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Analysis of the Science Course Curriculum Objectives and High School Entrance Examination Questions According to TIMSS Framework*

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Abstract: The aim of this study is to compare 2018 Science Course Curriculum (SCC), 2015 Trends in International Mathematics and Science Study (TIMSS) and 2018 High School Entrance Examination (HSE) in terms of content domains, cognitive domains and learning objectives. Qualitative research method, was used in this study. Data were analyzed using document review matrices to determine the similarities and differences between the objectives of SCC, TIMSS and HSE. SCC outcomes and HSE science questions were also classified according to TIMSS cognitive domains. Results show that the learning objectives of the fields of Physics, Biology and Earth Sciences of TIMSS are compatible with those of all grade levels of SCC and that the objectives of Chemistry are compatible with those of the seventh and eighth grades. Most of HSE questions are compatible with the objectives of SCC, however, the latest revision in the curriculum has introduced some eighth grade objectives to other grade levels. HSE science questions measure higher-level skills than TIMSS science questions. The subject domain of the "Organisms and Life" of SCC has the most learning objectives in the levels of "knowing" and "reasoning" while the subject domain of the "Physical Events" has the most learning objectives in the levels of "applying." Besides, the seventh-, fifth- and eighth-graders have the most objectives in the levels of "knowing," "applying," and "reasoning," respectively. It is hoped that the results will contribute the literature in improvement of science curricula and interpretation of national and international exams.

Keywords: *TIMSS, high school entrance examination, science curriculum, cognitive domain, content domain.*

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Introduction

It is crucial to ensure that students improve their high-level thinking skills (critical thinking, problem solving, analytical thinking, reasoning, scientific process, etc.) to show them the ways of acquiring scientific knowledge and to provide them with the acquisition of skills for them. Science course is quite important for the acquisition or development of high-level thinking skills. The skills that the students have acquired in this course provide opportunities for them to find solutions to real life problems through scientific ways and to interpret the natural events they have observed by considering them objectively (Kaptan & Korkmaz, 1997). Therefore, curricula should be prepared very carefully in accordance with the requirements of the era and the skills desired to be developed in students. In Turkey, the Science Course Curriculum (SCC) has been frequently revised in recent years. In each change or update, it is observed that new skills along with the regulations related to the philosophy of curriculum, the scientific content which is planned to be provided, teaching method, and the assessment and evaluation approaches are highlighted.

With respect to the Science Course, the SCC, which was most recently renewed in 2017 and put into practice at the 5th grade level and revised in 2018, stands out. Nowadays, the roles expected from individuals are also changing in accordance with the rapid developments in science and technology, the ever-changing needs of individuals and society, and the innovations in learning-teaching approaches included in educational sciences (Ministry of National Education [MoNE], 2018). The MoNE have described these roles expected from individuals as the roles that produce information, can use information in daily life and solve problems, think critically, are entrepreneurial and determined, have communication skills, can empathize, and make contributions to society and culture (MoNE, 2018). Along with the

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update of the curriculum, the concepts such as engineering and design skills, innovative thinking and Science-Technology-Engineering-Mathematics (STEM) integration have been added to the curriculum. Individuals who grow up with these skills in the education system play a major role in the development and improvement of countries.

Another factor that may be effective in changing or updating the curricula is the picture which emerges by the determination/comparison of students' achievement levels through the examinations performed at the national/international level. According to Keser (2005), international examinations such as Trends in International Mathematics and Science Study (TIMSS) and Program for International Student Assessment (PISA) are considered as one of the reasons for changing the SCC, because students prepare for national and international examinations with the SCC implemented in their schools. The results obtained from these examinations indicate students' achievement in science and the effectiveness of the science curriculum (Keser, 2005). With the information obtained from international examinations, education programmers determine which curriculum is more effective and efficient, and in accordance with these determinations, they focus on developing and renewing the SCC (Educational Research and Development Directorate, 2003). Indeed, international examinations such as TIMSS, which are held in every four years in science and mathematics, allow for the assessment of students' achievements at both national and international levels, the evaluation of the effectiveness of science and mathematics curriculum and the regular updating of education systems with the data obtained (Mullis & Martin, 2014; Provasnik et al., 2016; Yildirim, Ozguruluk, Parlak, Gonen, & Polat, 2016). These evaluations, on the other hand, are of great importance in terms of seeing the place of the level of education in Turkey among participating countries. Therefore, it was necessary to prepare contemporary curricula that would respond to today's needs and the curricula were updated and changed (Dogan, 2010).

In addition to international examinations, national central examinations are held in Turkey. As one of those examinations, high school entrance examination (HSE), which is held nowadays for the placement of secondary school students in high schools, has been implemented with many different names and different forms (single-step, multi-step etc.) from past to present. One of these evaluation studies is the HSE and this examination is performed for the placement in high school institutions. According to Berberoglu and Kalender (2005), placement examinations also lead the way in determining and evaluating the achievement. In Turkey, students take the HSE examination to continue their high school education in qualified high schools after receiving primary and secondary education for 8 years. With the last change made in 2017, the name of the examination was changed to HSE and has been implemented since the 2017-2018 academic year.

For secondary school final year students and their families in Turkey, the HSE is an examination which guides their lives. Because placement examinations for secondary education institutions are the first stage that determines the future of students. As a result of the desire of the students and their families to receive qualified education for a good future, the importance they attach to examinations such as HSE has also increased. In Turkey, high number of young population and the effects of qualified high schools due to the fact that they are few in number indicate how important these examinations are. Therefore, the data obtained from the HSE, which is one of the examinations that are implemented in our country and affect the future of students, is also considered as an important factor in revealing the effectiveness of the curriculum implemented in education.

The relationship between the knowledge and skills that need to be acquired in the curricula and the knowledge and skills measured in exam questions is quite important because HSE is an examination which measures the objectives in SCC. Therefore, the examination should be consistent with the objectives in the SCC, in other words, content validity needs to be ensured. Students take examinations such as HSE at the national level and TIMSS at the international level with the SCC taught to them in schools. Therefore, both national and international examinations reveal the effectiveness of SCC implemented in schools.

When the literature is reviewed, it is possible to find studies examining the TIMSS (Thomson, Wernert, O'Grady, & Rodrigues, 2017; Yildirim, Yildirim, & Ceylan, 2017) or the factors affecting science success in HSEs (Akay, 2017; Ulutan, 2018). Furthermore, there are also studies analyzing the course books according to TIMSS cognitive domains (Pektas, Incikabi & Yaz, 2015), the curriculum/national examinations (Afacan & Nuhoglu, 2008; Boyuk, 2017; Delil & Yolcu-Tetik, 2015; Delil, 2019) or HSEs (Arikan, 2018; Cepni, Ayyaci, & Keles, 2001). However, while there are many studies examining the TIMSS objectives of mathematics curriculum (Incikabi, Mercimek, Ayanoglu, Aliustaoglu, & Tekin, 2016) and the TIMSS mathematics questions within the scope of HSEs and/or curriculum (Basol, Balgalmis, Karli, & Oz, 2016; Baysura, 2017), there are very few studies examining the compatibility between TIMSS and the HSE (Afacan & Nuhoglu, 1999) or the SCC with the TIMSS and TBSE (Transition from Basic Education to Secondary Education Exam) (Boyuk, 2017) in the field of science. Furthermore, all of these studies were related to the examinations and/or curricula of the previous years.

In this study, it was aimed to determine the compatibility between the revised 2018 SCC and the scope of the 2015 TIMSS and 2018 HSE questions. In line with this aim, the SCC and the questions and objectives of TIMSS and HSE were comparatively analyzed. With SCC, students will continue to take international and national examinations such as TIMSS and HSE. Therefore, curriculum development experts take into account the results obtained from these examinations. Available curricula are also reviewed in accordance with the results obtained from these examinations,

and the education is reformed (Reddy, 2005; Tobin, Lietz, Nugroho, Vivekanandan, & Nyamkhuu, 2015). So, the levels of compatibility between the SCC, which was most recently revised in 2018, and 2015 TIMSS and 2018 HSE examinations, which were most recently implemented, were analyzed. The determination of the levels of compatibility of HSE and TIMSS, which are two important national and international examinations implemented to secondary school students in Turkey, and the SCC is considered to be important in terms of providing feedback to the relevant institutions and individuals in revealing and improving the effectiveness of the curriculum.

The problem determined in line with this information in this study is "What are the similarities and differences between the objectives and content of the 2018 SCC, 2015 TIMSS and 2018 HSE examinations?". The sub-problems based on this problem are as the following:

1. What are the similarities and differences between the objectives of the 2015 TIMSS 8th grade Science examination and the objectives of the 2018 SCC?
2. What are the similarities and differences between the objectives of the 2018 HSE Science examination and the 8th grade 2018 SCC?
3. What are the similarities and differences between the objectives of the 2015 TIMSS 8th grade Science examination and the objectives of the 2018 HSE Science examination?
4. What are the similarities and differences between 2015 TIMSS, 2018 HSE and 2018 SCC in terms of the units and objectives of the 2018 SCC?
5. What are the similarities and differences of the 2018 Science questions of HSE and the objectives of the 2018 SCC in terms of TIMSS cognitive domains?

Methodology

Research Design

The qualitative research method was adopted in accordance with the aim of the study. Qualitative research refers to revealing events in a realistic and holistic way in their natural environment using the knowledge acquisition methods such as observation, interview and document review/analysis (Yildirim, 1999). Qualitative research provides a detailed framework about a particular individual, group or condition (Fraenkel & Wallen, 1996). In the study, the document analysis method was used since it was aimed to comparatively describe the SCC and the TIMSS and HSE examinations. Document analysis involves the analysis of written materials that provide information about the phenomena which are planned to be investigated, and it can also be used as a research method alone (Yildirim & Simsek, 2011). Therefore, in the study, the objectives of the SCC and the objectives of Science questions in the TIMSS and HSE examinations were analyzed by document analysis matrices.

Data Collection Tools

The most recently revised objectives of the SCC, 2015 TIMSS and the questions of the 2018 HSE were used as the sources of data. The objectives of the SCC, which was revised in 2017 by the Ministry of National Education Board of Education, put into practice only at the 5th grade level, and revised again in 2018 and implemented at the 5th, 6th, 7th and 8th grade levels, constituted the first data source of the study. The objectives of the SCC, the objectives of the HSE questions and the Science 8th grade objectives of TIMSS were analyzed according to the cognitive domains that are described in TIMSS 2015 assessment framework.

Science objectives related to Physics, Chemistry, Biology and Earth Sciences content domains included in the TIMSS manual constituted the other data source of the study. TIMSS Science objectives, the objectives and content domains of SCC and HSE were comparatively analyzed. The cognitive domain levels of TIMSS Science questions were analyzed in accordance with the steps in TIMSS reports prepared by Yildirim et al. (2016) and Yildirim et al. (2017). Finally, the compliance of HSE questions obtained from the website of the Directorate General for Measurement, Assessment and Examination Services to the objectives and content domains were analyzed in accordance with the SCC and TIMSS examinations, and also HSE Science questions were analyzed according to TIMSS cognitive domains.

Data Analysis

The document review was performed at different stages (access to documents, analyzing the originality of documents, analyzing the documents, analyzing the data obtained) depending on the nature of the problem and the most comprehensive and in-depth analysis of the data and documents planned to be obtained as a result of the analysis (Yildirim & Simsek, 2011). HSE Science questions and the SCC, as the documents obtained in this study, were examined within the framework of TIMSS and analyzed with document review matrices. For instance, the matrix in Table 1 was used in the comparative analysis of the objectives of SCC, TIMSS and HSE Science questions according to content domains and grade levels.

Table 1. A sample of document review matrix

	2018 SCC		2018 HSE		2015 TIMSS	
	Content Domain	Number of Objectives	Content Domain	Number of Objectives	Content Domain	Number of Objectives
5th Grade						
6th Grade						
7th Grade						
8th Grade						
Total						

In the study, cognitive domains of TIMSS and HSE 8th grade Science questions were examined and comparatively analyzed. The content definitions of sub-cognitive categories in “knowing”, “applying” and “reasoning” (Mullis & Martin, 2014) were used in the classification of TIMSS and HSE Science objectives in terms of content domain.

Yildirim and Simsek (2011) stated that the information on the research process and how data are collected and analyzed should be expressed in a clear and detailed way in qualitative studies. Accordingly, data sources, stages of document analysis and how they were performed were stated in detail in the study. The research questions were formed to be clear and comprehensible and to ensure achieving the aim, and they were finalized by receiving the opinions of two experts.

Consistency is very important for the reliability of the research, and therefore, the consistency between the analysis performed by the researchers through document review matrices was examined. The agreement percentage formula was used for this purpose (Turnuklu, 2000). At least 80% agreement percentage obtained as a result of the calculation indicates that the research is reliable (Arastaman, Fidan, & Fidan, 2018). In this study, HSE Science questions and the objectives of the SCC were analyzed by two independent researchers in terms of cognitive domains, and the ratio of compliance was found to be 85%. In the conflicts, the skills included in the cognitive domains of TIMSS were re-examined by the researchers, and the analysis was completed when researchers reached a consensus.

Results

Results on TIMSS and SCC Science Objectives

In this section, the 2015 TIMSS 8th grade Science objectives and the objectives in the 2018 SCC related to the first sub-problem of the study were compared according to subject domains. The results obtained by comparing 223 objectives of different grade levels and subject domains in the SCC and 119 objectives of different content/subject domains in TIMSS Science 8th grade level were presented by categorizing them according to content domains in TIMSS. The distribution of the objectives divided by subject domains of the TIMSS Science 8th grade content domains according to grade levels in SCC is presented in Table 2.

Table 2. Distribution of the TIMSS 8th grade objectives according to grade levels in SCC

Content Domain	2015 TIMSS Subject Domain (Matching/Total number of Objectives) *	2018 SCC **			
		5th Grade	6th Grade	7th Grade	8th Grade
Biology	Characteristics and life processes of organisms (4/7)	1	5	-	-
	Cells and their functions (6/6)	-	-	2	2
	Life cycles, reproduction, and heredity (5/5)	-	-	4	3
	Diversity, adaptations, and natural selection (4/4)	1	-	-	1
	Ecosystems (10/10)	1	-	-	2
	Human health (4/4)	-	3	-	-
	Total (33/36)	3	8	6	8
Chemistry	Composition of matter (5/5)	-	-	5	-
	Properties of matter (12/12)	-	-	3	5
	Chemical change (6/6)	-	-	-	3
	Total (23/23)	-	-	8	8
Physics	Physical states and changes in matter (6/6)	3	2	-	-
	Energy transformation and transfer (4/5)	1	-	4	-
	Light and sound (7/7)	3	5	6	-
	Electricity and magnetism (3/6)	1	2	2	-
	Forces and motion (10/10)	1	3	2	3
Total (30/34)	9	12	14	3	

Table 2. Continued

Content Domain	2015 TIMSS	2018 SCC**			
	Subject Domain (Matching/Total number of Objectives) *	5th Grade	6th Grade	7th Grade	8th Grade
Earth Sciences	Earth's structure and physical features (1/6)	-	-	-	1
	Earth's processes, cycles, and history (8/9)	1	1	-	5
	Earth's resources, their use and conservation (6/6)	1	3	3	7
	Earth in the solar system and the universe (4/5)	2	2	1	-
	Total (19/26)	4	6	4	13

* The matching ratio of TIMSS objectives with SCC objectives.

** Each TIMSS objective can match with more than one SCC objectives (or vice versa).

According to Table 2, it was found that 33 of 36 objectives belonging to the 8th grade Biology content domain in the TIMSS Science examination matched with 25 objectives at different grade levels (5-8th grade) in the SCC. It was determined that 3 objectives of the "Characteristics and Life Processes of Organisms" subject domain in TIMSS did not match with any objective in the SCC. Moreover, it was determined that all 23 objectives of the Chemistry content domain at the 8th grade level in the TIMSS Science examination matched with a total of 16 objectives at the 7th and 8th grade levels in SCC.

In line with the results in Table 2, it was determined that 30 of 34 objectives of the Physics content domain at the 8th grade level in the TIMSS Science examination matched with 38 objectives at different grade levels in SCC. It was also determined that a total of 4 objectives of "the Energy Transformation and Transfer" and "Electricity and Magnetism" subject domains in TIMSS did not match with any objective in the SCC.

In terms of Earth Sciences, it was concluded that 19 of 26 objectives at the 8th grade level in the 2015 TIMSS Science examination matched with 27 objectives at different grade levels in 2018 SCC. It was observed that 7 objectives in TIMSS (most of them belonged to the "Earth's Structure and Physical Features" subject domain) did not match with the objectives in SCC.

Results on HSE and SCC 8th Grade Science Objectives

In this section, the objectives of 2018 HSE Science exam questions and the 8th grade SCC objectives, which were last updated in 2018, were comparatively analyzed. In fact, the Science exam questions in the HSE held in 2018 were prepared by taking into account the 8th grade objectives in 2013 SCC (Sensoy, Tanberkan, Suna, Eroglu, & Altun, 2018). Therefore, the analysis of the objectives of the 2018 HSE exam questions will ensure that the changes at the 8th grade level in the 2013 and 2018 curricula are revealed.

SCC includes the subject domains of "Earth and the Universe", "Organisms and Life", "Physical Events" and "Matter and its Nature". The distribution of HSE Science exam questions according to the 8th grade subject domains, units and topics of SCC is presented in Table 3.

Table 3. Distribution of 2018 HSE Science exam questions according to the subject domains, units and topics of 2018 SCC

Subject Domain	Unit	Topic	HSE Question Number
Earth and the Universe	Seasons and Climate	Formation of Seasons	-
		Climate and Air Movements	-
Organisms and Life	DNA and Genetic Code	DNA and Genetic Code	1-3
		Heredity	3
		Mutation and Modification	6
		Adaptation	-
	Biotechnology	6	
	Food Chain and Energy Flow	4	
	Energy Transformations and Environmental Science	4	
Physical Events	Pressure	Matter Cycles and Environmental Problems	5
		Sustainable Development	-
		Simple Machines	7-8
		Electric Charges and Electrification	11-12-13
		Electrically Charged Bodies	11-12-13
	Electrical Energy	Transformation of Electrical Energy	-

Table 3. Continued

Subject Domain	Unit	Topic	HSE Question Number
Matter and its Nature	Matter and Industry	Periodic System	15
		Physical and Chemical Changes	16
		Chemical Reactions	16
		Acids and Bases	17
		Interaction of Heat with Matter	18-19-20
		Chemical Industry in Turkey	-

According to Table 3, the objectives for 14 of HSE Science questions (1, 3, 4, 5, 6, 7, 8, 11, 12, 13, 15, 16, 17, and 20) were compatible with the objectives at the 8th grade level of SCC. However, the objectives of HSE Science questions 2, 9, 10, and 14 were not included at the SCC 8th grade level. When the curriculum was examined, it was determined that the objectives in questions 2 and 9 were taken to the 7th grade level, the objectives in question 10 were taken to the 6th grade level and the objectives in question 14 were taken to the 5th grade level. It was also noticed that some of the objectives that HSE Science 14, 18, and 19 questions intended to measure were removed from SCC.

Results on TIMSS and HSE 8th Grade Science Objectives

In this section, the objectives of 2018 HSE Science exam questions were compared with 2015 TIMSS 8th Grade Science objectives. As a result of the analyses, it was determined that TIMSS Science objectives were not compatible with the objectives in four of HSE questions (6, 11, 12 and 13), were partially compatible with the objectives of 12 of them (1, 2, 3, 7, 8, 10, 14, 15, 17, 18, 19 and 20) and fully compatible with the objectives in only four questions (4, 5, 9 and 16). There were no TIMSS questions that matched with some HSE questions about biotechnology applications, electrification, electrical charges, and electroscopes. Heredity, photosynthesis, food chain and chemical reactions were among the subjects that were compatible with the HSE and TIMSS questions. In other subjects (earthquakes, simple machines, climate changes, heat, sound, periodic system, states changes of matter, etc.), partial matching was observed in the objectives of HSE and TIMSS questions. The examples of some matches are presented in Table 4.

Table 4. Examples of matches related to HSE and TIMSS Science objectives

	HSE Objective	TIMSS Objective
Question 1	explain the concepts of nucleotide, gene, DNA and chromosome and establishes a relationship between these concepts	relate the inheritance of traits to organisms passing on genetic material to their offspring
	show the structure of DNA on the model and expresses how the DNA matches itself	-
Question 4	comprehend the relationship between producer-consumer-decomposer in food chain and give examples	identify and provide examples of producers, consumers, and decomposers
	comprehend the importance of photosynthesis in food production and explain how photosynthesis occurs	describe or model the basic process of photosynthesis (requires light, carbon-dioxide, water, and chlorophyll; produces food; and releases oxygen)
Question 6	discuss the positive and negative effects of current biotechnology applications by using research data	-
	research and report on the development of biotechnology applications from past to present	-

When the questions were analyzed in general, it was observed that a total of 44 objectives of the 2018 HSE 8th grade Science questions matched with 18 of the 2015 TIMSS objectives. Therefore, it can be said that 2018 HSE Science objectives and 2015 TIMSS Science objectives were partially compatible at the 8th grade level.

Results on the Analysis of TIMSS, HSE and SCC in terms of their Units and Objectives

When the 2015 TIMSS, 2018 HSE and 2018 SCC objectives were compared, the distributions of the objectives for each of them according to the subject/content domains are presented in Figure 1.

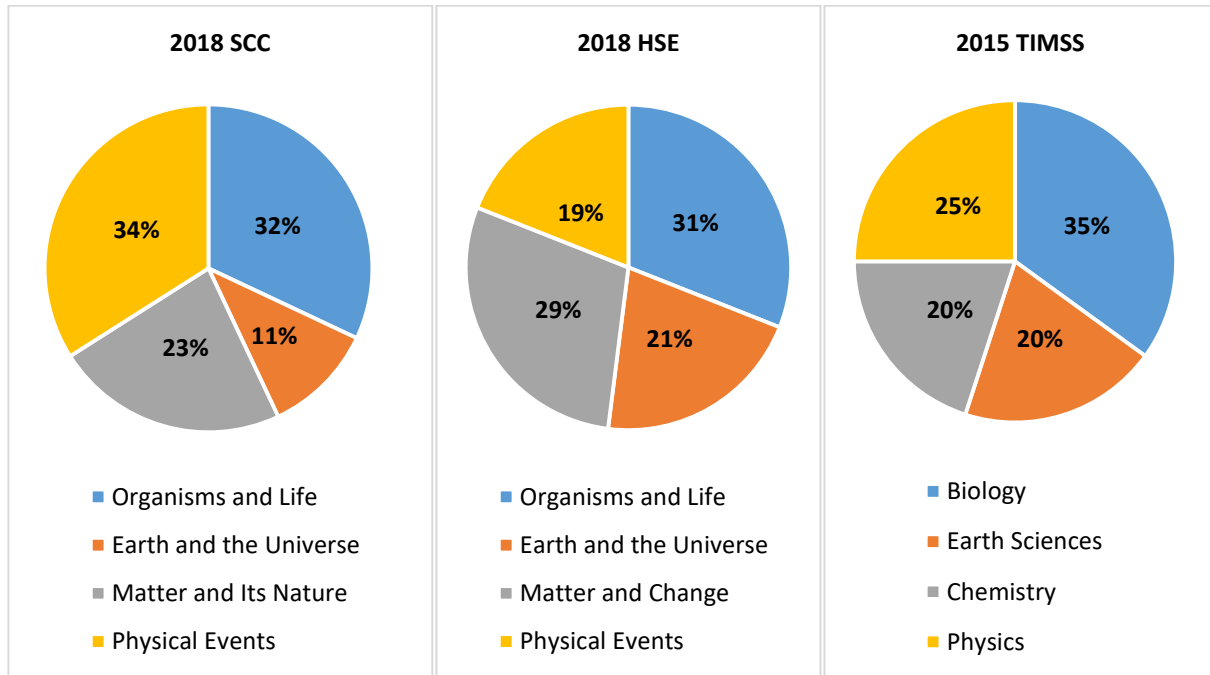


Figure 1. Distributions of SCC, HSE, and TIMSS objectives according to the content domains

There were 223 objectives in SCC, 78 objectives in HSE and 119 objectives in TIMSS for all content domains. TIMSS includes the "Biology" content domain in return for the "Organisms and Life" content domains in SCC and HSE; the "Earth Sciences" content domain in return for the "Earth and the Universe" content domains in SCC and HSE; the "Chemistry" content domain in return for the "Matter and its Nature" content domain in SCC and the "Matter and Change" content domain in HSE; the "Physics" content domain in return for the "Physical Events" content domains in SCC and HSE. When Figure 1 was examined, there were higher objectives related to Matter and Change domain in HSE, Biology domain in TIMSS, and Physical Events domain in SCC compared to others. In fact, the objectives in SCC and HSE included the objectives belonging to the same content domains. However, it was also determined that some objectives in TIMSS Earth Sciences content domain matched with the objectives in the Organisms and Life, Physical Events or Matter and its Nature domains in SCC.

Results on the Analysis of HSE Science Questions and SCC Objectives in terms of TIMSS Cognitive Domains

Analysis of HSE Science Questions According to TIMSS Cognitive Domains

The comparative analysis of 2015 TIMSS and 2018 HSE questions according to TIMSS cognitive domains is presented in Figure 2.

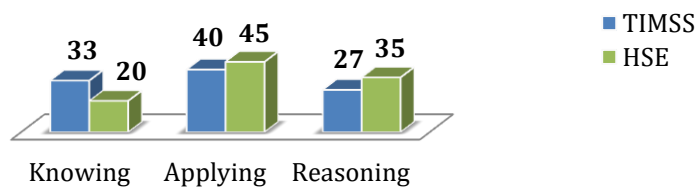


Figure 2. Distribution of TIMSS and HSE examination questions according to TIMSS cognitive domain levels (%)

When the data were analyzed within the scope of TIMSS cognitive domains, it was observed that 33%, 40% and 27% of TIMSS 8th grade Science questions consisted of the questions at the levels of "knowing," "applying" and "reasoning," respectively. It was determined that 20%, 45% and 35% of HSE 8th grade Science questions consisted of the questions at the levels of knowing, applying and reasoning, respectively. It was observed that the ratio of questions in the knowing cognitive domain was higher in the TIMSS examination compared to the HSE examination, however, the ratio of questions in the applying and reasoning cognitive domains was higher in the HSE examination compared to the TIMSS examination. Therefore, HSE appears as an examination which includes the questions that measure higher-level cognitive skills compared to TIMSS.

Analysis of SCC Objectives According to TIMSS Cognitive Domains

The distribution of the objectives of subject domains determined in 2018 SCC according to TIMSS cognitive domains is presented in Figure 3.

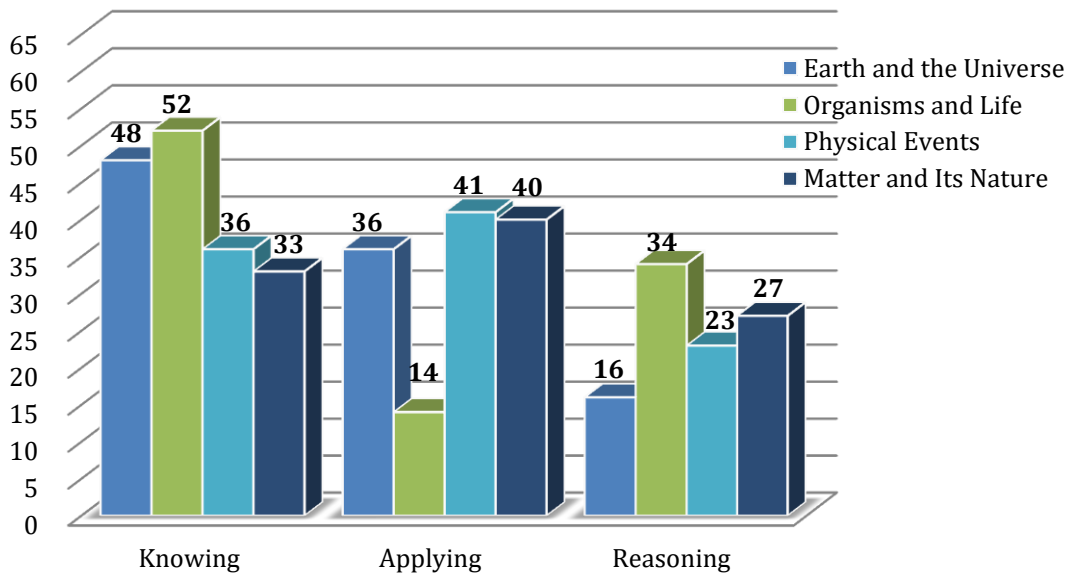


Figure 3. Distribution of the objectives in SCC subject domains according to TIMSS cognitive domains (%)

When Figure 3 was examined, it was observed that the objectives at the cognitive domain levels of knowing and reasoning were mostly included in the "Organisms and Life" subject domain, the objectives at the cognitive domain level of applying were mostly included in the "Physical Events" subject domain. When the subject domains were examined in general, the objectives were observed to be intensive in the knowing cognitive domain. It was observed that the objectives at the applying cognitive level had close percentages in the "Physical Events", "Matter and its Nature" and "Earth and Universe" subject domains, however, these were minimum in the "Organisms and Life" subject domain. At the reasoning level, it was observed that the maximum objective was in the "Organisms and Life" subject domain. The objectives in the "Physical Events" and "Matter and its Nature" subject domains were close to each other at reasoning level, however, the number of objectives in the "Earth and Universe" subject domain was quite small compared to other subject domains.

The distribution of the objectives at each grade level in the 2018 SCC according to TIMSS cognitive domains is presented in Figure 4.

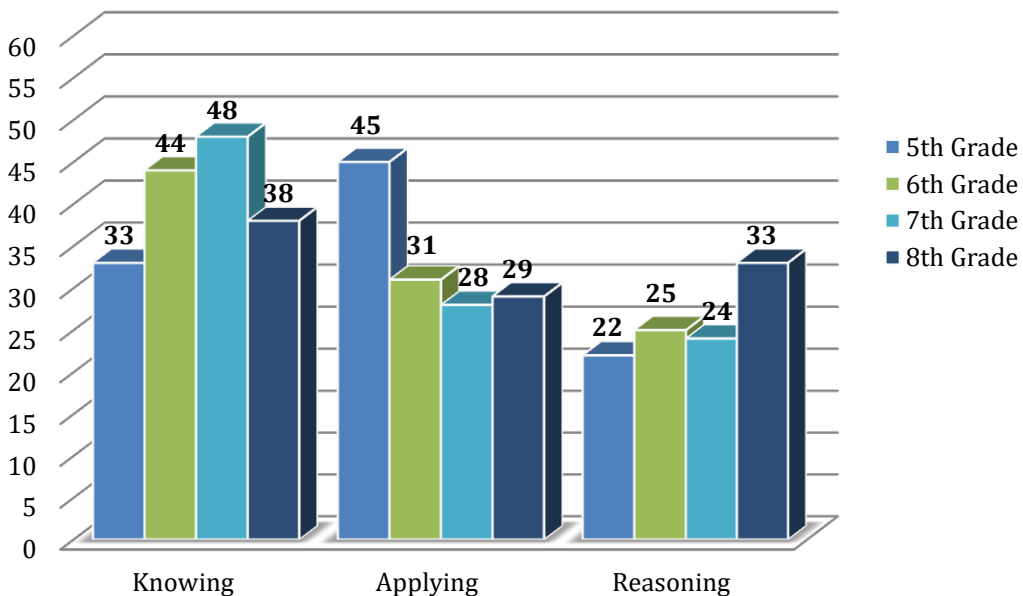


Figure 4. Distribution of the objectives in the SCC grade levels according to TIMSS cognitive domains (%)

When Figure 5 was examined, it was determined that the objectives representing the knowing cognitive level were maximum (48%) and minimum (33%) at the 7th grade and 5th grade, respectively, the objectives representing the applying cognitive level were maximum (45%) and minimum (28%) at the 5th grade and 7th grade, respectively, and the objectives representing the reasoning cognitive level were maximum (33%) and minimum (22%) at the 8th grade and 5th grade, respectively

Discussion and Conclusion

TIMSS and SCC Science Objectives

For the first sub-problem of the study, 2015 TIMSS 8th grade Science objectives and the 2018 SCC objectives were comparatively examined. With respect to this sub-problem, the objectives within the scope of the TIMSS Science content domains and SCC subject domains were examined in detail. When the data were analyzed, it was observed that the majority of TIMSS 8th grade Science objectives (excluding some objectives of Earth Sciences) matched with the objectives of SCC at different grade levels. When only the 8th grade level was examined, it was observed that SCC objectives did not match well with the TIMSS objectives. Boyuk (2017) reached similar results in his study comparing the objectives of 2013 SCC and 2015 TIMSS. However, it appeared that the 5th, 6th and 7th grade objectives were also important when it was considered that the TIMSS examination was held at the 4th and 8th grade levels and that the TIMSS examination measured not only the 8th grade but also the process. The repetition of the objectives at different subject and grade levels and the learning that need to be acquired holistically were included in the SCC (MoNE, 2018). It also indicates that the 5th, 6th and 7th grade knowledge constitutes the basis for the 8th grade. In conclusion, it can be said that similar approaches were used to determine the subjects and objectives in the SCC and 2015 TIMSS. It can be said that the 5th, 6th and 7th grade objectives in the SCC corresponded to TIMSS Science objectives, and thus, the SCC and TIMSS objectives were compatible with each other.

The fact that our students' success score in the TIMSS examinations is below the average or low also reveals the functionality of the curriculum, which leads to the questioning of the reasons for failure in examinations held in the international level despite the SCC which is prepared in a spiral structure and includes the objectives repeated at different subject and grade levels. According to Aslan (2005), one of the reasons for failure is that the subjects in the SCC are used as purposes, not as tools.

The students in Turkey had the highest success in the Physics content domain and the lowest success in the Earth Sciences content domain at the 2015 TIMSS 8th grade level (Yildirim et al., 2016). Abazaoglu, Yildizhan and Yildirim (2014) determined according to TIMSS 2011 data that the highest failure was in the content domains of Chemistry and Earth Sciences while Turkoguz, Balim, and Bardakci (2019) determined that students were mostly unsuccessful in the content domains of Physics and Earth Sciences at the 2011 TIMSS. In this study, it was also determined that the objectives of these two content domains (Physics and Earth Sciences) matched with the SCC objectives at a lower ratio compared to others. The researchers stated that the reason for low level of success in the Earth Sciences content domain was its place at the very end of the curriculum (Cakmak, 2019) and the problems experienced in learning due to students' inability to focus their attention in the periods during which the weather is hot and that are close to the closure of schools (Coruhlu & Cepni, 2015). The negative effects of environmental factors on learning were also stated by Seven and Engin (2008) in their study. By considering all these factors, Earth Sciences subjects were included in the first unit in 2018 SCC and it was emphasized that this change in the curriculum was positive (Akoglu, 2011). According to Turkoguz et al. (2019), the reason for failure in the physics content domain was that the concepts of physics were difficult and abstract. Furthermore, there researchers emphasized the effect of question type on student success and indicated that TIMSS included both open-ended and multiple-choice questions and students were able to answer open-ended Physics and Earth Sciences questions but they had difficulty in answering multiple choice tests.

Curricula are effective on student achievement, which also shows us that the results obtained from the examinations affect the changes in curricula. When the 2015 TIMSS 4th and 8th Science results were compared, it was observed that the success at the 8th grade level was higher. Buyukozturk, Cakan, Tan, & Atar (2014) indicated that it was due to the fact that 8th grade students prepared for HSEs. Since the subjects in SCC have a spiral structure, the students preparing for these examinations are expected to have the knowledge of 5th, 6th and 7th grade subjects. Karaman and Karaman (2016) emphasized that it was positive that previous learning supports new learning. Therefore, the fact that the TIMSS 8th grade Science objectives are compatible with the 5th, 6th and 7th grade objectives in SCC appears as a natural consequence. All these factors explain higher success in the TIMSS 8th grade Science test and the compatibility of SCC and TIMSS 8th grade objectives.

HSE and SCC 8th grade Science Objectives

The second sub-problem of the study was the comparison of the objectives of the 2018 HSE Science questions and the 2018 SCC 8th grade Science objectives. As a result of the analysis performed for this sub-problem, it was determined that some objectives at the SCC 8th grade level were removed compared to the previous curriculum, and some of them were taken from 8th grade level to other grade levels. It can be said that there was a decrease in number of objectives at the SCC 8th grade level due to the fact that some objectives of different subject domains were removed, the curriculum was made more simplified and/or some objectives were taken to other grade levels. Therefore, it was concluded that the curriculum did not meet the objectives of some HSE questions due to the changes in SCC, however, HSE Science questions and SCC 8th grade Science objectives were generally compatible with each other.

Some researchers (Ciray, Kucukyilmaz, & Guven, 2015; Karaman & Karaman, 2016) stated that reducing the number of objectives was one of the positive aspects of the curriculum. Furthermore, it was stated that the removal of some

subjects from the curriculum, the change of the grade level and the addition of some concepts to the curriculum were positive and appropriate decisions in view of the levels of students (Akyurek & Afacan, 2013; Ciray et al., 2015; Duman & Avci, 2016; Gunes & Gunes, 2005; Kirindi & Ulu, 2017). However, Ozcan & Duzgunoglu (2017) stated that reducing the limitations in the SCC with objectives may pose problems in practice.

2018 SCC has Science, Engineering and Entrepreneurship applications, which also supports students' learning by doing and the development of their skills to solve the problems they face in daily life. In their studies, some researchers (Deveci, Konus & Aydiz, 2018; Kirindi & Ulu, 2017; Ural-Keles, 2018) concluded that learning by doing and experiencing supports the development of problem solving skills. The raising of individuals with life, engineering and design and scientific process skills also ensures the raising of individuals who can use their high level cognitive skills, which will also positively affect the success to be achieved in international examinations such as TIMSS and PISA that include the questions measuring high level cognitive skills, and in national examinations such as HSE (Ural-Keles 2018). Engineering and Design skills included in SCC brought STEM approach into the forefront. Engineering and Design skills are considered as a reflection of STEM education and many studies have begun to be carried out in this field in recent years. In those studies, researchers indicated that the reflection of STEM education on the curriculum was an important and appropriate development (Baran, Canbazoglu-Bilici & Mesutoglu, 2015; Eroglu & Bektas, 2016; Karahan, Canbazoglu-Bilici & Unal, 2015; Yildirim & Altun, 2015). However, Colak (2017) stated that due to the decrease in mathematical connections in SCC, the relationship between Science and Mathematics would decrease and this would also have a negative effect on STEM applications. The HSE examination, which is important in terms of revealing the effectiveness of the curriculum, needs to be compatible with the curriculum to be able to achieve the objectives specified in the curriculum. For the development of Engineering and Design skills which are among the prominent skills in the curriculum, it is important that the examples of STEM implementation are included in the curriculum, and that the HSE involves questions to measure these skills.

According to MoNE, various and flexible assessment and evaluation approaches (process-based, alternative assessment and evaluation approaches/techniques etc.) are used in SCC (MoNE, 2018). However, some researchers stated that the assessment and evaluation dimension of the curriculum was similar to the 2013 SCC and needed to be improved (Ciray et al., 2015; Gomleksiz & Bulut, 2006). The TIMSS examination includes multiple choice and open-ended questions at different cognitive levels. However, there are only multiple choice questions in the HSE-type examinations. This factor also affects the success gained in international examinations. There are researchers who supported this situation and indicated that the required efficiency could not be achieved due to the problems experienced in using and applying the assessment and evaluation tools (Buyuktokatli & Bayraktar, 2014; Gomleksiz & Bulut, 2007). It is quite important that the HSE, which is a national examination which measures the effectiveness of the curriculum, is also compatible with the curriculum, and in this context, the assessment and evaluation approaches applied in the examination should be reviewed and developed.

TIMSS and HSE 8th grade Science Objectives

The third sub-problem of the study was the analysis of the objectives measured by 2018 HSE and 2015 TIMSS 8th grade Science questions. As a result of the analysis performed, it was determined that the TIMSS Science objectives were not compatible with the objectives in 4 questions in the HSE 8th grade Science test, were not fully compatible with, in other words, were partially compatible with the objectives in 12 questions and were fully compatible with the objectives in only 4 questions. TIMSS included a total of 119 science objectives. However, only 18 of these objectives matched with some objectives of the HSE questions, indicating that there were differences in terms of content between TIMSS and HSE. It is considered that it was due to the fact that the objectives in the HSE examination only measured the objectives at the 8th grade level while the objectives in the TIMSS Science examination measured the objectives at the 5th, 6th, 7th and 8th grade levels. Similarly, in the study carried out by Baysura (2017) and Boyuk (2017) to compare the questions of TBSE and 2015 TIMSS examination, they concluded that TIMSS 8th grade objectives could not meet the questions of TBSE, which may be due to the fact that the subjects included in the TIMSS belonged to the 5th, 6th, 7th and 8th grade levels. Furthermore, Science objectives/contents in the TIMSS examination are determined by receiving the opinions of experts in the countries that will take this examination. It is considered that this situation may arise due to the differences in the education systems and practices of the countries participating in this examination.

Although HSE is an examination which is held at the national level, TIMSS is performed at the international level. Students prepare for these examinations with the science curriculum in their countries, and therefore, it is important that the curricula should be updated to meet the needs in line with the developments and changes experienced. Our country has been participating in the TIMSS examination since 1999, and a number of arrangements can be made in the education system/curriculum in line with the results obtained. Since national examinations such as HSE are prepared in a way to include the objectives in the curriculum, it is considered that the examinations such as TIMSS and HSE, which can provide the evaluation or comparison of students' levels, are important to be compatible with each other in terms of the objectives they measure. Thus, the results to be obtained from an examination may ensure that the results to be obtained from another examination will be predicted.

Analysis of TIMSS, HSE, and SCC in terms of their Units and Objectives

The fourth sub-problem of the study was the comparative analysis of the units and objectives of 2018 SCC, 2018 HSE and 2015 TIMSS. It is remarkable that SCC had higher numbers of objectives of units compared to TIMSS. When HSE was examined in terms of unit and objective ratio, it was determined that the number of objectives was higher compared to TIMSS. It is considered the fact that the numbers of objectives of HSE and SCC were generally high compared to TIMSS may be due to the fact that the curriculum had a spiral structure and due to the objectives of the repeated subjects at certain grade levels.

In view of all results, although the numbers of units and objectives of the SCC were quantitatively higher than the subject domains and numbers of objectives of the 2015 TIMSS 8th grade Science, it was concluded that 2018 SCC met 2015 TIMSS 8th Grade Science subject domains in terms of content despite at different grade levels and with different names, in others words, 2018 SCC and 2015 TIMSS were compatible with each other in terms of content. There are also investigations carried out in the fields of Science and Mathematics supporting this result (Boyuk, 2017; Baysura, 2017).

It was observed that some of the units covering the HSE 8th grade Science questions were included at different grade levels in SCC and that some objectives and topics were removed. It was determined that the objectives of the units in HSE and SCC were compatible with the questions, despite these changes made in SCC.

The fact that the HSE examination measures the objectives in the curriculum is important so that the results obtained from this examination reveal the deficiencies in our education system. When it is considered that changes are made in the curricula in accordance with the results obtained in national and international examinations, it is important that the questions to be asked in the examinations meet the objectives in the curriculum. The results obtained from these examinations which are held at the national level enable us to predict the results to be obtained from international examinations. Therefore, the increase in success obtained from HSE examinations depends on the effective and efficient implementation of the curriculum, the elimination of problems encountered, and the assessment and evaluation of HSE questions to cover the objectives in the curriculum. Since the success obtained from the HSE examination will affect the success in international examinations such as TIMSS, attention should be paid to the preparation of HSE questions by considering this factor.

Since the results to be obtained from the HSE will also affect the international examinations, it is important that these examinations are compatible with the curriculum in terms of the objectives targeted to be measured. Therefore, while preparing the questions of HSE examination, the questions should be prepared by considering all grade levels, not just the 8th grade like TIMSS, which is also important for implementing the curriculum's spiral feature and repeating the subject covered at the lower grade at other grade levels by expanding. Furthermore, it is also important in terms of increasing both the achievement at the 8th grade level and the achievement at the 4th grade level and enabling students to focus not only on the examination but also on the process.

*Analysis of HSE Science Questions and SCC Objectives in terms of TIMSS Cognitive Domains**HSE Questions in terms of TIMSS Cognitive Domains*

The fifth sub-problem of the study was the analysis of HSE and SCC objectives in terms of TIMSS cognitive domains. It was concluded that 2018 HSE Science questions were at the applying level by 45% and at the reasoning level by 35%, 2015 TIMSS 8th grade Science questions were at the applying and reasoning levels by 40% and 27%, respectively, and that HSE and TIMSS Science questions were similar in terms of cognitive level. Similarly, in the study carried out in 1998-2000 in which Cepni et al. (2001) analyzed the HSE Science questions according to Bloom's taxonomy, it was concluded that HSE Science questions measured high level skills such as analysis, synthesis and evaluation. Baysura (2017) determined that the cognitive domain levels of TIMSS and TBSE Math questions were compatible with each other. However, when the studies in which the previous HSEs were analyzed in terms of cognitive level by some researchers were examined, it was observed that the questions were generally at the knowing and applying levels, there were a small number of questions measuring high level skills, and there were differences between the questions and TIMSS from cognitive aspect (Afacan & Nuhoglu, 1999; Caliskan, Kahya, & Temli-Durmus, 2018). Nevertheless, changes were made in the High School Entrance System in 2018 and it was observed that the HSE 8th grade Science examination, which was implemented for the first time, was compatible with TIMSS questions in terms of cognitive levels. In this case, it is considered that the success to be obtained in the HSE examination will be reflected positively on international examinations such as TIMSS. When it is considered, it is important that the questions of HSE examination continue to be prepared to measure high level cognitive skills.

The students in Turkey have not been able to achieve the desired success in the TIMSS examinations so far. It is considered that one of the reasons for this situation may be the fact that the assessment and evaluation examinations that are implemented by teachers in schools and the questions in the course books do not measure the high level cognitive skills of students. The inclusion of questions in the course books that are used as supplementary books in courses, and the knowledge-based questions in the examinations implemented may lead students to memorize, and students may not be able to develop their skills such as problem solving/critical thinking due to low/insufficient

number of questions requiring high level cognitive skills and the lack of attention to this issue. Tokcan (2005) examined the questions in the 6th grade course books according to Bloom's cognitive domain taxonomy and found that 97% of the questions were at the level of knowledge and comprehension. Similarly, there are also researchers who analyzed the exam questions of teachers in different fields and the questions in course books from cognitive aspect and achieved similar results (Akpınar, 2003; Baysen, 2006; Delil, 2006).

To increase the success in the HSE examination also means increasing the success in the TIMSS examination. In recent years, the questions parallel to the cognitive level questions in the TIMSS examination have begun to be included both in the curriculum and in the books and examinations. Indeed, such questions were also included in the HSE examination. However, students prepare for the HSE examination with course books and their levels are measured with the examinations prepared by the teachers. Therefore, it is essential that the questions in the course books and the written exam questions applied by the teachers should measure the high level cognitive skills of the students.

SCC Objectives in terms of TIMSS Cognitive Domains

When SCC objectives were examined according to the cognitive levels defined in TIMSS, it was observed that the ratio at the knowing and reasoning cognitive domain levels was maximum in the "Organisms and Life" subject domain, and the ratio at the applying cognitive domain level was minimum in the "Physical Events" subject domain. When subject domains were examined in general, it was observed that percentage rates were intensive in the knowing cognitive domain. However, the ratios at the applying and reasoning levels were also too high to be ignored. When it is considered that more importance was given to some cognitive skills/levels depending on the features of different subject domains in SCC, these differences are the expected results. Similarly, Incikabi et al. (2016) analyzed the Mathematics curriculum in terms of TIMSS cognitive levels and reported that it was focused on some cognitive domains due to the nature of content domains.

It was observed that 26% of the objectives according to subject domains in SCC were intense at the reasoning level. 35% of HSE questions and 27% of TIMSS questions were also at the reasoning level. When it is considered that students prepare for national and international examinations such as HSE and TIMSS with the curriculum implemented in schools, the objectives in the curricula should be at cognitive levels to meet the objectives in the examinations. It is important to take it into consideration in the studies of updating the curricula.

When the distribution of cognitive levels according to grade levels was examined, it was observed that the objectives representing the knowing cognitive level were mostly included at the 7th grade by 48%, the applying cognitive level were included at the 5th grade by 45%, and the reasoning cognitive level were included at the 8th grade by 33%. The concentration of objectives of the applying cognitive domain at the 5th grade, and the objectives involving high level cognitive skills such as reasoning at the 8th grade level indicate that the grade level and the cognitive levels that students should have were taken into account. It was indicated by Lee, Kim, and Yoon (2015) that the objectives in the knowledge dimension and scientific process dimension should be further included at the lower grade levels compared to higher grade levels. Incikabi et al. (2016) examined the objectives in the mathematics curriculum from a cognitive perspective and stated that some objectives were included only at the 8th grade level since they had high level cognitive skills. Delil (2006) indicated that Bloom's cognitive domain taxonomy and TIMSS cognitive domain classification were parallel in terms of content. It is seen that importance is attached to high level cognitive skills in TIMSS and in the renewed Bloom taxonomy. Furthermore, the objectives in the curricula were also prepared by considering the renewed Bloom taxonomy. When all these are taken into consideration, the reason for cognitive differences at grade levels appears.

In their study, Zorluoglu, Sahinturk and Bagriyanik (2017) analyzed the 2013 SCC according to the renewed Bloom taxonomy, it was concluded that the objectives were at the comprehension level and that higher level cognitive skills were not included sufficiently. Dogan and Burak (2010) also reached the similar result in their study. Mayer (2002) reported that the implementation, in other words, the transfer of learned knowledge to new situations provided meaningful learning. Intense objectives of the knowing cognitive domain at all grade levels, in other words, the fact that there are high numbers of objectives with low level cognitive skills indicates that the objectives in the curriculum are insufficient with respect to contributing to raising individuals who produce information, transfer it to daily life, solve problems and think critically. In order to raise individuals with the characteristics specified in the curriculum, there should be objectives and activities that will provide them with the acquisition of high level cognitive skills (Aydin & Yilmaz 2010; Cepni et al., 2001; Eroglu & Kuzu; Senemoglu, 2001; Zorluoglu, Kizilaslan, & Sozbilir, 2016). As it is stated in the renewed Science curriculum, it is attempted to ensure that students reach the information by providing them with cognitive skills, instead of transferring information to them. In their studies, researchers (Baysen, 2006; Dindar & Demir, 2006; Gunduz, 2009) also remarked the importance of this point. Therefore, it is important that grade levels and the cognitive characteristics that students should have are considered in the determination of objectives, and they should be determined in a way to ensure that they acquire high level cognitive skills in order to achieve these objectives in the curricula.

Suggestions

In this study, the objectives of the 2018 SCC and 2018 HSE questions were analyzed within the scope of 2015 TIMSS framework. The results obtained from the examinations such as HSE at the national level and TIMSS at the international level were shown as one of the reasons for updating the SCC, which was renewed in 2017 and implemented at the 5th grade level and then began to be implemented at all grade levels in 2018. Furthermore, when it is considered that students prepare for these examinations with the curricula in schools, the importance of the relationship between SCC and these examinations comes into view. The results obtained from these examinations are also important in terms of revealing the effectiveness of the curriculum and the reflection of its effects on the curriculum. When the relevant literature was reviewed, it was determined that there were very few numbers of such studies carried out in the field of Science. Therefore, this study is important with respect to guiding future studies to be carried out in this field. Based on the results obtained as a result of the study, the following suggestions can be offered by considering that the study was carried out only on the basis of the published sample Science questions of TIMSS and HSE Science:

- It can be ensured that the extent to which these examinations applied each year match the target percentages is monitored by determining a framework, like in TIMSS, related to the distribution of the questions to be asked in the HSEs for cognitive domains.
- It is possible to provide an opportunity to make comparisons with international examinations more properly by making HSE examinations more compatible with the learning and teaching approaches emphasized in the curricula and the assessment and evaluation methods.
- This study was carried out only at the secondary school level. TIMSS examinations are taken by both 8th graders and 4th graders. Therefore, this study can be carried out at the primary school level because the students who take the examination at the 4th grade level become 8th grader after four years. This is important for assessing the process and observing the shortcomings.
- The study was analyzed only within the framework of 2015 TIMSS, 2018 HSE and 2018 SCC. The examinations to be held in the future can be analyzed within the framework of SCC and can be examined for compatibility. Thus, the functionality and currency of the curriculum can be revealed by determining the level of compatibility.
- In the study, HSE and TIMSS Science questions were comparatively analyzed. Since the achievement in the HSE examination also reflects the achievement at the international arena, it is important to examine the compatibility of both examinations. Therefore, TIMSS examinations that are held in every four years and the HSE examinations that are held every year can be discussed, and comparison studies can be carried out in the following years.

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