensions of the HSEE were tabulated.

A random selection of 40 teacher-devised questions and 10 HSEE science questions were analyzed by three different researchers in order to determine the reliability of the analysis of exam questions prepared by science teachers and HSEE science questions. Considering the analyses, the level of agreement between the researchers' results was calculated as a percentage, with the consistency between the researchers calculated according to Miles and Huberman's (1994) reliability coefficient formula.

$$\text{Reliability} = \text{Consensus}/\frac{Consensus}{Consensus+Disagreement}$$

According to Yıldırım and Şimşek (2011), when a value of 0.70 or above is obtained using this formula, the studies are considered to be reliable. In the exam questions prepared by the science teachers, the percentage of agreement between the researchers was calculated as being 0.80 for the knowledge dimension and 0.82 for the cognitive process dimension. For the HSEE science questions, the reliability was established as being 0.87 for the knowledge dimension and 0.80 for the cognitive process dimension.

A suitable sample was selected in order to increase the external validity of the study. By providing detailed information about all stages of the study, it was ensured that the results of the research could be generalized to similar situations in the future. One of the methods applied to increase reliability in qualitative research is to compare the results obtained with those of researchers who conducted similar studies (Yıldırım and Şimşek 2011). In order to increase the reliability of the study conducted in this context, the previous studies conducted based on the RBT were also examined.

Results

"*How are the exam questions prepared by science teachers distributed according to the RBT knowledge dimension?*"

Table 5. Individual Analysis of RBT Knowledge Dimension Exam Questions.

	Factual Knowledge	**Conceptual Knowledge**	**Procedural Knowledge**	**Metacognitive Knowledge**
Teacher	%	%	%	%
T1	74	6	20	-
T2	36	50	14	-
T3	28	44	28	-
T4	40	41	17	2
T5	30	43	27	-
T6	21	57	22	-
T7	60	20	20	-
T8	56	36	8	-
T9	25	30	35	10
T10	72	4	24	-
T11	61	27	12	-
T12	72	14	14	-
T13	55	39	6	-
T14	50	50	-	-
T15	56	12	-	4
T16	55	10	25	8
T17	52	24	20	4
T18	50	43	7	-
T19	82	12	6	-
T20	90	3	7	-
T21	71	24	5	-
T22	68	29	-	4
T23	56	32	12	-
T24	54	41	5	-
T25	72	20	8	-
T26	82	15	3	-
T27	70	26	2	2
T28	60	33	4	3
T29	55	10	35	-
T30	51	39	8	2
T31	75	20	5	-
T32	35	50	10	5
T33	44	40	16	-
T34	50	15	35	-
T35	60	25	15	-

The findings obtained by analyzing the exam questions prepared by the science teachers in accordance with the RBT's knowledge dimension are presented in **Table 5**.

When **Table 5** is examined, it can be seen that the questions prepared by the science teachers were generally concentrated on the factual, conceptual, and procedural knowledge types. It was determined that the science teachers mostly used questions based on factual knowledge. It can be seen that T20 asked 90% of questions based on factual knowledge, whilst T6 asked conceptual knowledge questions at the rate of 57%. The teachers whose highest numbers of questions were on procedural knowledge were T9, T29, and T34 with 35%. The science teachers were noted to have asked only a limited number of questions of the metacognitive knowledge type, which is the highest type level of the knowledge dimension. These teachers were T4, T9, T15, T16, T17, T22, T27, T28, T30, and T32, with the highest proportion being 10% for T9.

Considering the findings presented in **Table 5**, the distribution of questions employed by the science teachers in the total knowledge dimension were determined and illustrated in **Figure 1**.

According to **Figure 1**, when the exam questions prepared by the science teachers were analyzed according to the RBT's knowledge dimension, it can be seen that 56.2% of the questions were on factual knowledge, 28.1% were on conceptual knowledge, 14.4% were on procedural knowledge, and 1.3% were on metacognitive knowledge.

"*How are the exam questions prepared by science teachers distributed according to the RBT cognitive process dimension?*"

The findings obtained by analyzing the exam questions prepared by the science teachers in accordance with the RBT's cognitive process dimension are presented in **Table 6**.

In **Table 6**, the exam questions prepared by the science teachers were analyzed according to the cognitive process dimension of the RBT. The questions asked by the science teachers generally focused on remembering and understanding. It is notable, however, that there were no questions asked at the creating level. As can be seen, T26 asked 70% of questions at the remembering level, T14 asked 65% of questions at the understanding level, T34 asked 35% of questions at the applying level, T32 asked 55% of questions at the analyzing level, and T16 asked 15% of questions at the evaluating level.

Taking into account the findings in **Table 6**, the distribution of the science teachers' questions according to the RBT's cognitive process dimension are illustrated in **Figure 2**.

According to **Figure 2**, when the exam questions prepared by the science teachers were analyzed based on the cognitive process dimension of the RBT, it can be seen that 37.4% of the questions were at the remembering level, 40.8% were at the understanding level, 10.8% were at the applying

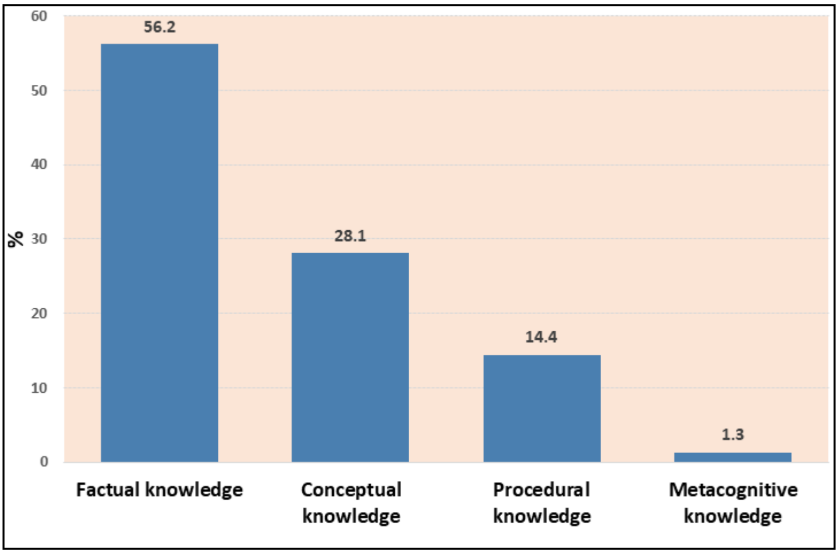

Figure 1. Exam Questions by RBT Knowledge Dimension.

level, 7.3% were at the analyzing level, and 3.7% were at the evaluating level. However, there were no questions asked at the creating level.

The total numbers showing which level the exam questions corresponded to in both the knowledge and cognitive process dimensions of the RBT are shown in **Table 7**.

Distribution of the 1,100 questions prepared by science teachers across both dimensions of the RBT are shown in **Table 7**. Accordingly, it can be seen that questions corresponding to the A1 level (Factual/Remembering) were the most popular with 360 questions, followed by the A2 level (Factual/Understanding) with 260 questions. As seen, the science teachers clearly favored questions at the remembering level under the factual knowledge type, at the understanding level under the conceptual knowledge type, at the applying level under the procedural knowledge type, and questions at the evaluating level under the metacognitive knowledge type.

"How are the HSEE science questions distributed according to the RBT knowledge dimension?"

Findings obtained from analysis of the HSEE science questions are presented in **Table 8** according to the RBT knowledge dimension by exam year.

Table 6. Individual Analysis of RBT Cognitive Process Dimension Exam Questions.

	Remembering	Understanding	Applying	Analyzing	Evaluating	Creating
Teacher	%	%	%	%	%	%
T1	66	14	20	-	-	-
T2	14	58	21	7	-	-
T3	20	36	28	12	4	-
T4	62	14	16	6	2	-
T5	49	36	12	-	3	-
T6	39	46	7	4	4	-
T7	40	40	15	-	5	-
T8	54	38	8	-	-	-
T9	10	60	15	5	10	-
T10	28	52	20	-	-	-
T11	39	46	9	-	6	-
T12	55	31	14	-	-	-
T13	36	61	3	-	-	
T14	20	65	-	5	10	
T15	24	36	20	16	4	
T16	5	40	20	20	15	
T17	32	40	8	8	12	
T18	38	57	5	-	-	
T19	55	39	3	3	-	
T20	55	39	6	-	-	
T21	50	41	2	5	2	
T22	43	50	-	4	3	
T23	50	32	12	6	-	
T24	38	43	3	16	-	
T25	28	56	8	8	-	
T26	70	18	3	3	6	
T27	33	54	-	11	2	
T28	38	47	4	-	11	
T29	30	40	30	-	-	
T30	46	28	3	13	10	
T31	20	55	5	10	10	
T32	15	25	-	55	5	
T33	12	36	8	40	4	
T34	40	25	35	-	-	
T35	55	30	15	-	-	

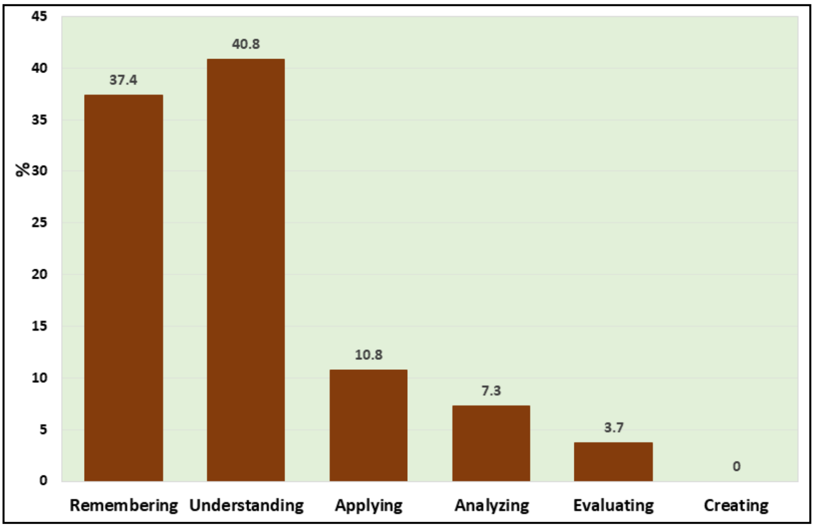

Figure 2. Exam Questions by RBT Cognitive Process Dimension.

Table 7. Numerical Distribution of RBT Exam Questions.

KNOWLEDGE DIMENSION	COGNITIVE PROCESS DIMENSION					
	1. Remembering	2. Understanding	3. Applying	4. Analyzing	5. Evaluating	6. Creating
A. Factual knowledge	360	260	0	9	5	0
B. Conceptual knowledge	87	162	0	50	16	0
C. Procedural knowledge	0	17	103	15	4	0
D. Metacognitive knowledge	0	0	0	0	12	0

Table 8. Analysis of HSEE Science Questions for RBT Knowledge Dimension.

	2018	2019	2020	2021
Knowledge dimension	*f* (%)	*f* (%)	*f* (%)	*f* (%)
Factual	1 (5)	0 (0)	2 (10)	2 (20)
Conceptual	11 (55)	7 (35)	9 (45)	10 (50)
Procedural	7 (35)	12 (60)	8 (40)	8 (40)
Metacognitive	1 (5)	1 (5)	1 (5)	0 (0)
Total	20 (100)	20 (100)	20 (100)	20 (100)

According to **Table 8,** it can be seen that most of the HSEE science questions for 2018, 2019, 2020, and 2021 focused on the conceptual and procedural knowledge of the RBT knowledge dimension. For 2018, 5% of the questions were of the factual knowledge type, 55% were of the conceptual knowledge type, 35% were of the procedural knowledge type, and 5% were of the metacognitive knowledge type. For 2019, 35% of the questions were of the conceptual knowledge type, 60% were of the procedural knowledge type, and 5% were of the metacognitive knowledge type. It is notable that no questions were asked of the factual information type in the 2019 HSEE. For 2020, 10% of the questions were of the factual knowledge type, 45% were of the conceptual knowledge type, 40% were of the procedural knowledge type, and 5% were of the metacognitive knowledge type. Finally, for 2021, 20% of the questions were of the factual knowledge type, 50% were of the conceptual knowledge type, and 40% were of the procedural knowledge type. Notably, no questions were asked of the metacognitive knowledge type in the 2021 HSEE.

"How are the HSEE science questions distributed according to the RBT cognitive process dimension?"

Findings obtained from analysis of the HSEE science questions are presented in **Table 9** according to the RBT cognitive process dimension by exam year.

Table 9 shows that the 2018 and 2019 HSEE science questions were mostly found in the cognitive process dimension of the RBT, in the levels of understanding, analyzing, and applying. As can be seen, for 2018 a total of 35% of the questions asked were at the understanding level, 25% were at the applying level, 35% were at the analyzing level, and 5% were at the evaluating level. For 2019, 40% of the questions were at the understanding level, 20% were at the applying level, 30% were at the analyzing level, and 10% were at the evaluating level. Notably, no questions were asked at the remembering or creating levels in any of the four exam years examined. As can be seen, the 2020 and 2021 HSEE science questions were mostly accumulated in the cognitive process dimension of the RBT, in the levels of understanding and analyzing. For 2020, 45% of the questions were at the understanding level, 10% were at the applying level, and 45% were at the analyzing level. Notably, no questions were asked in 2020 on the levels of remembering, evaluating, or creating. For 2021, 35% of the questions were at the understanding level, 15% were at the applying level, 45% were at the analyzing level, and 5% were at the evaluating level. For 2021, no questions were asked at either the remembering or creating levels.

Table 9. Analysis of HSEE Science Questions for RBT Cognitive Process Dimension.

	2018	2019	2020	2021
Cognitive process dimension	*f* (%)	*f* (%)	*f* (%)	*f* (%)
Remembering	0 (0)	0 (0)	0 (0)	0 (0)
Understanding	7 (35)	8 (40)	9 (45)	7 (35)
Applying	5 (25)	4 (20)	2 (10)	3 (15)
Analyzing	7 (35)	6 (30)	9 (45)	9 (45)
Evaluating	1 (5)	2 (10)	0 (0)	1 (5)
Creating	0 (0)	0 (0)	0 (0)	0 (0)
Total	20 (100)	20 (100)	20 (100)	20 (100)

Table 10. Distribution of HSEE Science Questions in RBT.

KNOWLEDGE DIMENSION	COGNITIVE PROCESS DIMENSION					
	1. Remembering	2. Understanding	3. Applying	4. Analyzing	5. Evaluating	6. Creating
A. Factual knowledge	0	4	0	1	0	0
B. Conceptual knowledge	0	22	3	12	0	0
C. Procedural knowledge	0	5	10	17	3	0
D. Metacognitive knowledge	0	0	1	1	1	0

Table 10 shows which of the HSEE science questions corresponds to which level in the RBT's knowledge and cognitive process dimension and how many questions in total.

It was observed that 80 of the science questions asked in the HSEE between 2018 and 2021 corresponded the most to the B2 level (Conceptual/Understanding) with 22 questions, followed by the C4 level (Procedural/Analyzing) with 17 questions. According to the examined HSEE science questions, questions at the understanding level were used more for the factual and conceptual knowledge types, and also questions at the analyzing level for procedural knowledge types. For the metacognitive knowledge type, it can be seen that only one question was asked from the applying, analyzing, and evaluating levels.

Percentage analysis of the HSEE science questions for 2018 to 2021 according to the RBT knowledge dimension are illustrated in **Figure 3**.

When **Figure 3** is examined, it can be seen that the HSEE science questions accumulated under the conceptual and procedural knowledge types

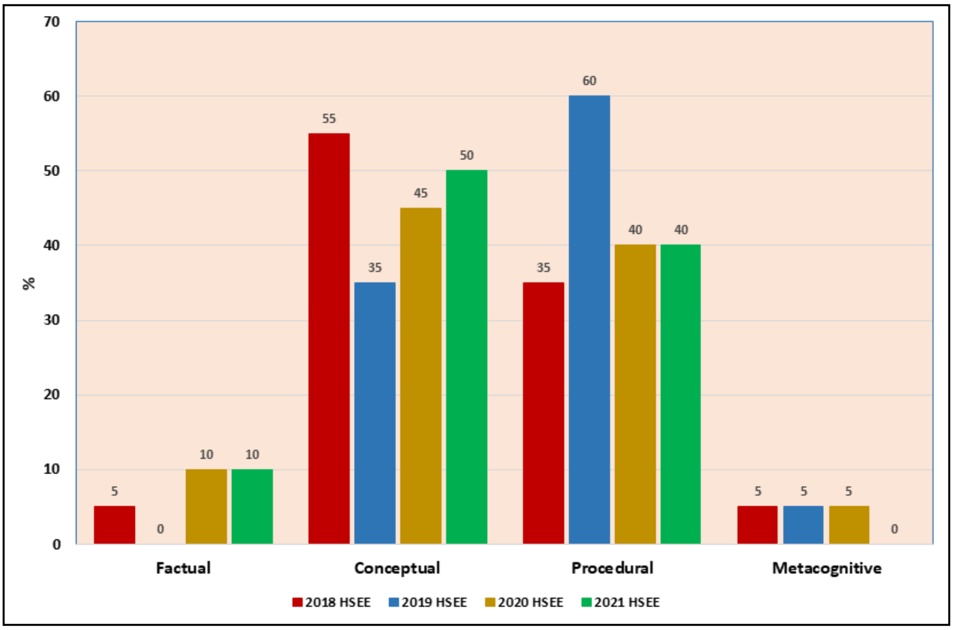

Figure 3. Percentage Comparison of HSEE Science Questions by Year for RBT Knowledge Dimension.

across all 4 years of the study data. It is noteworthy to mention here that not many questions of the factual or metacognitive knowledge types were found. While no factual knowledge type science questions were asked in the 2019 HSEE, no metacognitive knowledge type science questions were asked in the 2021 HSEE. The most science questions of the conceptual knowledge type were included in the 2018 HSEE, while the most science questions of the procedural knowledge type were included in the 2019 HSEE.

Percentage analysis of the HSEE science questions from 2018 to 2021 according to the RBT cognitive process dimension are illustrated in **Figure 4**.

When **Figure 4** is examined, it can be seen that the HSEE science questions were mostly concentrated on the understanding and analyzing levels, but that no questions were asked on the remembering or creating levels. The most science questions asked on the understanding level were from the 2020 HSEE, whilst the most asked on the applying level were from the 2018 HSEE, and the most on the analyzing level were from the 2020 and 2021 HSEE.

"To what extent are the science teachers' exam questions and the HSEE science questions compatible according to the RBT?"

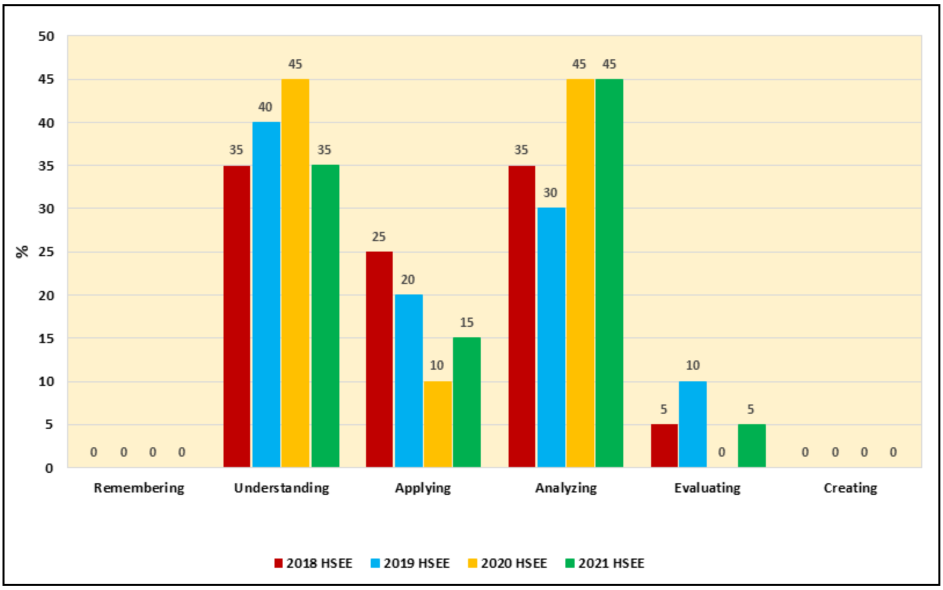

Figure 4. Percentage Comparison of HSEE Science Questions by Year for RBT Cognitive Process Dimension.

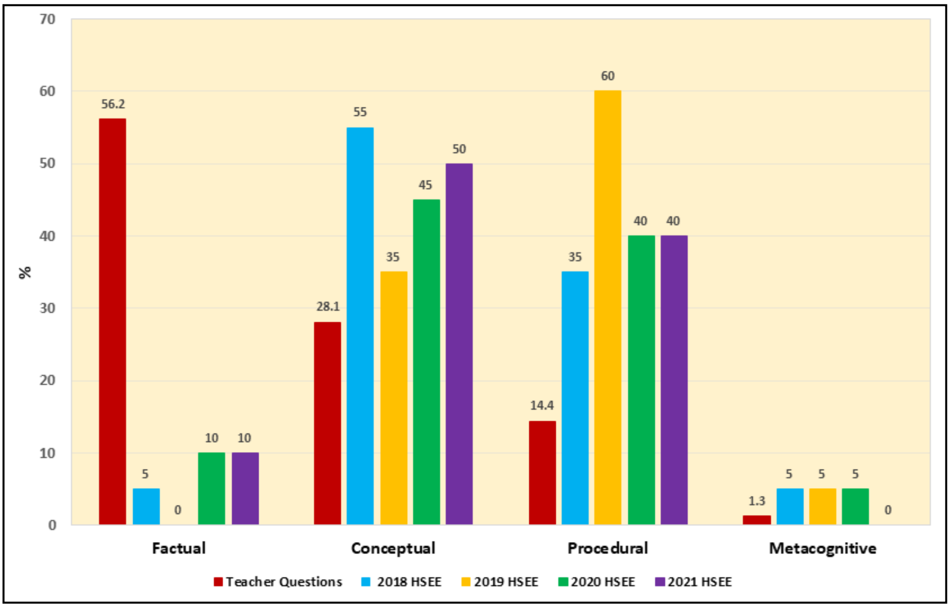

Figure 5. Percentage Comparison of Science Teachers' Written Exam Questions and HSEE Science Questions for RBT Knowledge Dimension.

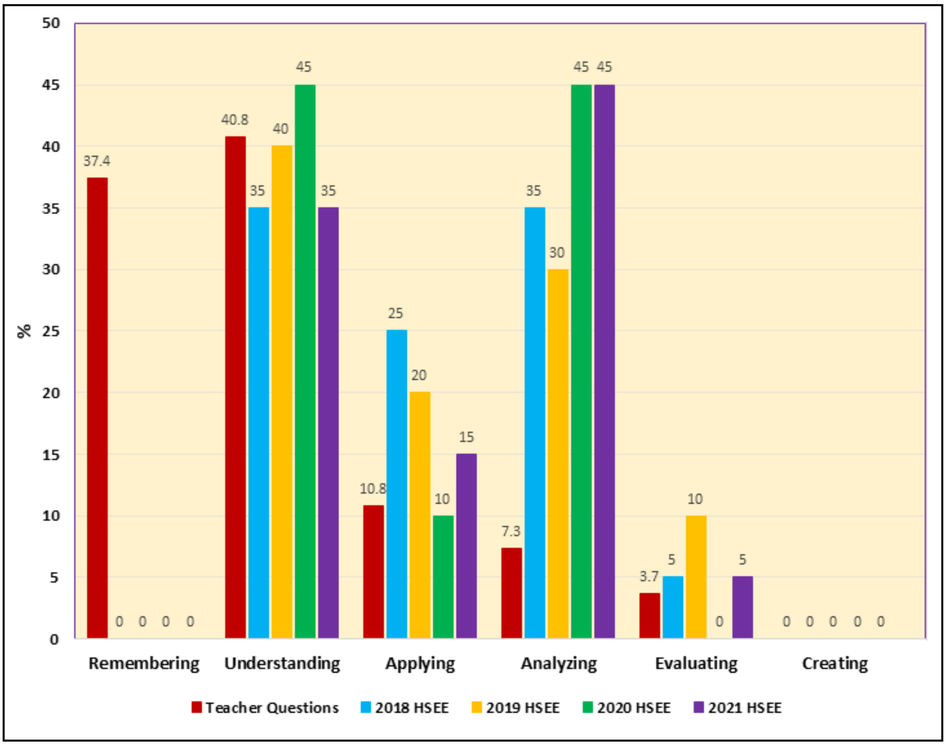

Figure 6. Percentage Comparison of Science Teachers' Written Exam Questions and HSEE Science Questions for RBT Cognitive Process Dimension.

The exam questions prepared by science teachers were compared with the HSEE science questions in terms of the knowledge and cognitive process dimensions of the RBT, and the results are illustrated in **Figure 5** and **Figure 6**, respectively.

According to **Figure 5**, when the science teachers' written exam questions were compared with the HSEE science questions, it can be seen that the science teachers' questions were mostly of the factual and conceptual knowledge type from the RBT knowledge dimension, whilst the HSEE science questions were mostly of the conceptual and procedural knowledge type. It is noteworthy to mention that the science teachers' exam questions were of the factual knowledge type with a maximum of 56.2% in the knowledge dimension. When the HSEE science questions were examined, it was seen that in 2018 they were of the conceptual knowledge type with a maximum of 55%, whereas in 2019 they were of the procedural knowledge type with a maximum of 60%, in 2020 they were of the conceptual knowledge type with a maximum of 45%, and in the 2021 the HSEE science questions were of the conceptual knowledge type with a maximum of 50%. No HSEE science questions of the factual type of information were asked in 2019, nor of the metacognitive information type in 2021.

According to **Figure 6**, when the science teachers' written exam questions and the HSEE science questions were compared according to the RBT cognitive process dimension, it was seen that 89% of the science teacher's written exam questions were at the lower cognitive levels of remembering, understanding, and applying, whilst 11% were at the higher cognitive levels of analyzing and evaluating. None of the science teachers' written exam questions were found corresponding to the creating level. It was observed that 60% of the 2018 HSEE science questions were at the lower cognitive levels (understanding and applying) and 40% were at the higher cognitive levels (analyzing and evaluating), that 60% of the 2019 HSEE science questions were at the lower cognitive levels (understanding and applying) and 40% were at the higher cognitive levels (analyzing and evaluating), that 55% of the 2020 HSEE science questions were at the lower cognitive levels (understanding and applying) and 4% were at the higher cognitive level (evaluating), and that 50% of the 2021 HSEE science questions were at the lower cognitive levels (understanding and applying) and 50% were at the higher cognitive levels (analyzing and evaluating). No HSEE science questions were found to be the remembering and creating levels in any of the 4 years analyzed.

Discussion & Conclusion

The findings obtained from the analysis of the science teachers' written exam questions according to the RBT revealed questions corresponding to each knowledge type in the taxonomy. However, the distribution of the questions across the different knowledge type was not found to be homogeneous. The science teachers' exam questions were mainly of the factual knowledge type, with a significant number of conceptual knowledge type questions. The fact that the science teachers mainly included factual knowledge questions may suggest that the teachers prefer not to take risks, as the least controversial question types are considered those that examine factual knowledge. Similar studies in the literature also support these results. In research where sixth-grade science course exam questions were analyzed according to the RBT, it was reported that the questions were mainly of the factual knowledge type in accordance with the knowledge dimension of the RBT (Ataş & Güneş 2020). The findings of a study by Ayvacı and Türkdoğan (2010) also support these results. In the current study, the science teachers used very few questions (1.3%) of the metacognitive knowledge type in the knowledge dimension; a type primarily considered as being within the affective domain. A complaint has been levelled that questions that examine the characteristics of the affective domain are not generally used in the measurement processes of exams (Tekindal 2009); a result that was also obtained in the current study.

When the exam questions prepared by the science teachers were analyzed according to the RBT's cognitive process dimension, it was found that their questions were mostly at the remembering and understanding levels, and that the proportion of questions at these levels were quite close to each other. It may be said, therefore, that the science teachers' preference for mostly remembering level questions could lead students to memorize their course content. Students who become accustomed to such question types are generally less able to achieve permanent learning, forgetting the acquired knowledge in just a short timeframe. Students with lower cognitive levels may be unable to decide how best to solve high-level questions. Similar results have been reported in previous studies on this same topic (Ataş & Güneş 2020; Dindar & Demir 2006; Karaer 2020; Tanık & Saraçoğlu 2011). Dindar & Demir (2006) found that in the fifth-grade science lessons, and also in the sixth grade according to Ataş and Güneş (2020), that teachers mainly used questions corresponding to the remembering level of the RBT's cognitive process dimension. In a study by Tanık and Saraçoğlu (2011), it was emphasized that teachers who ask questions with similar low-level thinking skills do not include many questions, especially those above the level of remembering. Additionally, Karaer (2020) analyzed organic chemistry questions in teaching field knowledge tests according to the RBT, and concluded that the questions were mostly at the understanding level in the cognitive process dimension of the RBT. Where there are considered too many problems presented in questions at the understanding level, it may not actually be a negative situation since it is believed that understanding level learning forms the basis for more advanced learning in order to ensure the permanence and transferability of what has been learned.

While the ratio of the questions asked at the applying and analyzing levels were found to be close in the current study, the number of questions asked at the evaluating level were notably very few, and no questions at all were asked at the creating level. The findings showed that the questions were stacked at the lower cognitive process levels in the exam questions prepared by the science teachers. It may be said that it is important to include more questions at the analyzing level in order for students to improve their critical thinking skills. It can therefore be considered a significant deficiency that questions examining higher-level cognitive features such as applying, analyzing, evaluating, and creating in educational environments were not adequately included in the data that was reviewed. In a study conducted by Ayvacı and Türkdoğan (2010), it was reported that teachers fail to take taxonomy into consideration when preparing written science and technology course questions, and that the distribution of questions according to the levels in the taxonomy can be quite irregular.

When the HSEE science questions were analyzed in the current study according to the knowledge dimension of the RBT, it was determined that most questions were of the conceptual and procedural knowledge type. When the percentage distribution of the 2018 HSEE science questions was examined, it was concluded that there was an excess of conceptual knowledge type questions, with only one each asked of the factual and metacognitive types. It is notable that the 2019 HSEE science questions were predominantly of the procedural information type, and that no factual information type questions were asked. It was concluded that the 2020 and 2021 HSEE science questions were mainly of the conceptual and procedural information type, and that the numbers of the questions in these two types of knowledge were very close to each other. On the other hand, only one question was found of the metacognitive knowledge type in HSEE 2020 and none in 2021. The literature shows similar findings from studies on this subject. In Çakir's (2019) analysis of TFBSE, HSEE, and PISA science questions according to the RBT, it was found that most of the 2017 TFBSE exam questions were of the conceptual knowledge type from the knowledge dimension. Similarly, Akyurek (2019) determined that the 2016-2017 TFBSE exams and the 2018 HSEE science questions were of the procedural knowledge type from the RBT's knowledge dimension. Similarly, Altun (2016) reported that the mathematics questions in the TFBSE (2014-2015) were mostly of the procedural knowledge type from the knowledge dimension.

When the HSEE science questions were analyzed according to the RBT's cognitive process dimension, it was revealed that the questions were mostly concentrated at the understanding, applying, and analyzing levels. No HSEE science questions were encountered at the remembering level, which is the lowest cognitive process level, or the creating level, which is the highest cognitive process level. The 2018 HSEE science questions were concentrated at the understanding, applying, and analyzing levels, with just one question at the evaluating level. While the 2019 HSEE science questions were mainly at the understanding and analyzing levels, two were asked at the evaluating level. The 2020 HSEE science questions were revealed to be homogeneously distributed between the understanding and analyzing levels, with no questions asked at the evaluating level. Notably, the 2021 HSEE science questions were mostly at the analyzing level. 2021 was also the year in which the most HSEE science questions were asked at the higher cognitive process level. These results can be said to be similar to the findings of previous studies in the literature. Ekinci and Bal (2019) revealed that the 2018 HSEE mathematics questions were mostly at the applying and analyzing levels in the cognitive process dimension. Similarly, Vural (2020) revealed that HSEE Turkish questions between 2010 and 2020 were at the understanding level in the cognitive process dimension, whilst TFBSE exam questions were at the analyzing level.

In the current study, the level of similarity between the exam questions prepared by the science teachers and the HSEE science questions was revealed to be very low when compared in accordance with the knowledge and cognitive process dimensions of the RBT. It was observed that the questions prepared by the science teachers were mostly of the factual knowledge type, which is the first level of the knowledge dimension, and the HSEE science questions were mainly of the conceptual and procedural knowledge types. It was revealed that very few questions were of the metacognitive knowledge type in both the exam questions developed by the science teachers and the HSEE science questions.

While the exam questions prepared by the science teachers generally consisted of the first three levels of the RBT's cognitive process dimension (remembering, understanding, and applying) that measure low-level thinking skills, an insufficient number of questions were asked from the last three levels (analyzing, evaluating, and creating) of the cognitive process dimension that measure high-order thinking skills. The HSEE science questions were found to be stacked at the RBT's cognitive process dimension's understanding, applying, and analyzing levels. It was determined that between seven and nine HSEE science questions were asked each year at the analyzing level, which measures high-level thinking skills. While there were no questions at the creating level in the exams prepared by the science teachers, it was observed that none of the HSEE questions were at either the remembering or creating levels. In particular, it was observed that the 2020 and 2021 HSEE science questions showed similarities in the RBT's cognitive process dimension; therefore, it may be assessed that the degree of difficulty of the exams held in these 2 years was similar. Accordingly, the results of the analysis of HSEE science questions compared to the exam questions prepared by science teachers can be said to not correspond to the RBT. In a study conducted by Eş (2005), it was reported that no concordance was found between the written exam questions of science teachers and the distribution of HSEE science questions to the levels in Bloom's taxonomy.

The fact that the questions prepared by the science teachers were found in the current study to be predominantly at the lower cognitive process level and the HSEE science questions at the higher level reveal a mismatch between the success of students in their written school exams and their HSEE success. In this context, it can be seen that students with a high level of school success do not achieve the desired success in the HSEE.

The current research was limited to 35 science teachers working in one province of Turkey, and with a combined total of 1,100 written exam questions devised by these teachers between 2018 and 2021 for eighth-grade students and 80 science questions asked in the HSEE over the same time period. Based on the current study's findings, changing the written school exams to include questions prepared by science teachers that cover all levels of the RBT's knowledge dimension will help students to reach the targeted goals. Science teachers must therefore work to include questions that measure the high-level skills of students when preparing written exam papers. This change is deemed very important in order for eighth-grade students to adequately prepare for sitting their centralized high school entrance exams.

The study's findings showed that the HSEE science questions examined were concentrated around certain levels of the RBT. However, including questions at every level of both the knowledge and the cognitive process dimensions of taxonomy will help to increase the content validity of the test itself. Science teachers should also be encouraged to include written exam questions according to certain standards. In this context, it would be helpful for science teachers to consider appropriate taxonomy when preparing exam questions and to ensure that the desired level of questioning is present in their exams in accordance with the taxonomy.

It is therefore considered necessary to conduct further studies to investigate the compatibility between students' science courses and their HSEE achievements. It is also important that professional development training is provided to teachers in order to create increased awareness of the significance of this link between school-based testing and centralized exams. In terms of inservice teacher training, it is suggested that it would be beneficial to include practical applications that include question preparation activities as well as theoretical information about taxonomies. In addition, the results of the current study and other similar research can be shared with teachers as part of any professional development training on this subject; an approach that may help teachers to realize the importance and relevance of improving the questions they set for school written exams.

Additionally, conducting test development activities that take taxonomies into account in undergraduate measurement and evaluation courses will provide teacher candidates with more professional skills in exam and question preparation. Teacher candidates with such skills could set an example to serving teachers when they start working in the profession. In this way, teachers could start to gain the skills necessary to create better exam questions that are a closer match to those faced by students in centralized exams such as the HSEE. It may be said that the preparation of exam questions by science teachers in accordance with the HSEE science questions is also of significant importance in helping to reduce students' exam-based anxiety.

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