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Middle School Science and Items of High School Entrance Examination: Examining the Gap in Turkey

ABSTRACT: This study presents findings from an analysis of the Turkish Science and Technology Curriculum Guidelines and their alignment to the university entrance examination. The analysis of the Science and Technology Curriculum focused on various related aspects: content areas and learning outcomes in terms of scientific process skills, science technology society and environment, attitudes and values, and cognitive objectives. The level determination examination (LDE) questions, which would allow for enrollment at elite high schools and would inevitably affect middle school students' university choices, were analyzed in an alignment study regarding the contents of the science and technology program. In order to investigate the relationship between high school science teaching and high school entrance examination, all relevant documents were analyzed by ten science teachers, who have been teaching science and technology courses at middle schools and are concurrently doctoral students at the science education department. The results indicated that the LDE questions and standards were not fully aligned because the first two alignment criteria have a high consistency while a range of knowledge and balance of representation criteria have a low consistency.

KEYWORDS: curricular studies, assessment frameworks, large-scale examinations

Introduction

In many countries, public high schools have become increasingly attractive to students because their main goal is to place students in a qualified university. According to Sahlberg [1], young students' attitudes towards technical high schools in Organisation for Economic Co-Operation and Development (OECD) countries are generally not positive, preferring instead to enroll in public high schools where they would get more opportunities to continue at university level. Because of the limited quota for entering qualified high schools, there is tough competition among students who want to enter these schools, which has continued for many years. It is known that many countries use different testing or alternative measurement and assessment systems at these types of entrance examination. The general information and description of middle and high school entrance examination systems or exit examinations for Cambodia, Indonesia, Philippines, Singapore, Thailand, Vietnam, China, Holland, and England have been reported in various studies [2–5]. In most of these countries, mathematics, science, and language lessons make up the main parts of these tests, which mostly consist of multiple choice questions aiming to measure students' cognitive levels or cognitive capacities [6].

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Recently, many researchers or policy makers in education have been interested in the examination systems of other countries or more specifically in what types of questions are being asked in nationwide middle-secondary schools or university entrance examinations. Some of these studies have investigated students' achievement scores in such exams [7–10], while others have investigated whether there is any significant difference between male and female students and what influence(s) students' achievement in these examinations [11,12]. Some researchers have investigated possible factors that could influence students' success in entrance exams [13,14]. Some studies have looked for the relation between students' entrance examination scores and their academic achievement. These studies have tried to determine whether it would be possible to measure students' behaviors or real abilities, which the new curricula require, with central examinations [15,16]. Some studies have mostly focused on the reliability of the questions in the existing curriculum and the cognitive levels of questions asked in these examinations [5,17–22].

A big debate has also started concerning the influence of central examinations on students' psychology and their negative effects on teaching, the students' learning process at schools, and the weakness of examinations in determining students' real abilities. For example, according to Sternberg [23], classic tests are able to measure students' analytic thinking or analytic capacities. But these types of tests or examination systems only focus on one type of intelligence. They mostly ignore students' creativity and practical abilities. In contrast, Wößmann [24] argued that multiple tests, based on central examinations and graduation examinations, have positive effects on improving students' performance. Because students are ranked according to the score they get from

such examinations, they will try to improve their capacities and abilities. In addition, these exams also have positive effects on the schools' quality and teachers' performance. However, according to some researchers, even if students are very good at solving multiple test questions, the same students may encounter problems in understanding concepts or solving scientific or technological problems related to real life situations [25]. Cepni and Cil [9] explained this situation in terms of procedural understanding being more dominant than conceptual understanding. Many teachers now know that even without understanding the real meaning of concepts, students may still be able to solve the test questions by memorizing certain rules which are valid in solving certain types of questions. They really do not use critical thinking skills and they may not do things in order to solve these questions either. Teachers mostly believe that if they emphasize concept learning or spend time on discovery learning, their students would get low marks on entrance examinations [26–29]. Therefore, it may be concluded that the nature of a nationwide examination is not consistent with the latest learning theories or active learning strategies. Teachers' achievements are directly related to how many questions their students are able to correctly solve in central examinations. Apart from the teacher-centered or student-centered approach, this new situation adds a new term to the existing literature, "exam-centered approach," in which the main focus is the ability to solve as many test questions as possible [30,31]. In many cases, experts in an exam-centered approach would recommend that students solve 500–1000 test questions per day so as to get accustomed to all styles of questions which could be asked in central examinations. One could thus observe many students at school or after school, "eating toast and at the same time solving test questions," that is, trying to learn the concepts via testing. All these habits do not fit in with the nature of a newly developed curriculum [12,25,32–35].

As Kasanen and Raty claimed [36], national exams put teachers in a difficult situation. Because students and teachers need to put in effort and time to prepare for the level determination examination (LDE)-type exams, they consider projects and performance works as a matter of formality. In the end, almost all teachers came to the same conclusion: "This new program is not suitable for our education, especially the assessment system, so we need a new one." In Turkey, many programs collapsed for the same or similar reasons [30]. The problem is that "what we should do in order to prevent teachers or students from spreading negative propaganda about the new curriculum," and "how we can convince them that the contents and assessment approaches in the new curriculum are mostly consistent with the nature of Trends in International Mathematics and Science Study (TIMSS), Programme for International Student Assessment (PISA), or the LDE" is not known. Actually, there have been studies that examine the relationship between the curriculum standards/objectives and assessments frameworks [21,37]. Standards-based curriculums, like the Turkish one, impose the alignment between content standards and nationwide exam questions [16].

The purpose of this study is twofold: (1) to analyze the content areas of the specified objectives of the new science and technology curriculum for grades 6–8 as scientific process skills (SPS), science technology society and environment (STSE), attitudes and values (AV), and cognitive; and (2) to investigate alignments of the LDE questions with the contents of the science and technology programs for grades 6–8.

Contextual Background

The Turkish education system is highly bureaucratized, centralized, and exam-oriented. All decisions related to educational matters follow a top-down procedure. All schools throughout the country must use the same curriculum developed and implemented by the National Ministry of Education. In many cases, teacher-centered approaches used in the teaching-learning process are still dominant [38]. The present conditions of the Turkish education system are summarized in Table 1 in terms of results from external and internal indicators.

TABLE 1—*External and internal indicators.*

International (external) indicators	National (internal) indicators
PISA Performance on Science Reading Test: Turkey had 434 points in the PISA Science Reading Test in 2003. In the next test in 2006, the average score among Turkish students was 424 points. At the last one, the PISA authorities announced that the average science reading test score was 454 points.	**The Average Scores of the Secondary Education Entrance Exam**: The average of the Science Lessons Questions is 4.79 questions from 25 science questions in 2005. At the last entrance examination which is now called the LDE (covering 6th -8th grade level curriculum) and took place in 2009, science achievement results were 29.8 % at 6th level and 33 % at 7th level.
TIMMS Performance: According to 2007 results, students at eighth grade level are ranked 31st among 49 countries.	**Students' Attitudes Towards Science and Mathematics**: Gradually decreasing starting from elementary schools.
The Relevance of Science Education (ROSE): There have been a few research concerning students and teachers' attitudes towards science and technology education and their epistemological knowledge and expectation for the future. Similarly, for example, the main problems of science (especially physics) teaching in Germany were summarized as: students' lack of interest and motivation in the subject, poor understanding of scientific concepts, ideas, methods, and results, and their lack of comprehension of the social, political, and epistemological role of science (Riess, 2000).	**Students' Socio-economic Conditions:** Changeable, but a few students (approximately 5 % of the students) are able to continue to qualified private schools. The learning environment in many cases lacks equipped and science laboratory, has overcrowded classrooms, and unqualified teachers.
	Teachers' Attitudes Towards New Curriculum: Recent research shows that the majority of teachers show negative attitudes towards the new science curriculum.
	The Average Scores of the University Entrance Exam: The average of correctly answered science questions were 3,9 out of 45 questions.

The PISA survey (measures students' knowledge in science; students' ability to use scientific knowledge and relate this knowledge to everyday problems; and students' performance in reading and mathematics; also collects data on the student, family, and institutional factors) could help explain the differences seen among countries. The survey concentrates for the most part on the science content area including the following subjects: health, natural supply, environment, hazardous matters, science, and technology. Students were assessed about their proficiency in scientific knowledge and attitudes before their graduation from elementary schools that have covered these subjects [40].

Turkey has had a lot of experience with curriculum development up until 2004. These attempts were described as a failure by many researchers [30]. Starting from elementary school, curriculum reforms were implemented in all subjects at all levels, including high schools. With the new curriculum, many changes have taken place in terms of learning areas and the secondary level school entrance examination system.

Learning Areas and Units of the New Science and Technology Curriculum

In Turkey, all curriculua are designed by a committee of experts at the National Ministry of Education and approved by the Board of Education and Discipline. All schools in the nation follow the same programs. In the case of science and technology education program, the curricula consist of vision, aims, reasoning, instructional methods and techniques, measurement and evaluation approaches, samples for measurement and evaluation, and materials for activities besides theoretical information. The program document consists of all the units and topic content with their outcomes from grades 6 to 8. The new primary science and technology curriculum has four content areas, as follows:

1. Physical Events
2. Life and Living Beings
3. Matter and Change
4. The Earth and the Universe

These content areas are engaged with through the instructional objectives of science process skills (SPS), science technology society environment (STSE), and attitudes and values (AV). These instructional objectives were integrated with the cognitive objectives (Fig. 1).

All the outcomes and learning areas are coded as SPS, STSE, AV, or cognitive. For example, an objective of sixth grade outcomes is stated as follows in the curriculum: "*Students can give examples of chemical change in which a matter transforms into a different matter (SPS-6, 8).*" However, some outcomes, which are addressed with verbs like "define," "explain," or "distinguish," are regarded as cognitive outcomes. An example from seventh grade is: "*Students can explain that the distance among the stars is measured in 'light year' units.*" All the SPS, STSE, AV, and cognitive outcomes were counted one by one by the author from grades 4 to 8. Some outcomes can target more than one learning area. For example, an outcome covering both STSE and AV learning is: "*Students can emphasize that physically changed matter does not change its identity (SPS-6, 8, 9; AV-2).*" In such a situation, the outcome is counted as both STSE and AV outcome and added to the total sum of outcomes.

System for Secondary School Entrance

With the new program, the secondary school entrance examination system was also changed. Before the change, only one exam used to be given, at the end of the eighth grade year. With the new system, students (sixth to eighth grades) start to take this exam at the end of each academic year. Even the name of this exam was changed. It is now called the Level Determination Examination (LDE), which aims to follow up students' performance each year for the executed curriculum. In these exams, students are responsible for the following lessons: Turkish, Mathematics, Science, Social Science, and English. These examination results make up 70 % of the final grade, while students' performance and behaviors in the classroom account for 30 % of the students' total scores. In this process, total score of the students is calculated by adding 25 % score of sixth grade level and 35 % score of seventh grade level to 40 % score of eighth grade level [41]. The LDE was first applied in the 2007–2008 academic year. Sixth and seventh grade students participated in this exam for the first time. Students in eighth grade took different exams because they followed the old curriculum during the 2007–2008 academic year. The wide usage of multiple choice questions in national tests in order to enroll at a variety of schools brought up new discussions about the validity of such tests. Riffert mentioned two types of validity: curriculum and criterion validity [42]. Curriculum validity is the similarity between the expected outcomes in tests among students and the curriculum
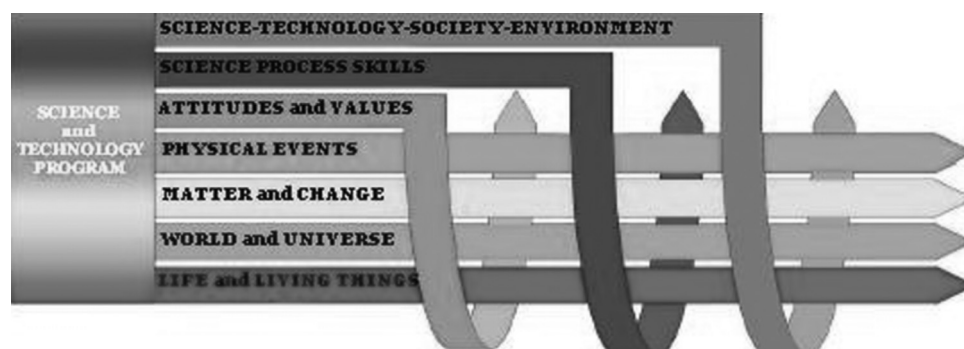

FIG. 1—*The structure of the new Turkish science and technology curriculum.*

executed in schools. In Turkey, because all schools implement the same curriculum, the validity of the curriculum has to be determined from the examinations. In international examinations such as TIMMS and PISA, the criterion of validity has to be acquired. For instance, PISA evaluates the level of scientific literacy of students. For this study, only science and technology questions from the LDE booklets for sixth to eighth grades were analyzed by reviewers according to objectives under the standards covering cognitive, SPS, STSE, and AV objectives.

Methodology

For the first research question, a task analysis of the elementary science and technology curriculum was conducted. Task analysis is the resultant of necessary skills and types of thinking in solving a problem [43,44]. In this context, task analysis is vital to explaining the knowledge and skills included in the curricula or systematic structure of an examination. The document analysis method was used in order to analyze the objectives in science and technology programs (6–8) [45]. The document analysis method is described according to systematic criteria [20]. After determining the number of outcomes in each unit, the sum total of the units' outcomes is calculated. Then, the percentages of learning areas are sorted out and the results are shown in tables. The general analysis for each learning level was accomplished after the unit analyses. In order to accomplish the objectives that were added to the corresponding learning level, the total number of outcomes, which will be dealt with in a one-year process, is determined in the same way. Then, the four learning areas of each unit are added separately. The percentages of SPS, STSE, AV, and cognitive objectives were calculated from the sum of outcomes.

For the second research question, all the data were analyzed by ten science teachers who have been teaching science and technology courses at middle schools in the Black Sea Region and who are at the same time pursuing their Ph.D. program at the science education department of the Fatih Faculty of Education. These teachers' teaching experiences amounted to between 3 and10 years in the field. The reviewers were trained by the researcher of this study during a Ph.D. course called "Using Learning Theories in Science Curriculum," covering the content analysis of the new science and technology curriculum, learning theories, assessment framework, and the objectives of science process skills (SPS), science technology society environment (STSE), and attitudes and values (AV).

It is possible to use different models in order to investigate the conformity between curriculum on the one hand and exam questions on the other [46,47]. The first model is a simple one that is used to make comparisons between exam questions and curriculum topics [5]. There is also another more comprehensive model, which allows for more detailed analyses. This comprehensive model consists of four criteria: (1) categorical concurrence (or content consistency), (2) depth-of-knowledge consistency (or cognitive demands), (3) range-of-knowledge correspondence (or content coverage), and (4) balance of representation (or distribution of test items) [37]. In the present study, Webb's model was used with some adaptations [37]. The explanation of these criteria

and the complete procedure employed in this study in order to fulfill the requirements for each criterion are summarized as follows:

(1) Categorical Concurrence Criterion

This criterion gives us general information on whether the assessments included items for measuring content from each standard. Normally, it is to be expected that the questions should cover all standards. First, tables for each unit were drawn up covering the objectives under each standard, and questions asked in the LDE were also placed in the tables. In order to determine whether the LDE included items for measuring content from each standard, the reviewers were asked to analyze LDE questions for the seventh grade. In this process, each reviewer coded the selected LDE question by linking directly to the objectives under the standard by marking when there was a match between the question and the objectives of the new seventh grade science and technology program. The acceptable agreement coefficient was identified to be at least 0.63 using a procedure developed by Subkoviak [48].

(2) Depth-of-Knowledge (DOK) Consistency Criterion

As Webb had argued [37], the DOK consistency between standards and assessment indicates alignment between what is elicited from students on the assessments as demanding cognitively and what students are expected to know and do as stated in the standards. Learning areas, unit, standards, objectives under the standards, and items of the LDE questions were considered to investigate the DOK consistency between the objectives and LDE. The LDE questions were categorized as SPS, STSE, AV, and cognitive according to the objectives of the two units. The revised Bloom's taxonomy was adapted into these criteria [49]. The reviewers compared all the objectives under the standards with the LDE questions according to the cognitive process dimensions of the revised taxonomy. In this process, LDE questions covering units 1 and 2 for the seventh grade were analyzed. The structure of the revised taxonomy is as follows:

1. Remember—retrieving relevant knowledge from long-term memory
2. Understand—Determining the meaning of instructional messages, including oral, written, and graphic communication
3. Apply—a procedure in a given situation
4. Analyze—Breaking material into its constituent parts and detecting how the parts are related to one another as well as their overall structure or purpose
5. Evaluate—Making judgments based on criteria and standards
6. Create—Putting elements together to form a novel, coherent whole or make an original product

The science and technology teachers were asked to consider the DOK levels of the LDE items and categorize concurrent objectives as compatible, partially compatible, and weakly compatible. The minimal acceptable DOK consistency level should be 50 % among the items and the coded objectives [37]. The DOK level

consistency was used for the cognitive objectives and the LDE questions covering these objectives. The other LDE questions relating to the objectives and belonging to AV, SPS, and STSE were also examined in-depth.

(3) Range of Knowledge Correspondence Criterion

This criterion mainly concerns what constituted the appropriate breadth of coverage for a standard, and it is used to compare what the standard required of students to be able to do with the span of knowledge that students need to correctly answer the assessment items. "*Full compliance*" represents 50 % or above; "*partial compliance*" represents 40 % to 50 %; and "*weak*" represents less than 40 % [37]. The two chapters that cover almost 50 % of the LDE questions were examined in-depth by the reviewers. The reviewers first examined the LDE questions and then compared them with the objectives under the standards to judge whether the depth and range of knowledge given in the objectives were adequate with respect to the span of knowledge that students need to answer the questions correctly. Apart from Webb's requirements for this criterion, interviews with each reviewer were also done for the purpose of augmenting the quantitative data with qualitative findings.

(4) Balance of Representation Criterion

Although the first three criteria are able to judge the alignments of curriculum standards and assessments from many angles, they do not mention how the questions are distributed among the objectives. The balance of representation criterion is used to indicate the degree to which one objective is given more emphasis in the assessment than another. An index is used to evaluate the distribution of assessment items for each standard [37]. In order to fulfill this criterion, the reviewers were asked to decide which LDE questions belong to which objective(s) under the standard by comparing the objectives under the standards for the two units of seventh grade science and technology curriculum. In this index, "unacceptable" indicates an index value below 0.60, "weak" indicates an index value of 0.60 to 0.69, and "acceptable" indicates an index value of more than 0.70.

Findings

In the first part of the study, the objectives under the standards belonging to the new science and technology curriculum programs (grades 6–8) were categorized as cognitive, SPS, STSE, and AV as follows. In the second part of the study, data obtained from the alignment studies were provided in detail.

Findings Related to the Science and Technology Curriculum Programs (6–8)

The new science and technology curriculum (grades 6–8) takes a spiral approach to each learning area. At the beginning, we analyzed the new curriculum as objectives (cognitive, SPS, STSE, and AV), unit-based for each level (grades 6–8) from the curriculum guidelines, and data were displayed in Table 2.

Findings from Table 2 show that the SPS objectives chiefly dominate the entire curriculum while the framework of the science

TABLE 2—*Percentile distribution of the outcomes of science and technology curriculum.*

Grade	Chapter	Cognitive	SPS	STSE	AV
6	1. Reproduction birth and growth in living things	53	37	5	5
	2. Force and Motion	38	62	–	–
	3. Particular Structure of the matter	23	59	4	14
	4. Electricity in our life	44	33	17	6
	5. Systems in our body	60	4	26	10
	6. Matter and heat	26	44	4	26
	7. Light and Sound	8	66	13	13
	8. What is earth's outer structure composed of?	26	36	29	9
7	1. Systems in our body	50	14	29	7
	2. Force and Motion	32	46	14	8
	3. Electricity in our life	62	32	6	–
	4. Structure and the properties of matter	56	25	13	6
	5. Light	20	50	13	17
	6. Human and environment	16	32	36	16
	7. Solar System and more: Space Puzzle	22	38	32	8
8	1. Cell Division and Heredity	48	27	22	1
	2. Force and Motion	42	46	4	8
	3. Structure and the Properties of Matter	35	35	15	15
	4. Sound	26	52	6	16
	5. States of Matter and Heat	38	38	12	12
	6. Living Things and Their Relation to Energy	52	24	20	4
	7. Electricity in our life	50	33	13	4
	8. Natural Process	10	40	40	10

teaching program mainly constructed on cognitive objectives. According to the percentage distribution of the objectives in the curriculum guidelines, SPS objectives are emphasized more at the sixth grade level than at the seventh and eighth grade levels.

Analysis of LDE Science and Technology Questions

As to the findings regarding the analysis of the seventh grade curriculum, the LDE science and technology questions asked in 2009 were given in this section. There were 18 questions in the seventh grade LDE science and technology section (see the Appendix). The dispersion of these questions according to chapters and learning areas is given in Table 3.

When we examined seventh grade LDE questions asked in the 2008–2009 academic year according to unit categories in the science and technology program, half of the questions were asked from only two units, "Systems in Our Body", and "The Structure and Properties of Matter."

Analysis of Seventh Grade LDE Questions for Two Units

In this section, alignment studies that investigate the relationship among LDE questions and objectives under the standards of the "Structure and the Properties of Matter" and "Systems in Our

TABLE 3—*The dispersion of 7th grade LDE questions.*

Learning areas	Chapters	N	%
Physical Events	Force and Motion	2	11.1
	Electricity in Our Life	2	11.1
	Light	2	11.1
Earth and Universe	Solar System and More: Space Puzzle	1	9.7
Matter and Change	The Structure and Properties of Matter	5	25
Living Things and Life	Systems in Our Body	4	20.8
	Human and Environment	2	11.1
	Total	*18*	*100*

Body" units, were carried out by the ten reviewers according to the four alignment criteria.

Criterion 1: Analysis of the LDE Questions for Categorical Concurrence—As seen in Table 4, five questions were asked about the Structure and Properties of Matter. This unit has five standards and 55 objectives. In this section, the reviewers first examined the questions and then specifically focused on the objectives under standards which were directly related to the LDE questions.

From Table 4, it can be seen that all reviewers gave hits for all the questions and only standard 5 did not take any hits. There was not any acceptable level of categorical concurrence between standard 2 and question 9. No question was asked in relation to standard 5. The science teachers slightly related questions 13 and 14 with the objectives under standards 4 and 5. For example, question 14 is related to the objective 3.5 under standard 3 and requires students to be able to explain the functions of the endocrine system using a model, board, or charts (STSE-4). Question 14 actually investigates whether students are able to show the endocrine system on the model, but students are not required to know the duties of the endocrine system. From the results, we can conclude that the content of the objectives under standards and the LDE questions examined were mostly met with a high agreement coefficient for the two units.

Criterion 2: Analysis of the Questions for DOK Consistency—Under this criterion, the objectives under the standards for "Structure and the Properties of Matter" and "Systems in Our Body" units were compared with the nine LDE questions based on the complexity of knowledge required by each part. At the first stage, the distribution of the seventh grade level science and technology program, according to the objectives under the standards, as SPS, AV, STSE, and cognitive, were done according to their compatibility with the LDE questions. The DOK consistency of the seventh grade curriculum and the LDE questions for the curriculum objectives in terms of cognitive dimension were investigated in the second stage.

From Table 5, the depth of knowledge for almost all of the questions is marked as suitable for the objectives under the standards. From these findings, we could say that on the basis of the complexity of knowledge being demanded cognitively, the objectives under the standards and the LDE questions were consistent to each other in general. Therefore, the DOK consistency of the nine questions was marked as consistent.

Criterion 3: Range of Knowledge Correspondence—In this process, each reviewer examined the LDE questions and wrote down what types of knowledge or abilities students should have to be able to solve these questions and what each objective under the standard provides to students.

TABLE 4—*Categorical concurrence of the 7th grade LDE questions and the standards.*

Units	Objectives	Question	Hits	Concurrence
Structure and the properties of matter	1.2. They guess that different elements of atoms are different by using the models and figures (SPS-5, 6).[a]	8	9/10	*Concurrent*
	2.3. Shows nucleus, the core of the fundamental particles and electrons on the representative pictures.	9	5/10	*Non-concurrent*
	3.6. To call the positively charged ions, "cation," negatively charged ions, "anion"	10	8/10	*Concurrent*
	4.2. Predict push/pull forces between ions, call the pull force "ionic bond"	11	7/10	*Concurrent*
	6.5. Notice the increase in the speed of solubility with the increasing temperature.	12	8/10	*Concurrent*
	6.6. Discover that the speed of solubility increases when solvent's particle shape is becoming smaller.			
Systems in our body	4.3. Explain which type of warnings does the sense organs take and how the answer is given (STSE-31, 32).[b]	13	7/10	*Concurrent*
	3.5. Shows endocrine gland; on model, board and/or diagram and explain its function (STSE-4).[c]	14	7/10	*Concurrent*
	1.2. Students guess that the nutrients are required to change to become beneficial to the body.	15	4/10	*Non-concurrent*
	2.1. Demonstrating structures and organs composing excretion system on model, board and/or schema (STSE-4).[c]	16	9/10	*Concurrent*
	2.2. Explain function and importance of excretion system.			

[a]SPS 5 Determines the differences and similarities among subjects or events. SPS 6 Makes comparisons based on observations for one or more specifications.
[b]STSE 31 Explains using the samples how developed technologies from the past until now change people's individual and social life, work habits and interactions with the environment. STSE 32 Explains using samples that the specific scientific or technological improvement can have positive or negative, predictable or unpredictable effects on the individual, society, and environment.
[c]STSE 4 Knows the importance of using models to develop and present scientific information.

TABLE 5—*Consistency of the 7th grade LDE questions according to the curriculum outcomes.*

Unit	Objectives	Question	Compatible	Partially	Weak	Consistency
Structure and the Properties of Matter	Objective 1.2	8	8/10	2/10	–	*Consistent*
	Objective 2.3	9	2/10	2/10	6/10	*Inconsistent*
	Objective 3.6	10	8/10	2/10	–	*Consistent*
	Objective 4.2	11	7/10	2/10	1/10	*Consistent*
	Objective 6.5– 6.6	12	8/10	1/10	1/10	*Consistent*
Systems in Our Body	Objective 4.3	13	7/10	2/10	1/10	*Consistent*
	Objective 3.5	14	2/10	2/10	6/10	*Inconsistent*
	Objective 1.2	15	1/10	3/10	6/10	*Inconsistent*
	Objective 2.1–2.2	16	7/10	2/10	1/10	*Consistent*

From Table 6, it can be seen that in nine questions belonging to two units, only four have acceptable knowledge correspondence with the objectives under the standards. Reviewers' extra explanations about objectives and questions gave us valuable qualitative data about knowledge correspondence. The reviewers' hits for each question support their explanations. Only four questions' knowledge correspondences were accepted as compatible. From these findings, we could say that a comparable span of knowledge expected of students by the objectives under the standards for the two units is not the same as or does not correspond to the span of knowledge that students need to correctly answer the nine LDE questions.

Criterion 4: Balance of Representation—In order to find how the questions asked were distributed among the objectives under the standards, a balance index calculation for each question was made.

From Table 7, only two of the five questions were hit as acceptable for the balance of representation criteria, and only one question was hit as acceptable for the "Systems in Our Body" unit for the balance of representation criterion. This criterion shows that LDE questions were not distributed equally within objectives under the standards. This means that some objectives had more emphasis on the LDE questions than others. Therefore, many standards were ignored and acceptable balances were not established.

TABLE 6—*Range of knowledge correspondence between questions and objectives.*

Objective	Question	Qualitative assessments of the results from the comparisons	Hits	Correspondence
Objective 1.2	8	Recognition of elements in atoms through the given models. Subject content in terms of learning areas, objectives and standards are compatible. Students' models must be compared to each other and similar ones must be categorized. In this context, question and objective appreciation is available.	80 %	**Full compliance**
Objective 2.3	9	Solution of the problem requires knowledge of the structure of the atom. Without knowing the concepts of protons, neutrons and electrons, it is not possible to solve the problem. Questions do not require any impression on the picture.	40 %	**Part compliance**
Objective 3.6	10	Knowing what is the concepts anion and cation is enough for finding the solution to the question.	70 %	**Full compliance**
Objective 4.2	11	What is the meaning of ionic bond for the solution to the question? Then, the atoms which are likely to take and give electrons should be determined by counting the electrons at the outer layer. At the end, proper atom or atoms which can trade electron with the given atom should be determined. This last stage is in compliance with STS-9.	80 %	**Full compliance**
Objective 6.5 Objective 6.6	12	The amount of sugar, liquid and type of liquid is held constant. Only the dimension of the particle and temperature of the liquid are changed. From this point of view, the question and the objective are coordinated.	70 %	**Full compliance**
Objective 4.3	13	For the solution to the question, just to have knowledge about two sense organs (skin and eye) is enough. Moreover, the reaction dimension given in the objective is also lacking.	40 %	**Part compliance**
Objective 3.5	14	Although the objective includes endocrine glands and hormones that they secrete, the question just mentioned concerns the hormone, not the endocrine gland responsible for the hormone. The question of subject content is partially coordinated with the learning area. There is not any relationship with scientific models.	20 %	**Weak**
Objective 1.2	15	Question only requires graph reading skills.	20 %	**Weak**
Objective 2.1, Objective 2.2	16	For the solution to the question, primarily excretion organs should really be determined on the given excretion system. This part of the question shows compliance with the objective; showing excretion organs on a visual material. In the solution to the question, the duties of the urinary bladder should also be known. But only the importance and functions of the excretion system are given in the objectives. Structure and function of other organs are not mentioned with the statement, but only shown on the model.	40 %	**Part compliance**

TABLE 7—*Balance index (BI) of selected LDE questions.*

Unit	Question	O[a]	H[b]	I[c]	BI	Representation
Structure and the properties of matter	8	2	3	$I_{1,2} = 8,5$	**0.67**	*Weak*
	9	3	5	$I_{2,3,4} = 9,1,1$	**0.4**	*Unacceptable*
	10	2	5	$I_{1,4} = 3,9$	**0.3**	*Unacceptable*
	11	4	7	$I_{1,2,3,7} = 1,6,1,2$	**0.79**	*Acceptable*
	12	3	7	$I_{1,2,3} = 1,3,7$	**0.71**	*Acceptable*
Systems in our body	13	5	6	$I_{2,3,5,6,8} = 5,1,8,4,2$	**0.2**	*Unacceptable*
	14	2	11	$I_{6,7} = 8,10$	**0.68**	*Weak*
	15	3	11	$I_{2,3,4} = 10,4,6$	**0.59**	*Unacceptable*
	16	4	11	$I_{8,9,10,11} = 2,10,4,1$	**0.73**	*Acceptable*

[a]O = Total number of objectives hit for the standard
[b]H = Total number of items hit for the standard
[c]I (k) = Number of items hit corresponding to objective (k)

Discussions and Implications

When the science and technology curriculum was analyzed, it could be seen that in both levels the objectives under the standards are dominantly SPS and STSE. This finding does not support the idea that a positive attitude development towards science and technology courses should start from the very first stage of elementary education. That is because developing scientific attitudes and values, as well as voluntary participation in science activities both at school and out of school, are the main targets for elementary science and technology education [50]. These weaknesses should be dealt with as soon as possible through necessary amendments to the existing science and technology program.

SPS objectives are in the majority at the second stage of elementary education, just as in the first stage of elementary education. Another interesting point is the SPS objectives increasingly become more weighted toward subject knowledge while the distribution of the objectives considered from sixth grade to eighth grade. Also, these objectives become more pronounced when compared with the STSE and AV objectives. At the end of elementary education, the SPS objectives gain more importance and are taken into consideration more than the STSE and AV objectives. Another interesting point is that the AV objectives are the least seen type of objective at the second stage of elementary education. Some studies have shown that approximately 80 % of high school students in Turkey do not like science courses, and AV objectives are the least emphasized in the science and technology curriculum, which is one of the weakest points of the curriculum [9]. AV objectives gain special importance because students are categorized at high school level and some will not encounter much science after elementary education.

For a detailed analysis, we focused only on the seventh grade LDE questions because the sixth and eighth grade levels have similar attributes (the same commission prepares all LDE questions in Turkey). At the seventh grade, the percentage dispersion of chapters and the number of questions asked on the LDE are as follows: Physical Events (33 %; 6), Earth and Universe (9.7 %; 1), Matter and Change (25 %; 5), Living Things and Life (33 %; 6). From these findings, for the seventh grade, there is a balance among percentage dispersion of the learning areas and the proportion of the number of questions. However, this is a superficial assessment. Examining by means of simply covering topics is never a good predictor of student achievement on standardized tests. If the evaluators use the coverage and cognitive emphasis together, they should be in a better position to predict more meaningfully students' performance on general tests [37,51].

When the balance between questions and the new science and technology program in the categorical concurrence criterion is analyzed, positive significant results are obtained. However, these results do not resemble the study of Saderholm and Tretter [21]. They analyzed similarities and differences between assessing structures of physics subjects such as Benchmarks for Science Literacy (Benchmarks), National Science Education Standards (NSES), National Assessment Governing Board (NAEP), and Trends in International Mathematics and Science Study (TIMMS). These indicators are giving direction to science curricula all over the world. In their study, Saderholm and Tretter determined that physics topics had different rates for each of these four indicators, and some physics topics included in NAEP and TIMMS are not included in Benchmarks or NSES [21]. However, altering objectives for international comparative studies does not have any educational meaning unless the coverage of questions considered at national level.

From the findings of the study, the vast majority of objectives and questions were coherent with the mental complexities of the LDE exam. Therefore, at the seventh grade level, LDE exam questions could meet the DOK criterion consistency in Webb's alignment model [37]. Similarly, the Chinese curriculum also draws attention to subject knowledge and understanding, and gives importance to the skills stated previously, such as application and analysis, in examinations [5]. Nationwide tests in Singapore require a higher level of thinking ability according to the standards, while there is a level of compliance between the examination and standards cognitive levels in the United States [16]. In this context, Turkey shows similarity with the United States in terms of LDE examination and compatibility of programs according to the DOK consistency criteria. However, both objectives and questions, including low cognitive competencies, should not

be overlooked. The PISA evaluation requires different skills, which are induction, deduction, logical thinking, system-based thinking, and critical thinking. These are fundamental for the cognitive domain. In order to get a high score from the PISA evaluation, there ought to be a high level of thinking ability and all activities should be in line with this purpose. At this point, Turkey has made an improvement in that the LDE exam contains very little knowledge level questions. However, objectives should be reviewed again according to the PISA and TIMMS objectives if Turkey wants to improve its place in international rankings. Consequently, higher level questions such as analysis, synthesis, and evaluation should be given more space in the LDE examinations [52].

Only three of nine questions were at the compatible level for being answered using knowledge described in the curriculum objectives when the questions were examined according to the range of knowledge correspondences criteria. In this respect, there is no compliance between the depth of knowledge in order to solve a question and the depth of knowledge that is envisaged in the standards. However, it can be claimed that examinations have to be adapted to schools rather than adapting schools according to the examinations [42]. The entrance examinations, which are vital to the student's future, are determined by the instructive activities of the teacher. It might help teachers to enhance students' ability to conceptualize rather than memorize by administering exams that are parallel to the outcomes and the topics of the curriculum.

Although the questions in the LDE examination are distributed according to each unit and there is a balance between the proportion of the standards and the number of questions, the balance of representation criterion is mostly neglected. All objectives under the standards were not considered sufficiently in the question distribution of the LDE exam. The standards are seen as a general framework and objectives are regarded as more specific achievements that students are expected to attain. While the questions in the LDE examination were prepared so as to include standards, they did not fully cover the objectives. For example, if there are six objectives related to one standard, which is supposed to be addressed with one question, the LDE questions are mostly intended to assess one or two of these objectives. Only three of nine questions investigated in this study include a large number of objectives. In other words, a large number of objectives that students are expected to reach remained well beyond the scope of assessment in the examination. Thus, it should be kept in mind during question preparation that the LDE questions should have more than one objective. It is believed that the coherency between the curriculum and national tests shows the importance of the curriculum and also shows how successfully students acquire the objectives [14]. Last but not least, should the LDE and the new curriculum have common characteristics; it would contribute to the assessment and improvement of the curriculum.

There have been studies on the analysis of the LDE questions. These claimed that the objectives under the standards had great consistency with the LDE questions. On the basis of this claim, all policy makers argue that this current LDE is valid and reliable and at the same time it reflects the nature of the current science and technology curriculum [9]. However, when we analyzed the LDE for this study by using the four criteria, we found that the questions only fulfill the first two criteria and not the rest, which investigate the close relationships between the curriculum and questions. In this case, we should re-assess all the exam questions for accurate conclusions. Assessment offices at the Ministry of National Education and some private schools are now looking for experts who are able to assess consistency among the curriculum guidelines and the questions asked in the exams. For now, there are only very few experts who are aware of the alignment issues and who are able to match the curriculum guidelines with the questions.

Finally, it could be concluded from the findings and discussion that Turkey wants and plans to improve its ranking in international indicators such as PISA and TIMMS. Turkey's willingness to improve in the educational area has already started to reflect in the PISA scores. According to the PISA results, the average performance on the 2006 science literacy test was 10-points lower than the average score in 2003. This decrease should not be seen as a dichotomy because the decrease might come from difficulties with the adaptation process of the 2004 science and technology curriculum program. With the gradual adoption of the philosophies and application of the 2004 science and technology program, the average science literacy score on the 2009 PISA for Turkey went up from 424 to 454 points. Although Turkey improved its PISA scores by 30 points, these scores still remain below the average science literacy point of OECD countries (compare 454 points with 501 points). At the same time, Turkey has continued to have a low place among the ranking of countries according to science literacy tests scores (36/41 in 2003, 44/57 in 2006, and 43/65 in 2009) [53]. In order to have a better ranking among participant countries in international examinations, Turkish policy makers should first analyze the contents and the nature of the questions asked in these international examinations. Second, all educators and researchers should be aware of the fact that the assessment framework of the international examination includes the concepts of scientific literacy; nature of science; basic science concepts; the relationships among science, technology, society and environment; and the reflections of the fundamental objectives of SPS, STSE, and AV. If students grasp all these issues, they will be very successful at these international examinations in addition to using the knowledge gained in solving everyday life problems. Theoretically, this might sound possible, but how exactly to put all these advanced ideas and goals into practice will remain as the key problem, which must be dealt with in the near future. We should keep in mind that raising achievement in terms of both internal and external indicators is a slow process that takes time.
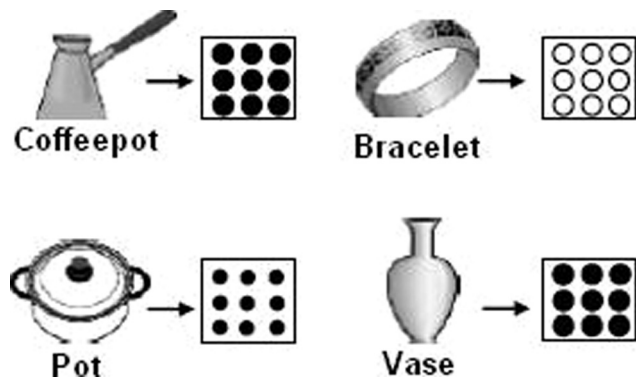
Acknowledgments

Appendix

Sample question from the level determination examination on science and technology.

8. The teacher brought four cards to the classroom displaying the particle models of some objects and asked the students "Which objects can be made of the same matter according to particle models?".

Which of the following student responses is correct?

A) Coffeepot-Vase
B) Coffeepot-Pot
C) Coffeepot-Pot-Vase
D) Coffeepot-Bracelet-Vase

11.

A) Fluorine
B) Magnesium
C) Argon
D) Argon and fluorine

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