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A Comparison of High School Mathematics Curriculum Documents: 2005-2011-2013-2018

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Abstract

Curriculums are updated according to the educational needs. In the Türkiye context, the high school mathematics curriculum was last updated in 2018. This study aims to compare high school mathematics curriculum documents in Türkiye since the 2005 reform in terms of basic elements of a curriculum (general objectives, content, learning-teaching processes, and assessment-evaluation approaches). In this qualitative study, which adopted a horizontal approach as one of the approaches of comparative studies, data were collected through documents. The data consist of official documents of the high school mathematics curriculums published in 2005, 2011, 2013, and 2018. Curriculum documents were analyzed based on general objectives, contents, learning-teaching processes, and assessment-evaluation approaches of the curriculums. Findings revealed similarities and differences between the basic components and the shortcomings of the curriculums. In particular, the changes in the number of learning objectives and accordingly in the contents were discussed. The pedagogical reasons underlying the radical changes regarding adding new content or removing some content may be a matter of curiosity. Curriculum developers are suggested to include the reasons for these changes.

Keywords: *Curriculum, curriculum evaluation, high school mathematics, mathematics education.*

Ortaöğretim Matematik Dersi Öğretim Programlarının Karşılaştırılması: 2005-2011-2013-2018

Öz

Öğretim programları eğitim ihtiyaçlarına göre güncellenirler. Türkiye bağlamında ortaöğretim matematik dersi öğretim programı en son 2018 yılında güncellenmiştir. Bu araştırmanın amacı 2005 reformundan günümüze Türkiye'deki ortaöğretim matematik dersi öğretim programlarının temel öğeler (genel amaçlar, içerik, öğrenme-öğretme süreçleri ve ölçme-değerlendirme yaklaşımları) açısından karşılaştırılmasıdır. Karşılaştırmalı eğitim yaklaşımlarından yatay yaklaşım benimsenen bu nitel çalışmada veriler dokümanlar aracığıyla toplanmıştır. Araştırmanın verilerini 2005, 2011, 2013 ve 2018 yıllarında güncellenen

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ortaöğretim matematik dersi öğretim programları oluşturmaktadır. Bu dokümanlar öğretim programlarının genel amaçları, içerikleri, öğrenme-öğretme süreçleri ve ölçme-değerlendirme yaklaşımlarına dayalı olarak analiz edilmiştir. Bulgular öğretim programlarının noksanlarını ve temel öğeleri arasındaki benzerlikleri ve farklılıkları ortaya koymuştur. Özellikle kazanım sayıları ve buna bağlı içeriklerdeki değişimler üzerinde tartışılmıştır. Programın içeriklerine eklemeler yapılması ya da bazı içeriklerin kaldırılması noktasında yapılan radikal değişikliklerin altında yatan pedagojik nedenler merak konusu olabilir. Öğretim programı geliştiricilere içeriklerdeki bu değişikliklerin nedenlerine yer vermeleri önerilmiştir.

Anahtar Kelimeler: *Matematik eğitimi, ortaöğretim matematik dersi, öğretim programı, program değerlendirme.*

Introduction

Detailed planning of teaching activities including learning-teaching processes constitutes a curriculum (Baki, 2015; Su, 2012). More generally, the curriculum is defined as “the framework of basic knowledge and skills targeted for the students under the guidance of teachers” (Ministry of National Education [MoNE], 2017, p. 3). Countries prepare curriculums according to what kind of education they aim for their citizens for the future (Korkmaz, 2017). In Türkiye, the Ministry of National Education [MoNE] Board of Education and Discipline prepares the curriculum documents based on “General Objectives of Turkish National Education” and “Basic Principles of Turkish National Education” (MoNE, 2005, 2011, 2013, 2018). Updates of curriculum documents have been the focus of educational reforms to improve students’ learning experiences and achievements (Li & Lappan, 2014). Dynamic structure of curriculum (Diker-Coşkun, 2017; Oliver et al., 2008) is updated and renewed in the light of advancements in science to respond to the changing needs of the individuals and the society (MoNE, 2017). There had been education reform movements between 2004 and 2005 and curriculums have been renewed in Türkiye (Akınoğlu, 2005). These renewal efforts turned into reform in 2005 in line with the changing educational philosophy of MoNE (MoNE, 2017). This reform aimed at a change in the focus, objectives, and content of the curriculum and a student-centered and constructivist approach (Bulut, 2007). For assessment and evaluation, a process-oriented approach was adopted instead of an outcome-oriented one (Ünal & Ünal, 2010). High school mathematics curriculums have been updated in 2005, 2011 (a revised version of 2005), 2013, and 2018 after the reform movements in 2005.

Statement of the Problem

Studies compare high school mathematics curriculums of different countries (Ibrahim & Othman, 2010; Karuku & Tennant, 2016; Meleta & Zhang, 2017; Ssebaggala, 2017). Similarly, there are also studies which compared primary school mathematics curriculums (Bal-İncebacak, 2022; Çoban & Aşçı, 2022; Koç, 2019) and secondary school mathematics curriculums (Güzel, Karataş, & Çetinkaya, 2010; Öztürk & Diker-Coşkun, 2022) in Türkiye with the curriculums of other countries. Besides, some of the studies compared the current and past mathematics curriculums in Türkiye at the elementary level (Albayrak, 2017; Baş, 2017; Gökbulut & Aslan, 2017; Özmantar & Öztürk, 2016), secondary level (Beyendi, 2018; İlhan & Aslaner, 2019; Özmantar, Akkoç, Kuşdemir-Kayıran, & Özyurt, 2018; Şen, 2017), and high-school level (Çiğdem, 2022; Özşentürk-Balçın, 2021; Yazıcılar & Bümen, 2017). Furthermore, some of the studies examined elementary mathematics curriculums (Işık & Kar, 2012), secondary mathematics curriculums (Tekalmaz, 2019), and secondary geometry curriculums (Cansız-Aktaş, 2013) in the light of teachers' opinions. Apart from these, some studies examined the learning objectives in primary school mathematics curriculum (Aktan, 2020), secondary school mathematics curriculum (Çelik, Kul, & Çalık-Uzun, 2018), and high school curriculum (Çil, Kuzu, & Şimşek, 2019) according to the renewed Bloom Taxonomy. Considering the importance of mathematics as a subject at the high school level, there is a need for further comparative research regarding the high school mathematics curriculums. Comparative education studies on the high school mathematics curriculum in Türkiye are not sufficient in number and future research studies are needed (Güzel et al., 2010).

The current study aims to contribute to both mathematics education and curriculum evaluation literature. Research studies focusing on the examination and comparison of current and previous curriculums can contribute to curriculum development studies (Sezgin-Memnun, 2013). Such comparison studies guide researchers to reveal the changes in the curriculum documents and the trends in these changes. In addition, discussion of these changes might be beneficial for program developers. Ghonoodi and Salimi (2011) explained the components of the curriculum as follows.

> "Curriculum is made up of elements which their appropriate coordination would guarantee the success of a curriculum. There is no consensus between the experts on elements of curriculum, but the most four common points of view concerning this issue are: objective, content, method and evaluation" (Ghonoodi & Salimi, 2011, p. 69).

This study aims to compare high school mathematics curriculums in Türkiye since 2005 reform in terms of basic elements of a curriculum as mentioned above. The problem statement of the study is "How did the high school mathematics curriculums change since the 2005 reform?" The sub-problems are as follows:

For the high school mathematics curriculums published in 2005, 2011, 2013 and 2018:

- How are the general objectives different?
- How are the contents different?
- How are the teaching-learning processes different?
- How are the assessment and evaluation approaches different?

Theoretical Framework of the Study

Curriculum evaluation is the process of making scientific decisions about factors such as the suitability, efficiency, and success of an existing curriculum (Hamilton, 1977; Uşun, 2012). There are different curriculum evaluation approaches in the literature (Bennett, 1979; Kirkpatrick, 1983; Stake, 1975; Tyler, 1949). One of them is Bloom's evaluation model based on the elements of a curriculum. The main elements of a curriculum are objectives, content, learning-teaching processes, and assessment and evaluation (Ghonoodi & Salimi, 2011; Gürkan, 2000; Moss, 2019; Özyurt & Kuşdemir-Kayıran, 2018; Sünbül, 2011; Uşun, 2012). In this model based on the elements of a curriculum, the curriculum is evaluated separately for each of these elements. In this study, the curriculum documents were evaluated based on the basic elements as in the book titled "Secondary school mathematics curriculums: A historical study" edited by Özmantar, Akkoç, Kuşdemir-Kayıran, and Özyurt (2018). Doğanay and Yeşilpınar's (2018) chapter was used to compare the general objectives of the curriculums and Şeker's (2018) and Kömleksiz and Gökmenoğlu's (2018) chapters were used to compare the learning-teaching processes, and Akbaş, Gürkan, and Büyüköztürk's (2018) chapter was used to compare assessment and evaluation approaches of the curriculums.

Objectives are determined by searching for an answer to the question "Why should we teach?" (Baki, 2015, p. 359). The objectives of a curriculum can be classified vertically and horizontally (Oliver et al., 2008; Özyurt & Kuşdemir-Kayıran, 2018). In the vertical classification, objectives are classified as distant objectives: general objectives, and specific objectives (Korkmaz, 2017; Özyurt & Kuşdemir-Kayıran, 2018; Sözer, 2000; Sünbül, 2011). Distant objectives consist of very general expressions that include objectives such as the civilization level of society and ideal human qualities (Sözer, 2000). General objectives are determined for the education levels and school types (Sünbül, 2011). Specific objectives, on the other hand, refer to the targeted developments specific to the subject or unit for teaching a course or a unit (Sözer, 2000; Sünbül, 2011). The most familiar horizontal classification consists of the *cognitive*, *affective*, and *psychomotor* learning domains of Bloom taxonomy (Bloom, Englehart, Furst, Hill, & Krathwohl, 1956). The *cognitive* domain is concerned with cognitive skills such as knowledge, reasoning, analysis, and synthesis (Bloom et al., 1956); *affective* domain with affective skills such as views, attitudes, and beliefs (Krathwohl, Bloom, & Masia, 1964), and the *psychomotor* domain with co-ordinated mind-muscle skills (Harrow, 1972; Simpson, 1966).

The content of mathematics curriculums is determined so that students will develop mathematical competencies and skills in line with curriculum objectives. One of the main components that directly affect learning is content (Karataş-Coşkun, 2017). The most important thing to consider when preparing or organizing content is objectives (Doğanay & Sarı, 2017). Besides, the content of the curriculum is organized by considering the students' interests, expectations, and plans (Diker-Coşkun, 2017). To reach the objectives of the curriculum, the answer to the question "What should we teach?" is sought (Gürkan, 2000, p. 17). In addition, the curriculum contents were prepared in accordance with the criteria of "validity and reliability", "scientificness", "being interesting", "usefulness", "learnability", "consistency with social facts", "compliance with objectives", and "applicability" (Baki, 2015, p. 364-365). In the curriculum where important ideas are effectively organized and integrated, the content to be learned should be well sequenced (National Council of Teachers of Mathematics [NCTM], 2000). The curriculum of a course consists of learning domains, sub-learning domains (units), and topics that constitute the lesson within a hierarchy, integrity, and continuity. Learning objectives are expressions describing the qualification, skill, or competency of students related to *cognitive*, *affective*, or *psychomotor* learning domains at the end of a sub-learning domain, a learning domain, or a semester (Diker-Coşkun, 2017).

In the learning-teaching process, the answer to the question "How should we teach?" is sought. This element describes how the content should be prepared for students to help them reach target behaviors (Gürkan, 2000). It also describes which teaching strategies, methods, and techniques will be used by considering the teaching principles. Teaching activities are organized based on the principles such as *clarity, meaningfulness, from simple to complex, guaranteeing knowledge and skills, from the known to the unknown, integrity, economics, active participation (activity), actuality, appropriateness to the purpose, student-appropriateness, spirality, from concrete to abstract, sociability, transfer, deduction, from close to remote, and proximity to life* (Aggarwal, 2014; Baki, 2015; Ergün & Özdaş, 1997; Harden & Stamper, 1999; Köksal & Atalay, 2017; Sözer, 2000; Sünbül, 2011; Taşkaya & Gül, 2020; Wu, Koçoğlu, & Akman, 2017). To mention briefly; the principle of *clarity* is concerned with facilitating learning by addressing different senses of students in the process of learning and teaching (Sözer, 2000). It is adherence to the principle of *meaningfulness* that the teacher arouses curiosity at the beginning of a lesson by saying that the subject is useful and necessary for students. The arrangement of content from easy to difficult is required by the principle of *from simple to complex* (Köksal & Atalay, 2017). The principle of *guaranteeing knowledge and skills* is concerned with teaching and repeating unchanged, universal, objective, and permanent information (Ergün & Özdaş, 1997; Köksal & Atalay, 2017). The principle *from the known to the unknown* is to connect newly learned information with existing prior knowledge in the learning-teaching process (Baki, 2015; Wu et al., 2017). The fact that the knowledge learned is a meaningful whole and the development of all aspects concerning students is the principle of *integrity* (Sünbül, 2011; Wu et al., 2017). Planning educational activities in a way that will help achieve the most objectives in the least time is an indicator of the principle of *economics* (Köksal & Atalay, 2017; Wu et al., 2017). *Active participation* or *activity* principle is to ensure that students actively participate in activities in the teaching-learning process (Sünbül, 2011). The fact that the elements of the curriculum are prepared according to the current changes is the requirements of the *actuality* principle. For the principle of *appropriateness to the purpose*, the teaching-learning process is designed in a way to reach the objectives of the course (Köksal & Atalay, 2017). In the *student-appropriateness* principle, the elements of the curriculum are prepared according to students (Ergün & Özdaş, 1997). The *spiral* curriculum is a curriculum in which subjects, units or learning areas are repeated iteratively throughout the course (Harden & Stamper, 1999). Reaching abstract thoughts from concrete objects or materials is the basis of the principle of *from* *concrete to abstract* (Baki, 2015). In the principle of *sociability*, the student is both expected to obey authority and to take decisions freely (Ergün & Özdaş, 1997; Köksal & Atalay, 2017). For the *transfer* principle, the newly learned knowledge is used in different situations or in other disciplines (Sünbül, 2011). The *deduction* principle is concerned with the way content is organized from general to specific (Köksal & Atalay, 2017). The principle of *from close to remote* is the order of the topics from the near to the more distant environment both timewise and spatially (Sözer, 2000). Relating topics and activities to daily life is a condition for the principle of *proximity to life* (Sünbül, 2011).

The last element, assessment and evaluation, search for answers to the question "What and how much has been achieved" (Özyurt & Kuşdemir-Kayıran, 2018, p. 8). There are three purposes of assessment and evaluation: *diagnostic*, *formative*, and *summative* (Driscoll et al., 1998). A *diagnostic* assessment aims to diagnose student' readiness and pre-knowledge at the beginning of curriculum implementation. *Formative* assessment is used to determine and eliminate student difficulties in the implementation process of a curriculum. The *summative* assessment aims to evaluate the level of achievement of students (Demirel, 1998; Driscoll et al., 1998).

Method

This research is a comparative case study which is one of the qualitative research models. Comparative case studies are an effective qualitative tool for social research fields including education (Bartlett & Vavrus, 2017; Vavrus & Bartlett, 2009). In this qualitative research, the horizontal approach, one of the comparative education approaches, has been adopted (Bartlett & Vavrus, 2017; Ültanır, 2000; Vavrus & Bartlett, 2009). In the horizontal approach, the basic elements of the national curriculums are examined separately (Vavrus & Bartlett, 2009; Yıldırım & Türkoğlu, 2018). In this research, Türkiye's 2005, 2011, 2013, and 2018 high school mathematics curriculums were compared. The basic elements discussed were general objectives, content, learning-teaching processes, and assessment-evaluation approaches.

Data Collection Tools and Process

The data were accessed through documents, as one of the qualitative data collection tools. Curriculums in Türkiye are prepared, updated, and renewed by the T.R. Ministry of National Education Board of Education and Discipline, "based on the 'General Objectives of Turkish National Education' and 'Basic Principles of Turkish National Education' expressed in Article 2 of the Basic Law of National Education numbered 1739", "in a way that complements each other at preschool, primary, and secondary education levels" (MoNE, 2018, p. 4). From the 2005 reform to the present the high school mathematics curriculums which were renewed and updated in 2005, 2011, 2013, and 2018 (MoNE, 2005, 2011, 2013, 2018) constitute the documents. The curriculum is among the documents that will be considered important in educational research (Mertens, 2010). The documents used as data collection tools in this research were selected by the criterion sampling method. In this method, which is one of the purposive sampling techniques, the pre-determined criteria are examined (Patton, 2001). The criteria set out here are high school mathematics curricula, which have been updated after the education reform in 2005 (Akınoğlu, 2005; MoNE, 2005, 2017) and are taught to high school students. The current curriculums examined were followed in Anatolian, Vocational and Technical, Fine Arts, and Sports High Schools (MoNE, 2018).

Analysis of Data

The data obtained from the documents mentioned above were analyzed by document analysis. Document analysis is the examination or evaluation of printed or electronic materials in a systematic procedure (Bowen, 2009). In this research, the stages of document analysis are: (a) accessing documents, (b) checking authenticity, (c) understanding documents, (d) analyzing data, and (d) using data (Forster, 1995; Yıldırım & Şimşek, 2016, p. 194-200). In the first stage, the documents were accessed from the official website of the Ministry of National Board of Education (Curriculums, n.d.) in different periods. In the process of understanding documents, these four curriculums were analyzed comparatively as a whole and in order (Yıldırım & Şimşek, 2016). In the process of analyzing the data, in line with the theoretical framework of the study, the general objectives, content, learning-teaching processes, and assessment-evaluation approaches of the curriculums were analyzed.

While analyzing the general objectives as part of the vertical classification, only the general objectives sections of the curriculums were examined. The items listed in the general objectives section were considered while performing the analysis. They were analyzed by descriptive analysis. The domains of Bloom Taxonomy (*cognitive, affective,* and *psychomotor*) were determined as the categories to be used for horizontal classification (Bloom et al., 1956).

The contents were analyzed in two components: (a) learning domains, (b) the number of learning objectives. The tables which consist of learning domains, the number of learning objectives, and the number of lessons devoted to them were considered at different grade levels. Learning domains and the number of learning objectives were analyzed by content analysis. Categories were determined and tables were prepared for the comparative analysis.

Learning-teaching processes were also analyzed in two components: (a) instructional principles, (b) teaching/learning strategies, methods, and techniques. Instructional principles were analyzed with descriptive analysis. The categories were created based on the most familiar instructional principles compiled from the literature. In this context, curriculums were analyzed based on the aforementioned principles such as *clarity, meaningfulness, from simple to complex, guaranteeing* *knowledge and skills, from the known to the unknown, integrity, economics, active participation (activity), actuality, appropriateness to the purpose, student-appropriateness, spirality, from concrete to abstract, sociability, transfer, deduction, from close to remote, proximity to life* (Aggarwal, 2014; Baki, 2015; Ergün & Özdaş, 1997; Harden & Stamper, 1999; Köksal & Atalay, 2017; Sözer, 2000; Sünbül, 2011; Taşkaya & Gül, 2020). In the curriculum texts, phrases, expressions, and sentences that directly refer to these principles were searched. Teaching/learning strategies, methods, and techniques were also analyzed with descriptive analysis. The whole curriculum text was considered. Only the words "instruction", "teaching", and "learning" which precede the word "strategy", "method", and "technique" were searched and it was made sure that these concepts express the concepts of teaching/learning strategies, methods, and techniques because these concepts can be used for different meanings or different descriptions in mathematics curriculums, apart from teaching-learning processes. Whether these concepts are included directly in the curriculums was identified through descriptive analysis.

We analyzed the purposes of assessment and evaluation approaches of the curriculum and which skill types were assessed. The categories of *diagnostic, formative,* and *summative* (Driscoll et al., 1998) have been adopted to analyze the purposes of assessment and evaluation. Categories of *cognitive*, *affective*, and *psychomotor* (Bloom et al., 1956) were used to analyze the skills. The assessment and evaluation tools and tasks that teachers can use in the lessons were analyzed with content analysis. The categories for these tools and tasks were determined.

The first author coded the categories for the components of curriculums. Then, for the reliability concerns, the second author checked the coding. The reliability level calculated by the formula "reliability = number of agreements / total number of agreements + disagreements" (Miles & Huberman, 1994, p. 64) was higher than 90%. Also, a consensus was reached by discussing the differences in coding. In this context, the curriculum documents were analyzed comparatively, and the following findings emerged. Findings are supported by quotes from the curriculum documents.

Findings

A Comparison of the General Objectives of the Curriculums

Table 1 presents a classification of fifteen goals in the 2005 curriculum and its revised version in 2011 according to the Bloom taxonomy (Bloom et al., 1956). As given in Table 1, eight out of the 15 objective statements refer to the *cognitive* domain, and seven of them refer to the *affective* domain, whereas none of them in the *psychomotor* domain.

Table 1.
Classification of General Objectives in 2005 and 2011 Curriculums Based on Bloom's Taxonomy (Bloom et al., 1956)

Using 2005 and 2011 mathematics curriculums, students will we able to	Cognitive	Affective	Psychomotor
Understand mathematical concepts and systems, establish relationships between them, use them in daily life and other learning domains	√		
Gain the mathematical knowledge and skills necessary for further education in mathematics or other fields	√		
Make inferences about induction and deduction	√		
Express their mathematical thinking and reasoning in the process of solving mathematical problems	√		
Use mathematical terminology and language correctly to explain and share their mathematical thoughts in a logical way	√		
Be able to use the skills of approximation and mental arithmetic effectively	√		
Develop problem-solving strategies and use them to solve problems in daily life	√		
Be able to establish models, to associate models with verbal and mathematical expressions	√		
Be able to develop a positive attitude towards mathematics, to have self-confidence		√	
Be able to appreciate the power of mathematics and its structure including relations network		√	
Be able to advance and develop their intellectual curiosity		√	
Comprehend the historical development of mathematics and its role and value in the development of human thought, the importance of its use in other fields		√	
Improve their systematic, careful, patient and responsible characteristics		√	
Improve the power of doing research, producing and using knowledge		√	
Establish the relationship between mathematics and art, to develop aesthetic feelings		√	

Reference: MoNE (2005, p. 12, 2011, p. 4)

The classification of four objectives in the 2013 curriculum is presented in Table 2. As given in from Table 2, three out of four objective statements refer to the *cognitive* domain and one of them refers to the *affective* domain, whereas none of them in the *psychomotor* domain.

Table 2.
Classification of General Objectives in the 2013 Curriculum Based on Bloom's Taxonomy (Bloom et al., 1956)

Using the 2013 mathematics curriculum, students will we able to	Cognitive	Affective	Psychomotor
Improve their problem-solving skills	√		
Gain mathematical thinking skills	√		
Use the unique language and terminology of mathematics correctly and effectively	√		
Value mathematics and mathematics learning		√	

Reference: MoNE (2013, p. I)

Table 3.

Classification of General Objectives in the 2018 Curriculum Based on Bloom's Taxonomy (Bloom et al., 1956)

Using the 2018 mathematics curriculum, students will we able to	Cognitive	Affective	Psychomotor
Develop problem-solving skills by considering problems from different angles	√		
Gain mathematical thinking and application skills	√		
Using mathematics correctly, effectively and beneficially	√		
Value mathematics and learning mathematics		√	
Recognize the historical development process of mathematics, mathematicians contributing to the development of mathematics and their studies		√	
Develop a perspective on whether a problem they encounter in life is a problem for them and reach a certain level of knowledge	√		

Reference: MoNE (2018, p. 11)

The classification of six objectives in the 2018 curriculum is presented in Table 3. As can be seen from Table 3, four out of six objective statements refer to the *cognitive* domain and two refer to the *affective* domain, whereas none of them in the *psychomotor* domain. The 2005 and 2011 curriculums are the ones with the highest number of general objective statements while the 2013 curriculum has the least. While none of the curriculums expresses the general objective statements listed in items for the *psychomotor* domain, the most objective statements are for the *cognitive* domain in all curriculums. Although there are no objective statements for the *psychomotor* domain in the general objective statements listed in the curriculums, introduction sections of all curriculums mentioned and *psychomotor* skills along with other skills to be developed (MoNE, 2005, 2011, 2013, 2018). For example, 2013 curriculum stated *psychomotor* skills such as "drawing graphics in accordance with the original", "using geometric tools (compass, ruler, etc.) in basic geometric drawings", and "using information and communication technologies" (MoNE, 2013, p. X).

Comparison of Curriculum Contents

The learning domains in the curriculums and the number of targeted learning objectives for these learning domains are presented in Table 4. Table 4 shows that the weight in the 9^{th}, 10^{th}, and 11^{th} grades of the 2005 and 2011 curriculums are given to the Algebra learning domain and the 12^{th} grade to the Basic Mathematics learning domain. However, considering that geometry and analytical geometry had a separate curriculum in these years, a great deal of emphasis was placed on geometry together with algebra. For example, the total number of learning objectives in the 2011 geometry and analytical geometry course curriculum were 200. In this program, geometry had 20 learning objectives in 9^{th}-grade, 44 in 10th-grade, and 38 in 11th-grade. With the extension of secondary education from three years to four years in the 2005-2006 academic year, the curriculum of Geometry-1 in the 10th-grade, Geometry-2 in the 11th-grade, Geometry-3 and Analytical Geometry Course (1-2) in the 12th-grade were started to be taught as separate courses (MoNE, 2010). As of the 2009-2010 academic year, new secondary education geometry curriculums were put into practice by making a difference in the approaches to geometry teaching (MoNE, 2010). The geometry curriculum has a vectorial approach to analytical geometry and “geometric proofs are based on synthetic, analytical, and vectorial approaches.” (MoNE, 2010, p. 8). Since the mathematics curriculums were compared in this study, the learning areas and learning objectives in these curriculums were not reflected in the table.

Table 4.
Learning Domains and the Number of Learning Objectives in the Curriculums

		Learning Domains										
Curriculum	Grade Level	Logic	Algebra	Trigonometry	Linear Algebra	Probability	Probability and Statistics	Fundamental Mathematics	Numbers and Algebra	Geometry	Data, Counting, and Probability	Total
2005	9	11	50	-	-	-	-	-	-	There is a separate curriculum.	-	61
	10	-	37	20	-	12	-	-	-		-	69
	11	-	31	-	15	-	-	-	-		-	46
	12	-	8	-	-	-	-	46	-		-	54
2011	9	10	48	-	-	-	-	-	-		-	58
	10 (4 hours a week)	-	30	19	-	-	-	-	-		-	49
	10 (2 hours a week)	-	17	13	-	-	-	-	-		-	30
	11 (4 hours a week)	-	28	-	14	-	15	-	-		-	57
	11 (2 hours a week)	-	17	-	6	-	10	-	-		-	33
	12 (4 hours a week)	-	5	-	-	-	-	34	-		-	39
	12 (2 hours a week)	-	3	-	-	-	-	25	-		-	28
2013	9	-	-	-	-	-	-	-	21	20	6	47
	10	-	-	-	-	-	-	-	17	18	9	44
	11 (advanced level)	-	-	-	-	-	-	-	31	7	-	38
	11 (basic level)	-	-	-	-	-	-	-	6	2	2	10
	12 (advanced level)	-	-	-	-	-	-	-	21	14	3	38
	12 (basic level)	-	-	-	-	-	-	-	2	5	-	7
2018	9	-	-	-	-	-	-	-	22	16	3	41
	10	-	-	-	-	-	-	-	15	4	8	27
	11	-	-	-	-	-	-	-	7	17	4	28
	11 (basic level)	-	-	-	-	-	-	-	9	6	-	15
	12	-	-	-	-	-	-	-	27	7	-	34
	12 (basic level)	-	-	-	-	-	-	-	2	2	1	5

Reference: MoNE (2005, 2011, 2013, 2018)

In the 2013 curriculum, 9th grade, 11th-grade advanced level, 11th-grade basic level, and 12th-grade advanced level focused on Numbers and Algebra, and 10th-grade and 12th-grade focused on Geometry. In the 2018 curriculum, at the 9th, 10th, 11th-grade basic level and 12th-grade levels, Numbers and Algebra, and 11th-grade Geometry learning domain stand out. In the 12th-grade, at the basic level, equal weight was given to Numbers and Algebra learning domain and Geometry learning domain.

Comparison of Learning-Teaching Processes of the Curriculums

The learning-teaching processes of the curriculums are examined in the context of instructional principles and teaching/learning strategies, methods, and techniques. Instructional principles considered in the curriculums are presented in Table 5.

Table 5.
Findings Regarding Instructional Principles Considered in the Curriculums

Instructional principles	2005	2011	2013	2018
Clarity	√	√	√	√
Meaningfulness	√	√	√	√
From simple to complex	√	√	√	√
Guaranteeing knowledge and skills	-	-	-	-
From the known to the unknown	√	√	√	√
Integrity	√	√	√	√
Economics	-	-	-	-
Active participation	√	√	√	√
Actuality	√	√	√	√
Appropriateness to the purpose	√	√	√	√
Student-appropriateness	√	√	√	√
Spirality	*	*	√	√
From concrete to abstract	√	√	√	√
Sociability	√	√	√	√
Transfer	√	√	√	√
Deduction	√	√	√	√
From close to remote	-	-	-	-
Proximity to life	√	√	√	√

Note: √ : Included * : Partly - : Not included
Reference: MoNE (2005, 2011, 2013, 2018)

As given in Table 5, instructional principles are generally taken into consideration. For example, in the 2013 curriculum, expressions regarding the use of many examples, multiple representations, different materials such as videos, books, and computer software and giving feedback to students can be evaluated within the scope of the principle of *clarity* (MoNE, 2013).

How to start the lesson in the learning-teaching processes arranged in a way to reach the goals is an important detail. For example, in the 2013 and 2018 curriculums, the statement “Lessons should start with the events and problems from daily-life, and there should be a need to learn some topics and concepts” expresses the requirements of the *meaningfulness* principle (MoNE, 2013, p. 53; MoNE, 2018, p. 43).

Reaching abstract concepts with the help of concrete objects is related to *from concrete to abstract* principle. For example, the sections that describe the approach of the 2005 and 2011 curriculums state that “With the conceptual approach adopted, it is aimed to help students create mathematical meanings and make abstractions from their concrete experiences and intuition" (MoNE, 2005, p. 11; MoNE, 2011, p. 4). This expression is also a clear sign of the principle of *concrete to abstract*.

The principle of *from simple to complex* can be observed in the order of the units and topics. For example, placing equation systems before inequality systems is just one example of this principle (MoNE, 2005, 2011, 2013, 2018). Similarly, the topics in all curriculums were prepared by adhering to the *deduction* principle. For example, explaining functions first, then exponential functions and then logarithmic functions (MoNE, 2005, 2011, 2013, 2018) are indications of sequencing subjects starting from general to specific.

In all curriculums, it was emphasized that the way students relate their newly learned knowledge with their prior knowledge will contribute to their mathematical understanding and achievement in the learning-teaching processes. This approach implies the importance of the principle *from the known to the unknown* (MoNE, 2005, 2011, 2013, 2018). While introducing the structure of the curriculum in 2018 along with *from the known to the unknown* principle, the expression "Thus, curriculums were prepared with an approach which leads to the use of metacognitive skills, promotes meaningful and permanent learning, linking what has previously learned, integrated with other disciplines and daily life around values, skills and competencies" is an indication of the principles of *transfer* and *proximity to life* (MoNE, 2018, p. 4). The relationship among various disciplines indicates the *transfer* principle, the relationship between new knowledge and daily life indicates *proximity to life* principle and integrating all these into values, skills, and competencies indicate *integrity* principle. The principles of *transfer*, *proximity to life*, and *integrity* are taken into consideration in 2005, 2011, and 2013 curriculums as well as in the 2018 curriculum (MoNE, 2005, 2011, 2013, 2018).

All curriculums state that developing students' *affective* and *psychomotor* skills as well as *cognitive* skills besides the integrity of meaningful relationships of mathematics (MoNE, 2005, 2011, 2013, 2018). For example, the 2011 curriculum aimed to develop students' "*cognitive, affective,* and *psychomotor skills*" and the aim of improving students in all aspects again points out the principle of *integrity* (MoNE, 2011, p. 7).

Emphasis was placed on the freedom dimension of the principle of *sociability* and obedience to authority in all curriculums (MoNE, 2005, 2011, 2013, 2018). For example, in the 2013 curriculum, the expression "…positive approaches such as cooperation and solidarity should be adopted and democratic learning environments should be created in which students can express themselves comfortably" indicates the freedom dimension of the principle of *sociability* (MoNE, 2013, p. III).

Democratic environments also require *active participation*. All curriculums since 2005 have adopted a student-centered approach in which the student is active in the learning-teaching process (MoNE, 2005, 2011, 2013, 2018). To ensure *effective* *participation*, content, learning-teaching processes, and assessment-evaluation approaches of the curriculums are structured according to the principle *student-appropriateness*. The curriculums state that the prior knowledge, developmental characteristics, individual differences, and readiness of students should be taken into consideration in the learning-teaching processes (MoNE, 2005, 2011, 2013, 2018).

All curriculums use the principle of *appropriateness to the purpose* and give information on how to organize the learning-teaching processes and what should be considered to achieve the goals and learning objectives (MoNE, 2005, 2011, 2013, 2018). For example, in the 2011 curriculum, the statement “Expressions of learning objectives are also the basis for structuring the learning-teaching processes” emphasizes that the process was shaped in line with the learning objectives and points out the principle of *appropriateness to the purpose* (MoNE, 2011, p. 21).

All curriculums stated that social changes and developments in information and communication technologies reshaped mathematics learning-teaching processes and changed assessment and evaluation approaches. Therefore, they use the principle of *actuality* (MoNE, 2005, 2011, 2013, 2018). Findings regarding whether teaching-learning strategies, methods, and techniques are included in all high school mathematics curriculums are presented in Table 6.

Table 6.
Findings Regarding Whether Concepts of Teaching/Learning Strategies, Methods and Techniques Are Included

Teaching/Learning Strategies, Methods, and Techniques		2005	2011	2013	2018
Teaching	Strategy	√	√	-	-
	Method	√	√	√	-
	Technique	√	-	-	-
Learning	Strategy	√	√	-	-
	Method	√	-	-	-
	Technique	√	-	-	-

Note: √ : Included - : Not included
Reference: MoNE (2005, 2011, 2013, 2018)

As given in Table 6, teaching strategies, methods, and techniques and learning strategies, methods, and techniques are included in the 2005 curriculum. In the 2013 curriculum, only the concept of teaching method was included, while none of these concepts was included in the 2018 curriculum. The 2005 curriculum’s section called “Notes on how to use the curriculum document” includes the statement “Instructional tasks in the classroom should use the teaching and learning methods, techniques and strategies considering students’ levels, learning environment, and environmental factors” (MoNE, 2005, p. 13). The 2011 curriculum’s section called “Learning and Teaching Process of Mathematics” states that some strategies should be taken into consideration to implement the curriculum effectively. One of the issues that should be taken into consideration while designing learning environments is stated as follows: “When choosing learning and teaching strategies, students’ prior knowledge, school resources, time allocated balto the topics in the curriculum should be taken into consideration" (MoNE, 2011, p. 19). Besides, the notion of teaching methods in the 2005 and 2011 curriculums is included in the "Basic Elements of the Curriculum" section. The former section stated that instead of memorizing the mathematical rules for the development of students' mathematical thinking skills, the teaching methods through which they will reach the rules by themselves should be used by teachers (MoNE, 2005, 2011). In the "Assessment and Evaluation" section, the notion of teaching method is included while explaining the objectives of assessment and evaluation. Apart from the summative purpose of assessment, the formative purpose is mentioned as determining the shortcomings of the teaching methods and revising them (MoNE, 2011). The 2013 curriculum stated that the curriculum did not dictate a specific teaching method (MoNE, 2013). None of these concepts were included in the 2018 curriculum (MoNE, 2018).

Comparison of Assessment and Evaluation Approaches of the Curriculums

Findings regarding whether the objectives of assessment and evaluation are explained in the curriculums are presented in Table 7.

Table 7.
Findings Related to the Objectives of Assessment and Evaluation

Objectives	2005	2011	2013	2018
Diagnostic: For identification purposes	√	√	-	-
Formative: For monitoring purposes	√	√	√	√
Summative: For decision purposes	√	√	√	√

Note: √ : Included - : Not included
Reference: MoNE (2005, 2011, 2013, 2018)

In the 2005 and 2011 curriculums, the objectives of assessment and evaluation are mentioned as assessing and evaluating the students' prior knowledge (namely *diagnostics*) monitoring and developing the acquired knowledge in the process, in other words *formative*, as well as *summative* evaluation in the context of grading (MoNE, 2005, 2011). For example, 2011 curriculum includes the following statement regarding the purposes of assessment and evaluation:

> "In this context, apart from grading, assessment and evaluation should be carried out with three purposes. The first one is for identification for the purpose of diagnosing prior knowledge, planning, grouping and guidance. The aim here is to determine whether the students have the necessary knowledge and skills to be successful in this course or not. The second is formative assessment and evaluation to monitor thinking and learning in the learning process. The aim here is to eliminate the deficiencies before moving on to a new subject or learning area. Finally, it is the diagnostic assessment and evaluation to diagnose the learning difficulties of the student." (MoNE, 2011, p. 57).

In the 2013 curriculum, a reference was made to formative and summative assessment with the statement "It is important to reveal the cognitive levels of the questions/tasks that will be used for both shaping and level determination in the learning-teaching process and which mental processes are measured in order to fully implement the assessment and evaluation approach of the curriculum" (MoNE, 2013, p. XII). Findings regarding which learning domains (Bloom et al., 1956) are included in the curriculum's assessment approach are presented in Table 8.

Table 8.
Findings Related to Assessment and Evaluation of Skill Types

Learning Domain	2005	2011	2013	2018
Cognitive	√	√	√	√
Affective	√	√	-	√
Psychomotor	√	√	-	√

Note: √ : Included - : Not included
Reference: Bloom et al., (1956); MoNE (2005, 2011, 2013, 2018)

As given in from Table 8, assessment and evaluation related to the *cognitive*, *affective*, and *psychomotor* domains are mentioned in the 2005, 2011, and 2018 curriculums. However, in the 2013 curriculum, only assessment and evaluation related to the *cognitive* domain is mentioned (MoNE, 2013). Forms to be used for monitoring students' *cognitive*, *affective*, and *psychomotor* skills are attached in 2005 and 2011 but not in 2013 and 2018 (MoNE, 2005, 2011, 2013, 2018). The 2018 curriculum emphasizes that *cognitive* measurements are not sufficient for the assessment and evaluation and that the *affective* and *psychomotor* skills should be measured. It states that "Education is given not only for" knowing (thinking)" but also for "feeling (emotion)" and "doing (action), therefore, merely cognitive measurements cannot be considered sufficient" (MoNE, 2018, p. 8). Findings related to assessment and evaluation tools and tasks in the curriculums are presented in Table 9.

The 2005 and 2011 curriculums present and explain a wide range of traditional and alternative assessment and evaluation tools and tasks. They also recommend using "Student portfolios" and "performance assessment" tasks (MoNE, 2005, p. 60; MoNE, 2011, p. 58). Besides, examples of which tools and tasks should be used for which learning domains are also presented. Although the names of assessment and evaluation tools and tasks are not included in the 2013 and 2018 curriculums, diversity in measurement and evaluation approaches has been emphasized, considering whether the academic success and development of students in mathematics can be measured with only one method or technique (MoNE, 2013, 2018). For example, 2011 curriculum includes the following statement:

> "Rather than an approach that only measures knowledge and results, applied during and at the end of the semester; it is important to exhibit an approach that requires intensive use of techniques that measure the process, considered as a part of learning, and that can measure skill while measuring knowledge" (MoNE, 2013, p. XII).

Table 9.
Findings Related to Assessment and Evaluation Tools and Tasks

Tools and Tasks	2005	2011	2013	2018
Peer assessment	√	√	-	-
Drill	√	√	-	-
Analytical assessment technique	√	√	-	-
Holistic assessment technique	√	√	-	-
Multiple-choice questions	√	√	-	-
Rubric	√	√	-	-
Experiment	√	√	-	-
Matching	√	√	-	-
Interview	√	√	-	-
Observation	√	√	-	-
Group assessment	√	√	-	-
Journal	√	√	-	-
Short answer questions	√	√	-	-
Quiz	√	√	-	-
Checklist	√	√	-	-
Homework	√	√	-	-
Problems posed by students	√	√	-	-
Teacher anecdotes	√	√	-	-
Scale	√	√	-	-
Self assessment	√	√	-	-
Performance assessment	√	√	-	-
Poster	√	√	-	-
Project	√	√	-	-
Exhibit	√	√	-	-
Oral exam	√	√	-	-
Presentation	√	√	-	-
Discussion	√	√	-	-
Performance report	√	√	-	-
Portfolio	√	√	-	-
Written exam	√	√	-	-

Note: √ : Included - : Not included
Reference: MoNE (2005, 2011, 2013, 2018)

Beyond all this, in the 2018 curriculum, mentions originality and creativity in academic standards assessment and evaluation tools and tasks.

> “No person is the same as another. For this reason, it is against human nature that curriculums and, accordingly, the assessment and evaluation processes are ‘suitable for everyone’, ‘valid for everyone and standard’. For this reason, it is essential to act with the understanding of maximum diversity and flexibility in the assessment and evaluation process. Curriculum is a guide in this respect. It cannot be considered as a realistic expectation to expect curriculums to include all the elements of assessment and evaluation. Since it is seriously affected by internal and external dynamics such as diversity in education; individual, education level, course content, social environment, school opportunities, etc. priority in ensuring the effectiveness of assessment and evaluation practices is expected from teachers and education practitioners, not from the curriculum. At this point, originality and creativity are the main expectations from teachers” (MoNE, 2018, p. 8).

Conclusion, Discussion and Recommendations

The findings of the study point out remarkable issues regarding the basic elements of high school mathematics curriculums under investigation. Although all curriculums aim to develop students in *cognitive*, *affective*, and *psychomotor* domains, statements of goals in the *cognitive* domain have weighted (Yazıcılar & Bümen, 2017; Uysal & İncikabı, 2018; Çiğdem, 2022; Doğanay & Yeşilpınar, 2018). In all curriculums, the purposes related to the development of the problem-solving skills of students are included in the purpose statements related to the *cognitive* domain. Various curriculums in other countries also aim at developing problem-solving skills (Australian Curriculum, Assessment and Reporting Authority [ACARA], 2017; Ministry of Education, Singapore [MoE], 2020; NCTM, 2000). In the context of the *affective* domain, 2005 and 2011 curriculums emphasize developing students' positive attitudes towards mathematics and 2013 and 2018 curriculums emphasize the importance of valuing mathematics and its' learning (MoNE, 2005, 2011, 2013, 2018). Since other elements of a curriculum are built primarily on objectives, it may be useful to write down the objectives for all domains. This expectation may be a good one in terms of curriculum *integrity*. Although the objectives for the *psychomotor* domain are not included in the items listed in general objectives of the curriculums, it is among the mathematical competencies and skills to provide students' development in the *psychomotor* and *affective* skills in 2005, 2011, and 2013 curriculums (MoNE, 2005, 2011, 2013). In the 2018 curriculum, there is no explicit statement regarding the development of *psychomotor* domain. However, the use of *psychomotor* skills such as compass and ruler was included in the expressions of the learning objectives of the 2018 curriculum (MoNE, 2018).

Along with general objectives, mathematical skills were included more in the 2005 and 2011 curriculums than in the 2013 curriculum and more in the 2013 curriculum than in the 2018 curriculum (MoNE, 2005, 2011, 2013, 2018). 2018 curriculum included all the sections in the Competencies Framework of Türkiye. One of them belongs to the skills in mathematics, knowledge, and technology. Remarkably, it may be worth discussing that the proving ability mentioned in 2005, 2011, and 2013 curriculums because proving is an important activity when doing mathematics (Almeida, 2001). Also, according to NCTM (2000), proof must be a part of students' mathematical experience starting from kindergarten to the end of their high school education. However, it is not included in the 2018 curriculum.

When the curriculum is examined in terms of the learning domains, some striking findings come to the fore. The most important one concerns statistics. Although this learning domain is included in the curriculums of many countries, it entered the Turkish mathematics curriculum in 2011. The Probability learning domain in the 2005 curriculum has been updated and it was named as the Probability and Statistics learning domain in the 2011 curriculum. Basic concepts related to statistics were included in the secondary school mathematics curriculum announced in 1998 for the first time in Türkiye (Akkoç & Yeşildere-İmre, 2015), but it was integrated into the high school curriculum in 2011 as the Statistics learning domain. Although statistics were included in the curriculum as a learning domain in 2011, it was not included in the 2013 and 2018 curriculums but was reflected in the learning objectives in the context of basic level mathematics courses (MoNE, 2005, 2011, 2013, 2018).

Another finding related to learning domains is that their number decreased to three in 2013 and 2018 curriculums: (a) Numbers and Algebra, (b) Geometry, (c) Data, Counting, and Probability. The geometry learning domain was considered as a separate course in the curriculums before 2013. Considering that the geometry is taught as a separate course, we have to mention that there is a significant decrease in the number of learning domains of the 2013 and 2018 curriculums. In addition, trigonometry, which is taught as a separate learning domain in 2005 and 2011 curriculums, was included in the geometry learning domain in 2013 and 2018 programs. Therefore, there has been a decrease in the number of topics and learning objectives related to trigonometry in 2013 and 2018 programs. Interestingly, the inverse trigonometric conversion formulas were removed from the program in 2013, while the conversion formulas were also removed from the program in 2018. Inverse conversion formulas have found its place in the 2011 curriculum with the learning objective of "Students will be able to convert the sum to product (conversion) and convert the product to the sum (inverse conversion)" (MoNE, 2011, p. 119). Deducing trigonometric conversion formulas was included in the 2013 curriculum and inverse conversion formulas would not be given. Since the conversion and inverse conversion formulas can be obtained from the sum and difference formulas by simple operations, these learning objectives are not at a conceptual knowledge level, rather procedural level (Hiebert & Lefevre, 1986; Star & Stylianides, 2013). The obstacle to conceptual learning in mathematics lessons can only be overcome by balancing these two types of knowledge (Star & Stylianides, 2013). With the 2005 reform, the structure of the secondary school mathematics curriculum was changed, and with the conceptual approach adopted, it was aimed to balance procedural knowledge with conceptual knowledge (MoNE, 2005). Balancing these two knowledge types and establishing a relationship between the two were clearly included in the objectives of the 2011 and 2013 curriculums, but no statement indicating these objectives was included in the 2018 curriculum. When the learning objectives related to trigonometry in the curriculums from 2005 to 2018 are examined, procedural knowledge is dominant. Therefore, extracting these learning objectives for the procedural knowledge of conversion and inverse conversion may have been beneficial in terms of balancing the conceptual and procedural knowledge. Logic is also another topic that was revised as a learning domain. As a sub-learning domain, it took place in the 11^{th} grade advanced mathematics course in the 2013 curriculum and the 9^{th} grade of the 2018 curriculum. Besides, while the proof and proving techniques are included in this sub-learning domain of the 2013 curriculum, in the 2018 curriculum being able to explain the concept of proof was seen as a sufficient achievement for students. Linear Algebra learning domain in the 2005 and 2011 curriculums and Matrix, Determinant, and

Linear Equation Systems subjects that constitute this domain were not included in the 2013 and 2018 curriculums. It may be beneficial to discuss the effects of excluding these subjects taught at the 11th grade from the curriculum in terms of students' high school and university education. Linear algebra has a different position than other subjects taught in high school mathematics courses in terms of its content (Aydın, 2009). In addition, learning linear algebra is not a prerequisite to learn the 12th grade topics. In other words, linear algebra taught in the 11th grade is not connected to other topics taught in the 9th, 10th, and 12th grades in terms of the *spirality* principle. However, when evaluated in terms of the principles of *transfer* and *proximity to life*, linear algebra contains higher level knowledge than the mathematical knowledge that high school students can use in other lessons and in daily life. Considering all these together, removing linear algebra will not pose a problem for students' high school mathematics education. When evaluated in terms of university education, it is necessary to consider the possible effects of encountering linear algebra for the first time at this education level. Subjects related to linear equation systems are taught in the courses such as Linear Algebra and Numerical Analysis in the Departments of Mathematics and Statistics of the Faculty of Arts and Sciences, the Faculty of Engineering and Faculties of Economics and Administrative Sciences. In addition, the solutions of these equations are also used in vocational courses. However, considering that teaching linear algebra is always difficult (Dorier, 2002), starting linear algebra at university may pose a problem for students. In fact, at which stage of mathematics education linear algebra teaching should begin has been a matter of debate in the literature for a long time (Day & Kalman, 1999). After analyzing the current situation in linear algebra lessons (Hu & Yang, 2020; Yan & Simin, 2020), these discussions could reach maturity with an increase in the number of studies on what to teach (Rensaa, Hogstad, & Monaghan, 2020) and how to teach (Stewart & Thomas, 2010; Yan & Simin, 2020).

Another finding obtained from the examination of the curriculums in terms of learning domains is that the *spirality* principle is taken into consideration in the 2013 and 2018 curriculums more than the 2005 and 2011 curriculums (Çiğdem, 2022). In the 2005 curriculum, the Logic learning domain is only in the 9th grade, the Probability learning domain is only in the 10th grade, the Linear Algebra learning domain is only in the 11th grade, and the Basic Mathematics learning domain is only in the 12th grade. Again, in the 2011 curriculum, the Logic learning domain is only in the 9th grade, the Trigonometry learning domain is in the 10th grade, the Linear Algebra and Probability and Statistics learning domains are only in the 11th grade, and Basic Mathematics learning domain is in the 12th grade only. The fact that the learning domains are located at only one grade level can be seen as a problem in terms of the *spirality* principle. It is important to include each learning domain at all grade levels in terms of the *spirality* principle because, topics are revisited, and new learning is related to previous learning so that the level of difficulty will decrease as students' competencies may increase (Harden & Stamper, 1999). In the 2013 and 2018 curriculums, numbers, algebra, and geometry learning domains were included at all grade levels. Data, counting and probability learning domain is included in all basic or advanced level mathematics courses. Following these results, the previous units of the 2013 curriculum were repeated in the next units ensuring spirality principle (Yazıcılar & Bümen, 2017). However, the finding concerning the continuity within the units of the 2011 curriculum in the same study does not partially match the findings of the current study in terms of learning domains. In the current curriculum, 9th grade ends with the data, counting, and probability learning domain, and it starts with this learning domain in the 10th grade. 10th grade ends with the geometry learning domain and 11th grade starts with this learning domain. However, while the 11th grade ends with the data, counting, and probability, the 12th grade begins with the numbers and algebra learning domain.

An important finding that draws attention to the learning domains is the sharp transitions. Modular arithmetic sub-learning domain of 2005, 2011, and 2013 curriculums was not included in the 2018 curriculum. Vectors sub-learning domain of the 2013 curriculum was not included in the 2018 curriculum. In other word, by integrating sub-learning domains or removing them completely, the number of learning domains decreased in the 2018 curriculum. In the 2013 curriculum, synthetic and analytical approaches were included in the solution of geometry problems, and the vector approach had been introduced (MoNE, 2013). However, the vectors sub-learning domain was removed from the curriculum without giving reasons in the next curriculum. Pedagogical reasons for the inclusion of subjects in the curriculums with sharp transitions or their removal may be a matter of curiosity. Curriculum developers may be recommended to include the reasons for the radical changes in the contents.

In all curriculums, the emphasis is on the algebra and geometry learning domains. Algebra needs to find an important place in school mathematics as it is the language of mathematics (Grønmo, 2018). Both the number of subjects and the time allocated to algebra in the programs are parallel to the weight given to the number of learning objectives. In 2005 and 2011 curriculums, while geometry was taught as a separate course, it had more learning objectives and more time was allocated to it. However, when it started to be taught as a learning domain in the 2013 and 2018 mathematics curriculums, its weight decreased. In the 2013 and 2018 curriculums, after the numbers and algebra learning domain, the weight is given to the geometry learning domain (MoNE, 2013, 2018). The minimum weight was given to the data, counting, and probability learning domain. Considering other countries' curriculums (ACARA, 2017; MoE, 2020; NCTM, 2000) and literature (Eichler & Zapata-Cardona, 2016; Usiskin, 2014), much attention should be paid to this learning domain.

When comparing the learning objectives of the curriculums (MoNE, 2005, 2011, 2013, 2018), the findings regarding their number are remarkable. In 2018 curriculums, the number of learning objectives of all curriculums decreased. This finding is also valid for other subjects such as geometry (Özşentürk-Balçın, 2021), science (Deveci, 2018), and physics (Bezen, Aykutlu, & Bayrak, 2020) curriculums. Combining or removing some learning domains, sub-learning domains or topics has led to a reduction in the number of learning objectives. Although their number has been reduced, higher-level *cognitive* skills have been targeted while preparing them in the updated 2018 curriculum. In the press conference document prepared by Board of Education and Discipline to reflect on the curriculum changes, despite the reduction in the number of learning objectives in all curriculums, the ones "that require the use of metacognitive skills" were included (MoNE, 2017, p. 11). In this direction, in the 2018 secondary school mathematics curriculum, it was emphasized that the renewed curricula were prepared in a way to encourage students to use metacognitive skills (MoNE, 2018). The learning objectives for low-level cognitive skills are intense in the 2018 secondary school mathematics curriculum (Çil et al., 2019). This is also true for 2018 primary school (Aktan, 2020), secondary school (Çelik et al., 2018), primary education (Kuzu, Çil, & Şimşek, 2019) mathematics curriculum. In the studies examining the achievements in the 2018 mathematics curriculum, it was emphasized that the learning objectives in the upper level cognitive level should be included more at all grade levels and in all learning domains (Aktan, 2020; Çelik et al., 2018; Çil et al.,, 2019; Kuzu et al., 2019). Also, reducing the number of learning objectives is a positive situation where teachers can better demonstrate their teaching skills (Diker-Coşkun, 2017). Achieving fewer but higher quality skills can reduce the intensity as well as contribute to students' mathematics learning. On the other hand, future studies could question whether the decrease in learning objectives would make a contribution in this direction.

The explanations about the learning-teaching processes are mostly mentioned in the 2005 and 2011 curriculums and the least in the 2018 curriculum (MoNE, 2005, 2011, 2013, 2018). In order for curriculum development efforts to be successful in practice, they should be adopted by teachers and supported by appropriate materials (Genç, 2007). The results of Akyıldız's (2016) study show that as the level of adopting and applying the curriculum of the novice teachers increases, they adopt the constructivist approach more, and as the decreases, they tend to traditional understanding. Ergün and Özdaş (1997) emphasized that teaching principles and methods demonstrate how to apply the curriculums developed. Especially considering the seniority levels of the teachers, the faculties they graduated from, and their educational background, it may be useful to include such information in the curriculums. According to teachers, one of the important teaching qualities is the use of different teaching strategies and methods (Bozkuş & Taştan, 2016). Because the modern teaching strategies, methods, and techniques have recently become a part of preservice teacher education, teachers who are new in the profession use more variety of techniques (Okur-Akçay, Akçay, & Kurt, 2016). According to the results of meta-analysis of studies examining the contemporary teaching approaches, they have a significant effect on mathematics achievement (Şad, Kış, & Demir, 2017). But, as the teachers become more experienced, they prefer direct teaching method (Okur-Akçay et al., 2016). In the current curriculum, how to design learning environments, which teaching materials to use, teacher and student roles in the learning-teaching processes are not included, and the current curriculum has been simplified. We think that how the learning-teaching processes would lead to the learning objectives, how to organize learning environments, and kind of activities to be included in the curriculum are weak aspects of the curriculums under investigation. "How detailed the curriculum depends on the level of curriculum control. In some countries, the curriculum document is just a (loose) framework within which different authorities develop their curriculum" (Wong, Zhang, & Li, 2014, p. 614). Because there is limited information about the above issues, teachers might feel restricted. However, preparing them in a rich framework and according to the preference of teachers can eliminate this anxiety as well as eliminate the deficiencies of the curriculums. When learning-teaching processes are examined in terms of teaching principles, teaching principles are generally taken into consideration during the preparation of the curriculum. However, starting the 9th grade with logic is contrast with *the known to unknown* principle and *from simple to complex* principle and this issue received criticism (Yazıcılar & Bümen, 2017). However, principles of *clarity, meaningfulness, from simple to complex, from the known to unknown, integrity, actuality, appropriateness to the purpose, student-appropriateness, from concrete to abstract, sociability, transfer, deduction* and *proximity to life* (Aggarwal, 2014; Baki, 2015; Ergün & Özdaş, 1997; Harden & Stamper, 1999; Köksal & Atalay, 2017; Sözer, 2000; Sünbül, 2011; Taşkaya & Gül, 2020; Wu et al., 2017) are considered in high school mathematics curriculums. The principles of *simple to complex*, *from concrete to abstract, deductive, and from known to unknown* have a special importance for mathematics education.

With the 2005 reform, assessment and evaluation approaches have gained a different meaning than they are for evaluating not only the product but also the process. In the current curriculum, which learning types are measured with which tools are not mentioned. The 2018 curriculum stated that the curriculum can guide the assessment and evaluation, but it emphasized that it is not possible to include all elements of assessment and evaluation approaches (MoNE, 2018). In addition, in the current curriculum emphasis is placed on maximum diversity and flexibility in academic standards in assessment and evaluation (MoNE, 2018). Teachers have a traditional evaluation approach to measure merely knowledge, as they remain hesitant about adopting this element of the curriculum due to their lack of knowledge about assessment and evaluation (Tuncel & Kazu, 2019). Teachers prefer traditional methods because they find themselves more sufficient in measuring student success (Gelbal & Kelecioğlu, 2007). Also, teachers' lack of knowledge about preparing, applying, and using assessment and evaluation tools can lead to time constraints (Karakuş & Mengi-Us, 2014). In addition, the branch and seniority levels of teachers also affect their approach to alternative assessment and evaluation tools (Büyüktokatlı & Bayraktar, 2014). In addition to all these, teachers' education levels and professional seniority also affect their self-efficacy for assessment and evaluation

(Kılıç, 2020). One of the reasons for the lack of knowledge of teachers about the purposes and methods of assessment and evaluation may be that the curriculums do not provide enough information. While preparing the curriculums, teachers' seniority, educational level, and assessment and evaluation approaches can be taken into consideration. It may be useful to include examples of alternative assessment and evaluation tools that will measure different learning domains in the curriculums. For teachers to adopt, apply, and eliminate these approaches included in the curriculums, teachers should be provided with in-service training support after curriculum changes (Karakuş, 2010). In addition, the opinions of teachers about these four basic components of the curriculum, to what extent they reflect these basic elements to the teaching processes as expressed in the curriculum, and the factors affecting them in this process can also be investigated. Multiple-choice high-stakes exams have an effect on teachers' inability to apply all dimensions of the curriculum (Çetin & Ünsal, 2019). Teachers determine exam-oriented content, exam-oriented methods and techniques such as lecturing, and they prefer multiple-choice exams (Çetin & Ünsal, 2019). At this point, the basic elements of the curriculum should be compatible with the structure of central high-stakes exams.

To limit the scope of this study, the curriculums were compared only in terms of their basic elements (general objectives, content, learning-teaching processes, and assessment and evaluation approaches). Future studies can compare different aspects of curriculums other than their basic elements. For example, in a similar way, Özmantar and Öztürk (2016) compared primary school mathematics curriculums and Özmantar et al. (2018) compared secondary school mathematics curriculums, further studies can compare curriculums in terms of different learning domains in a historical context. This research examined and compared only the high school mathematics curriculums since the 2005 reform. This is a limitation of this study. For future research studies, it can be suggested to evaluate and compare earlier mathematics curriculums before 2005. Also, researchers in other disciplines may be advised to carry out similar studies.

Research and Publication Ethics Statement

It was stated in the letter of Kırklareli University Scientific Research and Publication Ethics Board dated 20 July 2020 and numbered 35523585-199-E.10576 that it this study did not contain any ethical violations. The authors declare that ethical principles and rules were followed in all processes of this research. Both authors made contributions equally to all processes of the research. Also, both authors hereby declare that there is no conflict of interest.

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Genişletilmiş Özet

Öğrenme-öğretme süreçlerini içeren öğretim faaliyetlerinin detaylı bir biçimde planlanması öğretim programlarını oluşturmaktadır (Baki, 2015; Su, 2012). Dinamik yapıya sahip olan öğretim programları (Diker-Coşkun, 2017; Oliver vd., 2008) ilerleyen bilimin ışığında, dönemin, bireyin ve toplumun farklılaşan gereksinim ve ihtiyaçlarına cevap verecek şekilde güncellenmekte ve yenilenmektedir (Millî Eğitim Bakanlığı [MEB], 2017). 2004-2005 yılları arasında Türkiye'de eğitim reformu adı altındaki çalışmalarla öğretim programları güncellenmeye başlamıştır (Akınoğlu, 2005). Bu güncelleme ve yenileme çalışmaları MEB'in değişen eğitim felsefesi paralelinde 2005 yılında bir reforma dönüşmüştür (MEB, 2017). Bu reformla öğretim programlarının odak, hedef ve içeriklerinde değişim amaçlanmış olmakla birlikte öğrenci merkezli ve yapılandırmacı bir yaklaşım benimsenmiştir (Bulut, 2007). Ölçme-değerlendirme yaklaşımlarında da sonuç odaklı yaklaşım yerine süreç odaklı yaklaşıma geçilmiştir (Ünal & Ünal, 2010). 2005 yılındaki reform hareketinden sonra ortaöğretim matematik dersi öğretim programları 2005, 2011 (2005 programı revize edilmiş), 2013 ve 2018 yıllarında güncellenmiştir.

Alan yazında öğretim programlarıyla ilgili ülkemiz dışındaki farklı ülkelerin ortaöğretim matematik dersi öğretim programlarının karşılaştırıldığı çalışmaların (Ibrahim & Othman, 2010; Karuku & Tennant, 2016; Meleta & Zhang, 2017; Ssebaggala, 2017) yanı sıra ülkemizdeki ortaöğretim matematik dersi öğretim programlarının farklı ülke programlarıyla karşılaştırıldığı çalışmalar (Güzel, Karataş & Çetinkaya, 2010; Öztürk & Diker-Coşkun, 2022) da mevcuttur. Bunların dışında ülkemizdeki güncel ve daha eski ortaöğretim matematik dersi (Çiğdem, 2022; Yazıcılar & Bümen, 2017) öğretim programlarının karşılaştırıldığı çalışmalara da rastlanmaktadır. Ortaöğretimde matematik dersinin önemi göz önüne alındığında, alan yazında ortaöğretim matematik dersi öğretim programları ile ilgili daha fazla çalışmanın yapılması gerekliliği açıktır.

Bu araştırmada 2005 reformundan günümüze Türkiye'deki ortaöğretim matematik dersi öğretim programlarının (MEB, 2005, 2011, 2013, 2018) genel amaçlarının, içeriklerinin, öğrenme-öğretme süreçlerinin ve ölçme-değerlendirme yaklaşımlarının nasıl değişim gösterdiğinin karşılaştırmalı olarak incelenmesi amaçlanmıştır.

Program değerlendirme mevcut bir programın uygunluğu, verimliliği ve başarısı gibi etmenler hakkında bilimsel yöntemlerle karar verme sürecidir (Hamilton, 1977; Uşun, 2012). Alan yazında farklı program değerlendirme yaklaşımları (Bennett, 1979; Kirkpatrick, 1983; Stake, 1975; Tyler, 1949) mevcuttur. Alan yazındaki yaklaşımlardan biri de Bloom'un programın öğelerine dayalı değerlendirme modelidir. Öğretim programlarının temel öğeleri amaç, içerik, öğrenme-öğretme süreci ve ölçme-değerlendirmedir (Ghonoodi & Salimi, 2011; Gürkan, 2000; Moss, 2019; Özyurt & Kuşdemir-Kayıran, 2018; Sünbül, 2011; Uşun, 2012). Programın öğelerine dayalı öğrenme modelinde program bu öğelerin her biri için ayrı ayrı değerlendirilir. Bu çalışmada öğretim programları, programın temel öğeleri bağlamında değerlendirilmiş ve programlar karşılaştırılırken Özmantar, Akkoç, Kuşdemir-Kayıran ve Özyurt'un (2018) editörlüğünü yaptığı "Ortaokul matematik öğretim programları: Tarihsel bir inceleme" adlı kitap referans alınmıştır. Programların amaçları karşılaştırılırken bu kitabın üçüncü bölümü (Doğanay & Yeşilpınar, 2018), öğrenme-öğretme süreçleri karşılaştırılırken dördüncü (Şeker, 2018) ve beşinci bölümleri (Kömleksiz & Gökmenoğlu, 2018), ölçme-değerlendirme yaklaşımları karşılaştırılırken de on ikinci bölümü (Akbaş, Gürkan & Büyüköztürk, 2018) çerçeve olarak alınmıştır.

Bu araştırma nitel araştırma modellerinden karşılaştırmalı durum araştırmasıdır. Karşılaştırmalı durum çalışmaları eğitim de dâhil olmak üzere sosyal araştırma alanları için etkili bir nitel araçtır (Bartlett & Vavrus, 2017; Vavrus & Bartlett, 2009). Bu nitel araştırmada karşılaştırmalı eğitim yaklaşımlarından biri olan yatay yaklaşım benimsenmiştir (Bartlett & Vavrus, 2017; Ültanır, 2000; Vavrus & Bartlett, 2009). Yatay yaklaşımda ulusların öğretim programlarının temel öğeleri ayrı ayrı ele alınarak incelenir (Vavrus & Bartlett, 2009; Yıldırım & Türkoğlu, 2018).

Bu araştırmanın veri toplama araçları 2005, 2011, 2013 ve 2018 yıllarında yenilenen öğretim programlarıdır (MEB, 2005, 2011, 2013, 2018). Bu dokümanlardan elde edilen veriler, doküman analizi ile analiz edilmiştir (Bowen, 2009; Forster, 1995; Yıldırım & Şimşek, 2016). Veriyi analiz etme aşamasında çalışmanın kuramsal çerçevesi doğrultusunda programların temel öğeleri ayrı ayrı ele alınıp karşılaştırmalı olarak analiz edilmiştir.

Araştırmanın bulguları, incelenen ortaöğretim matematik dersi öğretim programlarının temel öğelerine ilişkin dikkat çekici hususlara işaret etmektedir. Tüm öğretim programları öğrencileri *bilişsel*, *duyuşsal* ve *psikomotor* alanlarda (Bloom, Englehart, Furst, Hill & Krathwohl, 1956; Harrow, 1972; Krathwohl, Bloom & Masia, 1964; Simpson, 1966) geliştirmeyi amaçlasa da programların genel amaçlar kısmındaki listelenmiş amaç ifadelerinde *psikomotor* alana yönelik amaç ifadesine rastlanmazken *bilişsel* alandaki amaç ifadeleri ağırlık kazanmıştır (MEB, 2005, 2011, 2013, 2018). Bu sonuçlar alan yazındaki çalışmaların sonuçlarıyla uyumludur (Çiğdem, 2022; Doğanay & Yeşilpınar, 2018; Uysal & İncikabı, 2018; Yazıcılar & Bümen, 2017).

2013 ve 2018 öğretim programlarındaki öğrenme alanı sayısı üçe indirilmiş ve sayıca en fazla kazanım sayılar ve cebir öğrenme alanına, en az kazanım veri, sayma ve olasılık öğrenme alanına ayrılmıştır (MEB, 2013, 2018). Kazanım sayıları incelendiğinde mevcut programdaki kazanım sayısında diğer programlara göre sayıca azalmaya gidilmiştir (MEB, 2018). Talim ve Terbiye Kurulu Başkanlığı'nın öğretim programlarında yapılan değişiklikleri yansıtmak için hazırladığı basın toplantısı dokümanında tüm öğretim programlarında kazanım sayılarının azaltılmasına rağmen "üst bilişsel becerilerin kullanılmasını gerektiren" kazanımlara yer verildiği ifade edilmiştir (MEB, 2017, s. 11). Bazı öğrenme alanlarının, alt öğrenme alanlarının veya konuların birleştirilmesi veya çıkarılması, kazanım sayısında azalmaya yol açmıştır. Öğretim programlarının içeriklerine eklemeler yapılması ya da bazı içeriklerin kaldırılması noktasında yapılan radikal değişikliklerin altında yatan pedagojik nedenler merak konusu olabilir. Öğretim programı geliştiricilere içeriklerdeki bu değişikliklerin nedenlerine yer vermeleri önerilmiştir.

Öğrenme-öğretme süreçlerine ilişkin açıklamalara en çok 2005 ve 2011 programlarında, en az ise 2018 programında yer verilmiştir (MEB, 2005, 2011, 2013, 2018). Öğrenme-öğretme süreci; öğretim ilkeleri açısından incelendiğinde genel olarak öğretim ilkelerinin programın hazırlanması esnasında göz önüne alındığı söylenebilir. Ancak mevcut programda 9. sınıfa mantık konusuyla başlamanın bilinenden bilinmeyene ilkesi ile basitten karmaşığa ilkesinin bu sınıf seviyesi için göz ardı edildiğiyle ilgili eleştiriye (Yazıcılar & Bümen, 2017) sebep olmuştur. Ancak ortaöğretim matematik programlarında genel olarak açıklık, anlamlılık, basitten karmaşığa, bilinenden bilinmeyene, bütünlük, güncellik, hedefe görelik, öğrenciye görelik, somuttan soyuta, sosyallik, transfer, tümdengelim ve yaşama yakınlık ilkelerinin göz önüne alındığı görülmektedir (MEB, 2005, 2011, 2013, 2018).

Tüm öğretim programlarında sürece odaklanan ölçme ve değerlendirme yaklaşımlarına yer verilmiştir (MEB, 2005, 2011, 2013, 2018). 2005 ve 2011 öğretim programlarında çok çeşitli *geleneksel* ve *alternatif* ölçme-değerlendirme araç ve görevleri tanıtılıp nasıl uygulanması gerektiği hakkında bilgilere yer verilmiştir (MEB, 2005, 2011). 2013 ve 2018 öğretim programlarında bunlara yer verilmemiştir (MEB, 2013, 2018). 2018 öğretim programında öğretim programının ölçme ve değerlendirmeye yön verebileceği belirtilmiş ancak ölçme ve değerlendirme yaklaşımlarının tüm unsurlarına yer verilmesinin mümkün olmadığı vurgulanmıştır (MEB, 2018). Ancak tüm bunların da ötesinde 2018 öğretim programında "ölçme ve değerlendirme sürecinin 'herkese uygun', 'herkes için geçerli ve standart olması' insanın doğasına terstir" ifadesine yer verilerek ölçme ve değerlendirme araç ve görevlerinde akademik standartlarda "azami çeşitlilik ve esneklik" vurgusu yapılmıştır (MEB, 2018, s. 8).